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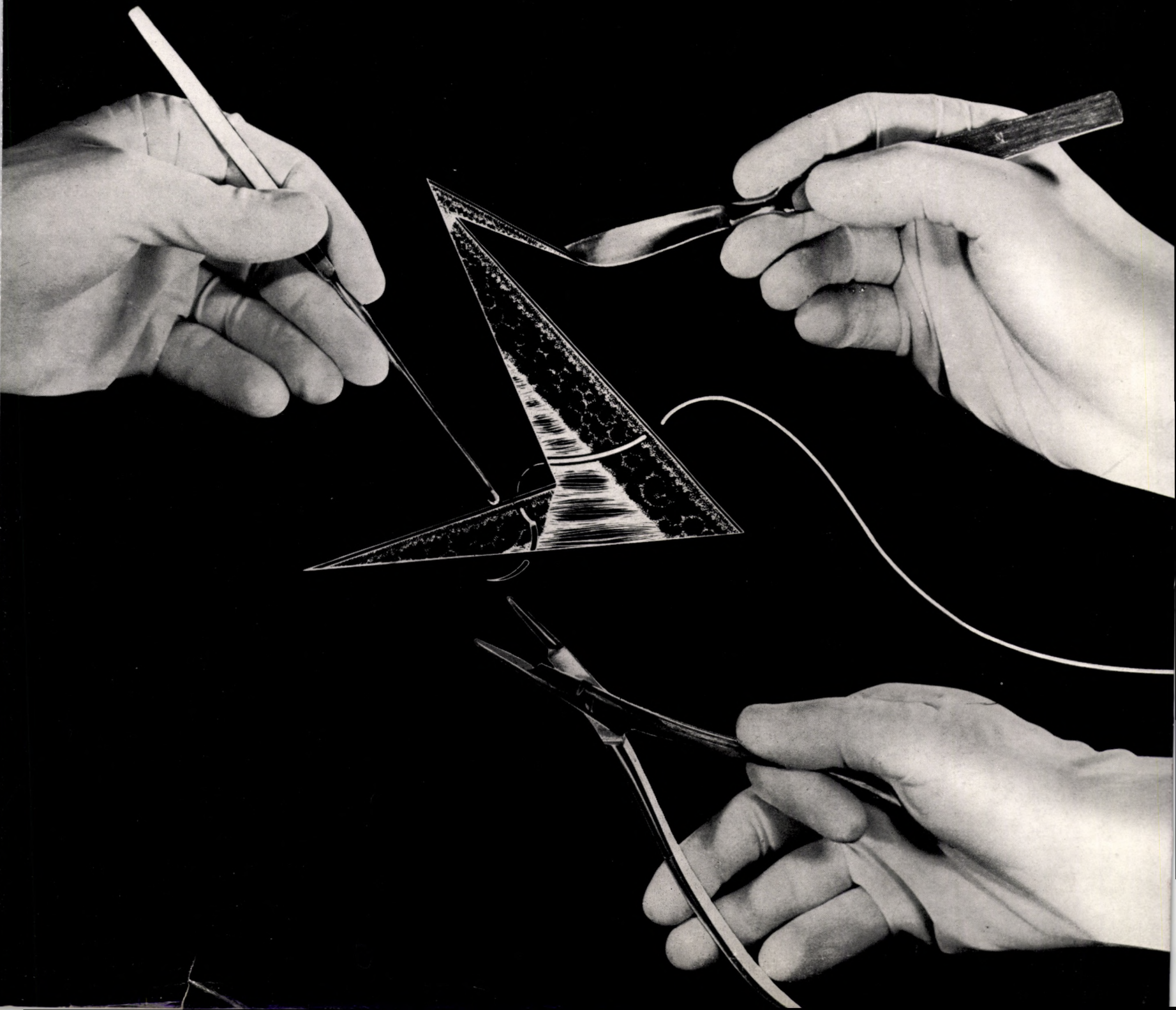
Techniques for Ideal Wound Healing

by **János Zoltán**

English-language edition
edited by **E. F. Shaw Wilgis**
Frederik Hansen
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By Professor János Zoltán, M.D.,
D.Sc., F.I.C.S.

English-language edition edited by
E. F. Shaw Wilgis, M.D., F.A.C.S.
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The techniques and concepts depicted
in this volume provide expert,
step-by-step instruction in the surgical
procedures necessary for the optimal
healing of skin wounds in terms of both
cosmetic appearance and restoration
of function.
Professor Zoltán's method of presentation
relies heavily upon painstaking attention
to detail, using clinical photographs
and complementary drawings to illustrate
fully and with unparallelled clarity each
step of every procedure. The accompanying
written explanations of the illustrations
are comprehensive yet refreshingly
uncluttered, incisive, and straightforward.
This is by no means a "how to" manual
for the unskilled, but it is unquestionably
the most authoritative professional treatise
available for every surgeon who deals
with ordinary or unusual problems of skin
wound repair. In their Foreword to this
English-language edition the American
editors state: "The practicing surgeon . . .
will encounter few problems which cannot
be solved using the principles and
techniques outlined."
For serious students of surgery, and their
teachers, this work is the premier text
in its field, concentrating on fundamental
principles to introduce the concept
of atraumatic tissue handling and to
demonstrate how skin and subcutaneous
tissue can be used and shifted to give
the least possible scar.
Professor János Zoltán has achieved
widespread international recognition
as a distinguished teacher and practitioner
and for his many contributions to
the advancement of plastic surgery, skin
grafting, transplantation surgery, and other
specialized surgical techniques. He is
the author of 98 scientific publications,
including 14 major texts.
In addition to the present English edition,
Cicatrix Optima has appeared in Hungarian
and Russian, and will be published
in German and Greek as well.
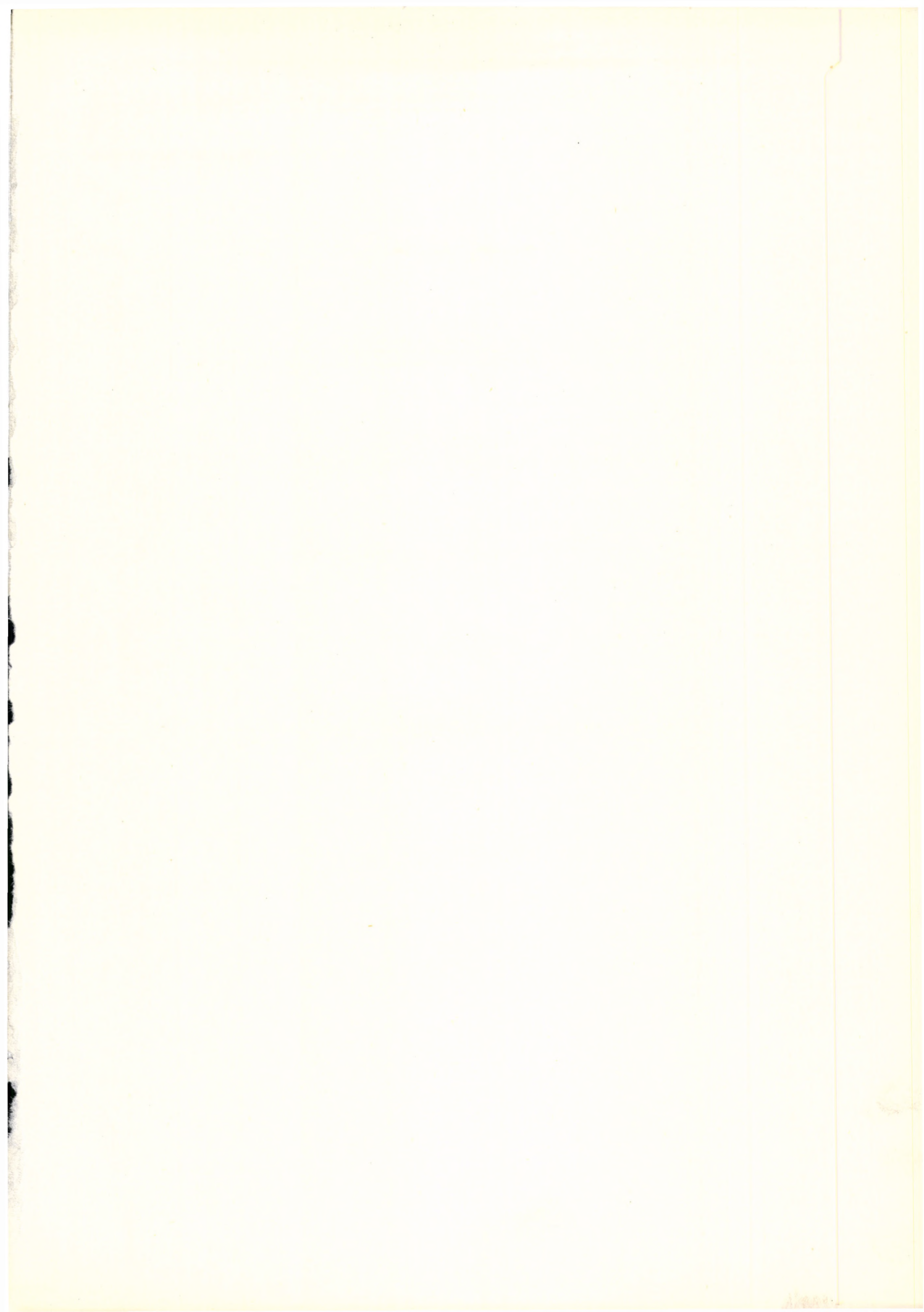
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Techniques for Ideal Wound Healing

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Foreword
to the English Edition

It has been a stimulating and rewarding experience to aid the publication of Dr. Zoltán's manuscript. Our role in the editing and revision of the English-language edition of CICATRIX OPTIMA has been a minor one, as this is first and foremost Dr. Zoltán's work.

When first presented with this material we were struck with the artistic arrangement of the drawings and photographs and thought they alone would make a fine publication. The pictorial representation of the techniques of preparing and handling tissues is self explanatory.

Our role has been to condense Dr. Zoltán's thoughts into a concise English text to complement the photographic plates. Naturally, whenever more than one surgeon is involved, there will be minor differences of opinion. We have attempted to present the material as Dr. Zoltán wishes with minor corrections to allow for differences in supply of suture material, dressing material, and instruments which exist from country to country. We found no serious differences in techniques and philosophy except that in certain instances the practice in this country will differ. These differences are mainly traditional ones.

We sincerely believe that this book can be a useful reference for student, practitioner, and teacher alike.

To the student it introduces the concept of atraumatic tissue handling. It also shows how skin and subcutaneous tissue can be used and shifted to give the best possible scar.

The practicing surgeon will find it useful as a handy problem solver. One will encounter few problems which cannot be solved using the principles and techniques outlined.

The teacher will find it a refreshing interlude to the sometimes esoteric and complicated situations one encounters in academic life. The value of retreating to basic principles can never be overestimated.

In essence, we have enjoyed this experience in international cooperation. We thank Dr. Zoltán for the opportunity of working with his manuscript. The publication of this work will serve as a tribute to Dr. Zoltán's lifetime vocation.

EFSW
FH
BM

Publisher's Preface
to the English Edition

Only very occasionally does a medical publisher have the good fortune to participate in bringing a truly unique work such as CICATRIX OPTIMA to the attention of clinicians and investigators. With its unparalleled pictorial depictions it represents a major contribution toward the advancement of surgical wound healing techniques.

When these extraordinary photographs first reached us from Akadémiai Kiadó, the Publishing House of the Hungarian Academy of Sciences, in 1972, Drs. Wilgis, Hansen, and McGibbon graciously accepted our invitation to assist in revising and editing Dr. Zoltán's original manuscript. They have made every effort to avoid encumbering these superb illustrations with unneeded text, carefully heeding the adage that a picture is worth a thousand words.

During the years that this edition has been in preparation we have enjoyed a friendly and stimulating association with the Editorial Staff of Akadémiai Kiadó. Thus it now gives us pleasure to express our appreciation for their steadfast cooperation in the successful completion of this significant publishing project.

Surgery is an international art to which CICATRIX OPTIMA will make a major contribution. We are therefore proud to make this invaluable volume available to surgeons, teachers, and students.

UNIVERSITY PARK PRESS
Baltimore, Maryland
U.S.A.

Acknowledgments

Preface to the Russian Edition

Between 1949 and 1951 Dr. J. Zoltán was active at the Third Department of Surgery of Budapest Medical University, then under my directorship. I remember him as a talented research worker showing an intellectual approach to our profession.

Professor Zoltán, a renowned surgeon today, already has a successful career as plastic surgeon behind him. His immense clinical experience is evident from the present useful and interesting book which will, no doubt, be a welcome addition to the libraries of Soviet surgeons active in different fields.

Questions related to the primary healing of wounds of different origin are highlighted and factors enhancing ideal wound healing both as regards cosmetic results and restoration of function are described. In addition, methods of primary skin replacement in different regions of the body, amongst others in individuals susceptible to keloid formation, are outlined.

The author also deals with instrumentation and technical details, several of which are his own innovations. The most suitable methods of anesthesia and hemostasis are presented, as the choice of these may have an important role in the success of the operation.

The illustrations, which faithfully convey the author's ideas and appeal to the visual memory of the reader, make the book even more valuable.

We welcome the publication of this work in Russian and are sure that it will be of great interest to surgeons in our country.

<div align="right">

B. V. PETROVSKI
Member of the Academy of Sciences
of the USSR

</div>

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Introduction

The manner in which the skin and subcutaneous connective and adipose tissue heal is essentially determined by the minute details of surgical technique. Uneventful healing of skin wounds following surgical intervention restricted to the body surface is of prime importance. Functionally harmful and cosmetically undesirable cicatrization signifies the virtual failure of the operation. The healing of skin wounds is equally important following operations affecting the supporting structures and locomotor organs because any complication (dehiscence, necrosis, suppuration) may have an adverse effect on the ultimate viability of the deeper structures that were the subject of surgical management. It is commonly known that in cases of open wounds, the fate of fractured bones, opened joints, severed tendons, and nerves depends on the healing of the skin wound. If healing is uneventful, any corrective intervention necessitated by the imperfect union of a deeper structure can be eventually carried out so as to restore the patient's freedom of movement and working capacity. However, infections caused by defective healing of the skin may damage irreversibly the affected deeper structures. In addition to prolonging hospitalization, this condition may give rise to undesirable occurrences such as suppuration or dehiscence. These frequently cause serious secondary complications or make reoperation (i.e. hernia) necessary. Cicatrix remaining after wound healing represents a serious problem even if the surgically treated organ is situated in a deep layer. There is an increasing tendency to admit that patients are justified when complaining of bulky, itching, and uneven scars chafed by their clothes, or if cicatrices are so ugly as to embarrass them, leading to inhibition and thereby disturbing their relationships with other people. Distorting scars and, in particular, functionally undesirable cicatrices may be the cause of psychological disturbances that, being of somatic origin, can be remedied only by surgical correction.

It is odd that the different physiological factors influencing wound healing such as the blood count, level of serum protein, protein fraction, metabolism, hormonal action, level of vitamins, etc., are better known than the local conditions created or influenced by surgical techniques. Usually, some individual predisposition is blamed for cicatrization although undesirable cicatrices are much more frequently the result of faulty surgical technique. Susceptibility to keloidosis is also referred to more often than seems justifiable.

Disturbances of healing, suppuration in particular, can be best prevented by aseptic and tissue-sparing surgery; the use of antibiotics does not make these precautions superfluous. Atraumatic management of the tissues is as important for the prevention of infections as the totality of aseptic measures. The principle of atraumatism applies to all surgical activities and to all tissues affected by them. Because it also represents a psychological safeguard, it has more than purely local significance: by avoiding unfavorable effects on the central nervous system, atraumatic management contributes to problem-free wound healing.

Introduction

The human body is a complete unit and has to be treated as such. Of course, the management of the deep structure, the "target" organ, is the essential part of the intervention, but every tissue through which this target organ is approached must be regarded as an integral factor in the whole operation. Provided that the patient's physiological functions are normal, the course of wound healing and also the quantity and quality of the cicatricial tissue are governed by the following factors of surgical technique.

LINE AND MANNER OF INCISION. The manner in which an incision is made may prove to be decisively important irrespective of the structure to which it opens a path, and irrespective of what is happening to it.

MANAGEMENT OF EXPOSED TISSUES. The problem of atraumatic treatment of tissues is closely related to the line and manner of incision; coarse and very strong hooks do not need to be applied if the exposure is long enough and runs in the correct direction.

HEMOSTASIS. Trouble-free healing is seriously endangered by early or delayed postoperative hemorrhage. It should be prevented by an appropriate method of hemostasis; but if the necessity arises, effective drainage measures must be implemented.

CLOSURE OF WOUNDS. The process of suturing is of major importance; the technique adopted and the instruments and materials employed considerably influence wound healing.

DRESSING AND IMMOBILIZATION. These protect the operated area and the line of suture and also ensure rest, a fundamental requirement of uneventful healing. These are, therefore, integral parts of the operation and should be planned carefully and performed with utmost precision.

CHANGE OF DRESSING; REMOVAL OF SUTURE. Dressing and suture should be removed at a time determined by the degree of healing and should be carried out so as not to traumatize the line of suture. If this precaution is disregarded, complications may ensue, even at an advanced stage of healing.

REPLACEMENT OF SKIN DEFECTS. It is a fundamental principle of current surgical practice that, except in cases of threatening anaerobic infection, skin defects must be covered, no matter whether of traumatic or surgical origin. It is essential, therefore, that all surgeons should be familiar with methods of primary skin replacement.

This book presents observations that will help surgeons to achieve smooth wound healing and to obtain functionally and cosmetically favorable results. I sincerely hope that it will appeal both to experienced surgeons and to those at the beginning of a career in surgery as well as to specialists of related branches of surgery, because it deals with problems and procedures concerning the human body as a whole.

The arrangement of the book was dictated by the present tempo of life, all concepts being expressed by way of illustration so that the accompanying text complements and supplements the illustrations rather than vice versa. Accordingly, every group of special surgical procedures is illustrated by photographs and drawings planned to make a lasting impression on the minds of surgeons, thus enabling them to "copy" the pictures onto the human body by means of their scalpels.

Poor Scars Resulting from Poor Incisions

The degree of scar in a wound depends to a great extent on the direction of the wound in relation to the body region and underlying structures.

A. The solid line represents the ideal wound direction. The more acute the angle formed between the line of incision and the ideal line, the smoother the scar will be.

A

B

B and C. The wound in the ideal direction produces a fine line. The hypertrophic scar is not in the ideal direction and makes a large angle with the ideal wound.

C

D through J. Various scars, all running at angles to the ideal direction. The solid line in each figure indicates the ideal suture line.
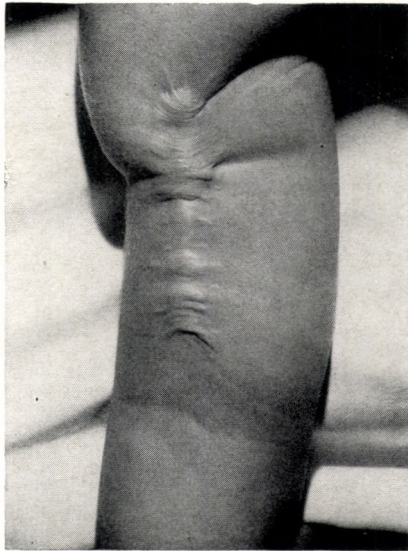
K

L

K and L. A poor scar caused by a
misdirected incision can be surgi-
cally remedied only by transfer-
ring the incision line to a more
correct direction or by changing
segments of the incision to the
ideal direction. Simple excision
and reinsertion of the sutures
along the previous line would
restore undesirable conditions.
The figures represent transposition
of a longitudinal scar by interpos-
ing segments in the ideal direction
by means of a Z-plasty.

Results
of Poor Surgical
Technique

Technical faults committed at wound closure are another cause of undesirable or distorted scars. Some of the most frequent mistakes are shown.

B

A
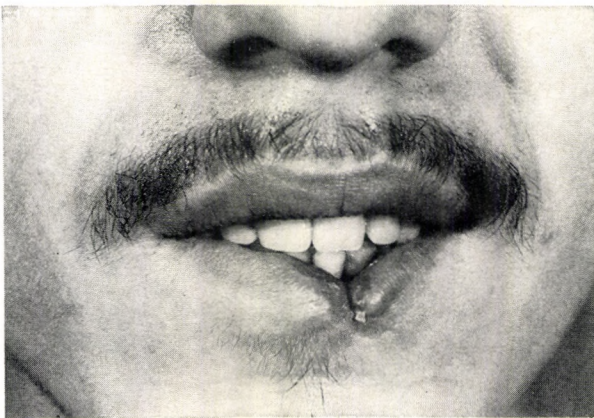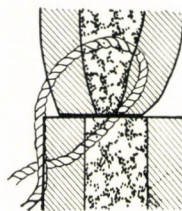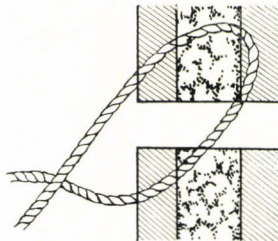
A and B. The result of imperfect coaptation of wound edges.

C

C. The inevitable result of suturing overlapping uneven wounds.

D
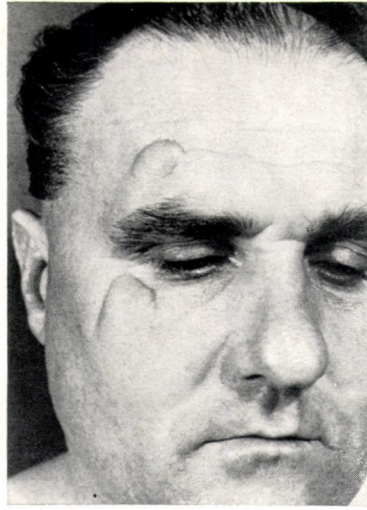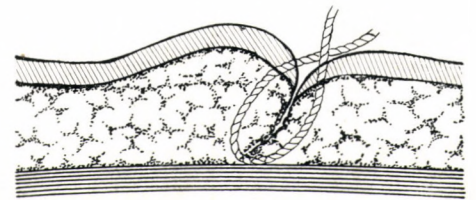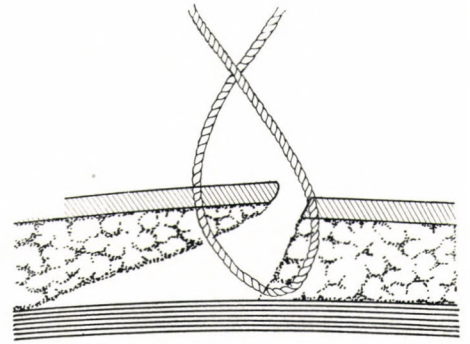
D. A contracting hypertrophic scar resulting from forced unification of tense wound edges.
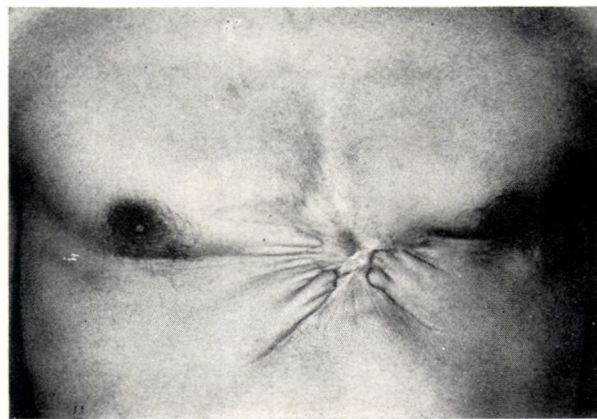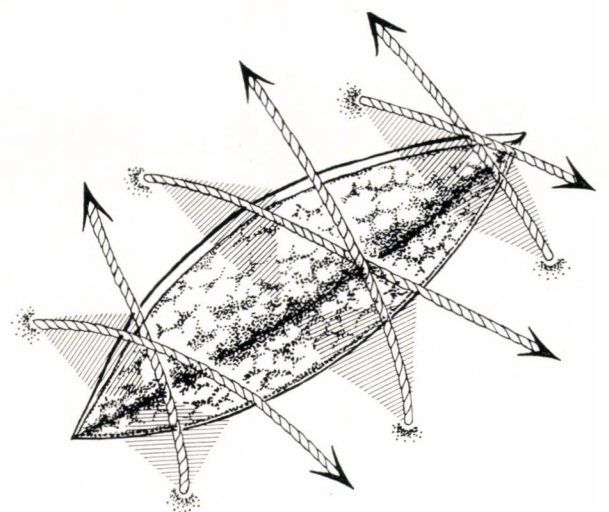
E
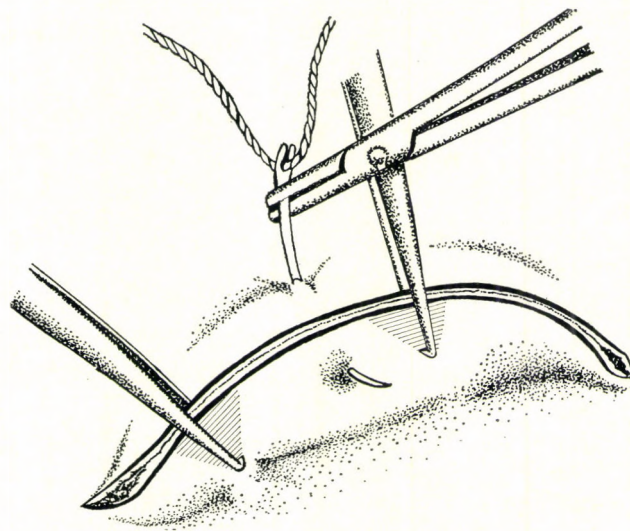
F

E and F. The use of coarse, large suture material, together with gross tissue handling, produces ugly "ladder-like" masses of scar. Such material, tied too tightly and left in place too long, contributes to this problem.
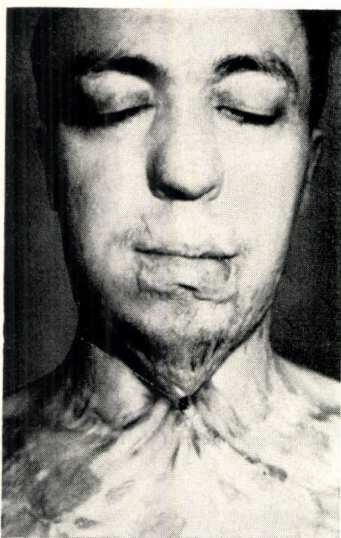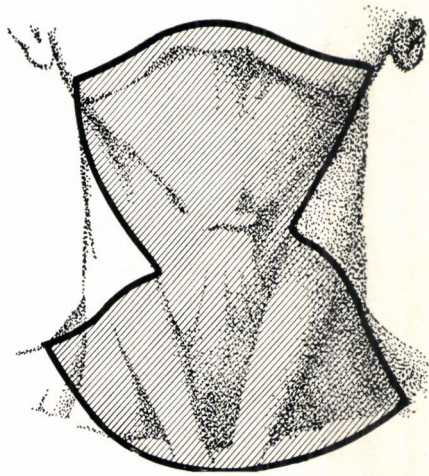
G

G. The failure to replace skin defects leads to constrictive hypertrophic scars. The only remedy is replacement of the missing tissue.

Direction
of Incisions According
to Muscle Movements

Incisions in areas with wide movements can be
made along a line which promises optimal wound
healing. This line usually runs perpendicular to
that of the muscle movement and corresponds
to the skin tension line.
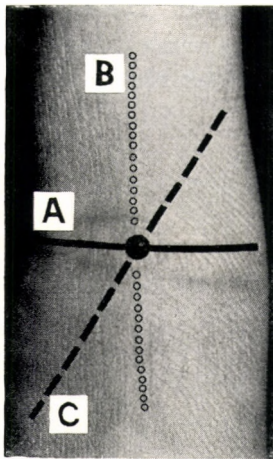
A

A. The nearer the incision runs to line A, the
better the scar.
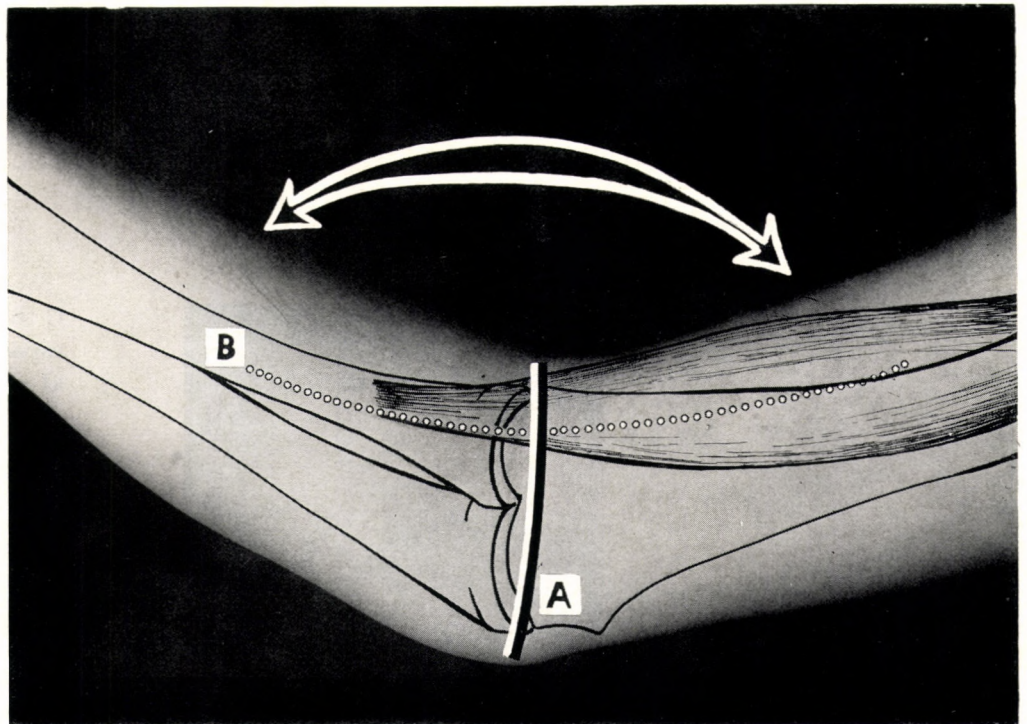
B

B. Further illustration of the muscle movements
across the elbow joint. Again line A, perpendic-
ular to the muscle movement, is the optimal
incision.

Determination
of the Lines of Skin Tension
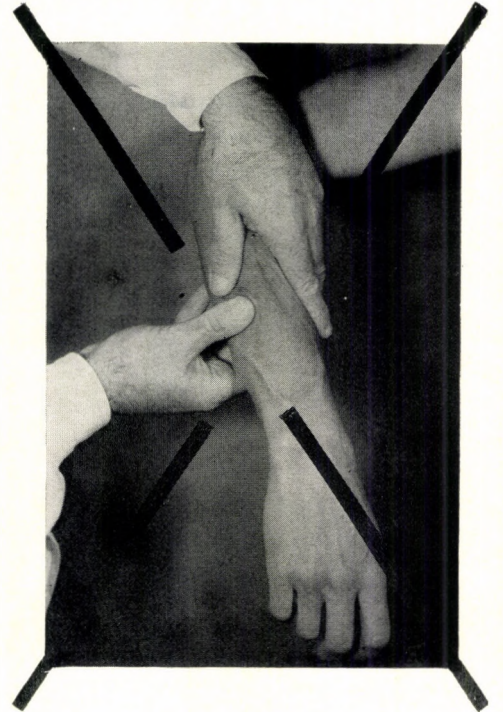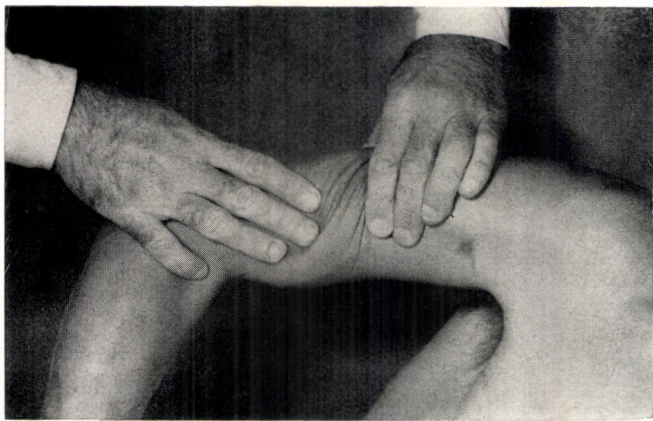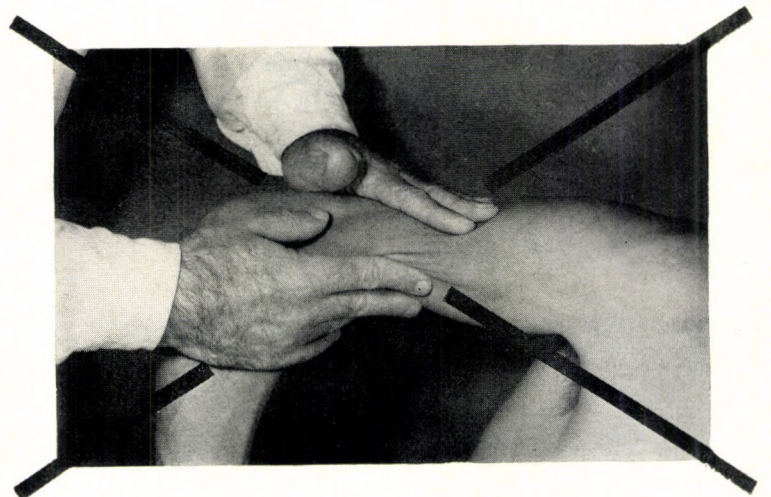
A through D. As stated above, muscle movements tend to form the elastic fibers in the skin into lines which run at right angles to the main direction of motion. One can demonstrate these lines of tension by pressing the skin together and observing the folds and wrinkles formed by movements of the hands.
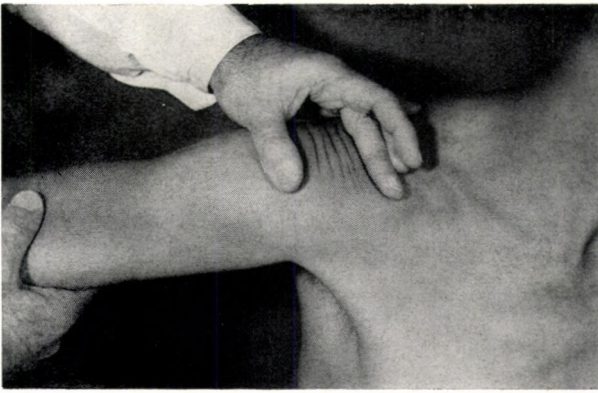
E
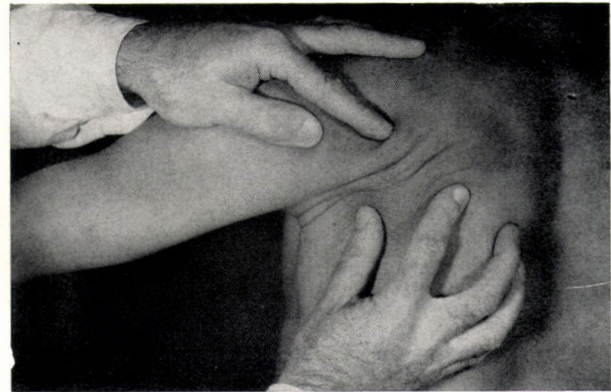
F

E through H. This manipulation enables the surgeon to determine the lines of skin tension and even their ramifications on the trunk and extremities.
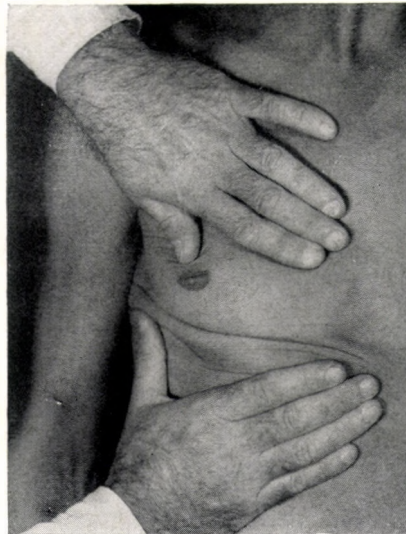
G
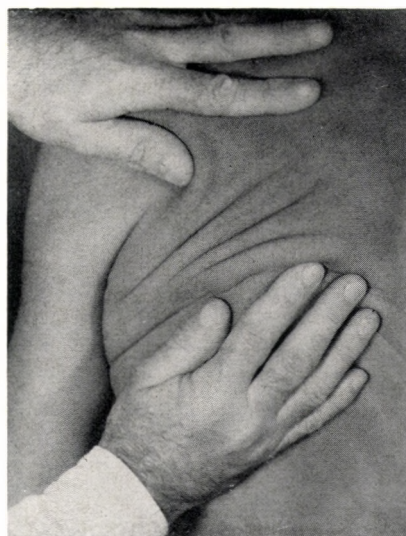
H

Careful Execution
of Infiltration Anesthesia

Local infiltration anesthesia should be carried out with the least possible pain for the patient.
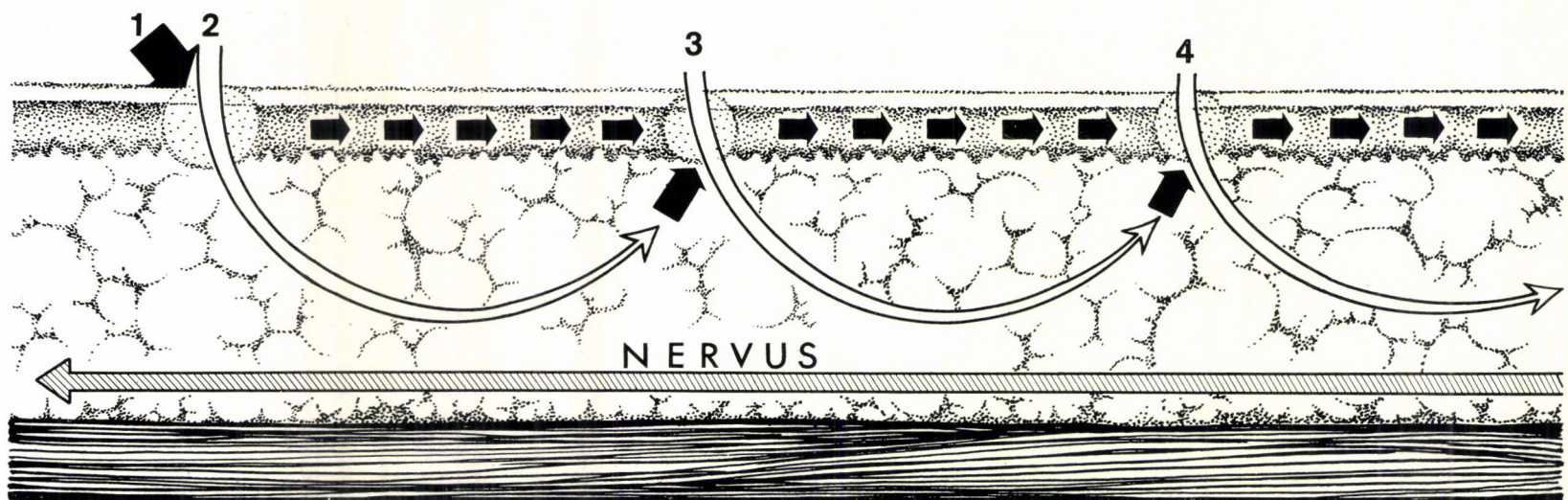
A

A. Infiltration is carried out in a direction opposite to that of sensory nerve conduction. By doing so the conduction of pain to the center at the very beginning of the procedure is suppressed. The needle is first introduced through a wheal (1) and then injecting continuously is pushed in the subcutis towards the periphery (2). The injection is less painful if performed slowly and without strong pressure. If the area to be anesthetized is long, a new wheal should be raised from below by the sub-cutaneous infiltrating needle at the site of each new puncture (3, 4).

B

B. The skin is pinched between two fingers and through this point the anesthetic is introduced into the dermis. The adjacent subcutaneous infiltration is carried out through this wheal.

C. The infiltration pattern used to obtain a skin graft from the thigh. The numbers indicate the points and order of injections; the arrows show the direction of infiltration. Subcutaneous infiltration is followed by intradermal ("orange peel") infiltration in the stippled area.
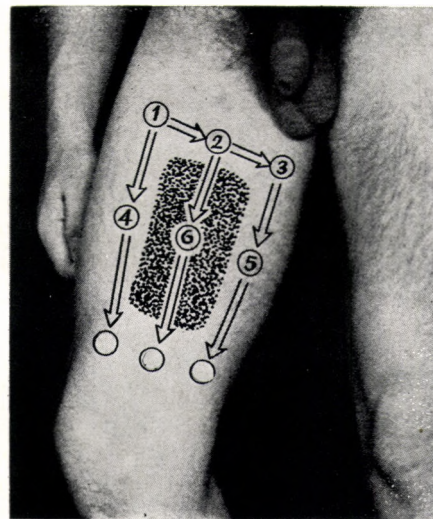
C

D

D. Typical pattern for infiltration anesthesia on the face. The direction of subcutaneous infiltration is shown by the white arrows, while the black arrows indicate the direction of intradermal infiltration.
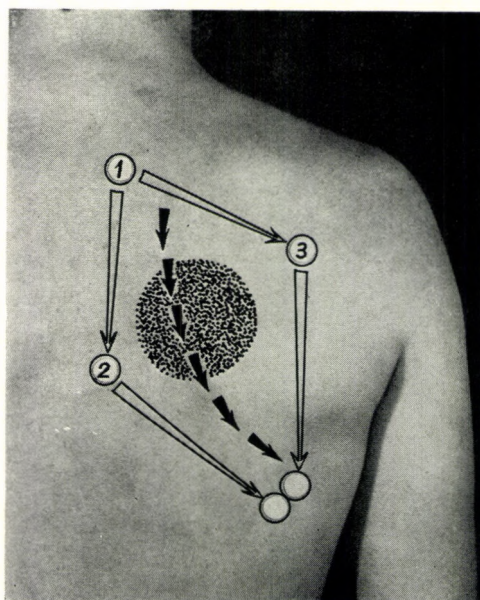
E

E. Infiltration pattern used if the operation is to be on the trunk. The numbers indicate the sites and order of punctures.
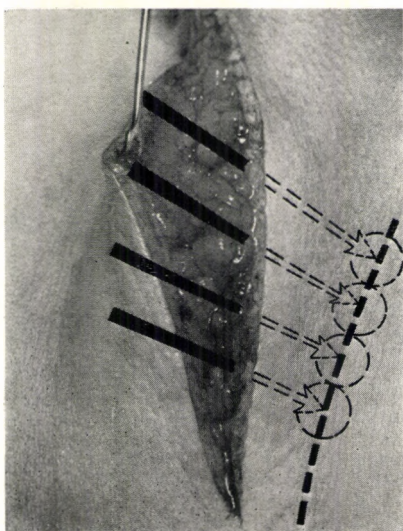
F

F. Should a second incision be necessary in the course of operation, subcutaneous and intradermal infiltration may be carried out through the existing wound.
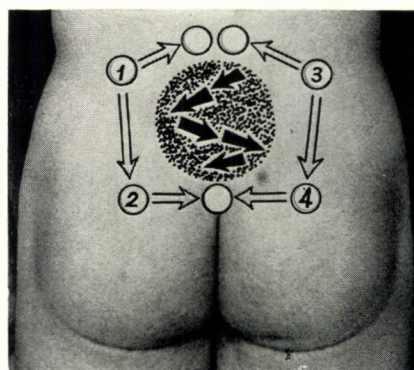
G

G. Tactics of anesthesia for operations in the midline of the body (i.e., in the sacral region).

Size of the Syringe
and the Needles
as a Factor of Anesthesia
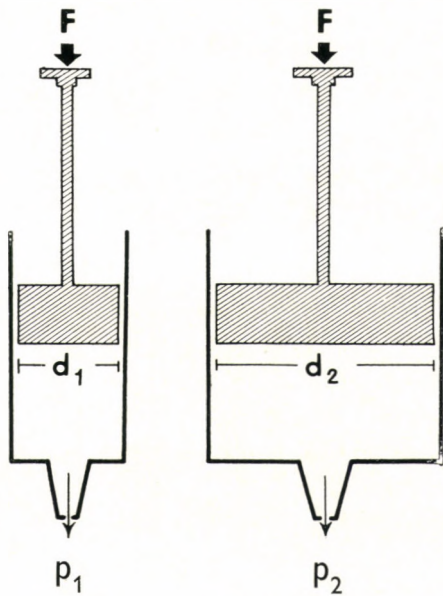
$$p = \frac{F}{d^2 \frac{\pi}{4}} = \frac{F}{A}$$

$$d_2 = 2\,d_1 \qquad A_2 = 4\,A_1$$

$$\frac{p_1}{p_2} = \frac{\dfrac{F}{A_1}}{\dfrac{F}{4\,A_1}} = \frac{4}{1}$$
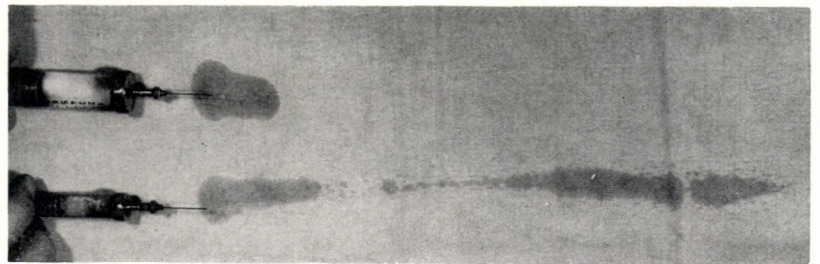
A

A. Local anesthesia can be performed without undue stress for the patient if the syringe and the needle are of suitable dimension. Provided that the pressure is constant (F) and the pressure of the anesthetic fluid (p) when leaving the syringe (as shown by the formula) is inversely related to the square of the piston's diameter (d), using the same needle and exerting the same pressure, the fluid will be driven from a 2-ml syringe with four times as much force as from a 10-ml syringe. It follows that with a 2-ml syringe much lower finger pressure suffices for the injection of the anesthetic fluid. Pain of injection may be diminished by this mechanical factor, inasmuch as the resistance of tissue is more easily perceived if the force required for the injection is less.

B

B and C. A 2-ml syringe and small record needles (Nos. 20 to 22)* are used for any kind of conduction anesthesia (1), for the raising of wheals at the beginning of infiltration anesthesia (2), for facial infiltration (3), and whenever infiltration has to be made against considerable resistance, as in an area of scar (4).
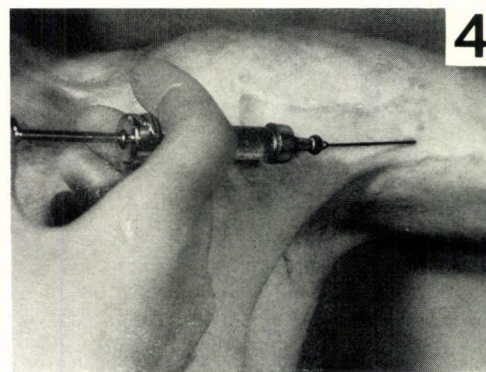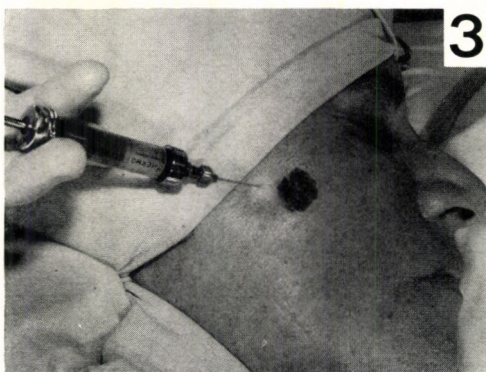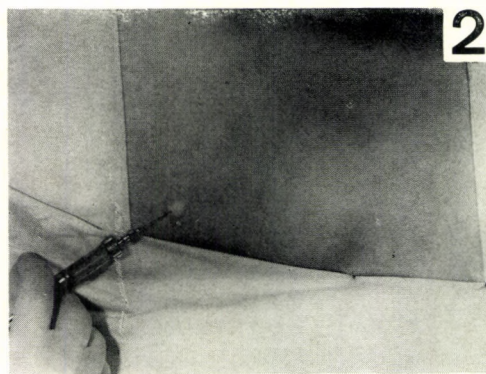
C

* In general, the American editors agree with the principles stated but tend to use the much smaller disposable needles, usually No. 27, for raising a wheal, and No. 25 for subcutaneous infiltration.

Also recommended is the use of a control syringe which allows aspiration between injections to help avoid intravascular injections. This latter feature is important when dilute (1 : 100,000 or less) solutions of adrenalin are incorporated into the local anesthetic to prolong the duration of anesthesia and to diminish bleeding.

D. A 10-ml syringe and needles
of the range of Nos. 8 to 14 are
used for the infiltration anesthe-
sia of larger intact skin surfaces.
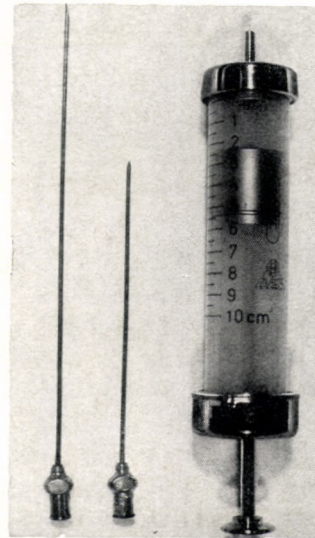
D
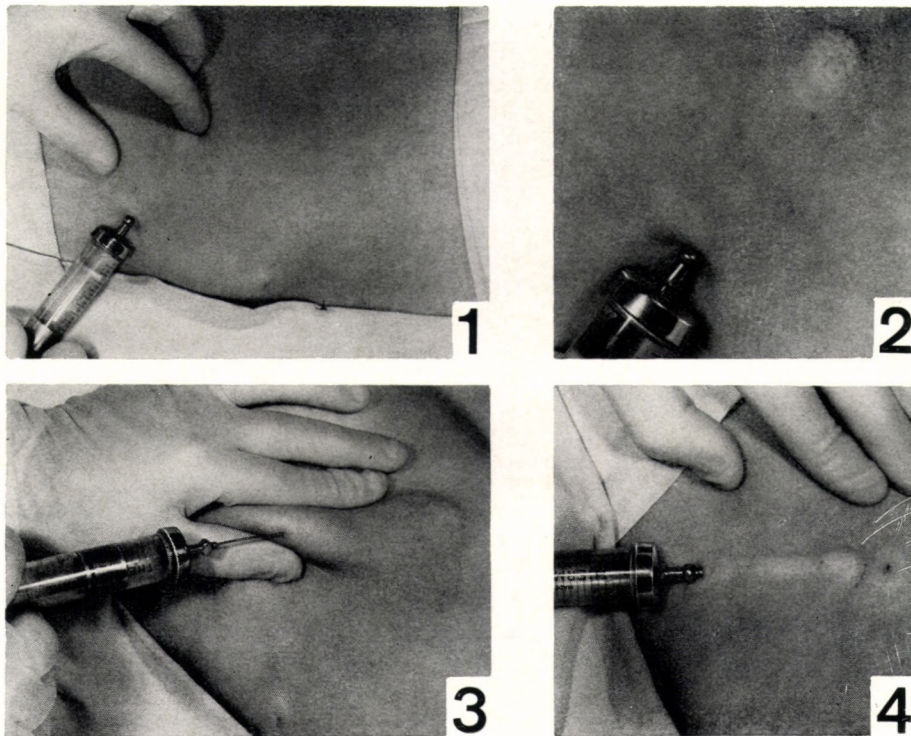
E

E. A 2-ml syringe with a small needle is employed for the first intra-
dermal injection, while a 10-ml syringe is employed thereafter; at the
point of the needle in use the corium has to be infiltrated from the interior
by means of that same needle, thus preparing the site of the next punc-
ture (1, 2). When making the infiltration, the anesthetizing fluid has
to be uniformly but economically distributed in the subcutis. There are
various tricks to facilitate the advance of the needle while the fluid is
being injected (3). After the subcutaneous infiltration, the corium is
infiltrated along the line of the intended incision, a manipulation carried
out with a 10-ml syringe and a thin (Nos. 18 to 20) record needle (4).

Scalpels and the Manner of Holding Them
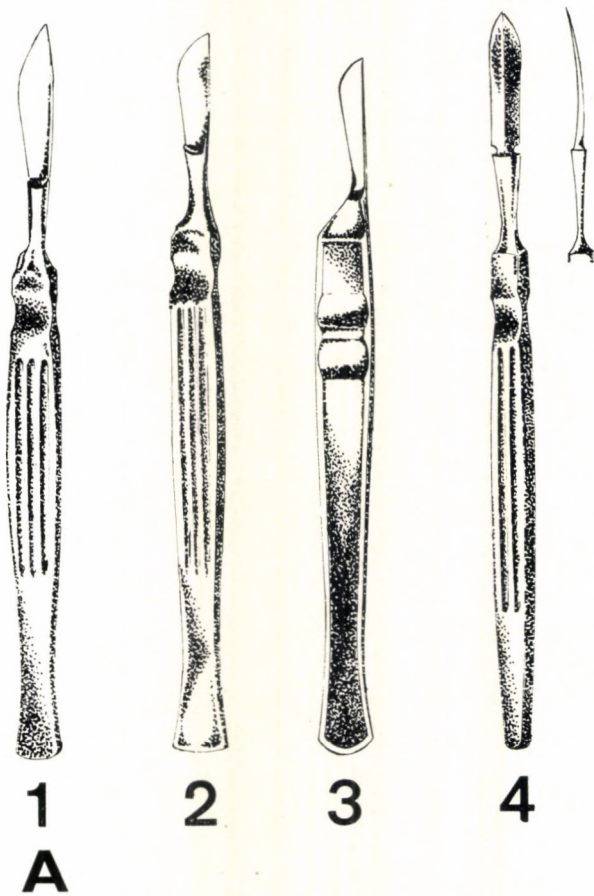
A. The curves of the so-called round-bellied scalpels in general use may be different (1, 2, 3). Joseph's curved, double-edged knife is well suited for the purposes of sharp dissection (4).

B

C
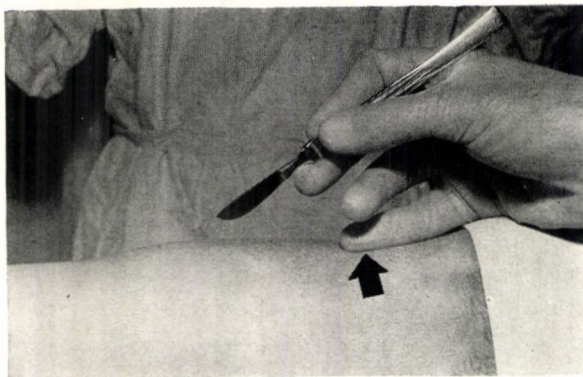
B. Tortuous or angulated incisions are most reliably made if the scalpel is held like a pen. In order to achieve accurate and firm incisions, it is necessary to support the hand with two fingertips or the entire little finger.

C. Rarely should the scalpel be held in the conventional manner, because the surgeon is not able to support his hand. This hold is suitable when long, nearly straight incisions are made.
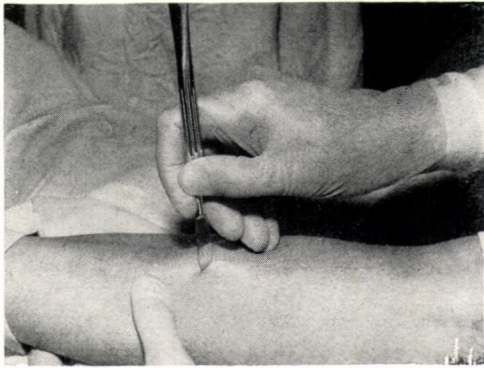
D
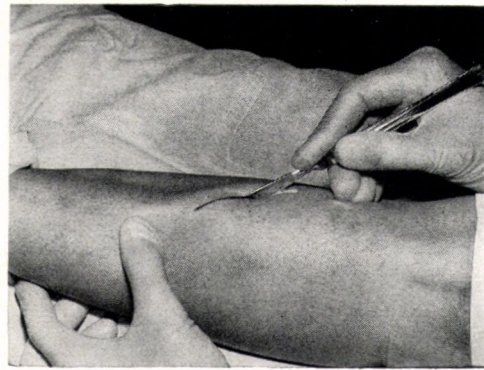
E

F

D through F. Incisions of equal depth throughout are achieved if the scalpel is held perpendicular to the skin surface, driven to the desired depth at the origin of the intended incision, then tilted to an angle of 45° incising to the terminal point of the intended line of incision. The scalpel is then once more returned to the vertical position to complete the incision.
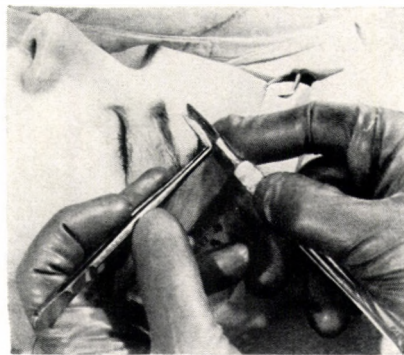
G

G. If it is necessary to excise a very strictly defined piece of variably shaped skin, both the hand holding the knife and that holding the forceps should be supported at several points to ensure the precision and firmness of the intricate manipulation.

H and I. In general, the scalpel should be drawn towards the surgeon. Accordingly, the incision should always start at the point most removed from the operating surgeon. Pushing the knife away from the surgeon renders its advance uncertain, especially in cases of intricate ramifying incisions.

H

I

Techniques of Incisions
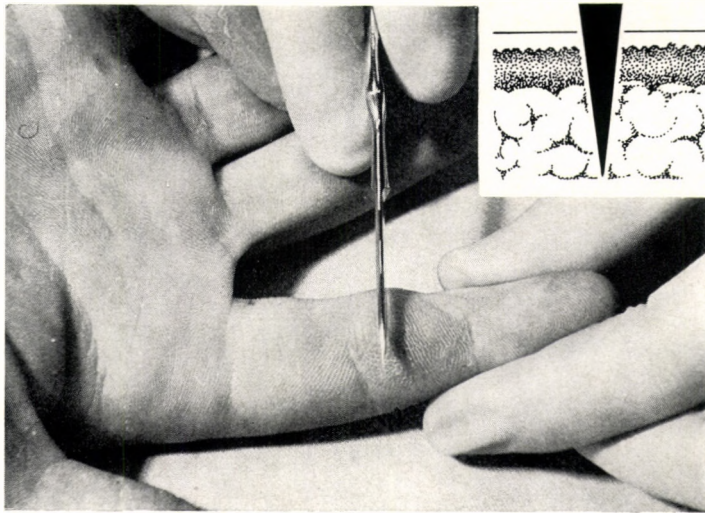
A

A. When making incisions the scalpel should generally be at right angles to the skin surface.

B
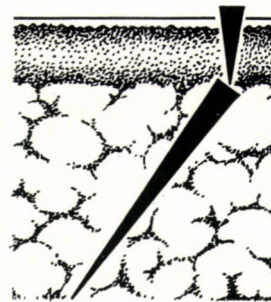
B. An oblique incision is justified when the recipient area is being prepared for a split skin graft to facilitate suturing of the graft and to prevent formation of a dead space. If the skin is thin, the obliquely held scalpel should be driven with a single stroke to the desired depth. If the subcutaneous adipose tissue (and so also the corium) is thick, both the epithelium and the corium should be incised perpendicularly; this done, the scalpel should be tilted and the adipose tissue cut obliquely.
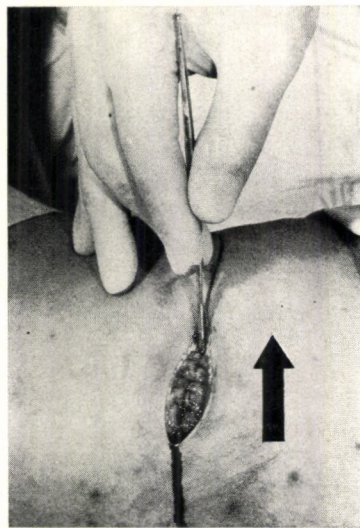
C

C and D. If, because of the patient's recumbent position, the operative area is oblique, the incision should be made from the lower to the higher point so that the flow of blood does not obscure skin markings.
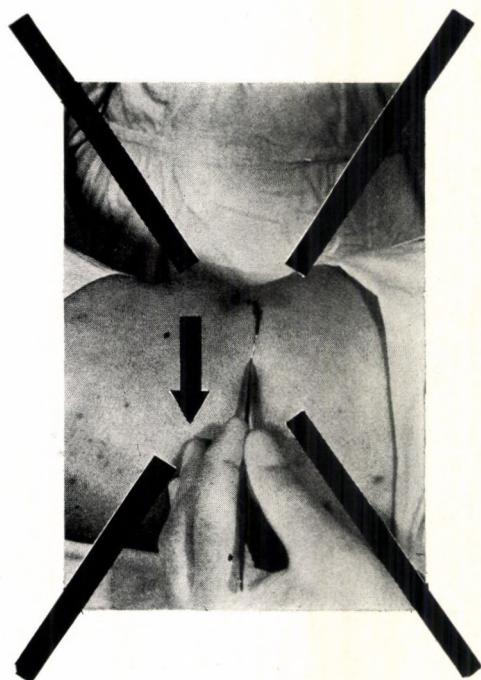
D
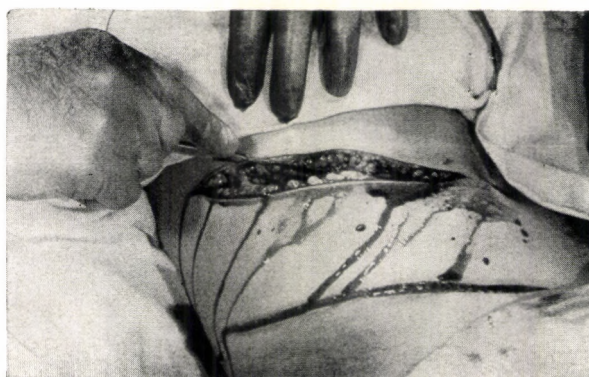
E

E. If the surface of the patient's body is oblique and we have to make two parallel incisions, the operation must start at the lower point so that the flow of blood will not obscure the vision. This applies to the undermining procedure as well.

F
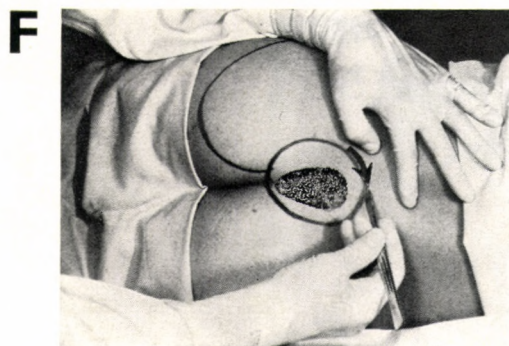
1
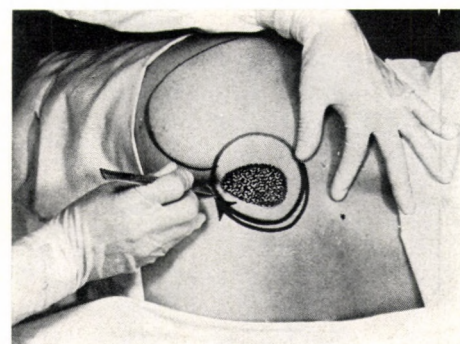
2

3
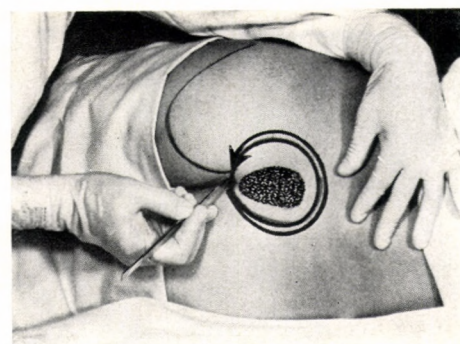
4

5
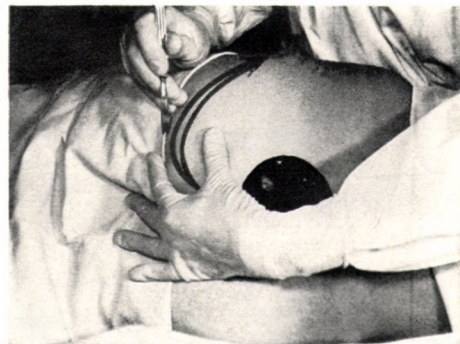
6

F. The sequence of incisions should be predetermined if several must be made, taking into account the object and nature of the operation, the requirements of asepsis and principles of surgical techniques. The intended line of incision may be marked on the skin by sterile dyestuff before anesthesia. If, for example, some pathologic structure has to be extirpated and the resulting skin defect is to be covered by flap rotation, the procedure should be as follows. First, the area to be excised should be circumcised at the lowest point of the oblique body surface, and the scalpel advanced without interruption as long as the surface is in an unchanged position (1, 2). This done, the area must be circumcised on its higher side, connecting the terminal points of the first incision (3, 4). The pathologic structure is then removed at the required depth. Thereafter, we start incising from the terminal point of the premarked rotation flap where it contacts the defect, and advance the scalpel as long as we are able to do so without moving the supporting hand (5). Finally, having changed our position, we complete the incision around the flap (6).
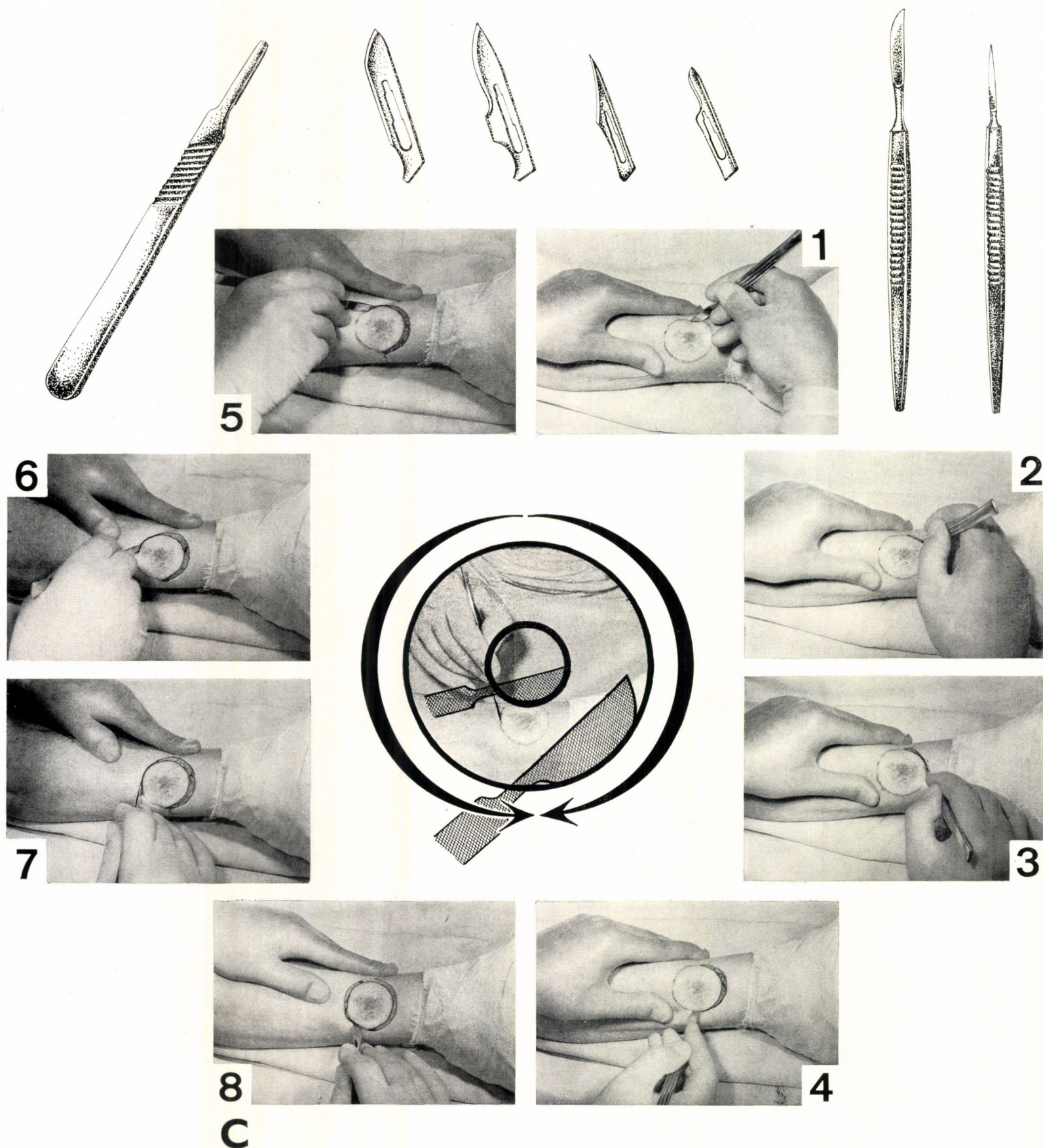
C. It is often necessary to make semicircular or circular incisions which require the use of suitable sized and shaped scalpes. It is impossible to incise the skin vertically in the area of the arc with an inadequate scalpel since an incorrect scalpel undercuts the skin obliquely on the concave side. The scalpel should be round-bellied and its curvature congruent with the arc of the intended circular incision (middle drawing). Circular incisions must start at a point most removed from the surgeon and should be made first on one and then on the other side of the arc. The scalpel, held at right angles to the skin, is first driven in at the point which corresponds to "12 o'clock" in the drawing (1) and is advanced without interruption clockwise until the "6 o'clock" point is reached (2 through 4). When performing the incision, the surgeon's elbow and wrist are rigid and the arm is rotated from the shoulder while the fourth and fifth fingers lean against the skin, thus promoting the accuracy of the incision. This done, the scalpel returns to the origin of the incision. In like manner the opposite arc of the circle is completed (5 through 8).

Management of Wound Edges
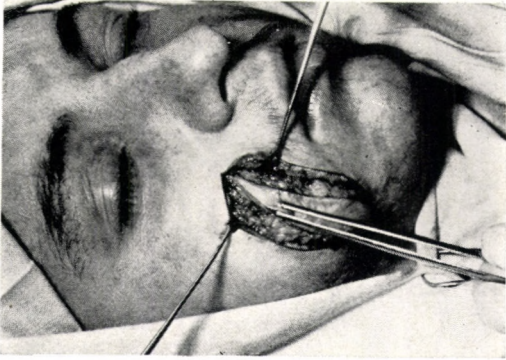
A
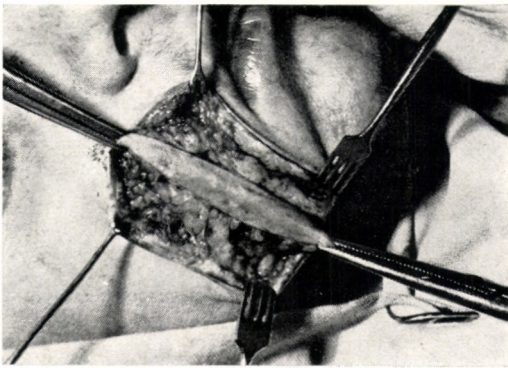
B
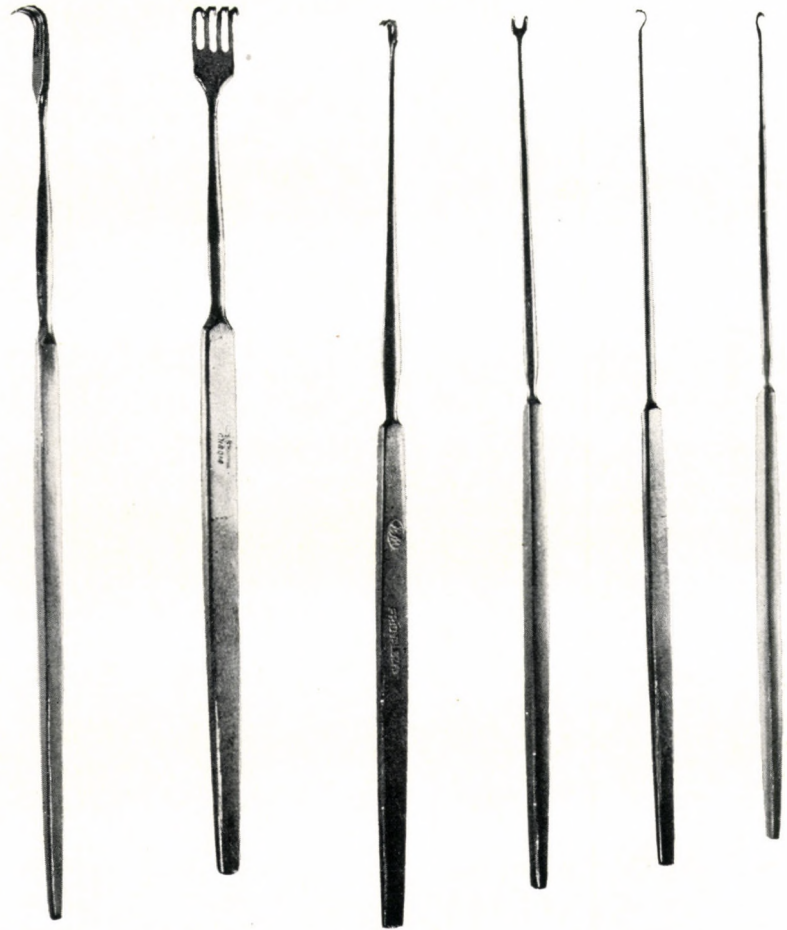
A and B. It is a fundamental principle of atraumatism that the wound edges to be united by suture should be held or lifted only with fine pointed hooks which have one, two or four prongs. The traditional surgical forceps, Kocher's clamp forceps, or Pean's bulldog forceps should be used only when the piece of skin to be grasped is destined to be removed.

C

D
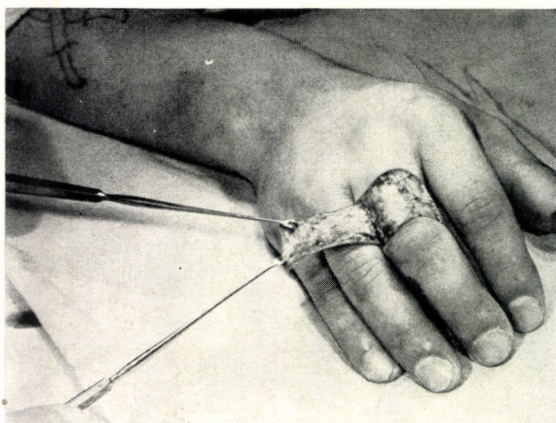
C. The tissues of flaps and wounds of traumatic origin require partic-
ular care. Injury reduces the vitality of such tissues, and the con-
sequent neurovascular damage is not always perceptible to the
naked eye. Incision and undermining diminish the supply of blood
to pedicled flaps to a considerable degree. Such tissues are even more
sensitive to surgical trauma than intact structures. Fine hooks
should be used to hold wound edges and flaps.
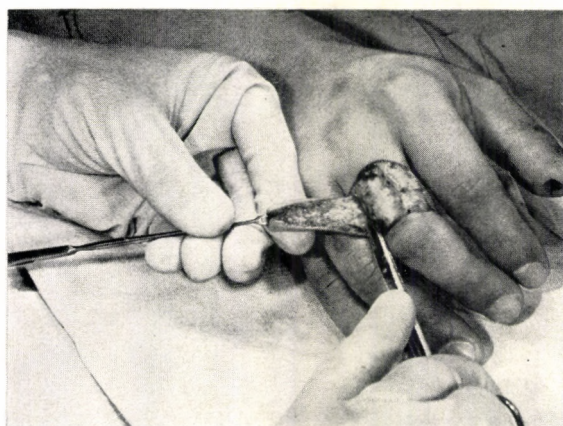
D. A simple hook will suffice for dissection if the skin of the flap is
supported by the surgeon's finger on the contralateral side.
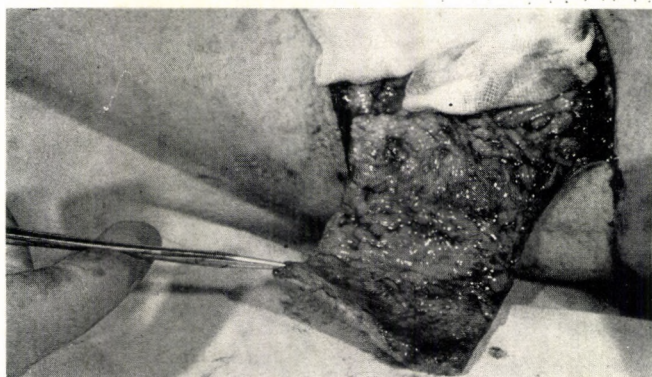
E
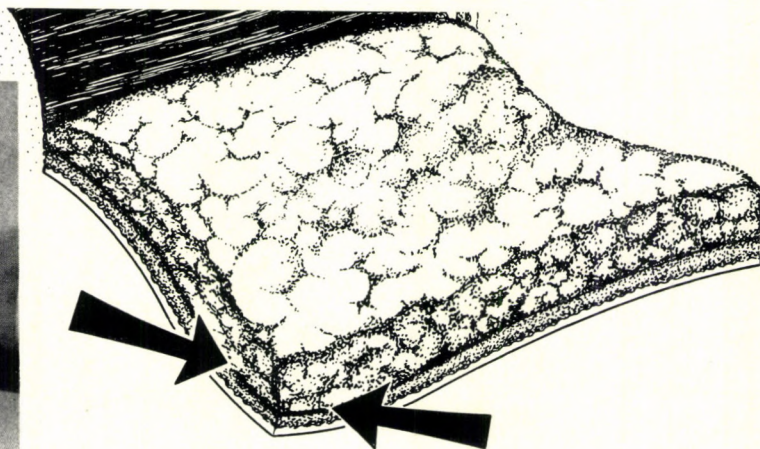
E. Fine hemostats of the "mosquito" type should be used for holding
the flap. No matter how fine the hemostat, the skin itself must never
be grasped by it, nor should the fragile subcutaneous adipose tissue
be seized by the tool. The boundary between the corium and the
subcutis can be grasped without causing damage (at the point
indicated by arrows in the drawing).

F
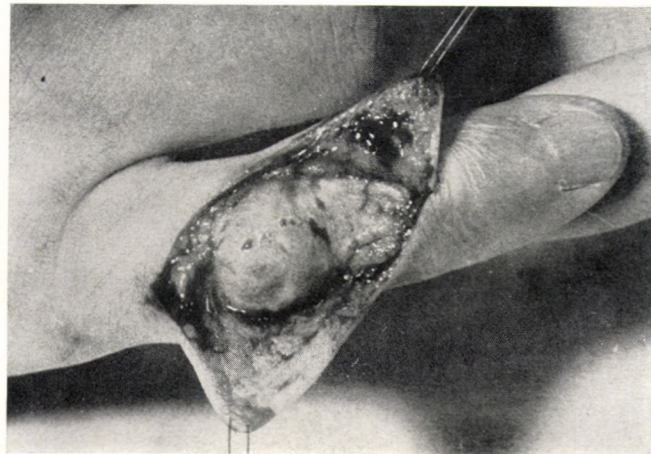
G
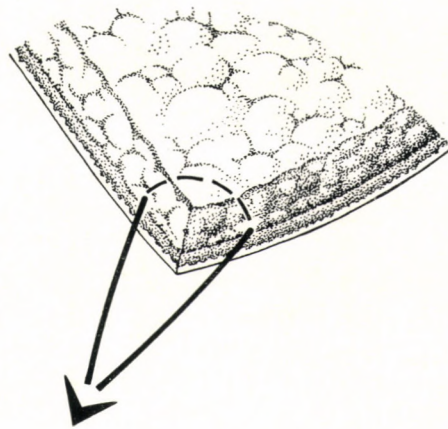
F and G. For prolonged exposure, the edges are retracted by stay sutures and not by hooks. The suture ends are held by a fine hemostat. The stay suture should be made parallel with the skin surface at the boundary between corium and fat, as indicated in the drawing.

Straight Dissecting Scissors

A
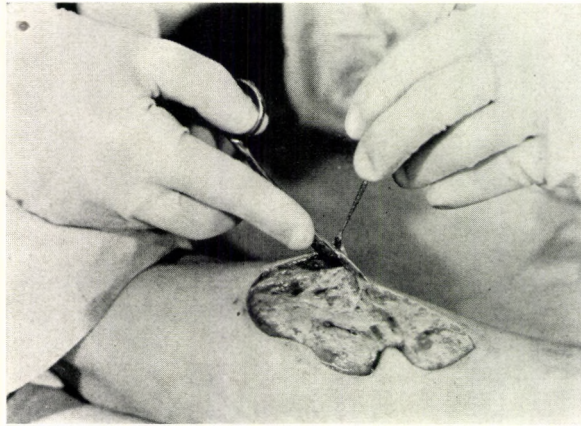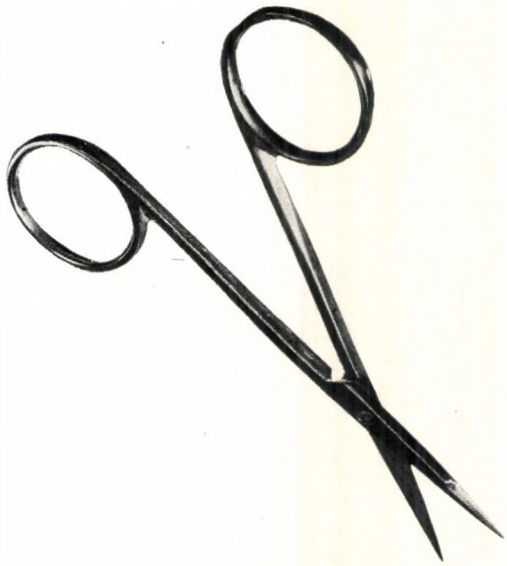
A. These are usually sharp pointed scissors which may have long or short shanks. The outer edges of the blades are also beveled, almost sharpened. They are particularly useful when developing a plane of dissection in places where the skin is thin and adheres firmly to the underlying structure, as on the face and hand.
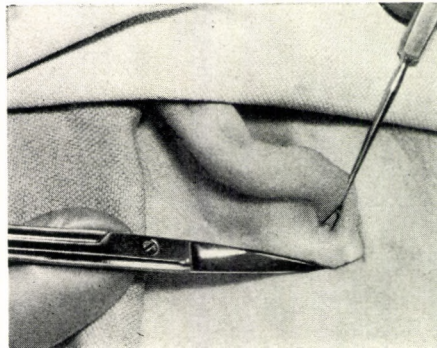
B
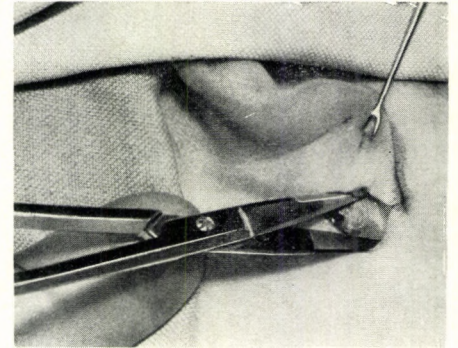
C

B and C. The pointed blades permit cutting and spreading so that both sharp and blunt dissection can be performed.

Curved Dissecting Scissors

A
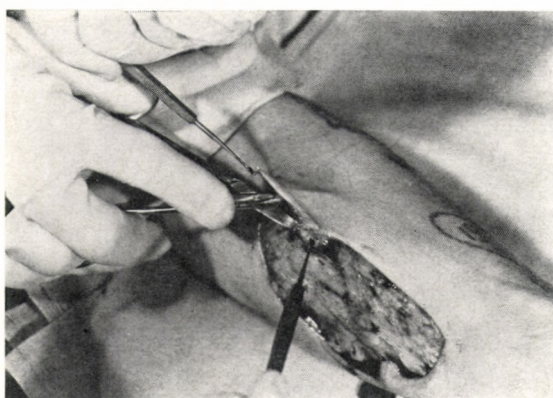
A. These are usually blunt and pointed and, like the sharp scissors, may have long or short shanks. They are useful for undermining in areas where skin is not so firmly attached, as on the arm and leg, for example.
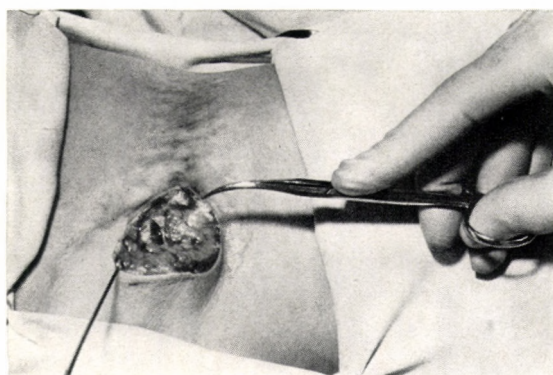
B

B. With both sharp and blunt scissors the index finger is useful for support and allows better control.

Dissecting Techniques
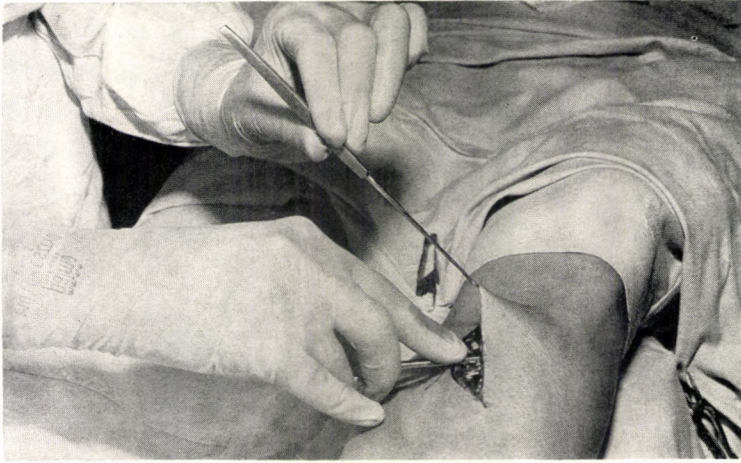
A. Skin hooks are used for elevation of the skin; they produce minimal trauma. The use of forceps should be avoided unless the area grasped is to be excised. Undermining is facilitated by elevation of the skin edge at approximately 45° and with slight traction toward the operator.

A

B
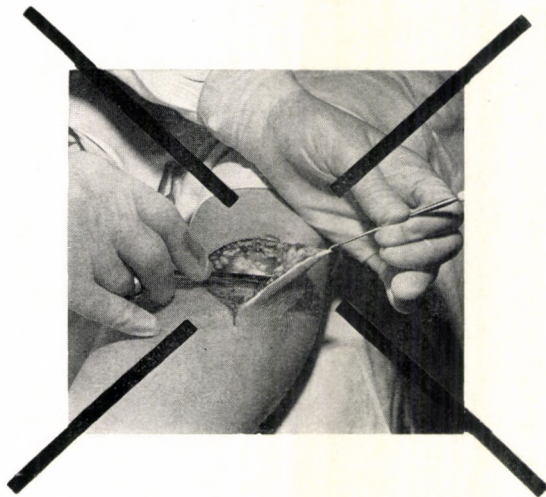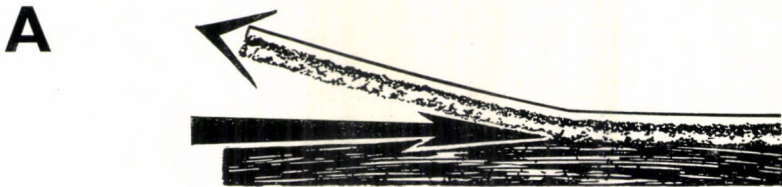
B. Elevation of the skin at a greater angle than 45° tends to allow an incorrect plane of dissection to be entered. This may produce such complications as buttonholing.
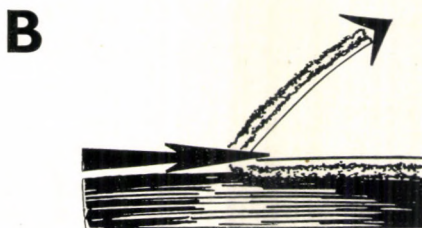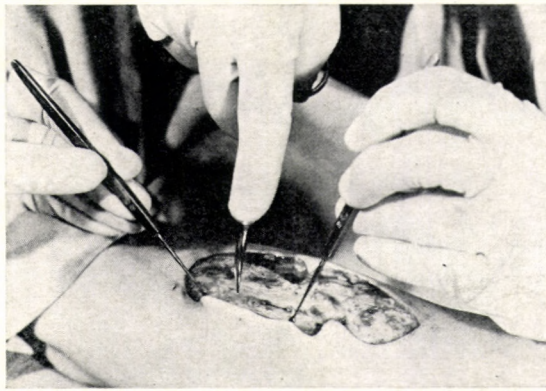
C
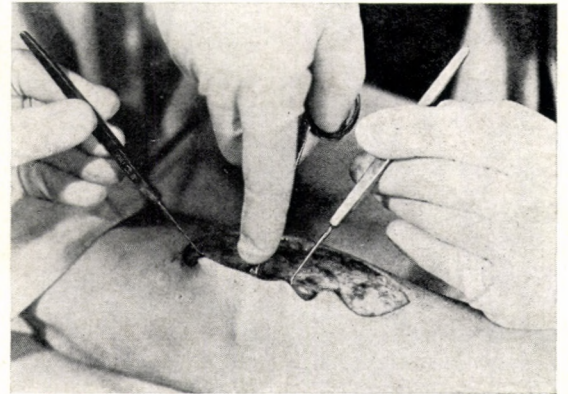
D

C through E. Undermining is performed by introducing the scissors with blades closed into the tissue parallel to the skin and then opening the scissors. Intervening septa can then be cut to free the skin.
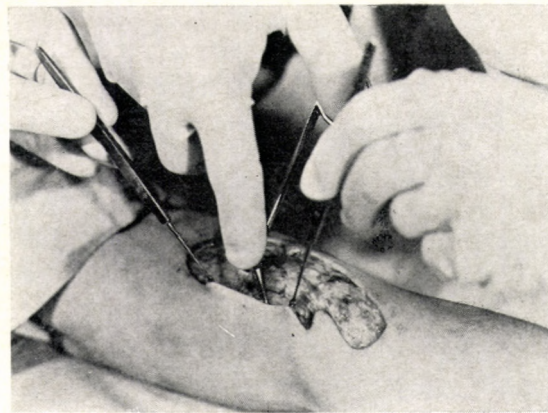
E

F. Blunt dissection scissors are also used for isolation and dissection of deeper structures. When blunt dissection is performed, the points of the scissors should be turned away from important structures.
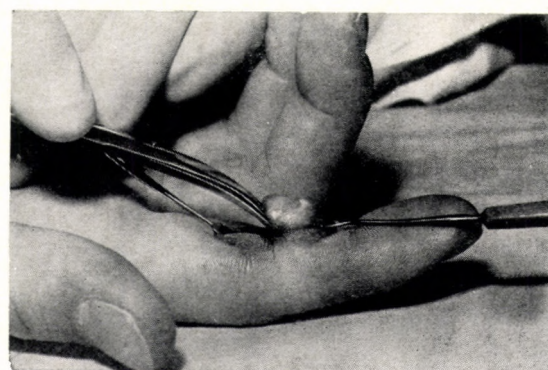
F
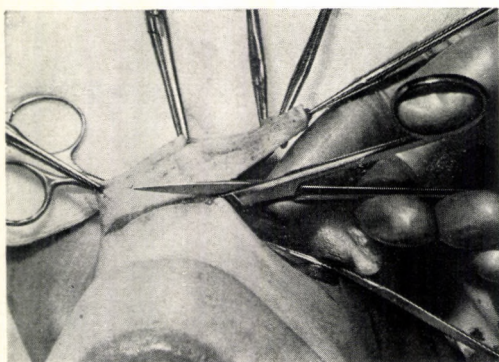
G

G. When skin is undermined, it is more difficult to cut with a scalpel because of increased mobility. Slight stretching of the skin edges helps to immobilize the part to be cut. If the line of proposed incision is then scored down through the corium with a scalpel, the remaining subcutaneous tissue is easily divided with scissors.
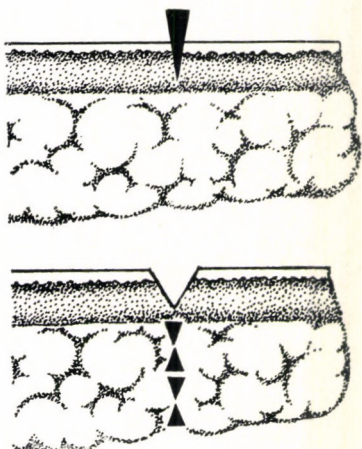
H. It should be remembered to allow for stretching when attempting to incise a straight line; otherwise concavity may result.
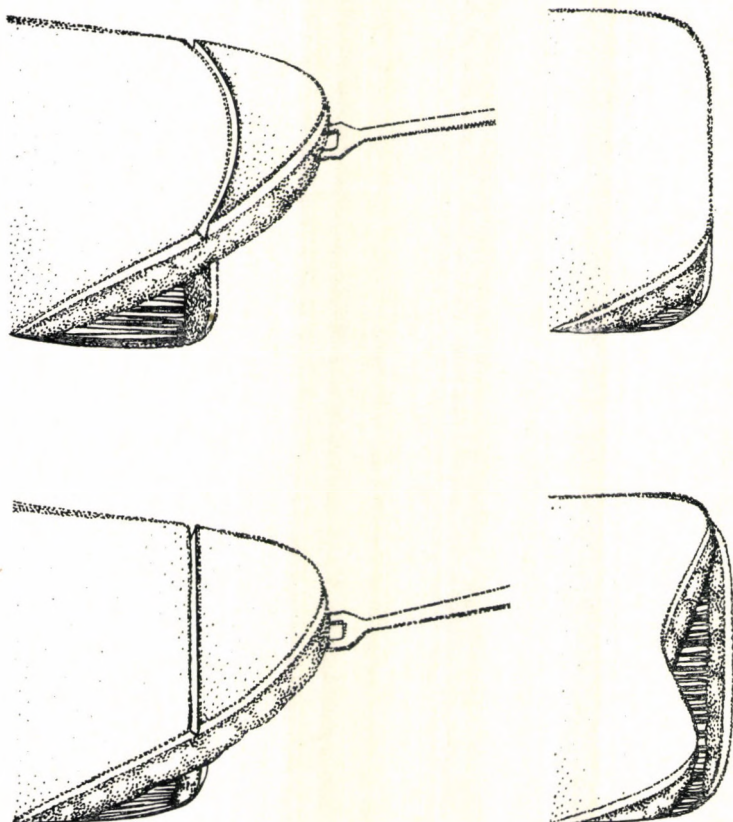
H
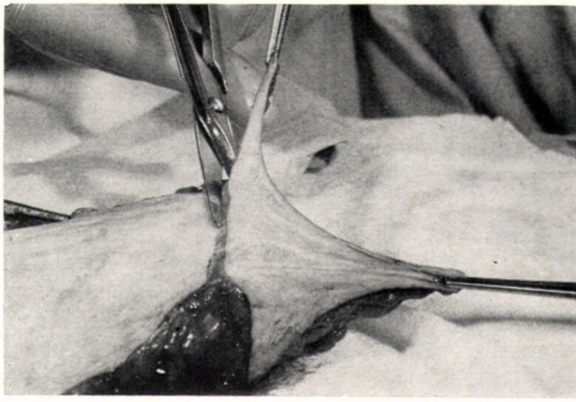
I
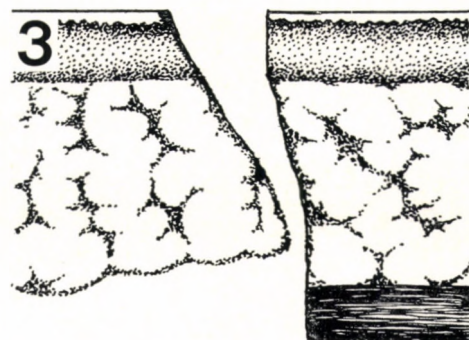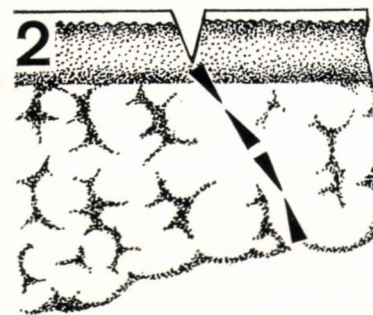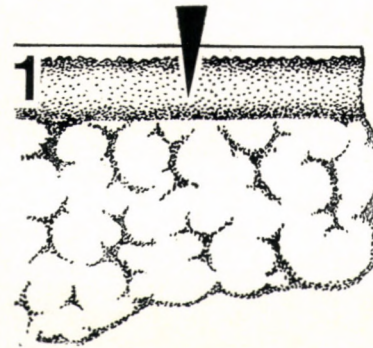
I. It is often necessary to leave a
rim of subcutaneous tissue extend-
ing beyond the cut surface of the
skin edges. This is done by cutting
the skin in a vertical plane with a
scalpel (1) and then using scissors (2)
at an angle of 45° to complete the
cut (3).

Hemostasis

Hemostasis must be obtained before the wound is closed. Ideally, this should be done with a minimal amount of ligation material or the least amount of electrocoagulation.
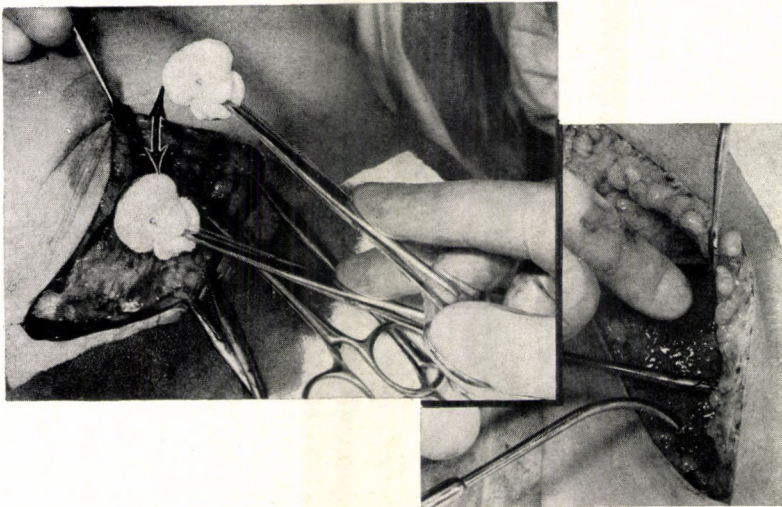
A

A. The best method to control oozing and minor bleeding is probably to exert gentle continual pressure on the bleeding surface with a moistened gauze sponge. Rubbing or abrading of the area must be avoided since this may dislodge thrombi and may cause further bleeding.
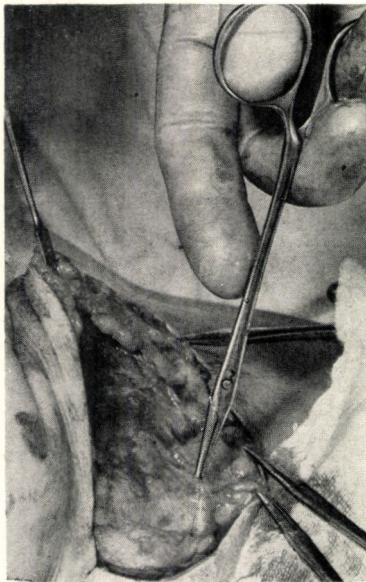
B

B. Bleeding points should be clamped with fine hemostats.
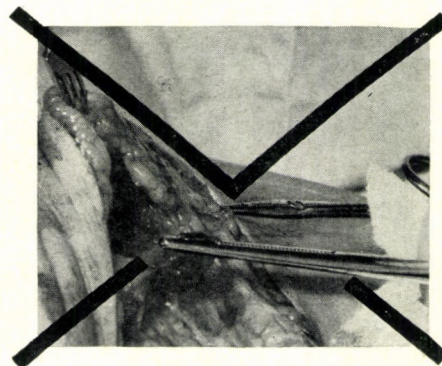
C

C. Grasping large amounts of tissue which would necrose, fibrose, and cause further scarring should be avoided.
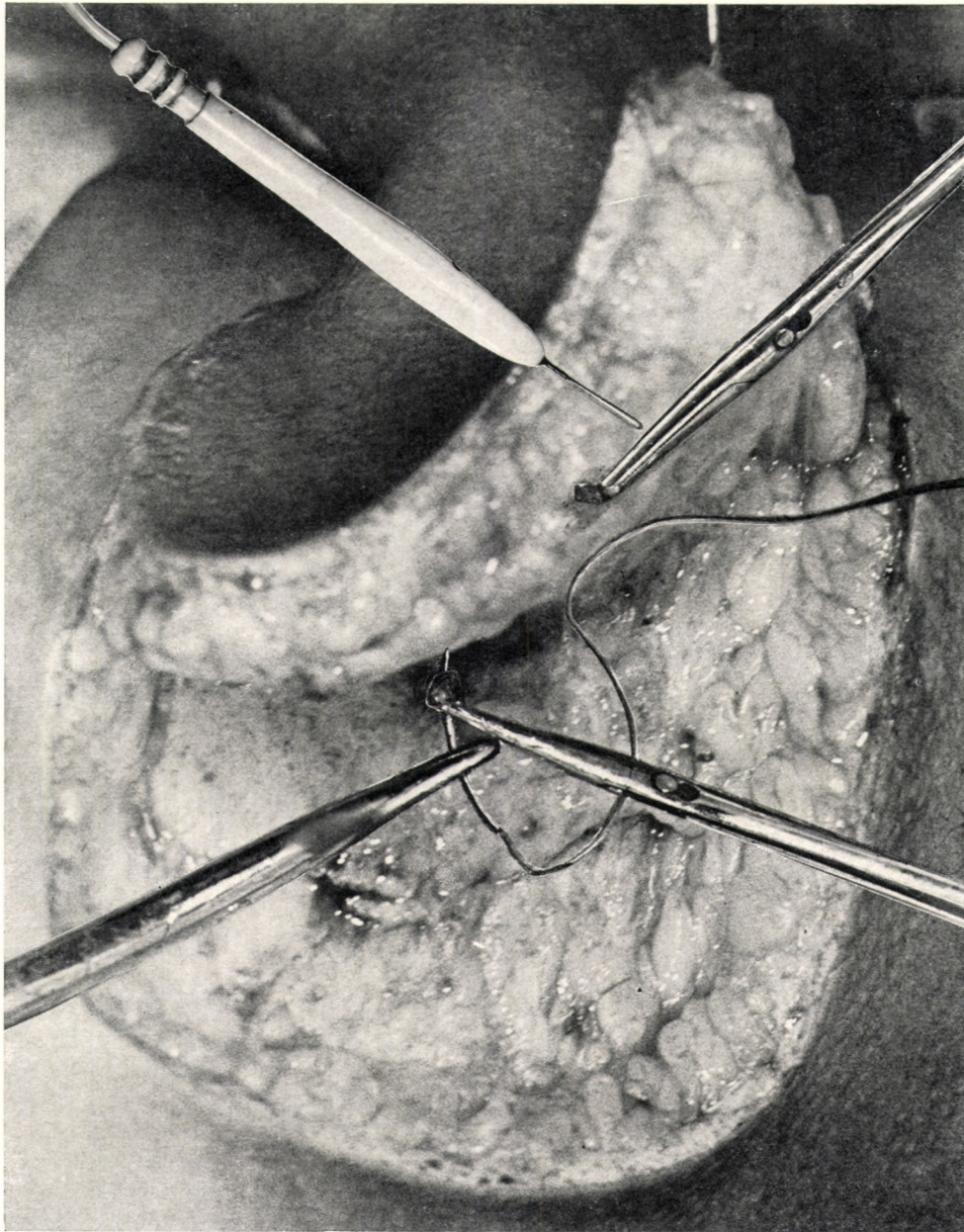
D

D. Electrocoagulation or ligation of clamped vessels is allowed only if the wound itself is closed by suturing.

Drainage of Wounds

When satisfactory hemostasis has been obtained at the end of a procedure, drainage of wounds often is omitted. There are times, however, when collections of serous or sanguinous fluid can be anticipated (when large skin flaps have been mobilized or extensive exposures performed). In these cases, drainage should be considered.

A. Ideally, the drainage should emerge away from the wound closure.
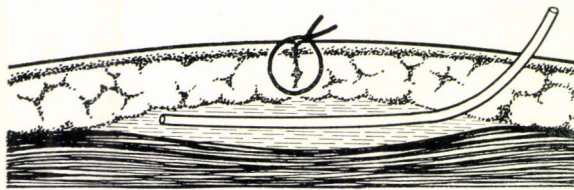
A

B. If the wound has been closed in layers, each potential dead space should be drained.
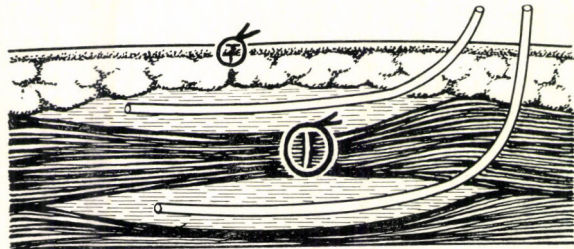
B

C and D. To be most effective, the drain should have multiple drainage ports or openings and should be brought out to the surface through the skin in a dependent manner by a separate stab wound.
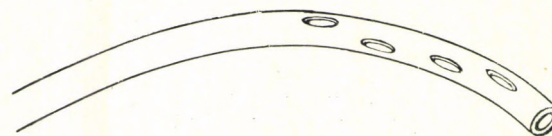
C
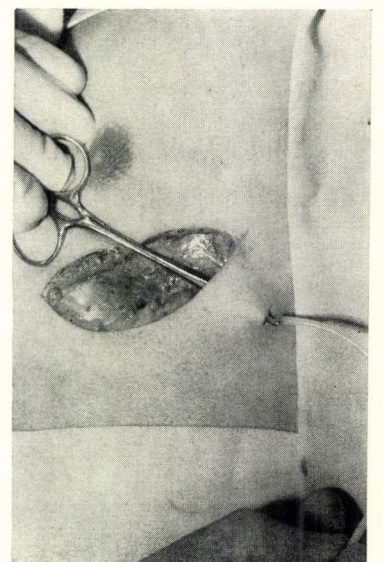
D

E

E. The drain should be se
cured by a suture attached
to the stab wound.
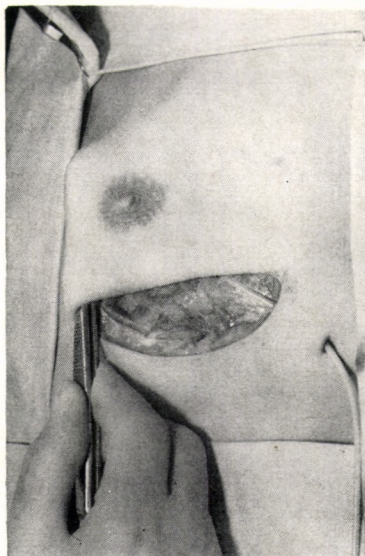
F

F. The drainage tube should
be positioned so that one
end lies superiorly in the
wound to give maximum
drainage opportunity.
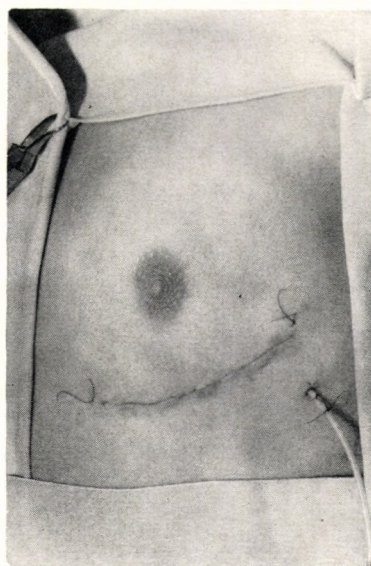
G

G. The original wound should
be closed hermetically.
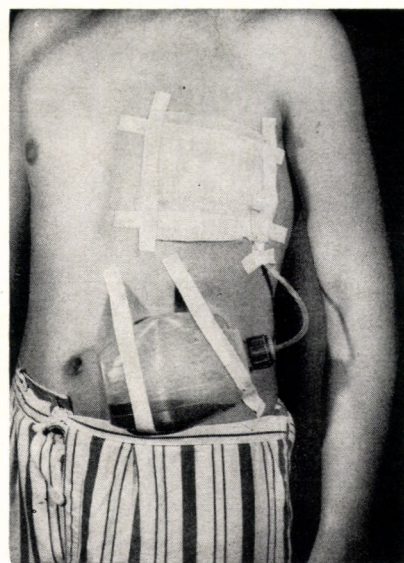
H

H. A suction apparatus can
then be applied.

Principles
of Wound Closure

Whenever possible, wounds should be closed without tension.
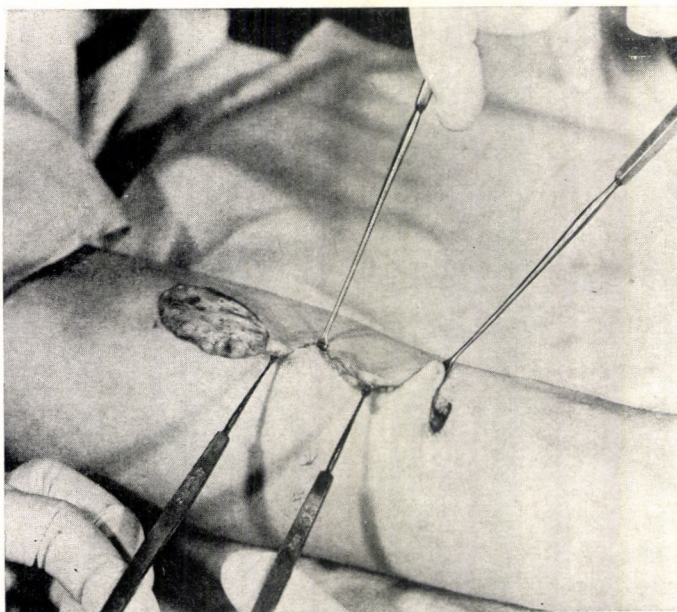
A. An easy way to determine whether tension exists is to pull the skin edges together using skin hooks. Undue tension with this maneuver indicates that a true tissue defect exists. In this case, primary closure is not advisable, and tissue replacement must be considered.

B. Deep wounds should be closed in anatomical layers and dead space should be avoided. Transcutaneous sutures (which, brought to the surface, can later be removed) should be used for the unification of tendons (1), muscles (2), fasciae (3), subcutis (4) and skin (5).

A

B
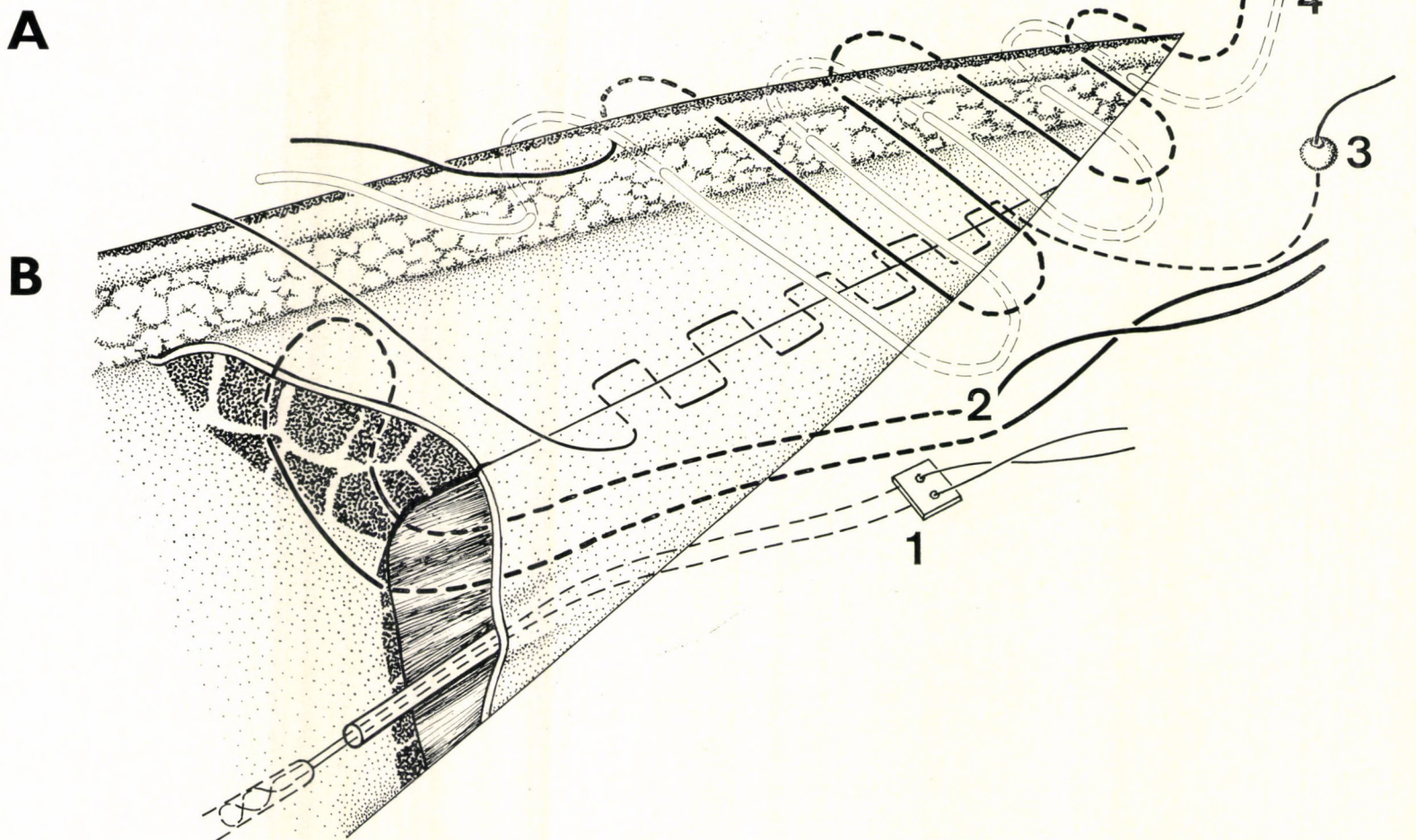
Needle Holders
and Instrument Tying

Needle holders come in a variety of shapes and sizes, and the choice is again one of individual preference. Most needle holders have a ratchet lock, but some are without this and some others incorporate a cutting edge to act as a scissors as well as a needle holder.
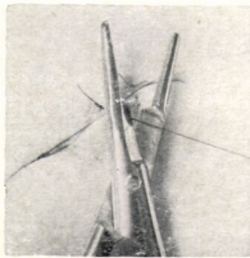
A

A. The needle holder of Crile modified by the author. By adding the scissors it allows the surgeon to cut off the thread when tying is accomplished.
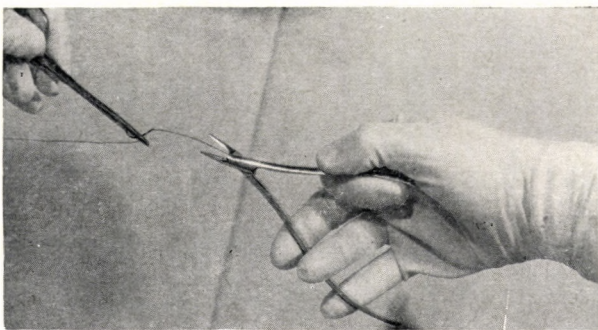
B
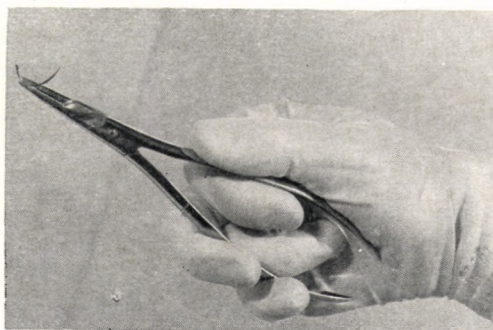
C
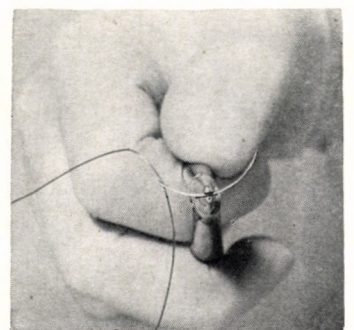
D

B through D. The technique of handling the author's instrument.
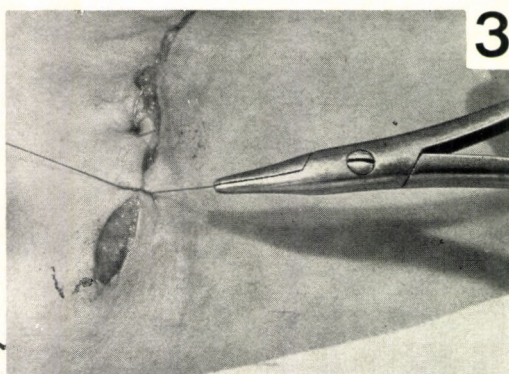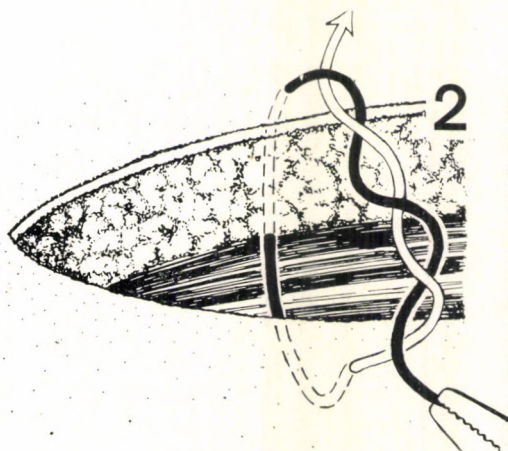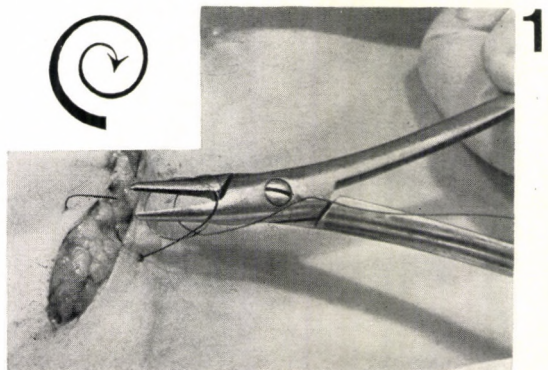
E. If at all possible, instrument tying is advocated, because of the advantages of speed and economy of sutures. The technique of the instrument tie using a needle holder is demonstrated in 1 through 6.
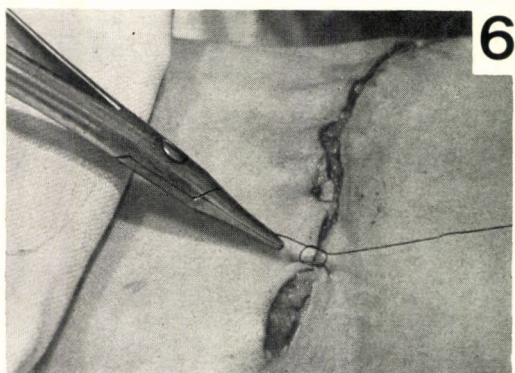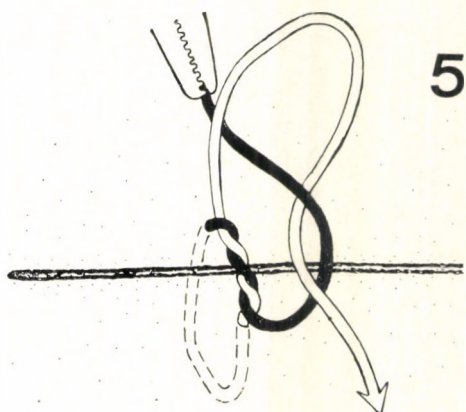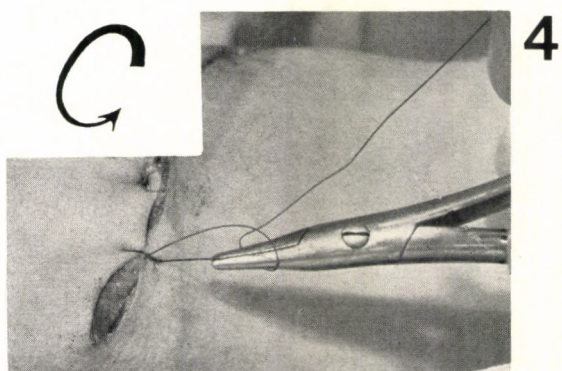
Suturing Technique

Wound edges should be traumatized as little as possible during suturing.

A. Grasping and crushing the skin edges with forceps as shown should be avoided; otherwise, unsightly crush marks will appear later and will mar an otherwise good result.
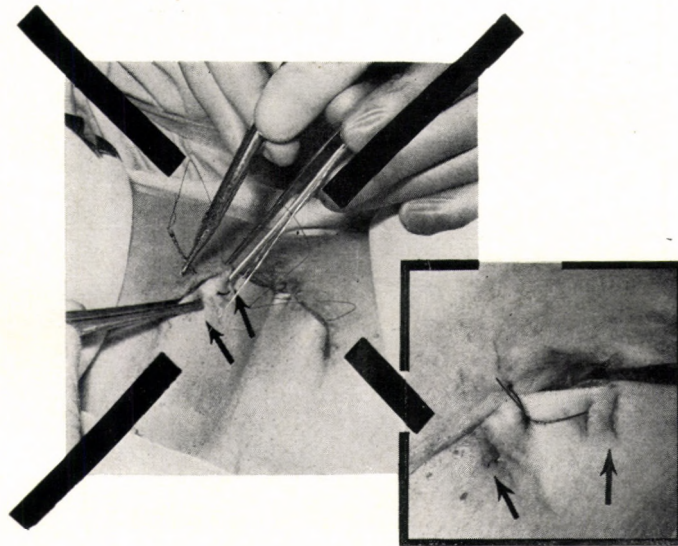
A

B. Good control of skin edges can be obtained by using a skin hook. The skin hook also can facilitate entry and exit of the needle.

B

C

D
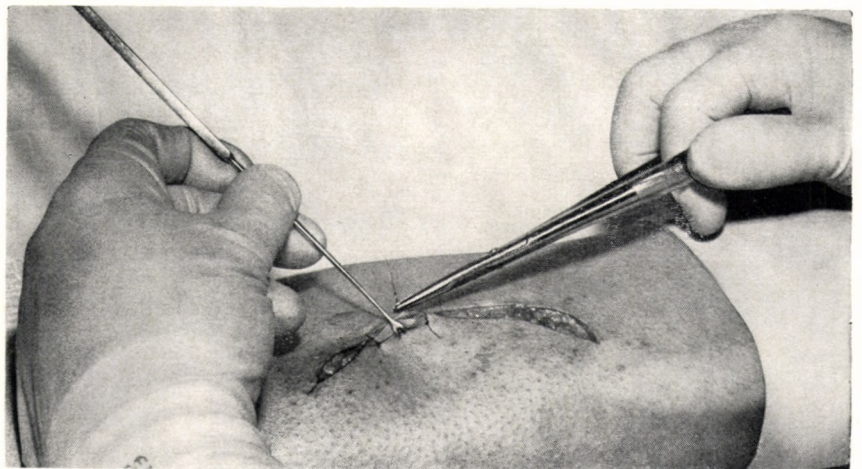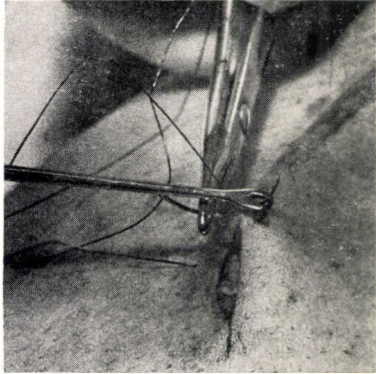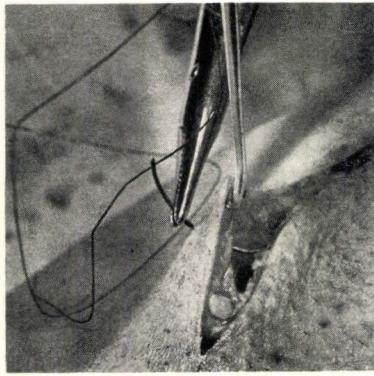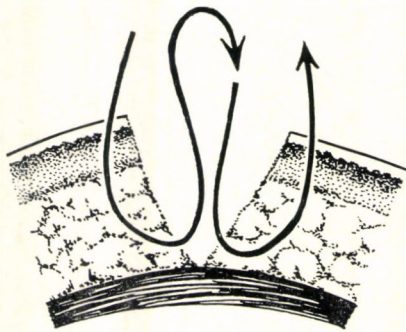
C and D. Whenever possible, use a two-stage approach; in other words, a needle having passed through one edge of the wound should be drawn out of the wound before reentry through the other side of the wound, as shown in the diagram. This will ensure that the needle is inserted at the right angle and will result in slight eversion of the skin edges when the suture is tied.
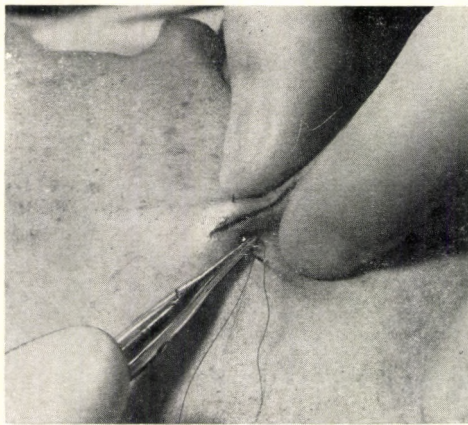
E

E. For small wounds, manual control of skin edges can produce satisfactory results.

F

F. As an alternative to a skin hook, pick-up forceps can be used in the atraumatic manner, as shown.

G
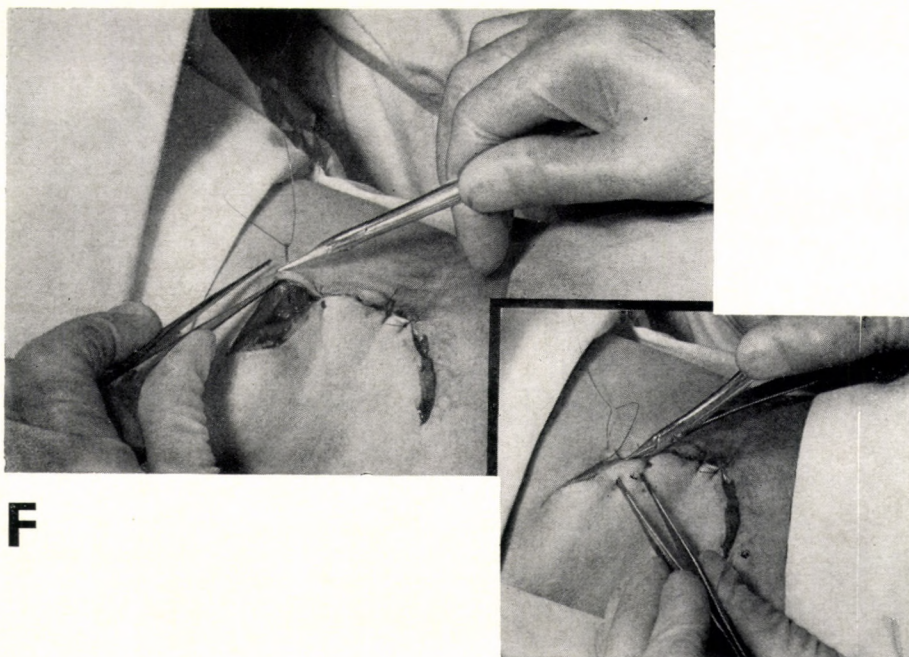
G and H. Modifications of instruments are often used, as shown in the diagram. Here, the instrument has a double hook at one end and a loop at the other.

H

Simple Interrupted Sutures
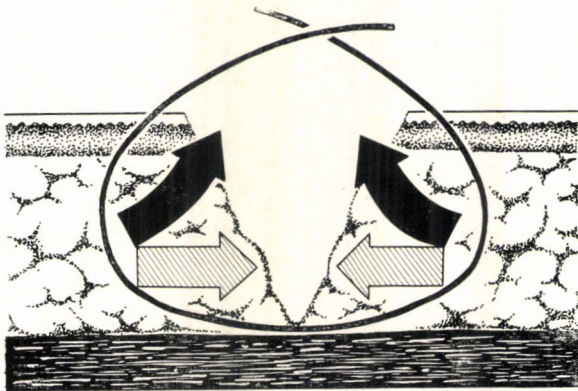
A. The simple interrupted suture should close any dead space and produce good skin edge approximation with slight eversion. This result is obtained by the correct angle of entry of the needle. It is important to notice also that the entry and exit of the needle are close to the skin edge.
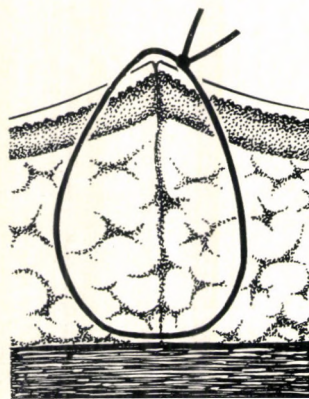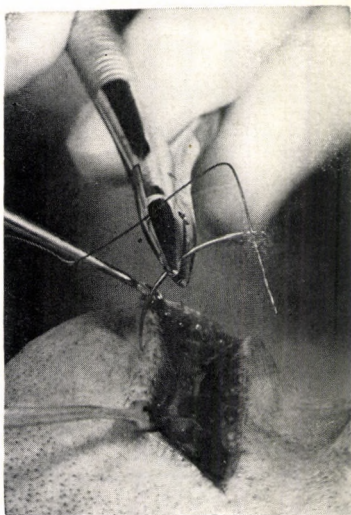
A
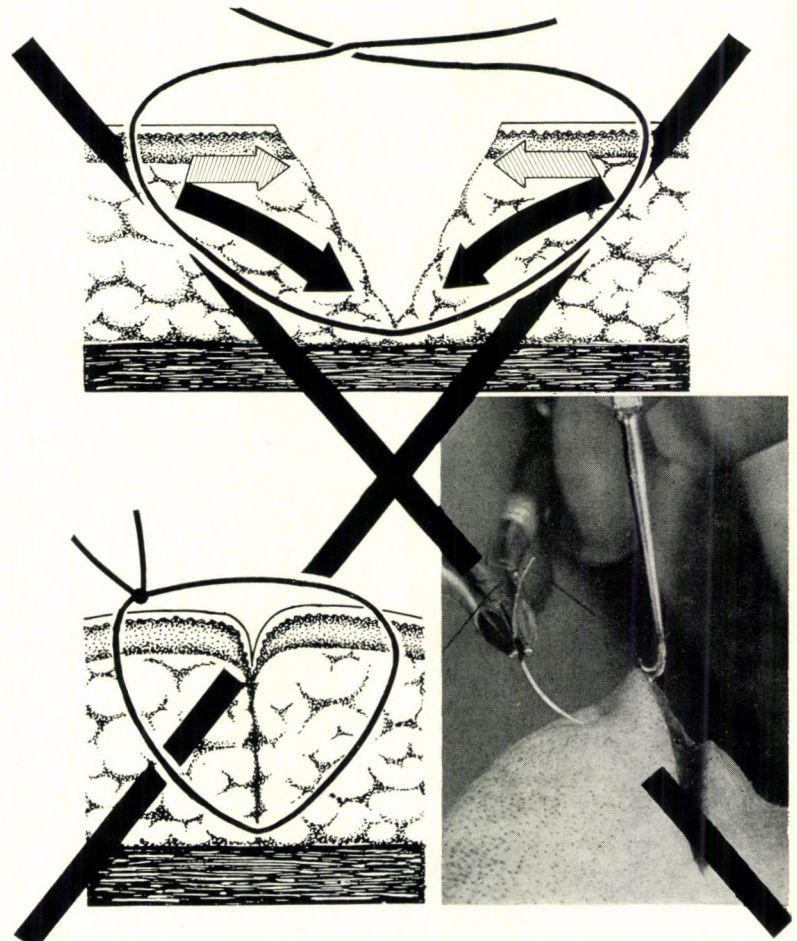
B. Too shallow an entry will result in the inversion of the skin edges.

B

C. When one edge of the wound is undermined, it is usually advisable to suture from the mobile side to the immobile side.
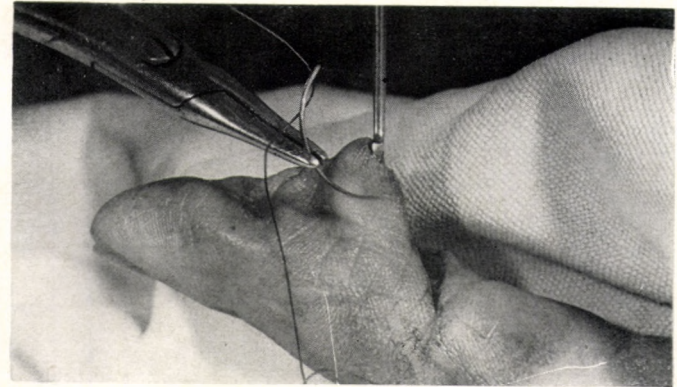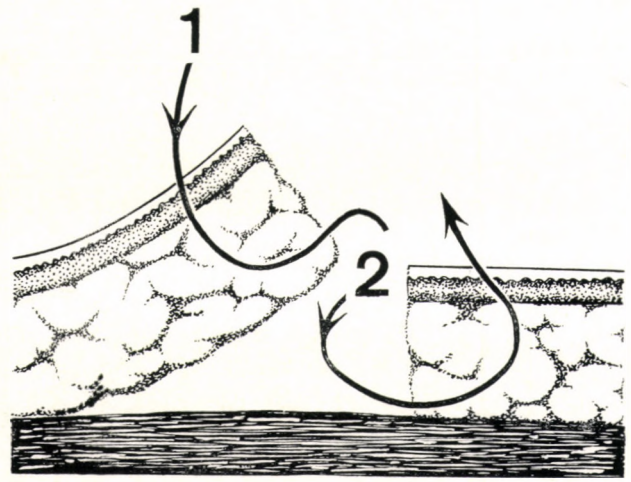
C

D. When wound edges of different thicknesses occur, a stepoff scar will result unless appropriate adjustment of the bite on the thinner side is made.

$a = b$

D
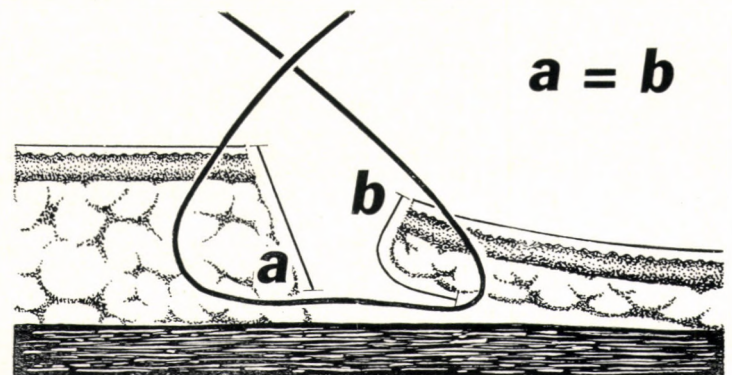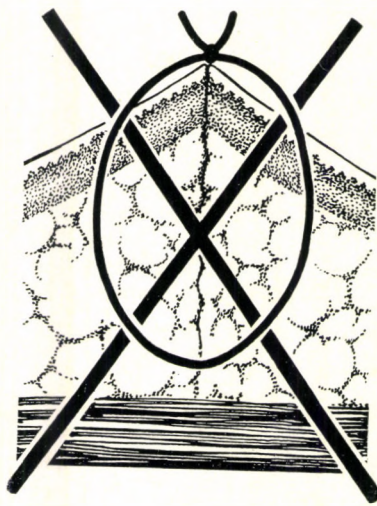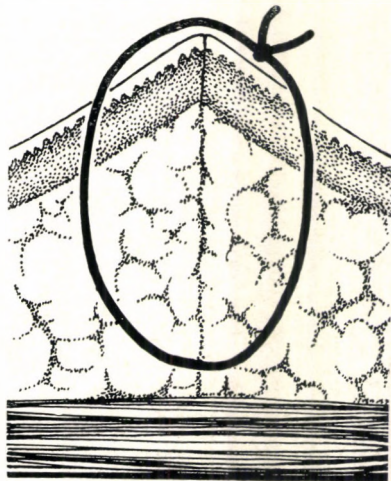
E. Suture knots should be tied to lie on the side and not above the line of repair.
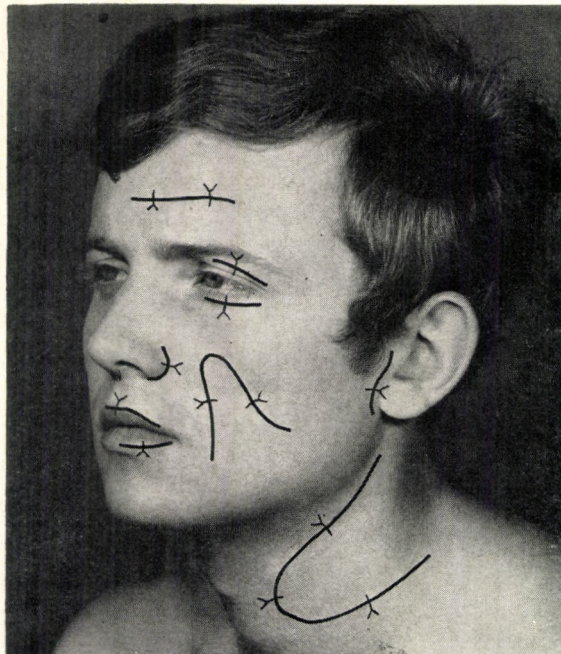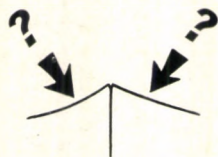
F. The decision as to which side of the repair the knot should be placed can usually be governed by placing the knot away from the most vital structure or where it is likely to show the least scar.

The Horizontal and Vertical Mattress Sutures

There are times when a horizontal mattress or vertical mattress suture is more appropriate than a simple interrupted suture. Both these stitches have the advantage of naturally everting the skin edges.
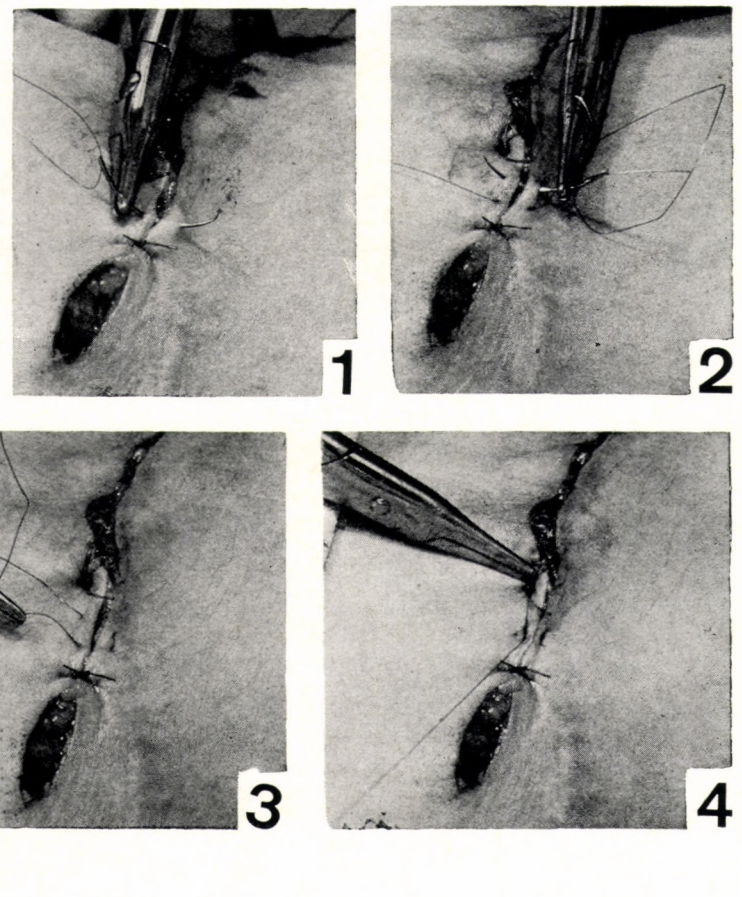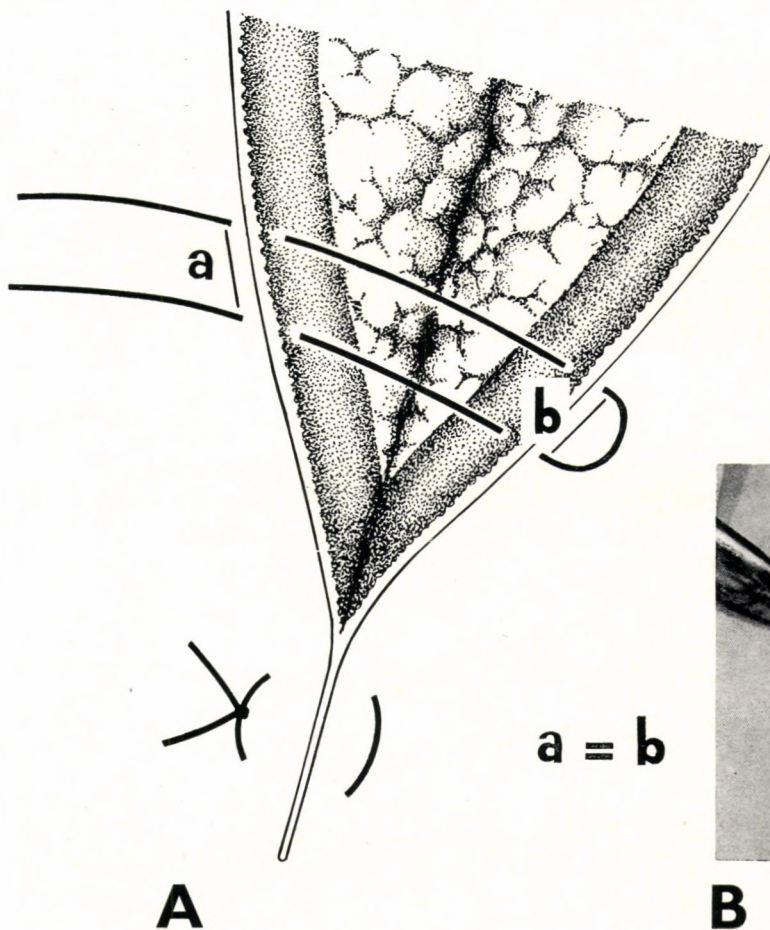
A and B. Diagrammatic representation of the horizontal mattress suture and the technique performed (1 through 4).

$$a = b, \quad c = d, \quad e = f$$
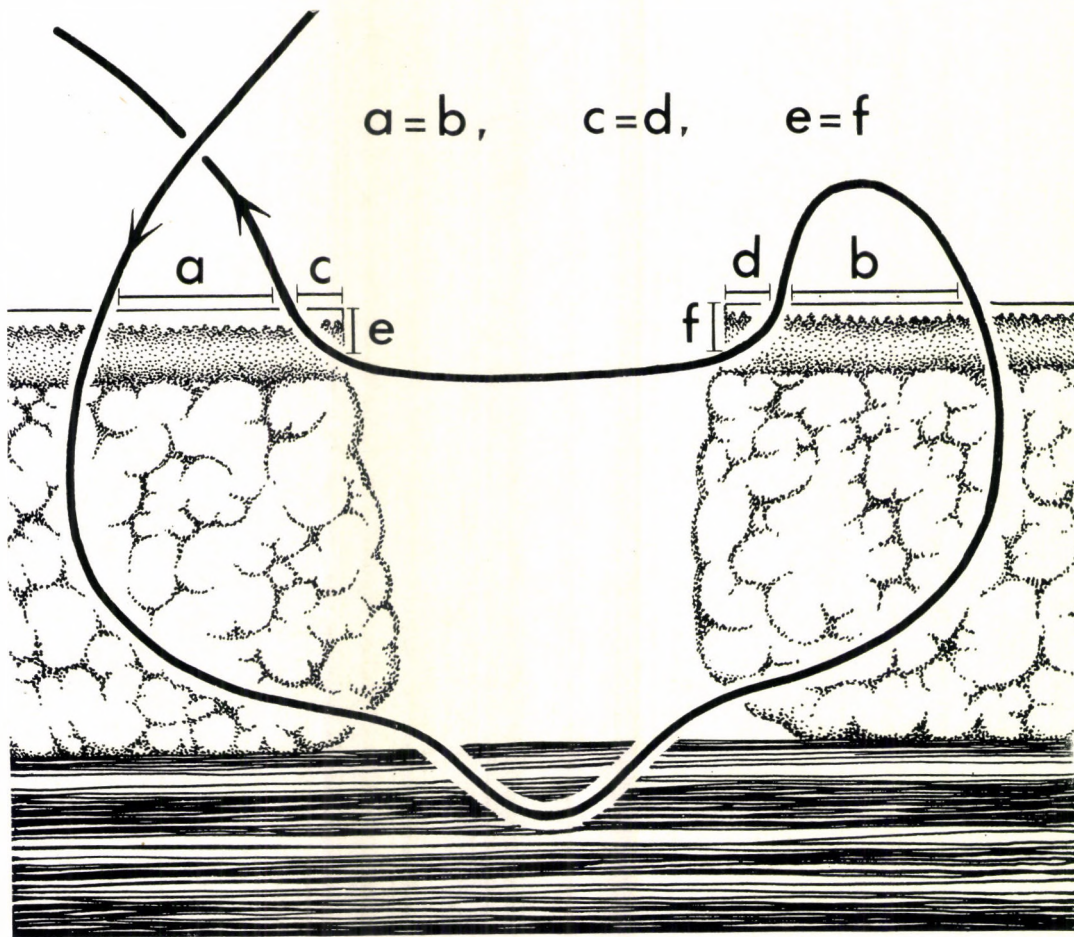
C
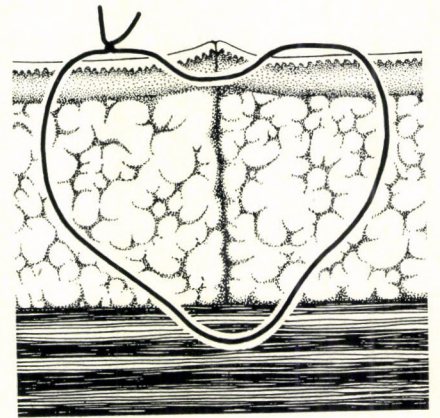
C. The correct placing of the vertical mattress suture.

D

1

D. In 1 through 5 the technique of the vertical mattress suture is shown.
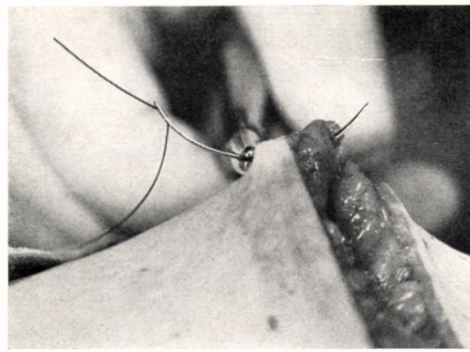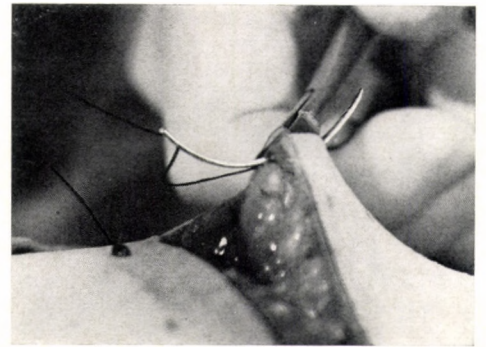
2
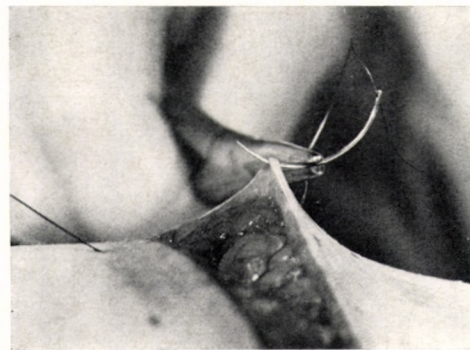
3
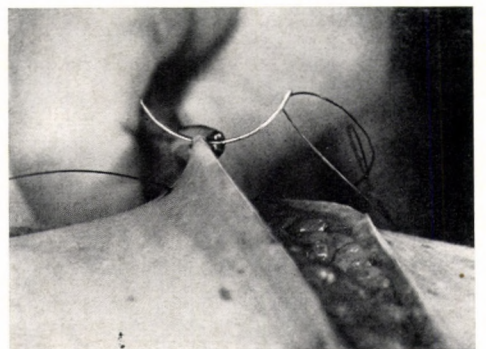
4
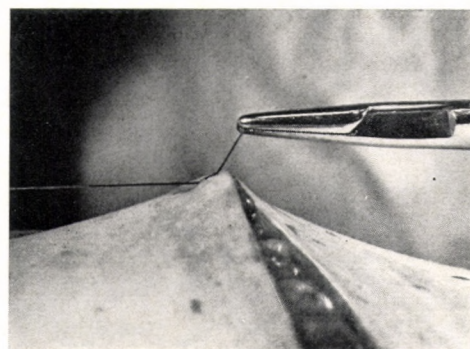
5

"Corner" or "Tip" Stitches

The blood supply of acutely angled, triangular areas of skin is often precarious. Simple interrupted sutures perpendicular to such surfaces could compress the subdermal network of vessels and result in necrosis of the tip of the triangle.
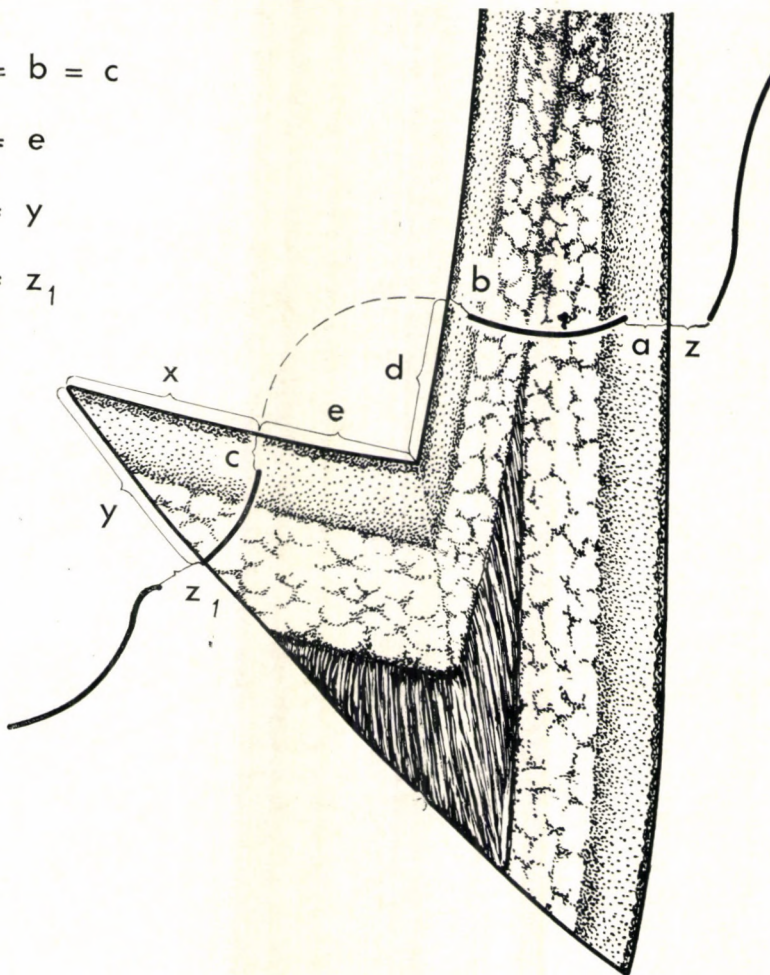
A. The technique of the corner or tip stitch, which ensures that the suture runs below the subdermal network; thus when the suture is tied, no compression on this delicate blood supply results.

$a = b = c$

$d = e$

$x = y$

$z = z_1$
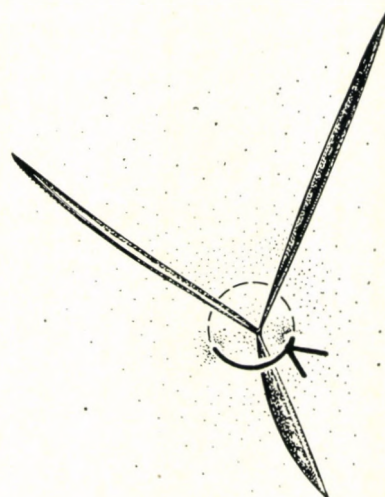
A
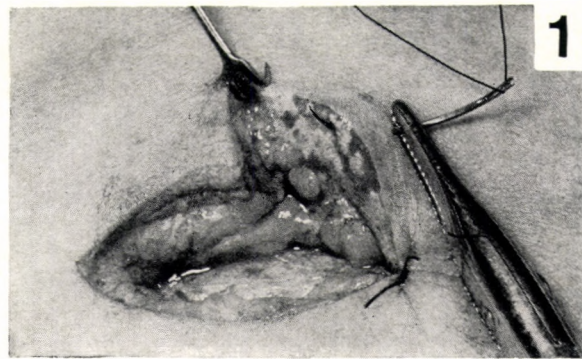
B

B. The technique is well demonstrated in 1 through 6.

C. A similar technique can be used for closing small triangular and irregular defects.
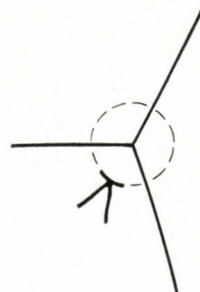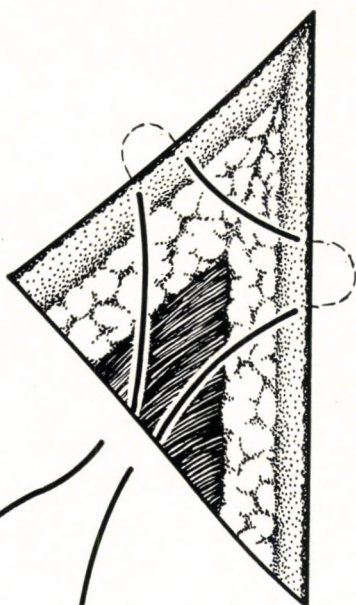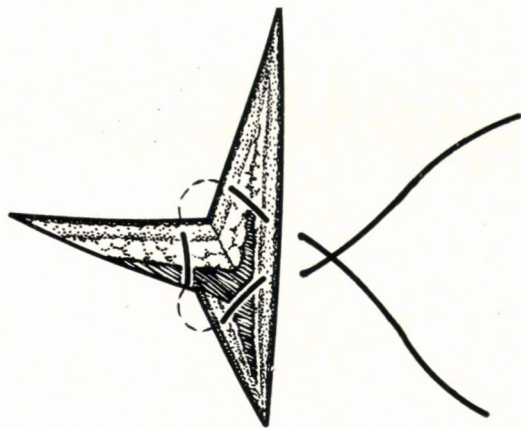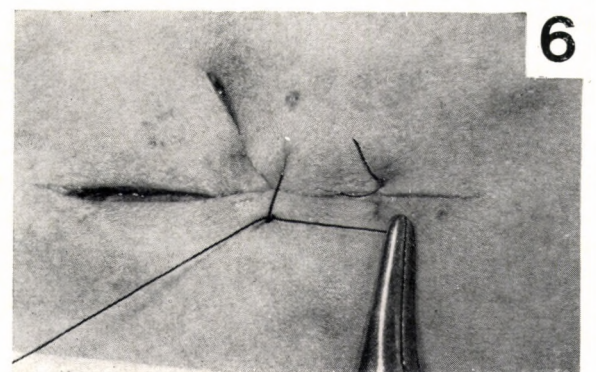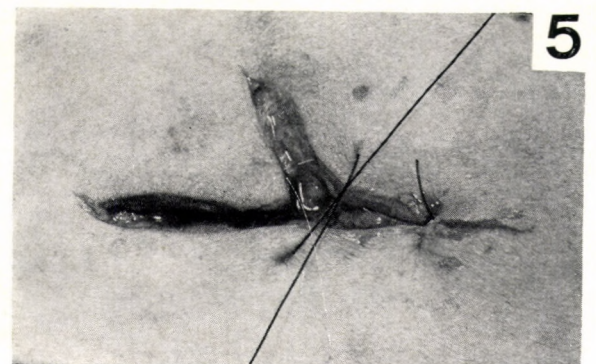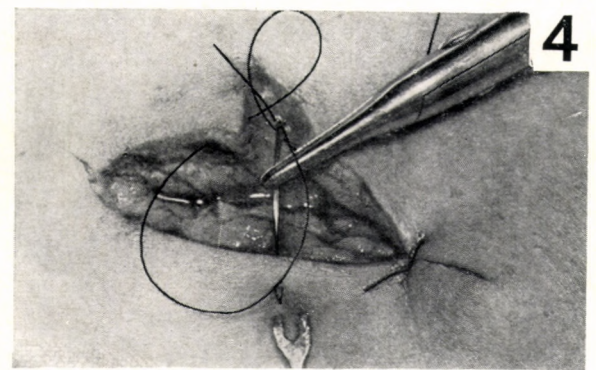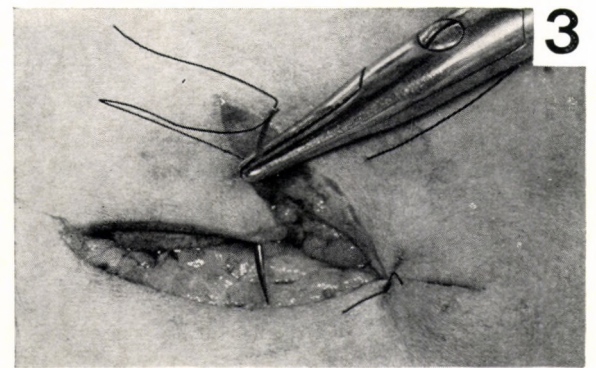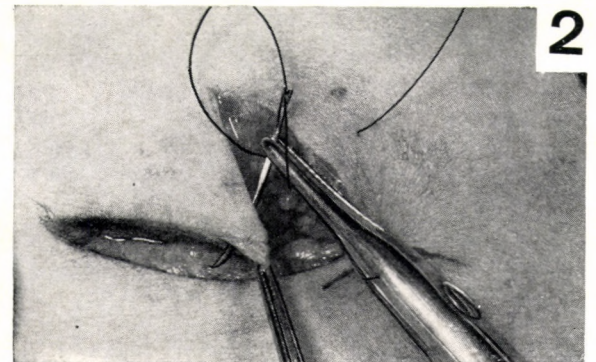
C

Closure
of Superficial Wounds

A single row of intracutaneous running sutures is employed for the management of wounds that extend only to the subcuticular adipose tissue. The strength of the closure is supplemented by the use of "steri-strips."
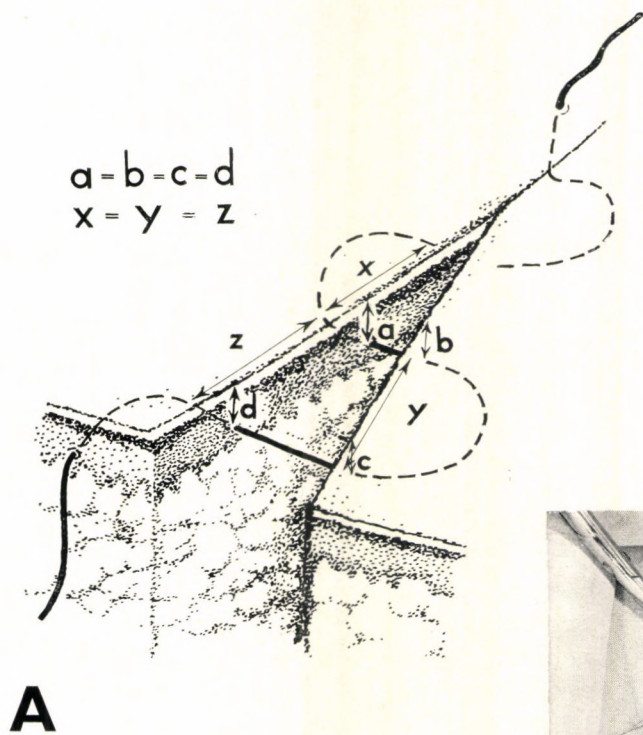
A. Diagram showing the placement of the running subcuticular suture.

B through E. The actual suture placement.

$a = b = c = d$
$x = y = z$

A

B

C

D

E
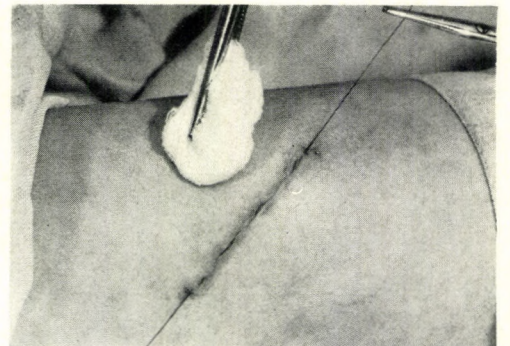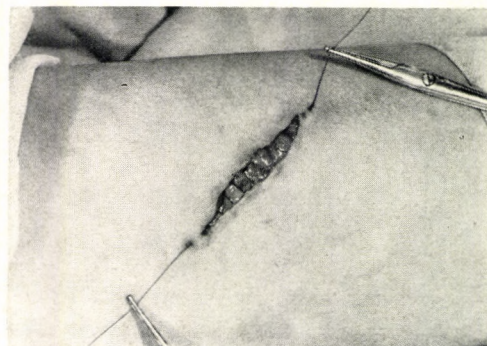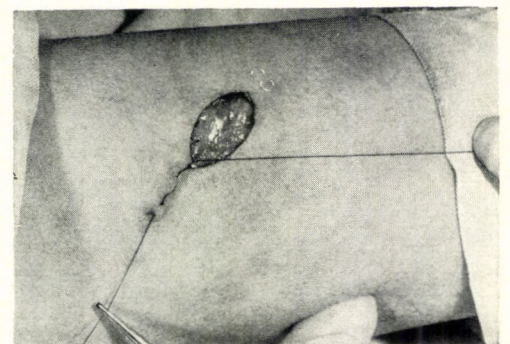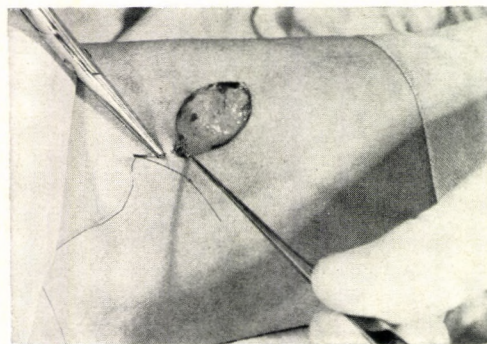
F through J. Steri-strips are used to supplement the wound closure. These are placed both across the suture line and along the length of the wound to secure the cross strips and immobilize the loose ends of the running suture.

F
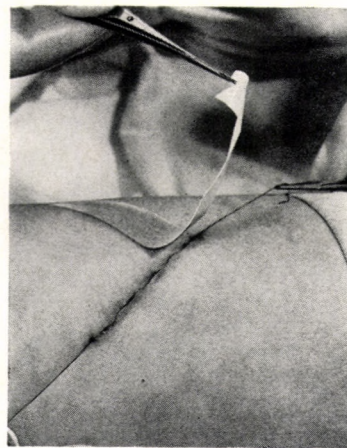
G
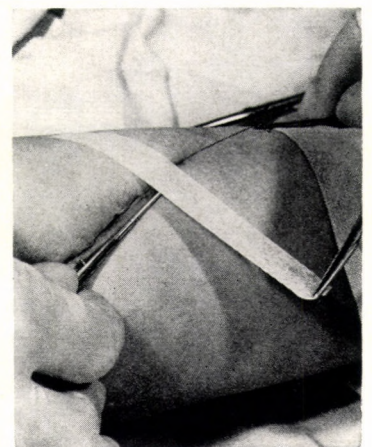
H
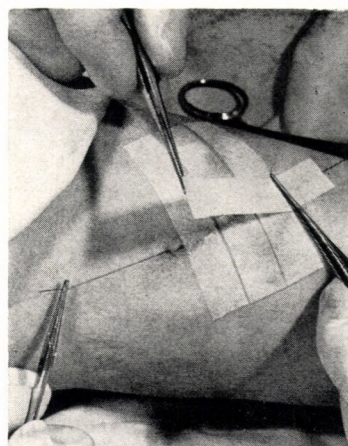
I
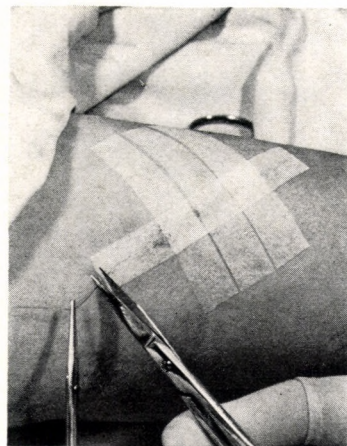
J

Closure
of Deep Wounds
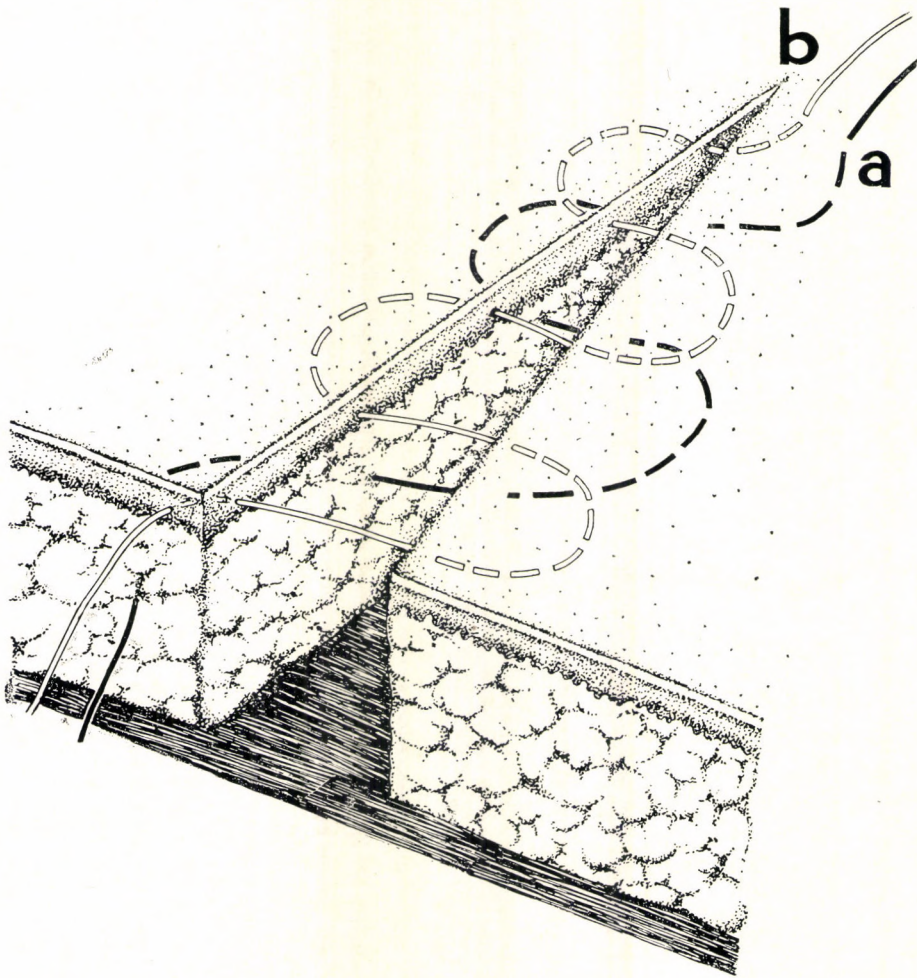
A. Deep wounds involving skin and subcutaneous tissue should be closed by two rows of running sutures. The deeper suture (a) runs in the approximate middle of the subcutaneous tissue; the superficial suture (b) is kept in the corium. Both ends of the two sutures are brought to the surface and tied next to the two terminal points of the wound. This tie can be made over a button or a cotton tube.

A

B
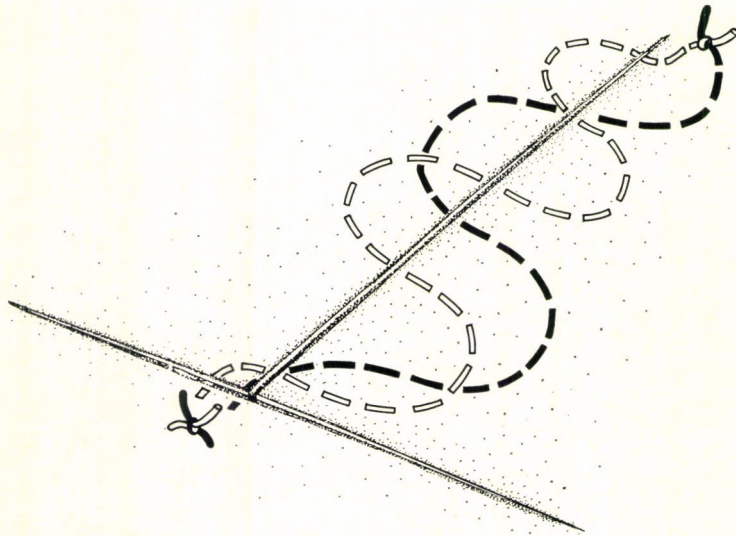
B through D. Insertion
of the deeper suture.
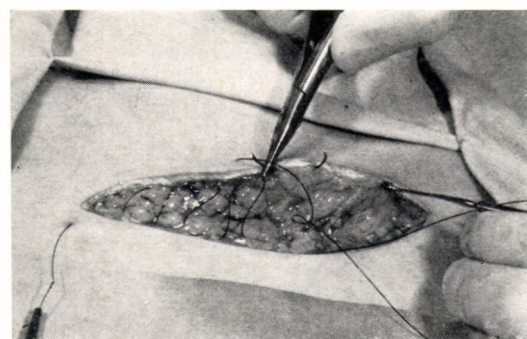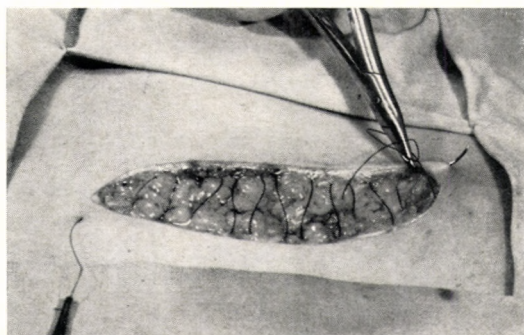
C
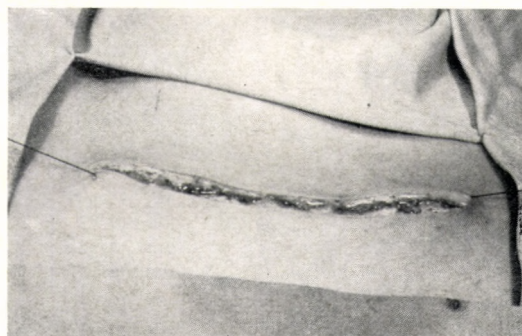
D

E. If the wound is extraordinarily long and
suture removal would be difficult, it is advis-
able to interrupt the superficial suture at 6-
to 8-cm intervals.

6 - 8 cm

E

F

G
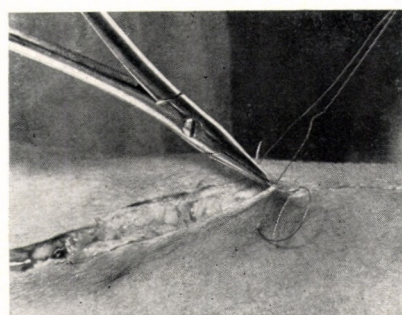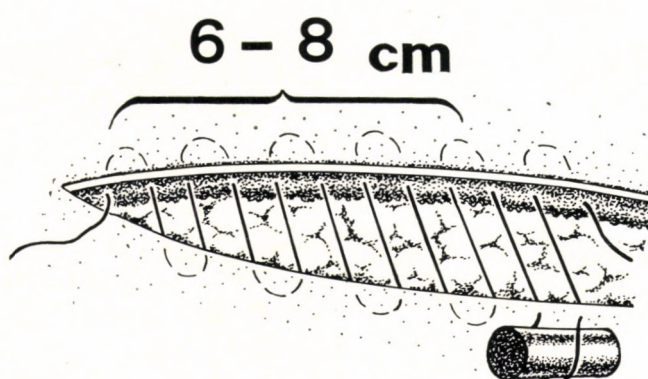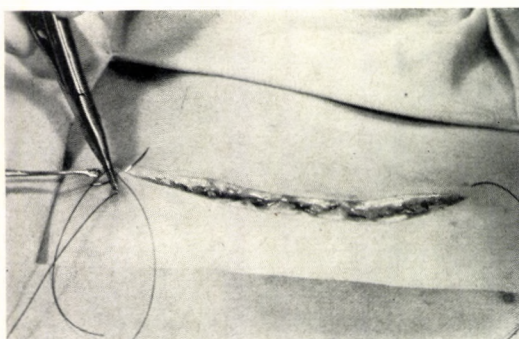
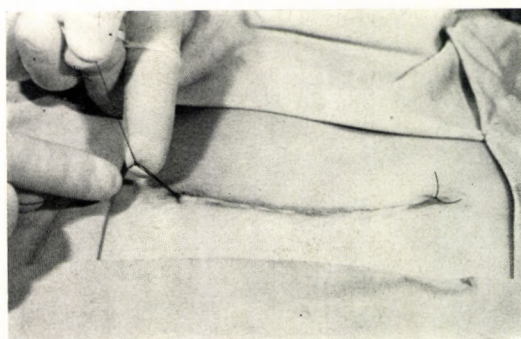F through K. Insertion of
the superficial suture and
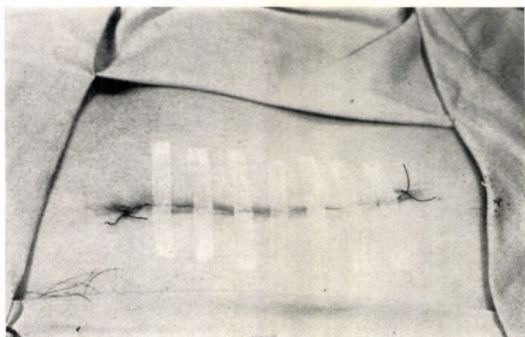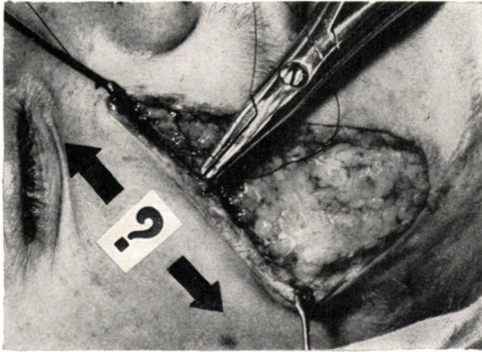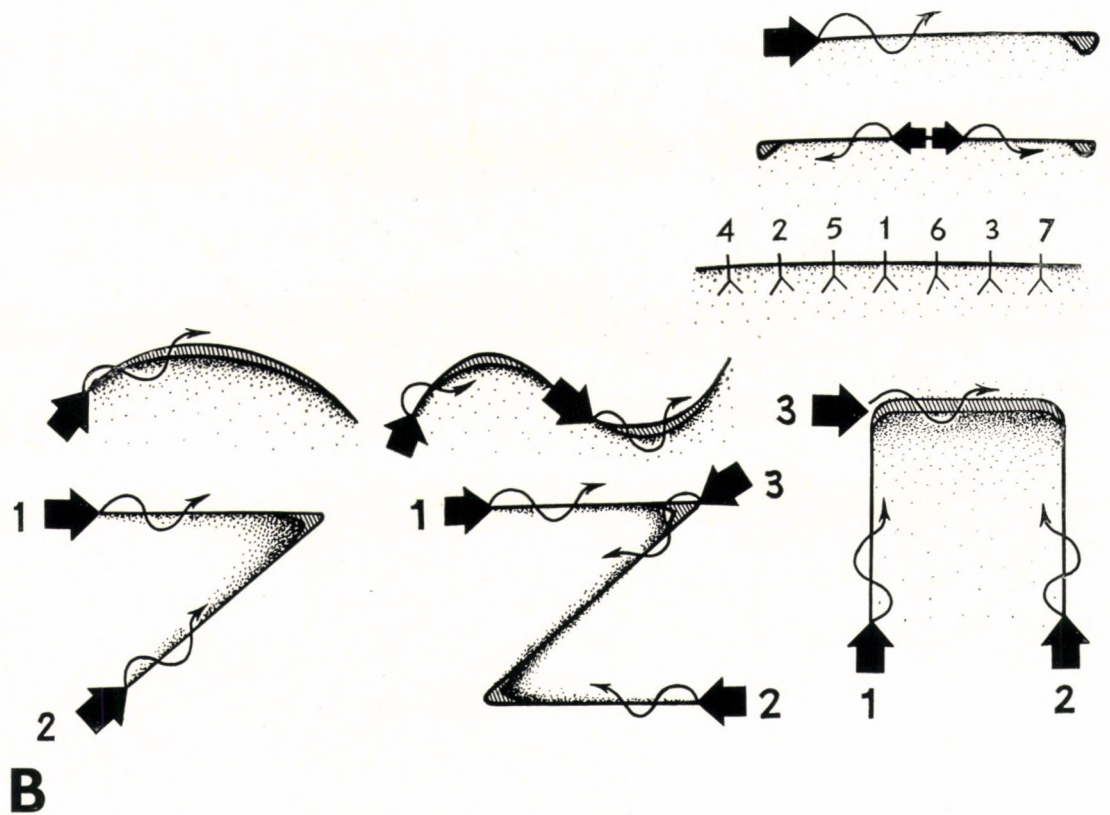the two sutures being tied.
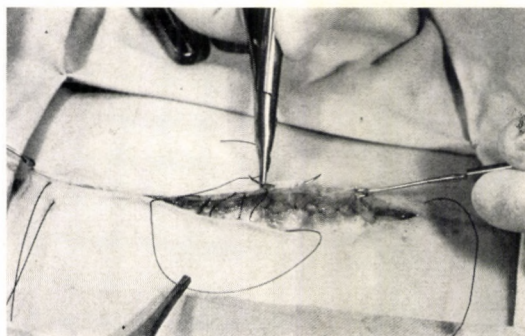

H
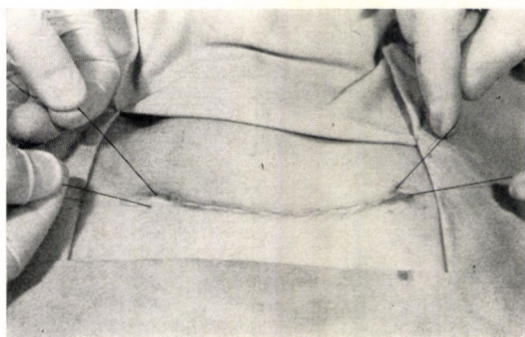
I

J

K

Direction of Suturing

A. The starting point and direction of suturing are of importance in the closure of skin wounds.

B. On terminal points of a wound united by running suture, the skin usually forms a so-called "dog's ear" which has to be excised. One method to obtain even wounds is the "halving" method. In managing curved wounds or those with acute angles, the suture must be interrupted at each change in direction. Suturing should always be made toward the vertex of acute angles.
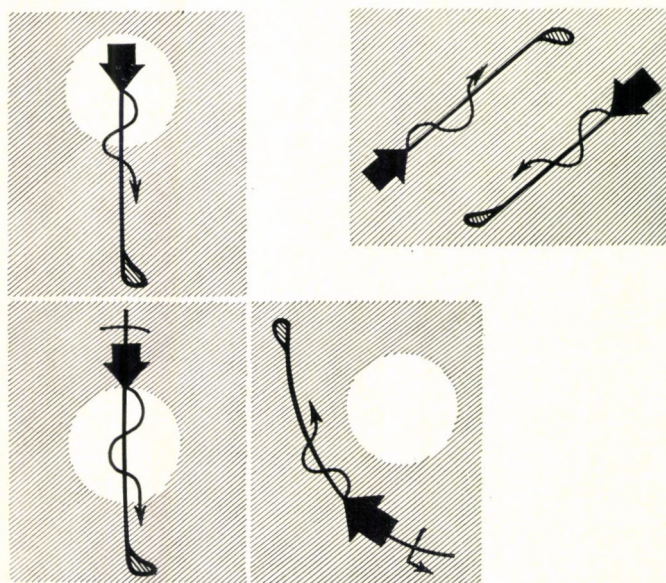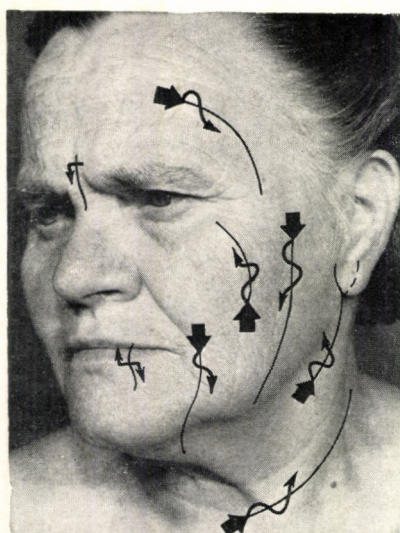
C. If the operative region includes a functionally important structure, suturing should begin near the critical area and proceed away from it.
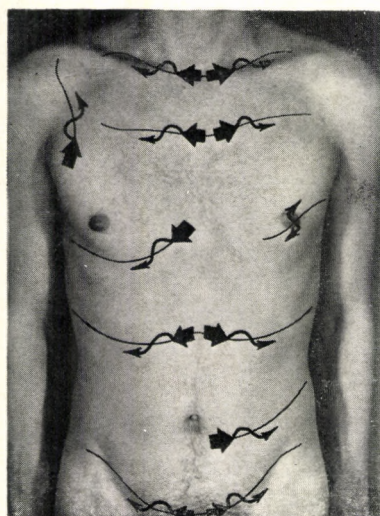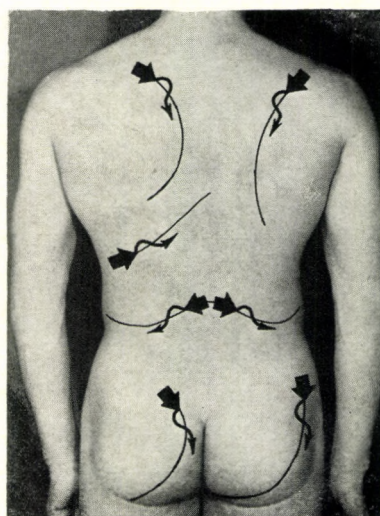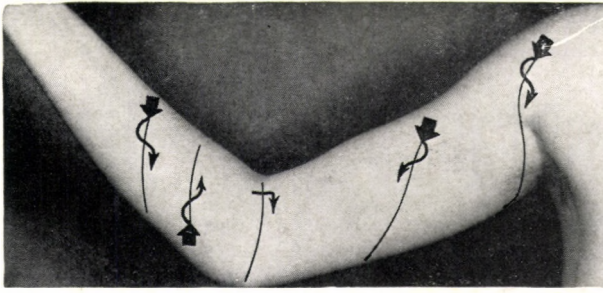
C
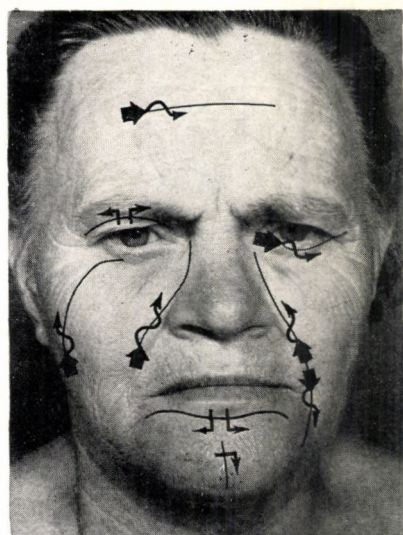
D

E

D through L. Suture directions in various regions of the body. Face, D, E. Trunk, F, G. Arm, H. Hand, I, J. Finger, K. Leg, L.

F

G

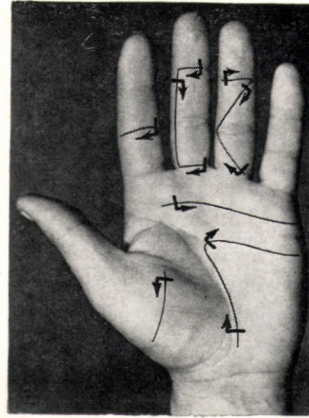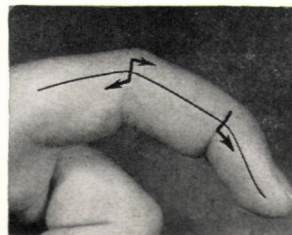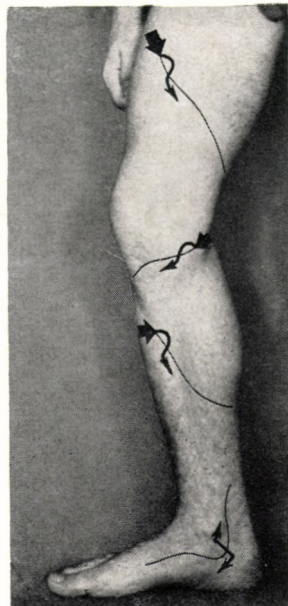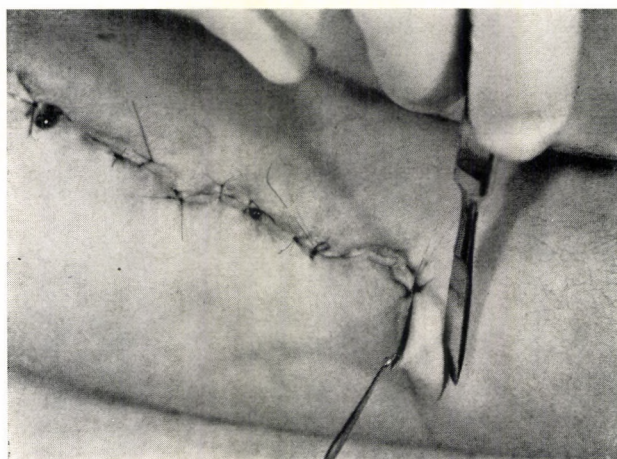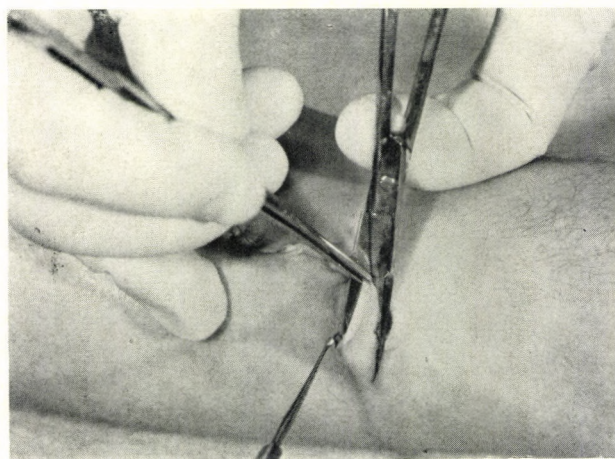H

I

J

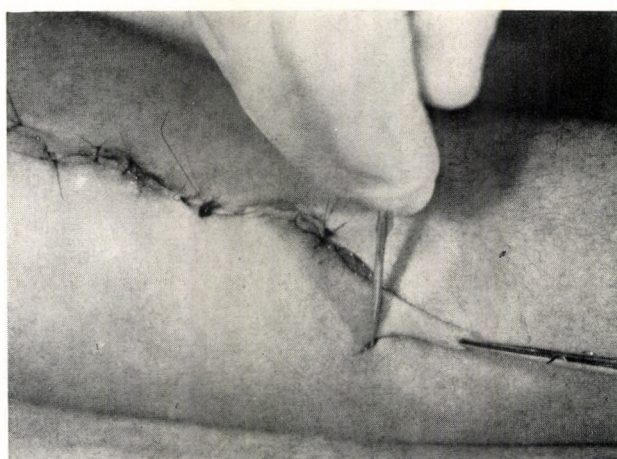
K

L

Excision
of Dog's (Pig's) Ear

When the two margins of a wound are of unequal length, the skin of the longer edge is excess and forms a tag commonly known as a "dog's ear." This must be removed.


A

B

C

D

A through D. The technique of removing the "dog's ear." The excess skin is lifted with a hook; an incision is made on one side; the triangular flap thus formed is undermined and removed. Excision of the "dog's ear" should be made according to the lines of skin tension.

E. If the tension lines arch away from the end of the suture line, the excess skin must first be incised on the convex side, undermined and then excised along the concave side. The resecting line of incision should be in the lines of tension.
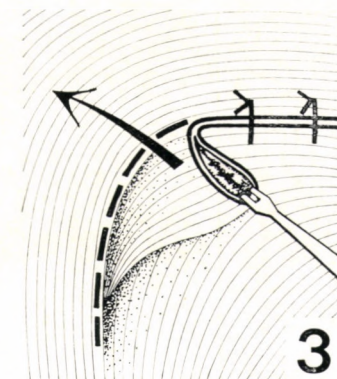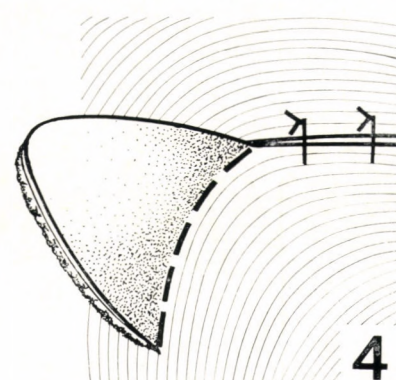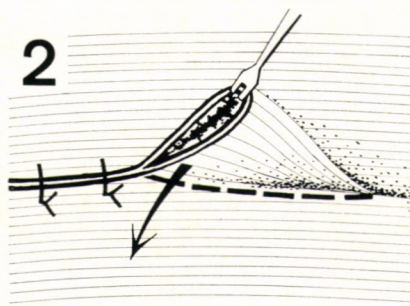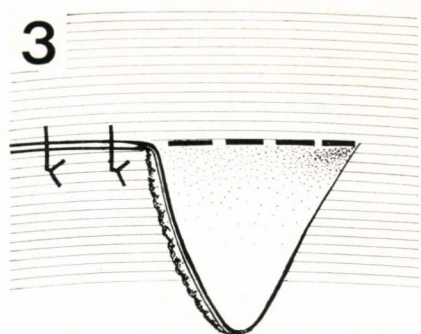
E

1
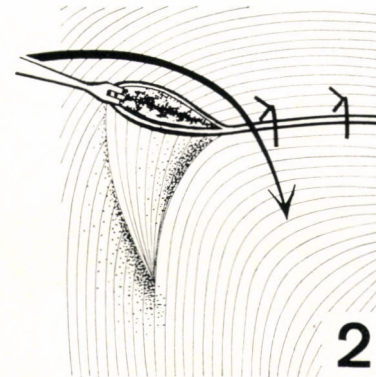
2

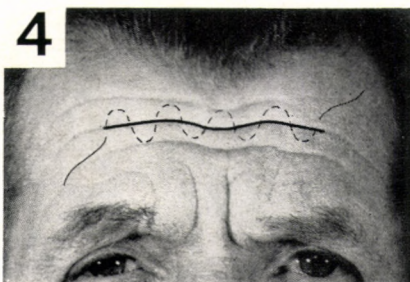
3

4

5

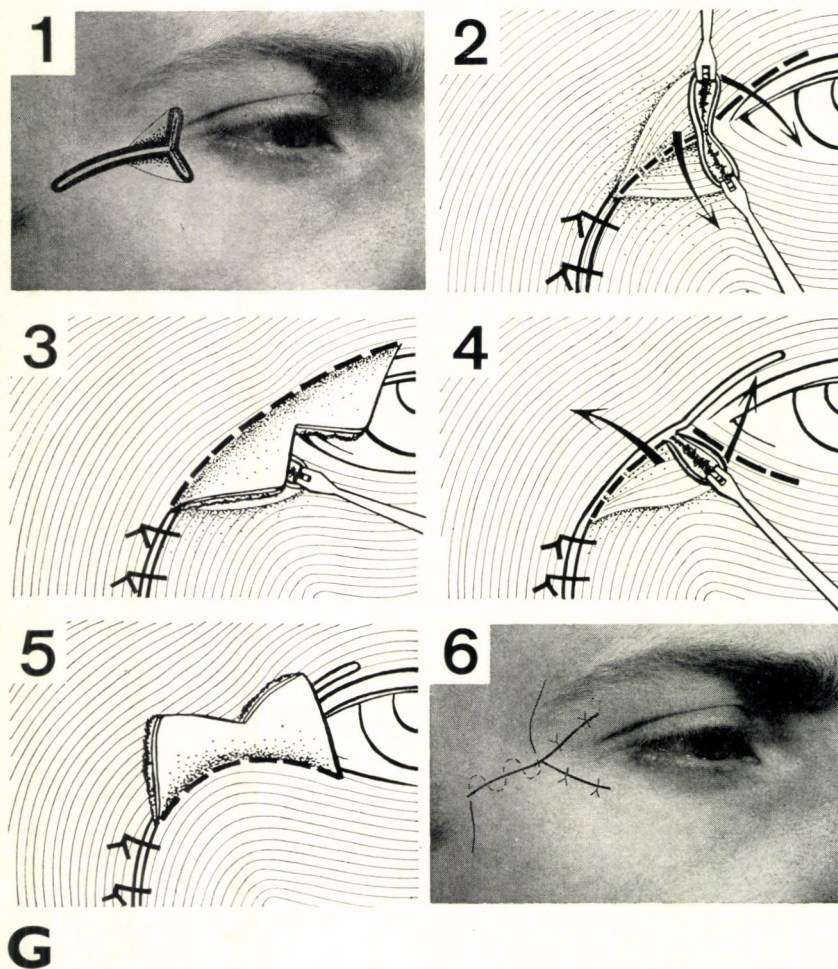
1

2

3

4

F

F. Excision of the excess skin when the lines of tension follow a straight course.

G

G. Around the canthus, where the skin tension lines run in branching directions, the excess skin must be divided into two parts, as illustrated.

Techniques of Excision and Closure

A. On the removal of a diseased area total excision of the pathologic structure is the prime consideration. Do not compromise total excision for easy closure, since closure can be effected in one of many ways.

A

B
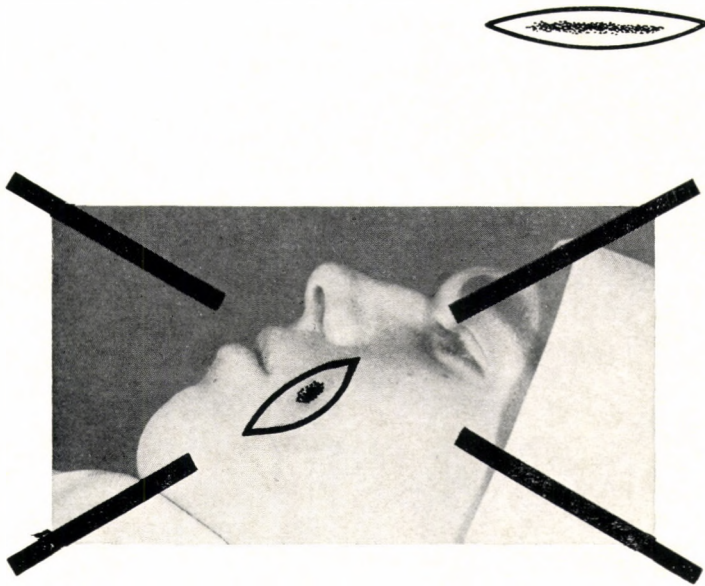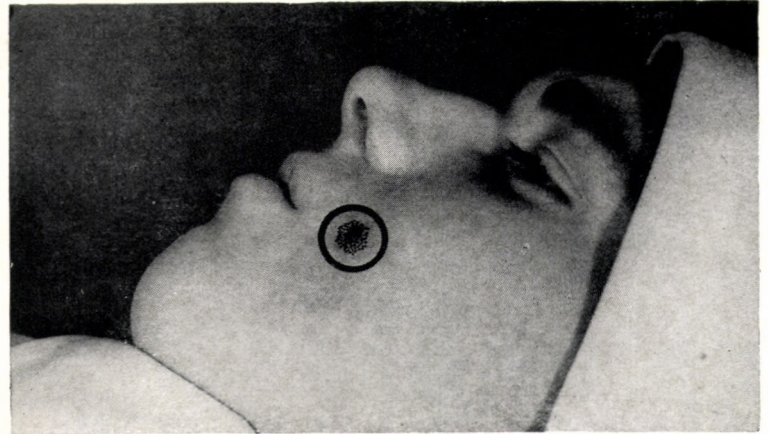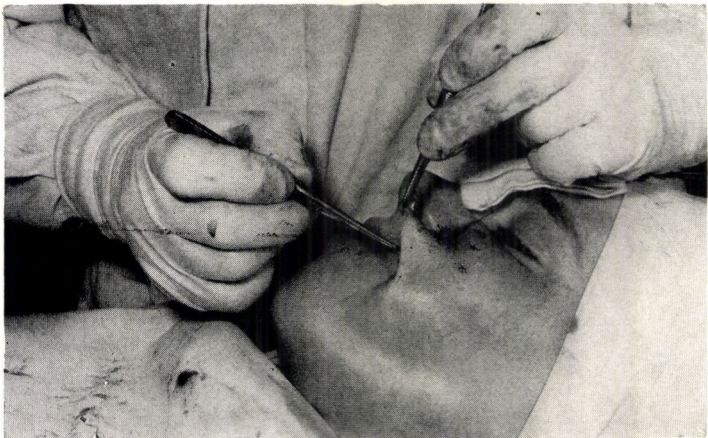
B and C. The principle of undermining wound edges enough to allow a tension-free closure.

C

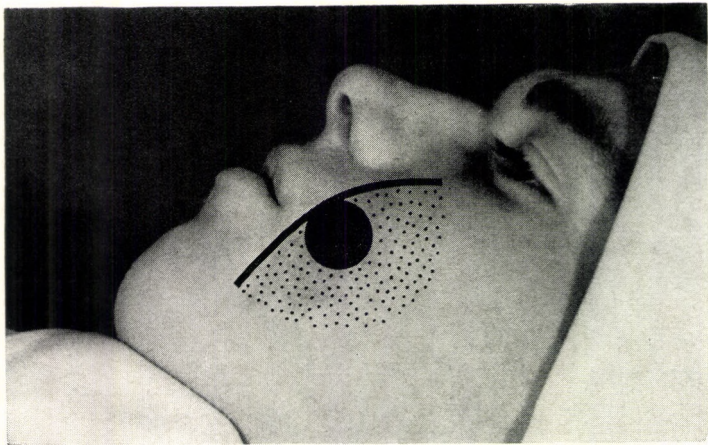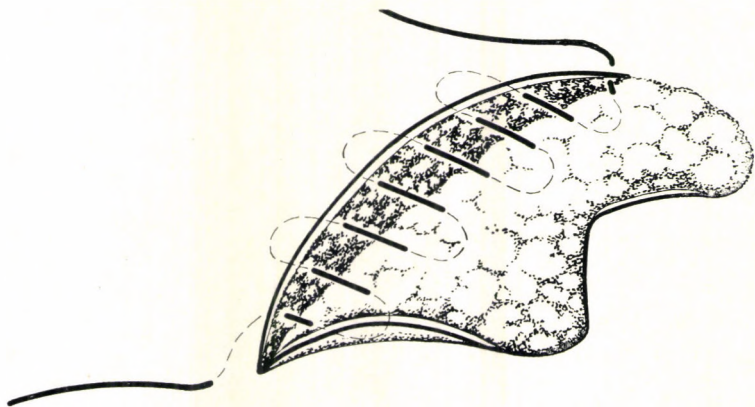

D. If the wound edges can be approximated without stretching, the base of the immobile portion can be united with the mobile subcuticular layer by suture. After this suture is placed, the amount of excess skin becomes visible.

D
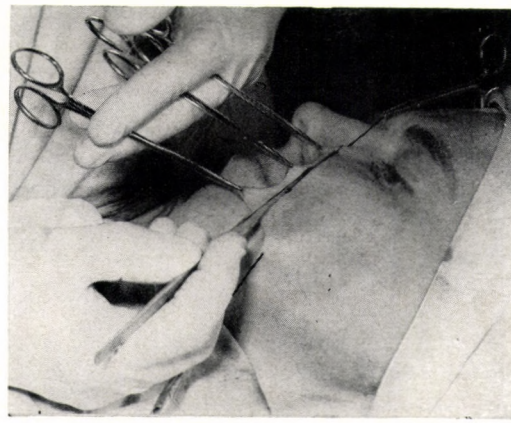
E

F

E through G. The excess skin is then removed and the wound completely closed.
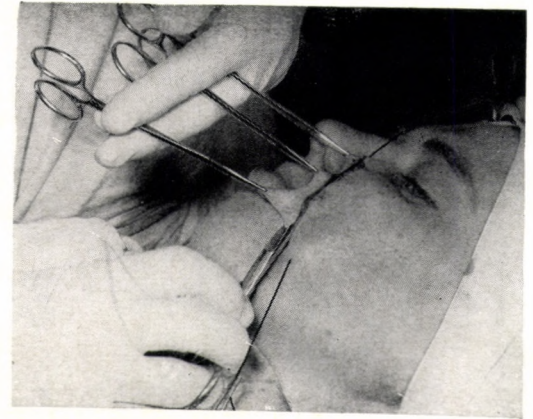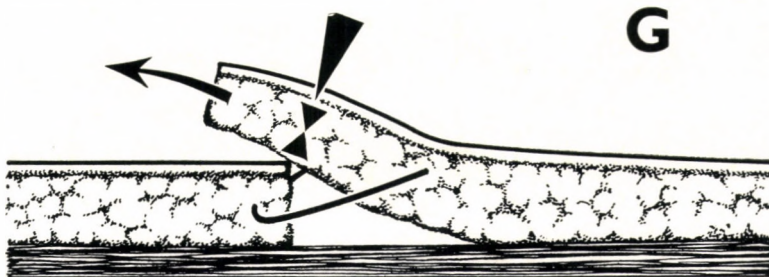

G

Stairstep Unification
of Wound Edges

If important deeper structures such as tendons and bones have
been surgically treated, the overlying skin and subcutaneous tissue
may be closed in "stairstep" fashion to create a broken scar and
healthy tissue may be placed over the repaired structure.

A

B

C
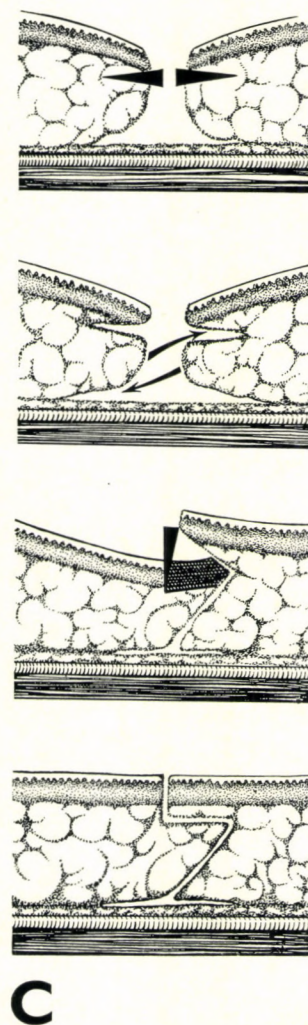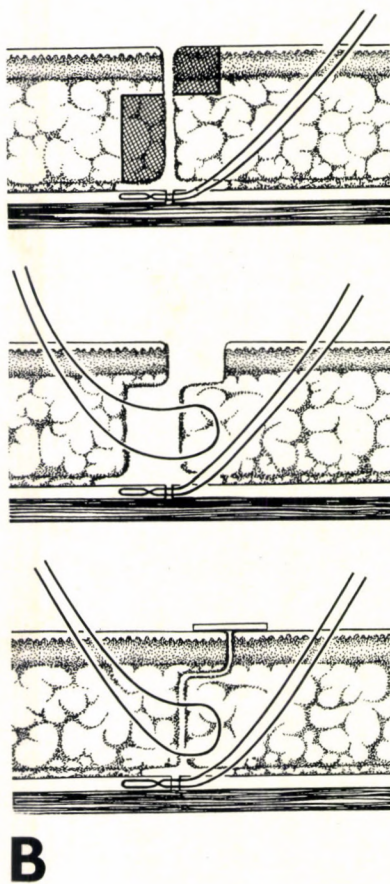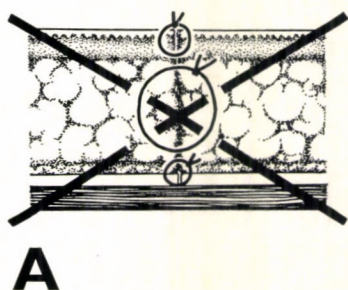
A. The layers of the tissues must not be united in the same plane
over a deeper moving structure.

B. Closure of the skin and subcutaneous tissue over a repaired
structure.

C. When the subcutaneous layer is thin, the two sides can be
mobilized and superposed, creating a broken incision and a some-
what thicker covering.

Z-Plasty

Z-plasty is an old and useful method of breaking up scars that run at right angles to the proper line of incision.

A. This method consists essentially of making two accessory incisions of equal length running at 60° to the original line of the wound. The two triangular flaps thus formed are unde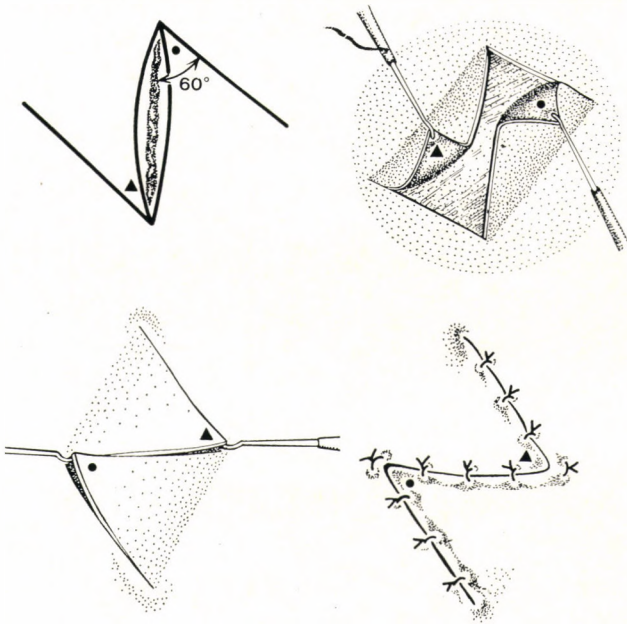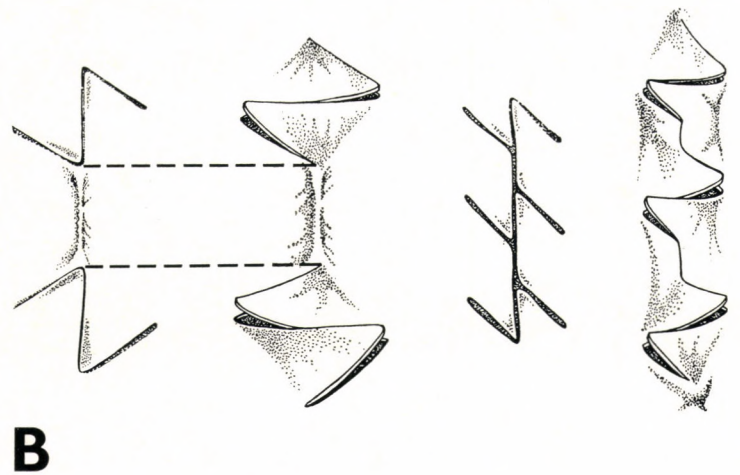rmined, transposed, and sutured. In this way three incisions, instead of the original single line, are made: one (the middle one) is optimal, the other two are more acceptable. Z-plasty also adds some degree of length to the incision and changes the general direction of the scar to a more favorable line.

$A_1 B_1 = x + y$

A

B
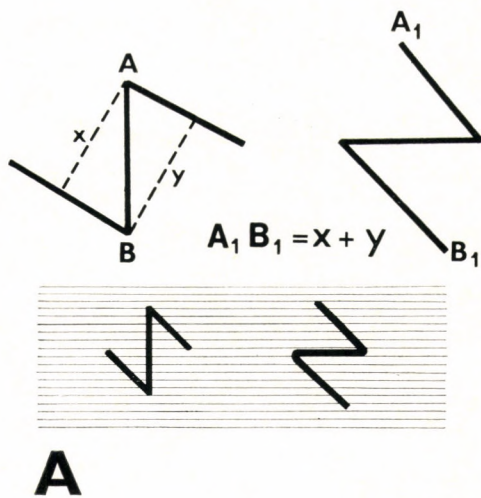
B. A series of successive Z-plasties used to divide a long wound into optimal scars interposed into the course of the incision.

1

C

2
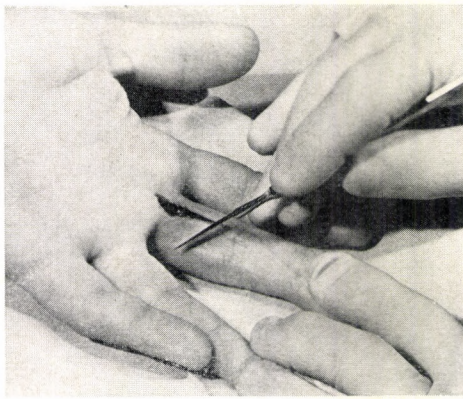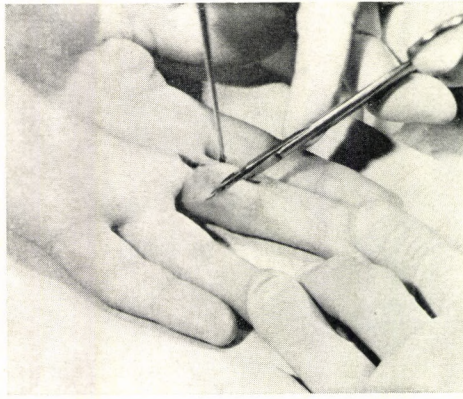
3

4

5

6

7
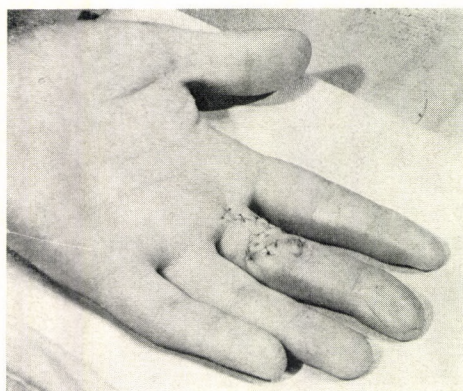
8

C. The surgical technique of the Z-plasty is demonstrated in 1 through 8.

Keloids and Hypertrophic Scars
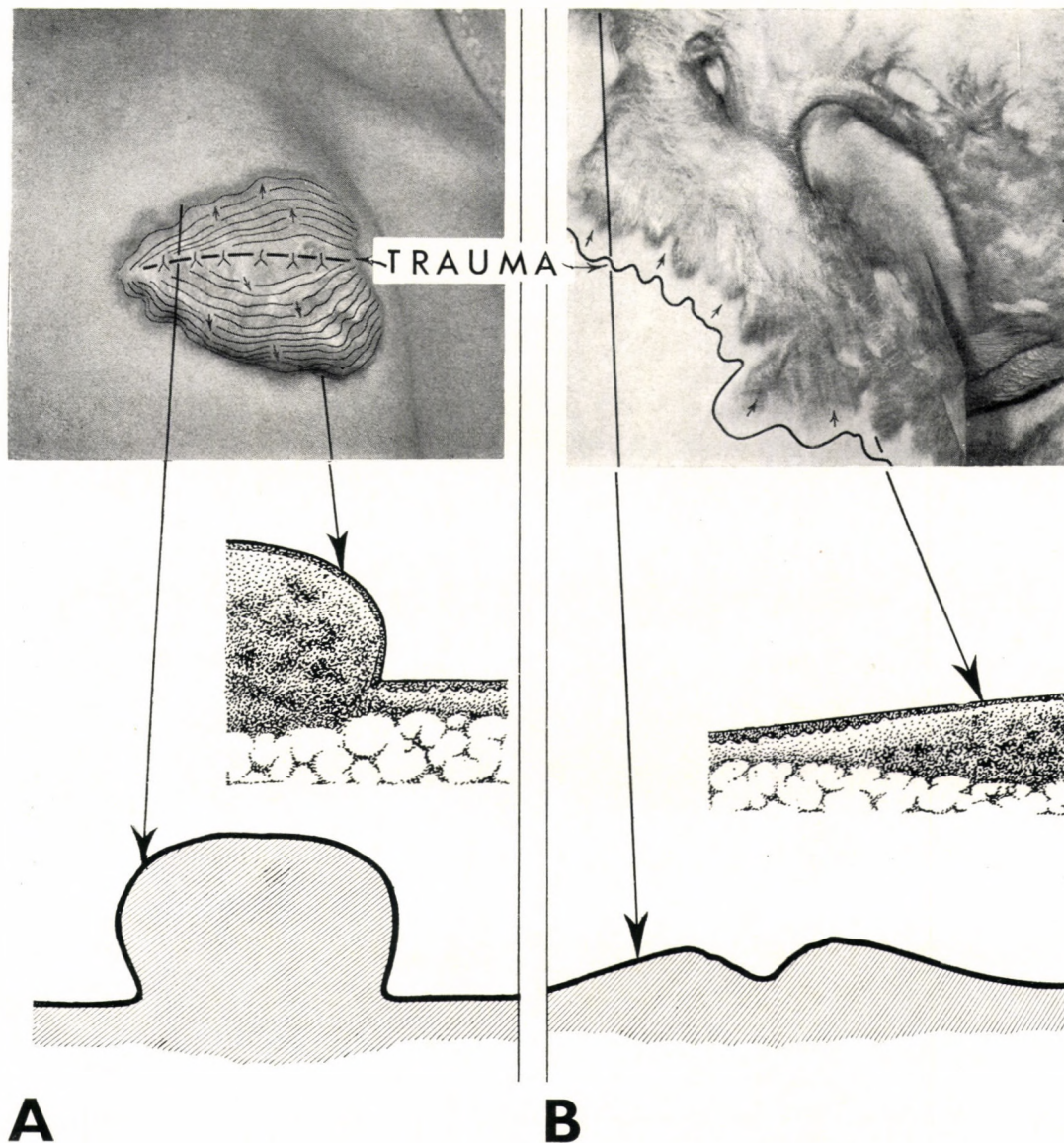
A and B. Keloids and hypertrophic scars arise in response to injuries such as lacerations, surgical incisions, burns and infections. Keloids are benign tumors of dense, fibrous tissue which develop in the dermis and are usually covered with a thin layer of epidermis.
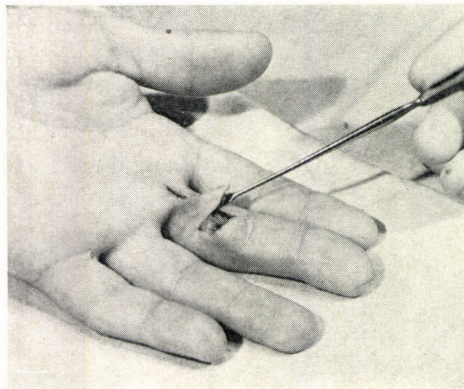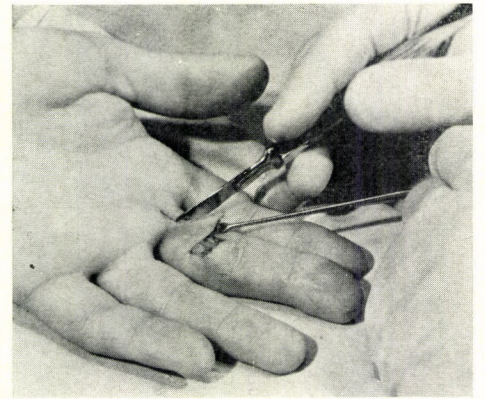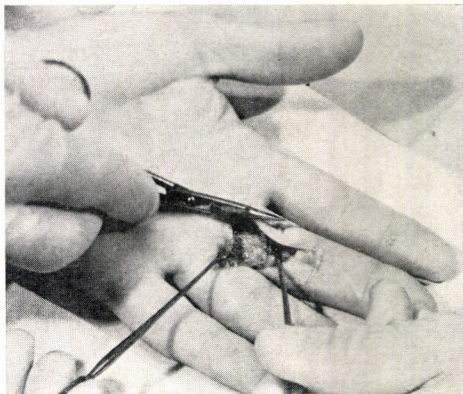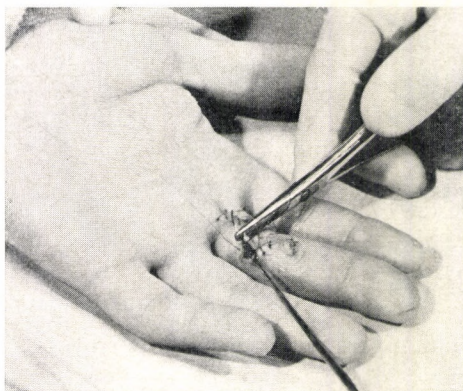
In both these conditions, there appears to be some abnormality in the fibroplastic proliferation phase of wound healing. In the keloid, this process continues after normal healing would have ceased with the tumor enlarging and extending into areas of skin outside the limits of the normal wound trauma (A). The keloid protrudes from the surrounding skin with sharp boundaries, but the surface may be quite smooth.

The hypertrophic scar, although showing an overreaction to the fibroplastic proliferation phase of healing, does not extend outside the limits of the wound. These scars protrude less from their surroundings and have an irregularity of their surface, in comparison to the keloid (B).
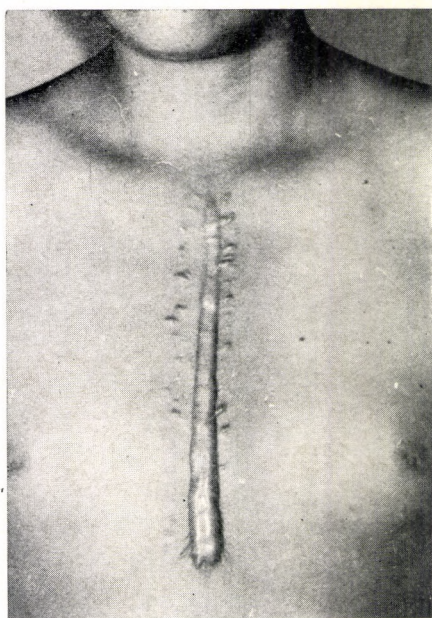
C through F. Typical sites for keloid formation are the sternal area (C and D), the shoulder (E) and the lobe of the ear (F).

G

G and H. Typical hypertrophic scars in the region of the neck and the sternal area. The lower scar looked like a keloid, but excision and skin grafting have healed well. suggesting that it was in fact a hypertrophic scar.
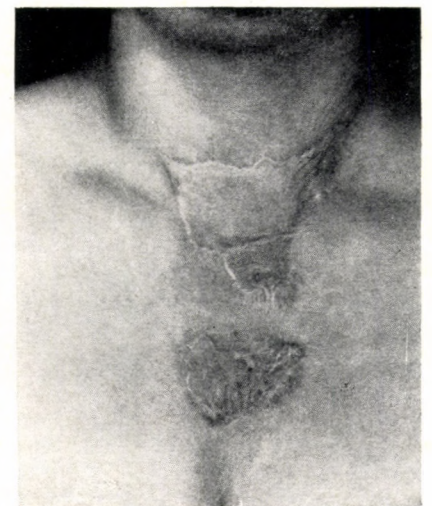
H

I
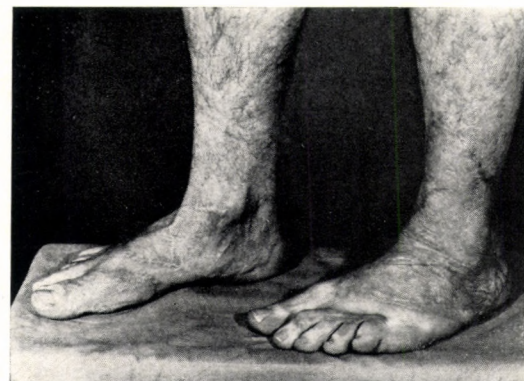
J

I and J. Hypertrophic scars looking like keloid on the feet. After excision and free skin grafting they healed completely.

Factors to be Considered in Excising Keloids

A

A. The keloid scar develops in the dermal area. When it is decided to remove a keloid, certain rules should be observed.
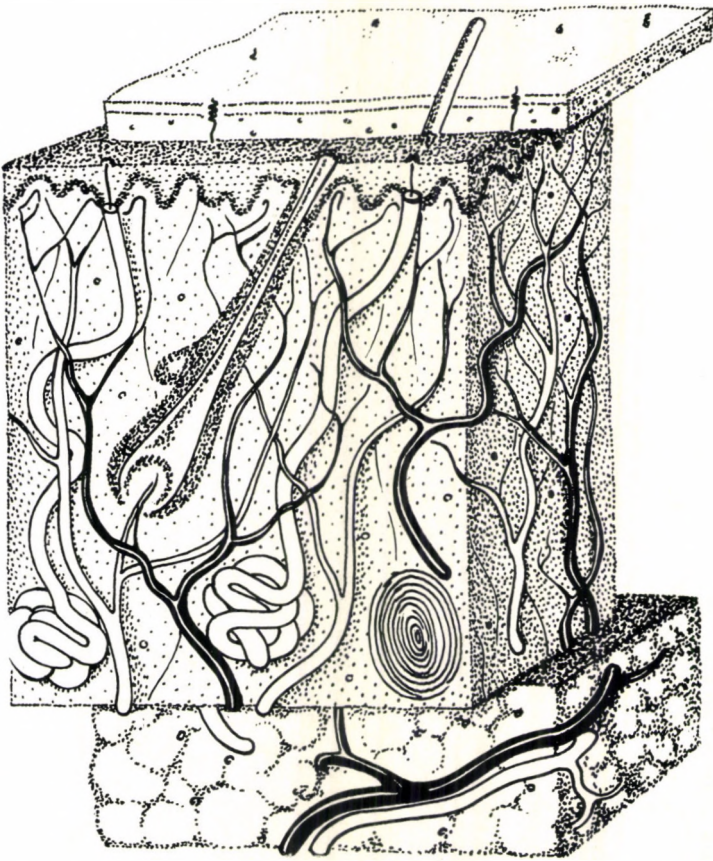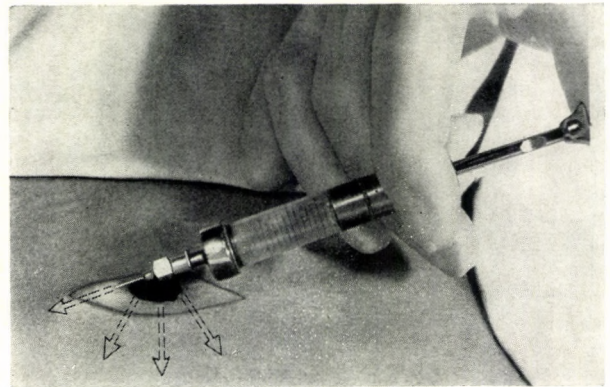
B

B. The proposed area of excision should be infiltrated with local anesthetic in the manner shown so that no needle puncture occurs outside of the site of the proposed excision.

C. The excision should be performed cleanly with little traumatization to the dermal area. Repeated cuts should be avoided.

C
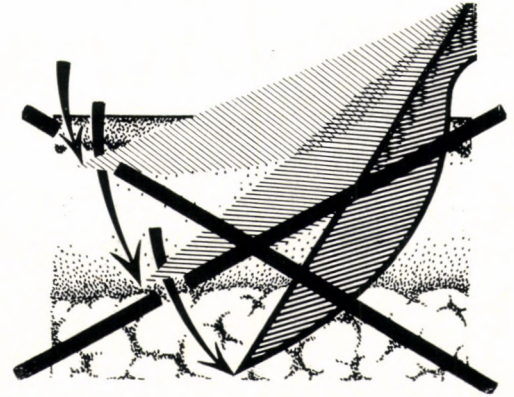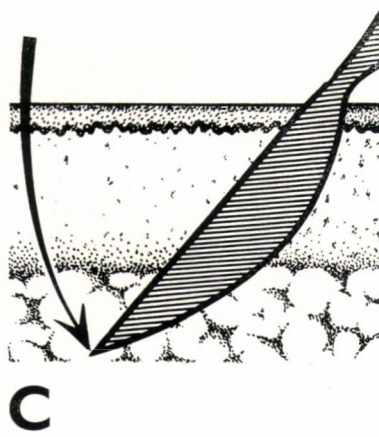
D. If undermining of the area to be closed is necessary, care should be taken to avoid using any instruments that will crush or pierce the dermis area.
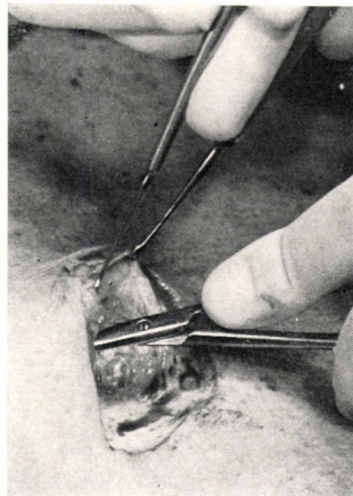
D
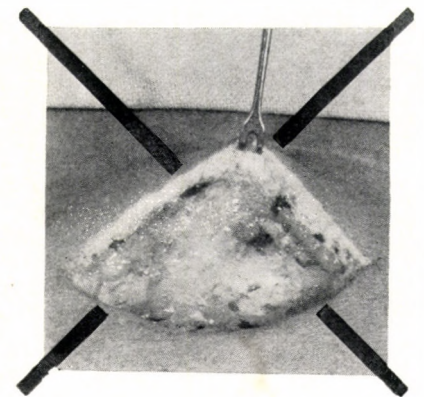
E. Cutting with scissors is inadvisable inasmuch as further dermal crushing and trauma will occur.
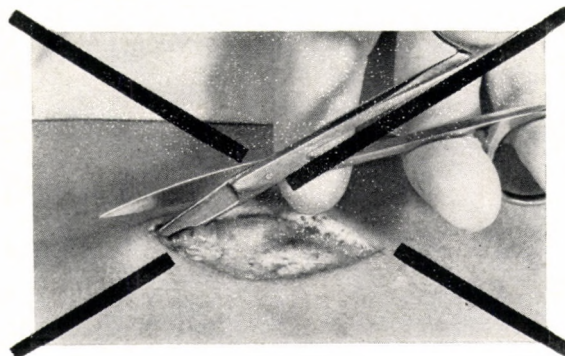
E

Closure
of Wounds Following Excision
# of Keloids

After excision of keloids the skin edges are brought together with little tension, and a row of subcuticular running suture is made for the closure. If, however, tension exists in bringing the skin edges together, a skin graft is indicated.
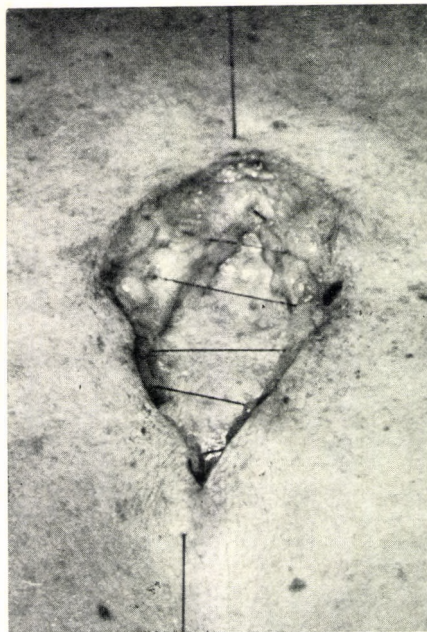
A. If the skin edges are brought together easily, the subcuticular stitch can be used for closure. Whenever possible, sutures on the skin edges should be avoided because these will invariably lead to further keloid formation.

A

B. Steri-strips can be used for final skin edge approximation.

B

C. If skin grafting is necessary, a thin graft should be taken in order to prevent development of keloid at the donor site.
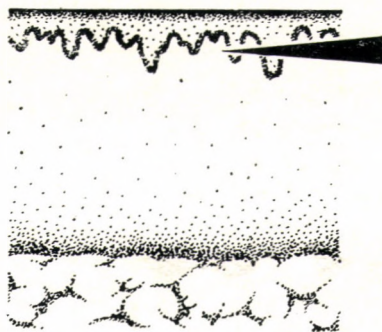
C

D. Skin grafts should be laid on the defect and, if possible, attached without the use of sutures. Some sutures are permissible in the deeper part of the wound; that is, in the subcutaneous tissue. But, as far as possible, suturing of the skin edges should be avoided. As shown in the diagram steri-strips have again been used to immobilize the skin graft.
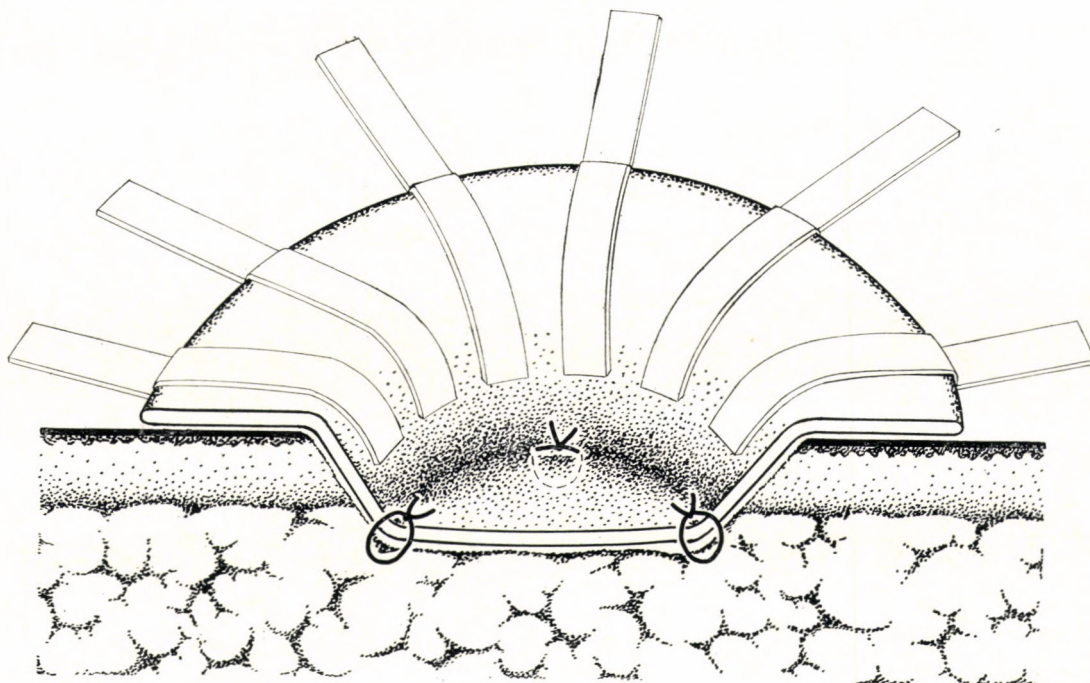
D

E. It has been found beneficial to immobilize the part even after minor operations on patients with keloids. Accordingly, extremities have been immobilized by plaster splints. This allows healing to occur with a minimal amount of trauma.

E

F

G

F and G. The photographs of the
popliteal region before and after
excision show a typical appear
ance of a keloid that recurs
around the edges of the graft
and also the keloid formation in
the region of the skin donor sites.

Intralesional excision of the condition has been performed in some cases
with varying success.

There have been varying reports of success with injection of steroids during
and after the excision into the site of the keloid. Some advocate steroid
injection into the area at intervals of two-three weeks for several doses.
Others advocate the use of X-ray treatment in the postoperative phase.
At this time no consistently satisfactory manner of treating this difficult
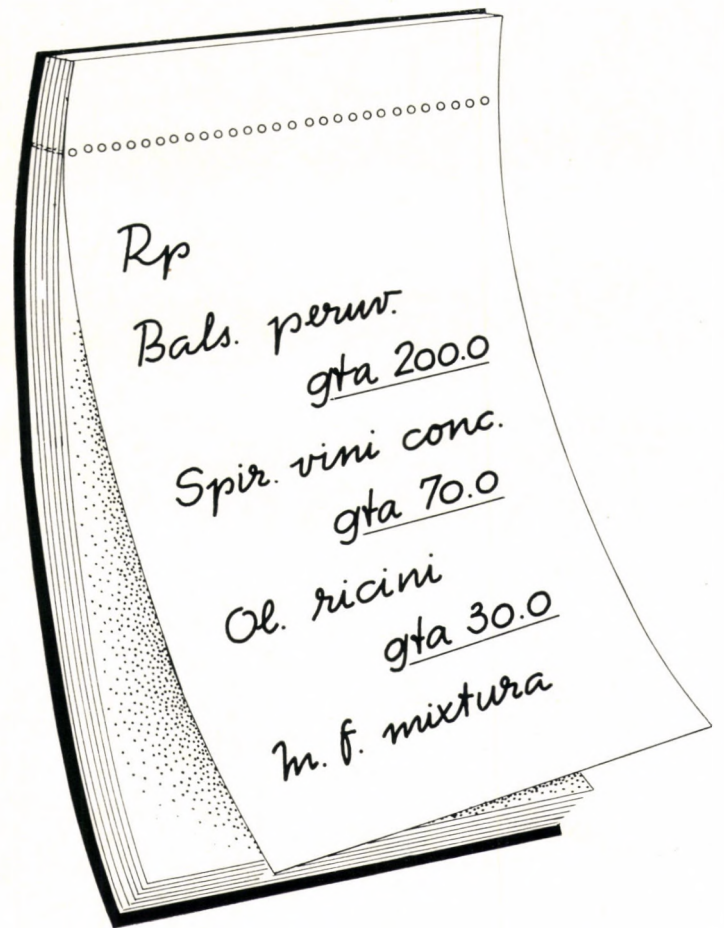condition exists.

The Lowermost Layer of Dressing: the Impregnated Sheet of Gauze

The first postoperative dressing should be so constructed that its subsequent changes can be carried out atraumatically. This precaution saves the patient much pain and prevents secondary infections. Each layer of the dressing should be separately removable; it should absorb the exudate and so keep the suture line dry; and should not adhere to the wound. The lowest layer of the dressing must be permeable and should not absorb the fluids. To meet these requirements, a sheet of gauze is saturated with an oily substance so that it will not absorb the tissue fluids but will allow them to pass across its meshes and be absorbed by the superposed multilayer dry gauze pad. Such impregnated gauze is prepared as follows.

A

A. A band of loosely meshed redoubled gauze is immersed in the fluid prepared according to the prescription.

Rp
Bals. peruv.
gta 200.0

Spir. vini conc.
gta 70.0

Ol. ricini
gta 30.0

m. f. mixtura

B

B. The superfluous fluid is squeezed out by pulling the saturated strips between the shanks of a forceps.

C

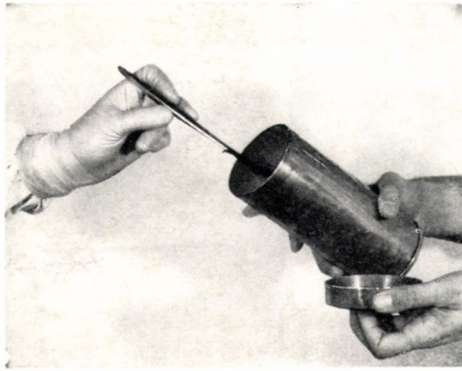C. The saturated strip of gauze is placed in a special box.

D

D. The metal box is sterilized in a hot air sterilizer.

E

E and F. The required quantity of gauze is removed from the box under sterile conditions.
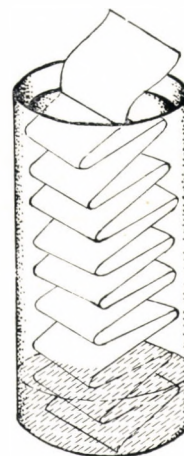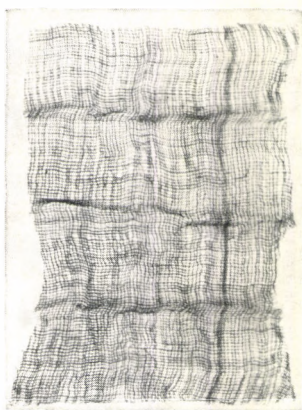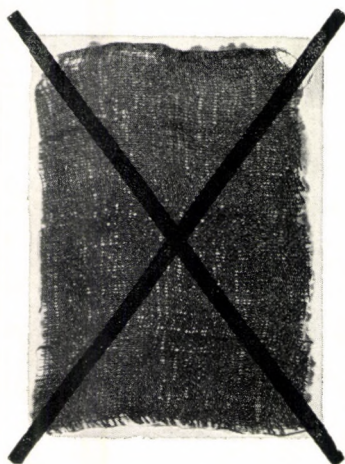

F

G

G. The redoubled sheet of gauze is unfolded and placed as a single layer on the operative area. The lowest portion of the gauze is oversaturated and must not be used.
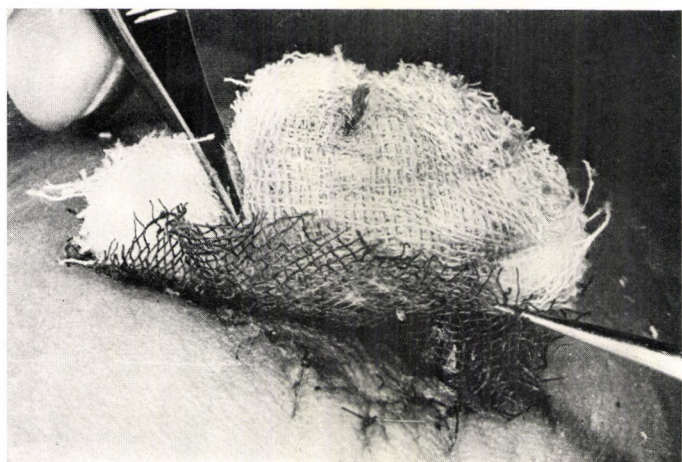
H

H. The meshes of the impregnated fabric must be permeable. Sheets thickly saturated with fat or some other substance do not allow humidity to pass through; such sheets keep the suture in a kind of "wet chamber" which interferes with the process of healing and may become the site of infections.


I

I. At the removal of the dressing the upper dry sheets of gauze have absorbed the fluids discharged by the tissues and, beneath them, the impregnated sheet can be lifted off the dry sutures easily.

Protective Dressing

A. In general, it is by protective dressing that the suture is saved from contamination. The dressing consists of two layers, an impregnated sheet in direct contact with the suture line, and the superimposed stratified gauze pad, the latter extending beyond the former.
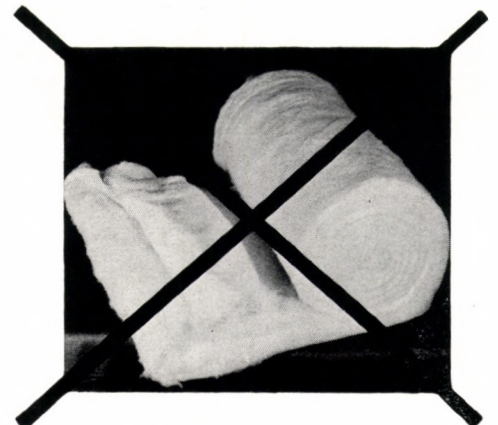

A

B

C
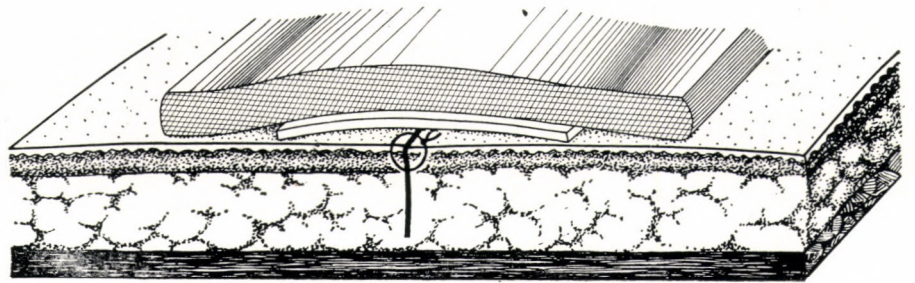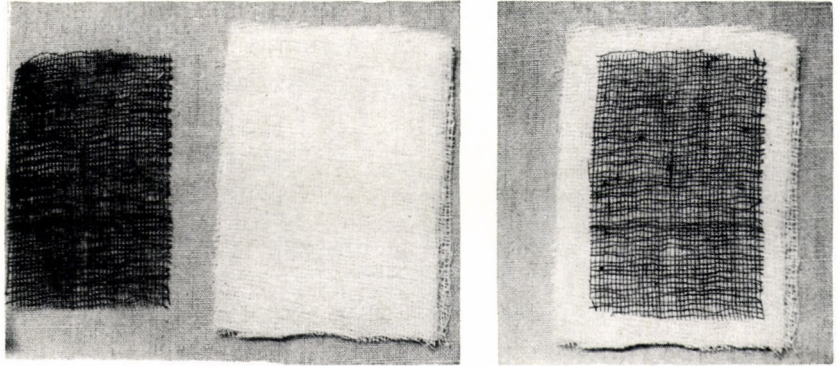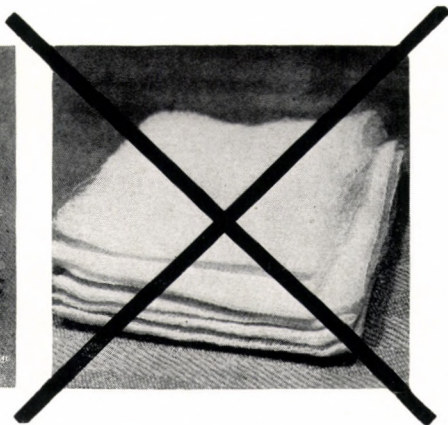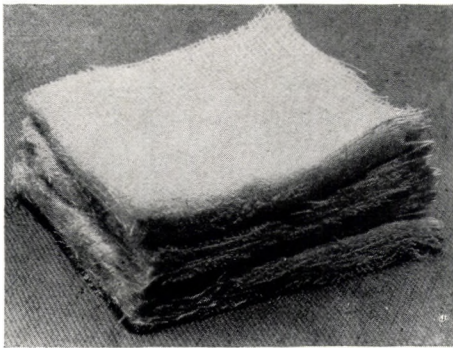
B. If, in order to obtain compression, a thick gauze pad is used, it should be made up of smooth and foldless sheets of gauze. A dressing of uneven thickness and hardness produces different pressures on the different points of the operative area and the layers cannot be removed gently one by one.
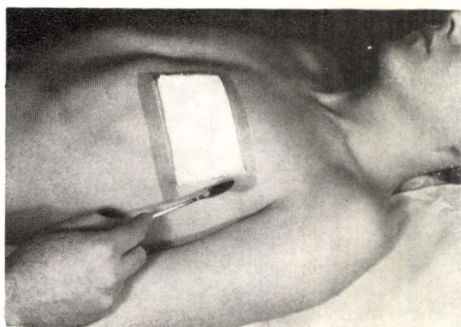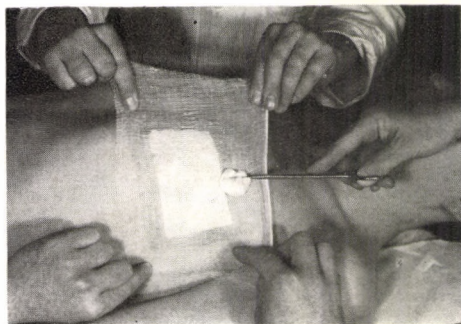
C. Cotton wool should not be employed to cover the suture line of aseptic operations. We use synthetic rubber or microscopic multiporous sponge or steel wool in the pressure dressing.*

* Absorbent cotton is used satisfactorily by the American editors. The important consideration is that the pad be smooth, even and resilient.

D

E

F

D through F. The postoperative dressing may be immobilized by applying a cover sheet and fixing it with adhesive. The frame of adhesive fluid must be painted exactly at the borders of the gauze pad; the cover sheet, evenly drawn out in all directions, is then placed upon the pad without displacing it. The adhesive dries more quickly if a towel is pressed repeatedly upon the frame formed by it; the borders of the cover sheet must not be cut off before the adhesive has dried completely.
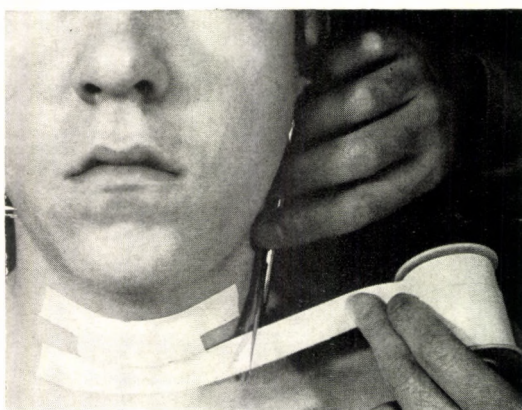
G

G. If the dressing is fastened by adhesive tapes, they must not be so closely spaced that they prevent proper ventilation of the dressing.

H and I. Adhesive tapes of porous paper are well suited for securing protective dressings, especially in wounds united by steri-strips.
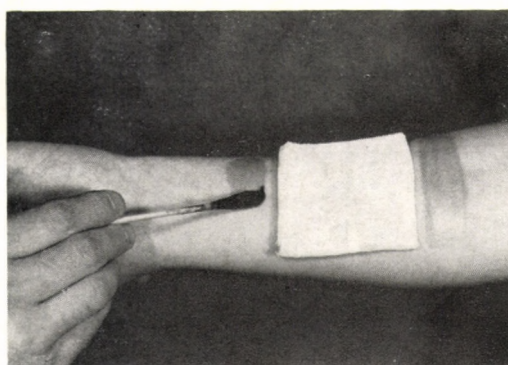

H

I

J and K. If the surgical dressing of extremities is fixed by bandage, it is advisable to prevent its slipping by a few adhesive strips. Bandaging of an extremity should always proceed centripetally.


J

K

Pressure Dressing

This form of dressing is used if pressure is expected to promote healing, to prevent complications, and if there is desire to preserve the pattern formed by the operation. The preparation of pressure dressings is represented here in connection with full thickness or split-skin grafting, as it is for these grafts that this kind of dressing is most frequently used.
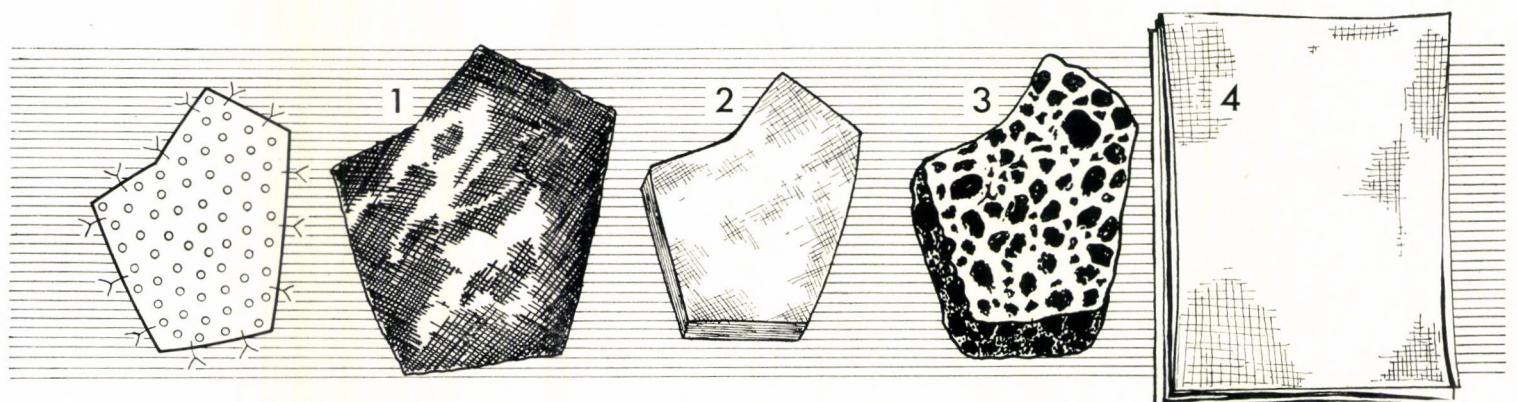

A
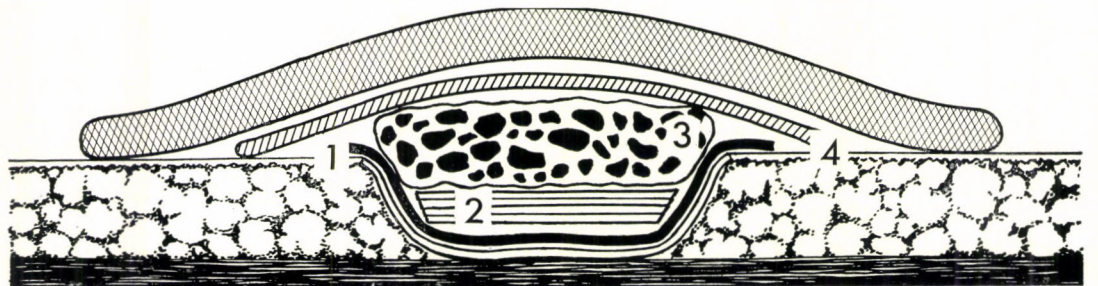
A. Pressure dressings consist of several layers:

(1) An impregnated sheet of gauze (tulle gras); while identical in shape with the graft, it extends in all directions 1 to 2 cm beyond the suture of the graft.

(2) A gauze pad, which, sharply cut around its edges, consists of several flat, unfolded superimposed dry sheets. Its shape and dimensions must be exactly identical with those of the graft (or rather of the undermined area of skin).

(3) The next is a rubber sponge, 3 to 5 cm in thickness, of the same shape and size as the gauze pad.

(4) Last is a multilayer cover sheet of gauze which, larger than the other layers, covers all the rest.

B. The dressing, as described in the foregoing, is fastened by a bandage wound around the limb; a regular padless plaster splint is then mounted. The splint is bandaged around the limb and held in the prescribed position until the plaster of Paris has set.

B
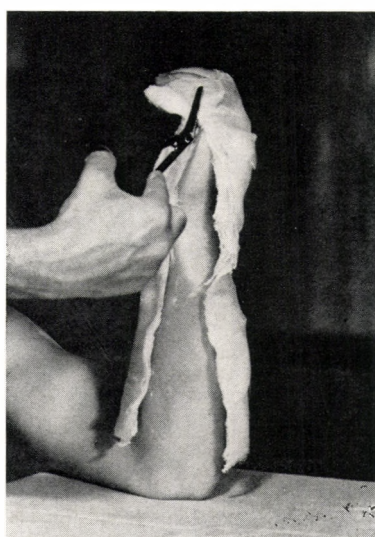
C

C. Both the bandage over the dressing and that over the splint have to be cut off immediately above the skin as the plaster has dried in the desired position.

D and E. The limb is then so swathed by a centripetally winding elastic rubber bandage that it exerts a uniform pressure over the whole part of the body involved.


D

E

F

G

F and G. The surgically managed extremity is bolstered up. After operations on the hand and the forearm, the hand of the recumbent patient is propped up and suspended from a line of gauze stretched over the bed. The hand of an ambulant patient is placed in a triangular sling. The limb is immobilized by plaster splint or abduction splint after operations on the upper arm and the shoulder region.

The circulation of extremities under pressure dressings has to be measured repeatedly during the first 24 hours. The elastic bandage has to be unwound at any sign of circulatory disturbance. Only after having found the site and determined the cause of the disturbance, and after having eliminated it, is renewed bandaging permissible. The time at which the pressure dressing is to be removed depends on the nature of the operation. If it was intended only to prevent complications, the dressing may be removed after 24 to 36 hours. Pressure dressings applied to undermined areas of skin are taken off after 7 to 10 days.*

* Except in unusual cases the American editors lack enthusiasm for elastic dressings for longer than 2 to 4 hours postoperatively.

Immobilization
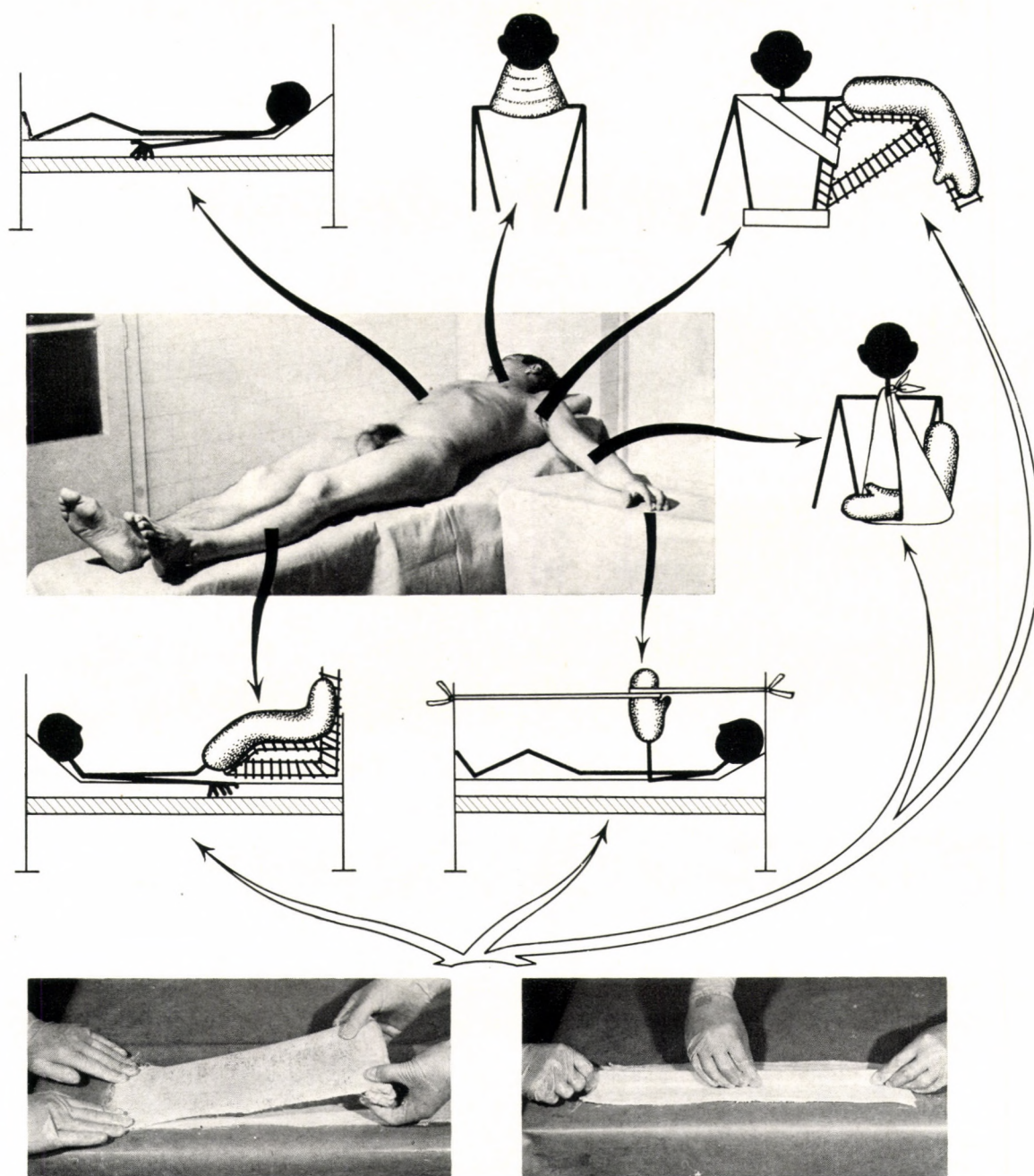
A

A. The smooth healing of a wound depends to a great extent on immobilizing the
operative area. Simple bed rest is necessary after operations involving the trunk
and head. The neck should be immobilized by a Schanz collar; a plaster bed may
be necessary after extensive operations. Excepting minor superficial interventions,
the extremities should be immobilized by plaster dressings and propped up in a position
which facilitates venous blood flow. The hand of bedridden patients is propped up
and suspended from a line of gauze stretched over the bed; that of ambulant patients
is tied to the neck. An abduction splint should be applied after major operations on
the upper extremities. The lower extremity, after being plaster splinted, may be placed
on a Braun's frame.
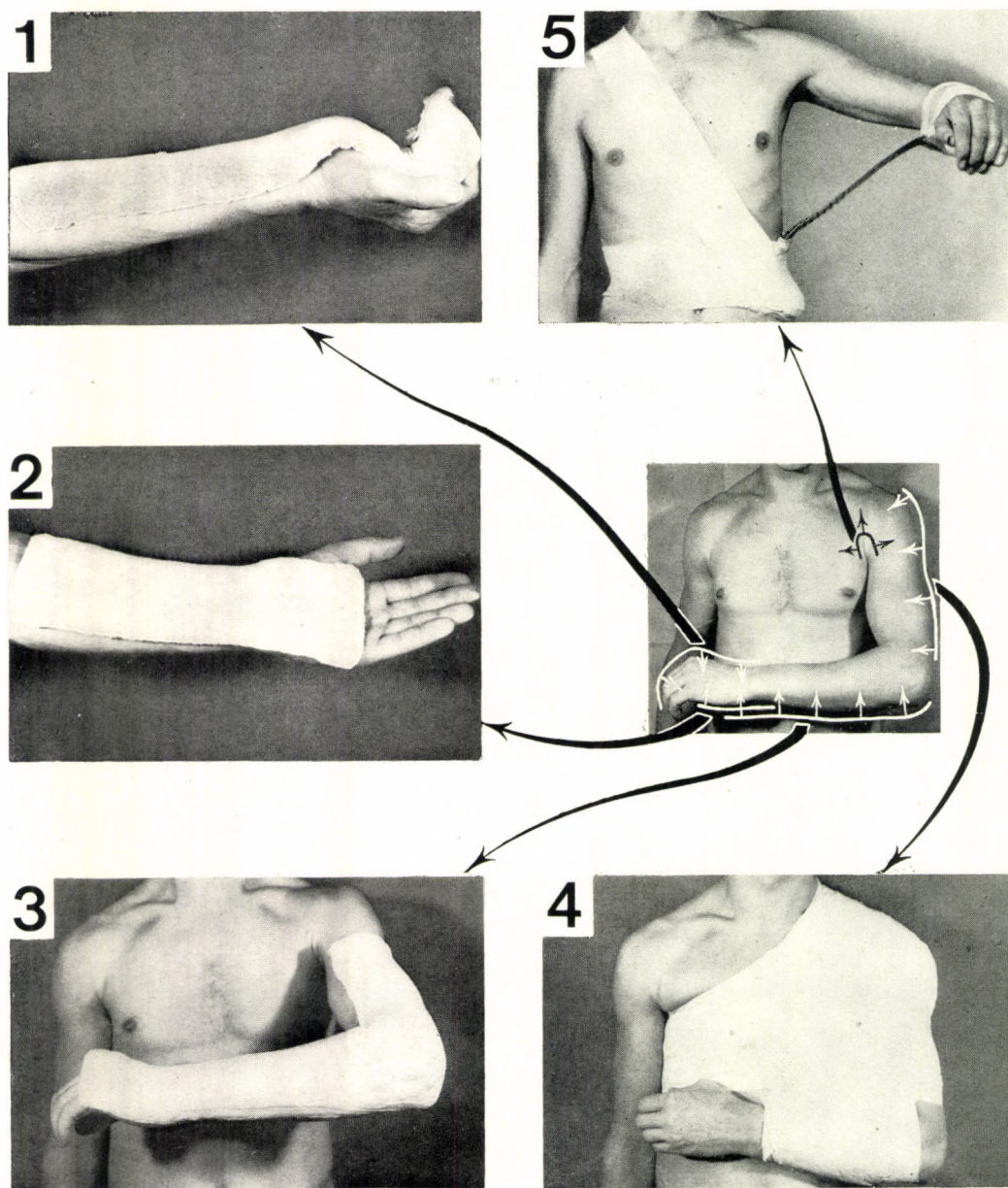
B

B. Plaster casts to be applied after operations involving the upper extremities should be large enough to immobilize all joints whose movement may displace the skin of the area involved. After operations involving the fingers, the palm and the wrist, a volar plaster splint, which extends from the fingertip to the elbow and immobilizes the joints in the functional position, should be applied (1). If the operation is confined to the skin of the carpal region, the splint should reach only to the proximal joints and leave the fingers free (2). The plaster splint applied after forearm operations extends from the proximal joints of the fingers to the upper third of the upper arm (3). Immobilization of the shoulder region and the upper arm is ensured by a simple Desault bandage (4). After major interventions affecting the axillary fossa, an abduction splint may be applied which leaves the operative area accessible for the subsequent removal of the suture (5).

C. After operations affecting the portion between the ankle and the thigh, the plaster splint should reach the gluteal fold (1). After operations on the feet or the malleolar region, the plaster splint to be applied must extend from the end of the toes to the popliteal fossa (2). The dorsal splint immobilizing the leg should leave the heel uncovered. The extremity should be placed on a Braun's frame in both cases.
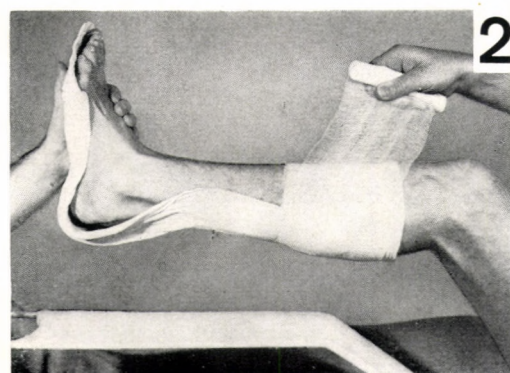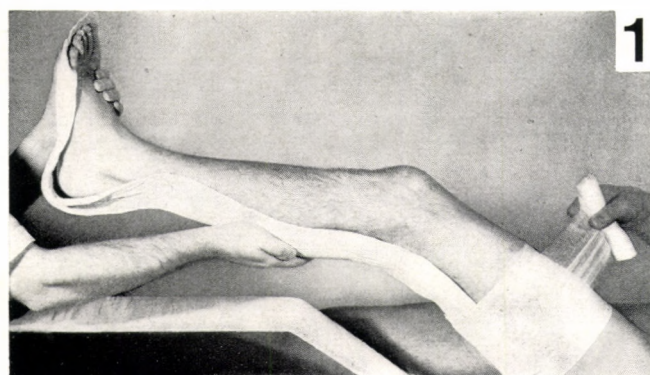
C
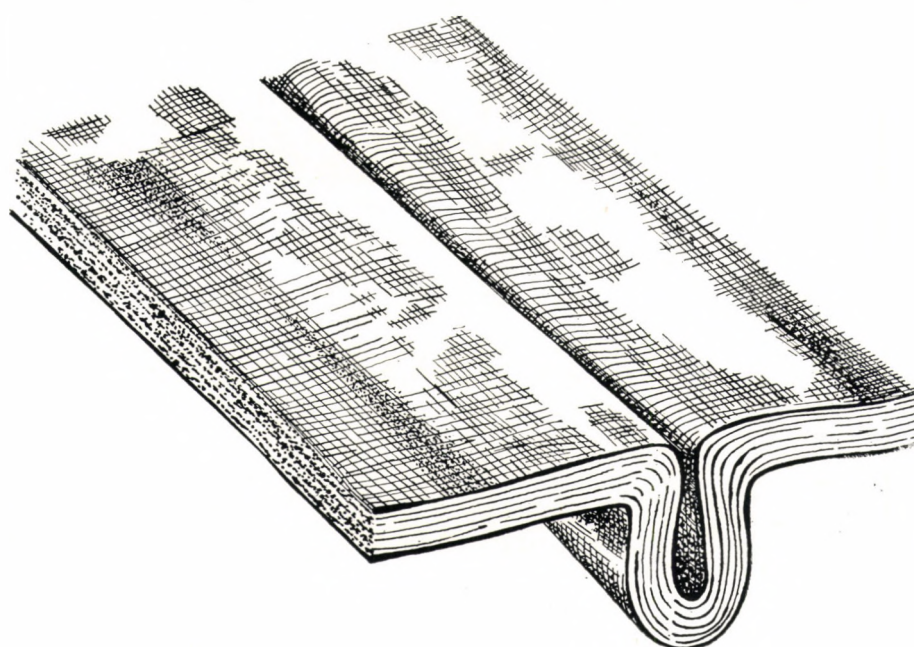
D. The firmness of the plaster splint can be increased if a fold is made along its central line. By doing so we obtain a splint of adequate rigidity for the preparation of intricate plaster dressings which leave certain parts (e.g., the popliteal fossa) of the extremity uncovered.

D

Removal of Dressing
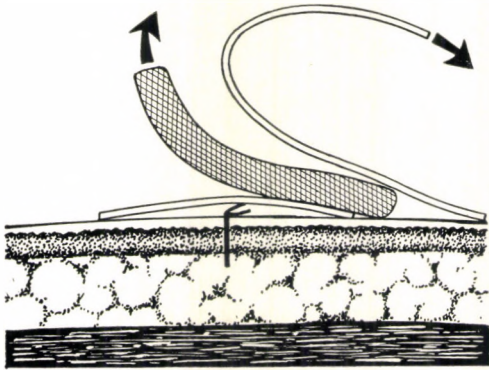
A. The surgical dressing must be removed carefully layer by layer.
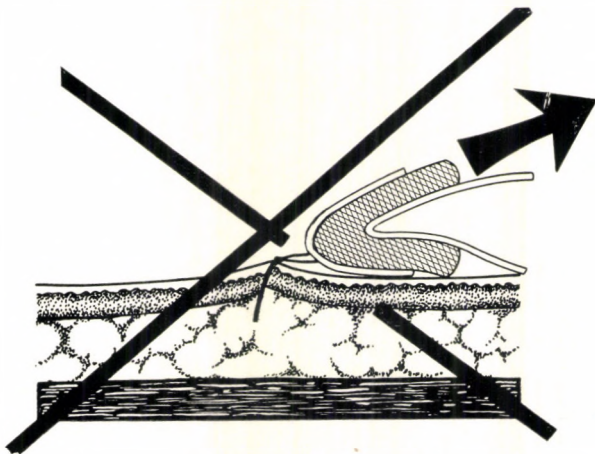
B. Abrupt removal of the dressing "en masse" traumatizes the line of the wound, provokes hemorrhage and so facilitates secondary infection and impedes healing by first intention.
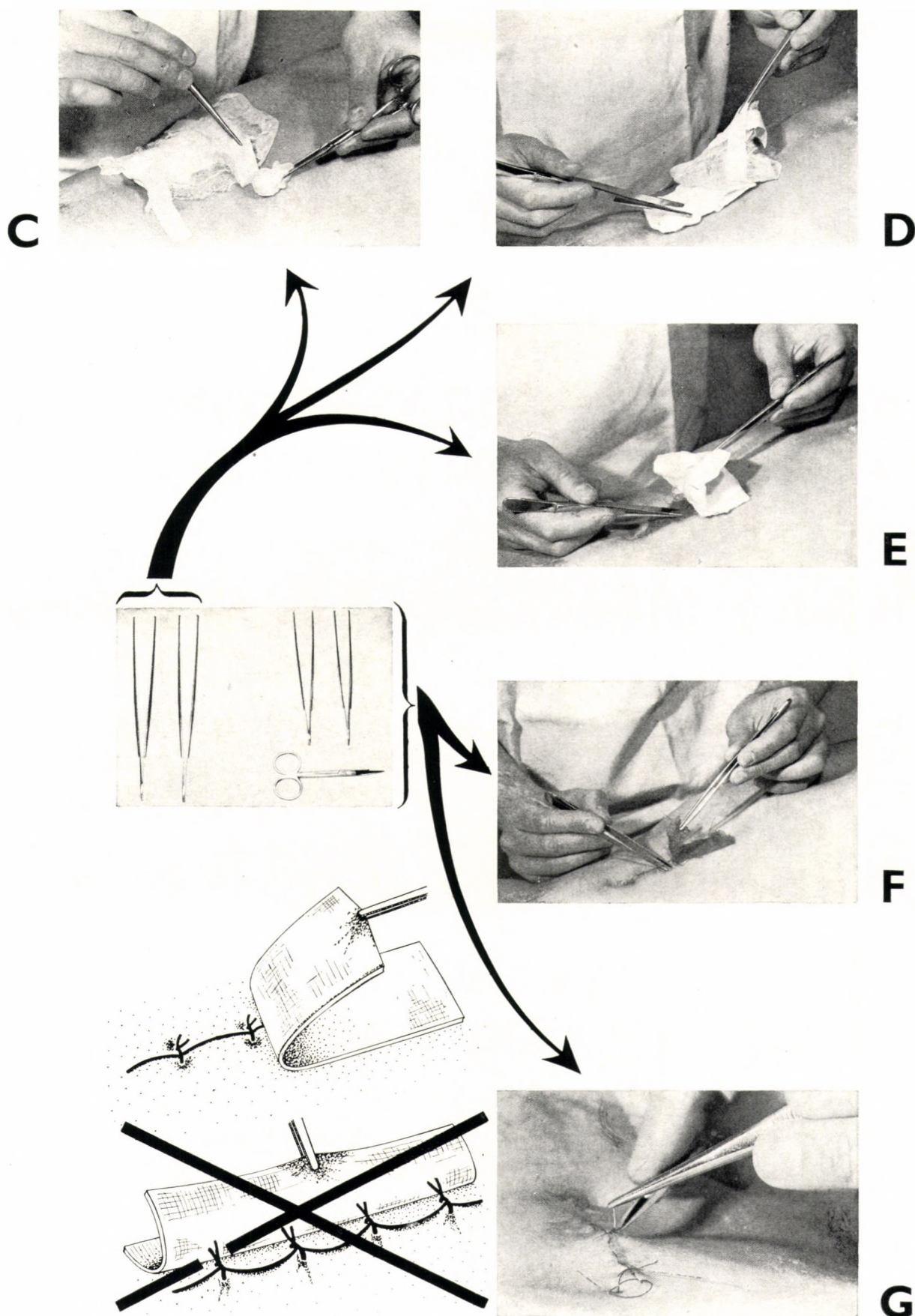
C through E. At the removal of the dressing all adhesive should be removed with adequate solvents. Two forceps are used: the toothed surgical forceps with which the upper layer is lifted, and a smooth forceps which supports the base when the successive layers of the dressing are pulled off so that the suture line is protected against traction.

F and G. After having reached the innermost layer (the impregnated sheet of gauze covering the line of suture) two fresh, smaller sterile forceps have to be substituted for those employed previously. The impregnated sheet should be pulled off parallel with and not at right angles to the line of suture, and the second forceps should support the suture. The lower supporting forceps must be employed for the removal of the suture. (Mixing up the forceps in the course of the procedure entails the risk of infection.)
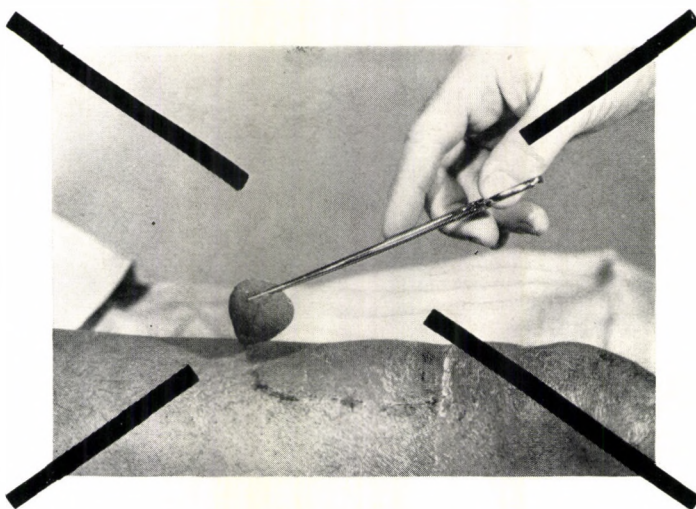
H

H. Whether or not the suturing thread is or is not removed, the line of suture must not be washed, rubbed or iodized.

I

I. The line of suture on uncovered body surfaces has to be left open after removal of the dressing. In order to protect it, we spray Plastubol* over the suture line.
When applying the spray to the face, the eyes and other apertures should be covered.
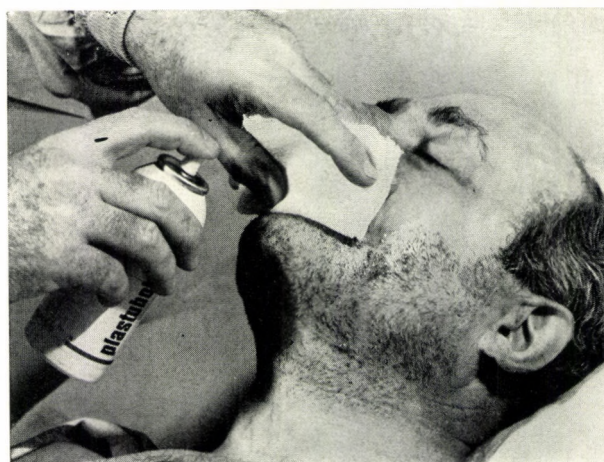
J

J. If the line of suture is on a covered part of the body surface, a wide-meshed strip of gauze is placed on it and fixed by spraying with Plastubol.

* Aeroplast.
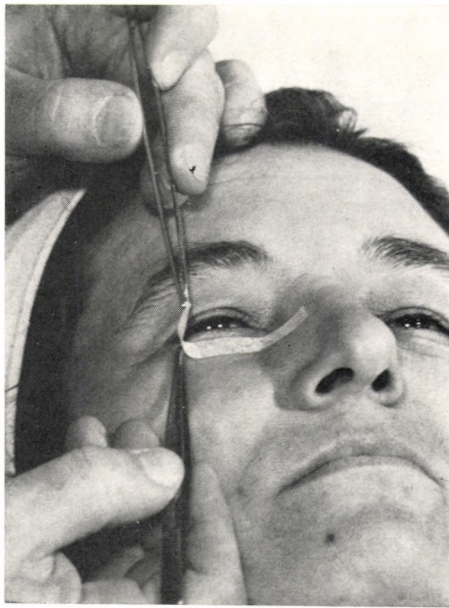
K

K. Steri-strips employed for the uni-
fication or the covering of the
wound are removed on the 5th to
7th postoperative day. No solvent
is necessary for this manipula-
tion. The strips are always lifted
off parallel with the line of suture,
and the base is supported by the
second forceps.
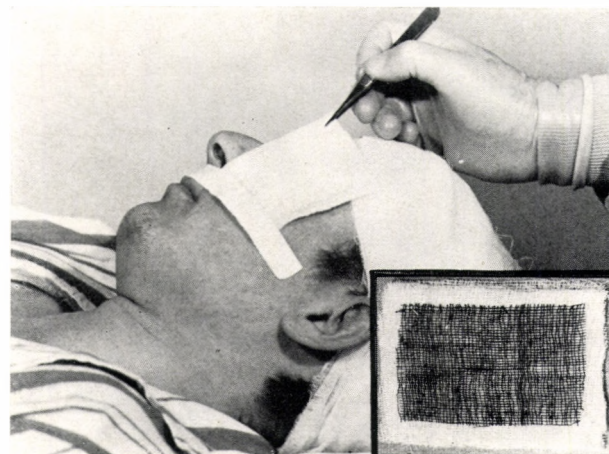
L

L. If because of the nature of the operation
and the affected region of the body, it is
necessary to apply a second dressing, it
should be like the first, that is, the line of
suture should be covered with a layer of
impregnated gauze over which an over-
lapping multilayer gauze pad and a cov-
ering sheet must be placed and then
immobilized.

Removal of Interrupted Sutures
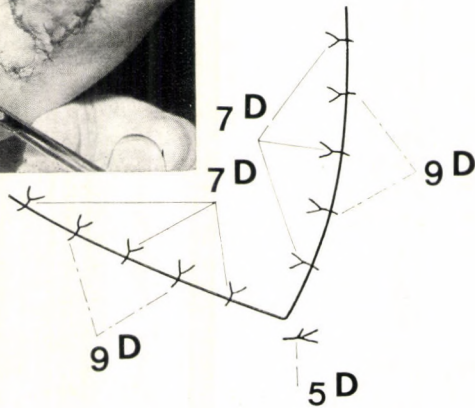
A

A. It is a fundamental rule that the interrupted suture must not be removed at a single stroke along its entire length. Removal must be performed in stages according to the nature of the operation; the suture is taken off piecemeal by means of the "halving method"; i.e., every other stitch on the 5th, 7th, and the rest on the 9th day.*
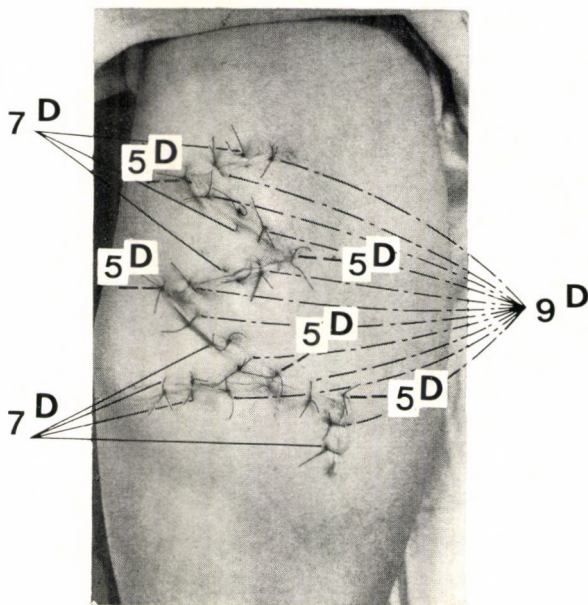
B

B. Technique for removal of interrupted sutures of zig-zagged wounds of irregular course.
It is from the tip of the flaps, i.e., the most vulnerable points, that the sutures are first removed on the 5th postoperative day. Sutures from the remaining areas are then removed by the halving method, i.e., every other stitch on the 7th, and the rest on the 9th day.

* The American editors agree in general with the main points of this chapter. However, on facial skin interrupted sutures are removed completely, at one sitting, on the 3rd or 4th day and the wound supported by steri-strips thereafter. Sutures left in longer on this area of rapid healing may produce "railroad tracks" on the scar.

C

C and D. Steri-strips have to be detached from the suture line in an atraumatic manner. The edges of the strips are lifted by a forceps while the skin is supported by a second forceps. Each strip is lifted from both sides only as far as the suture line; the position is then changed so that the part of the strip which is directly above the suture may be lifted in a direction parallel to the incision, while the second forceps, likewise changing its position, supports the skin on both sides of the suture.

D
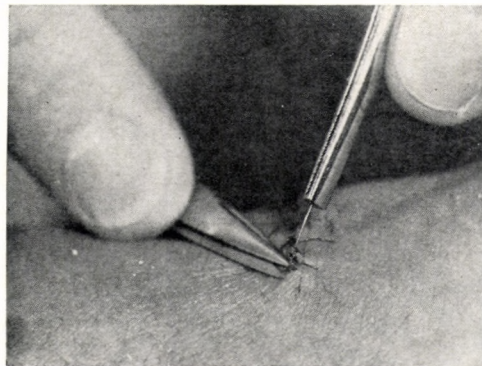
E

E. In order to remove the interrupted suture, the thread which extends beyond the knot is lifted by a forceps. Thus the thread emerges from the puncture channel and is cut at this point. Atraumatism is promoted if both the hand holding the forceps and that holding the scissors are supported; while pulling out the cut thread the skin should be supported by the slightly open ends of the scissors.
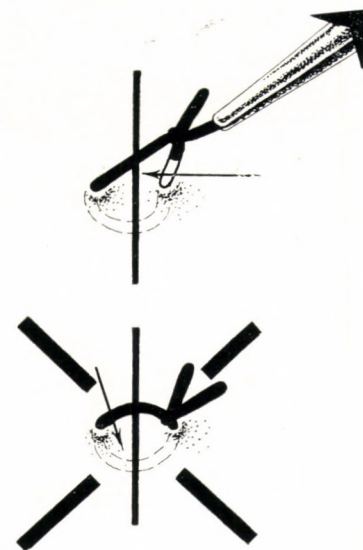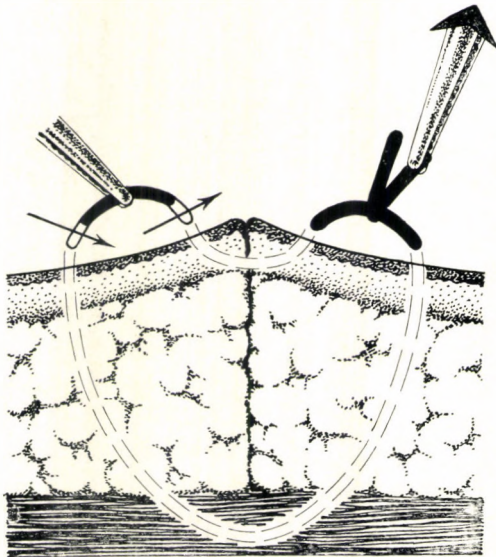
F

F. When removing a vertical mattress suture, that part of it which runs above the skin surface on the side opposite the knot is lifted and cut on both sides. Seizing the knot, the thread is pulled out.
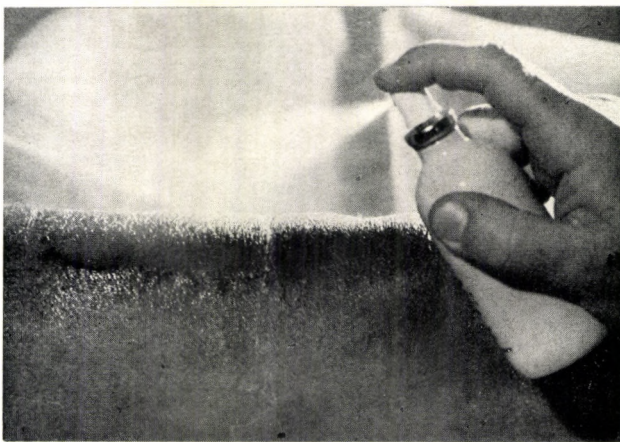
G

G. The stitches removed, the suture line is thinly sprayed with Plastubol and the area is then left without dressing.

Removal
of Running Sutures
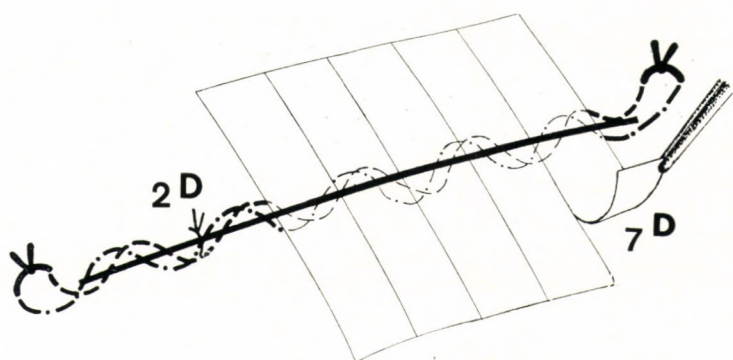
A. If the double row running suture has been supplemented by interrupted adapting stitches, the latter are removed on the 2nd postoperative day. Steri-strips applied to cover the suture line must be removed on the 7th postoperative day. The time of removal may be advanced during hot summer months.
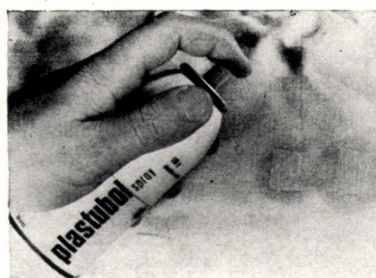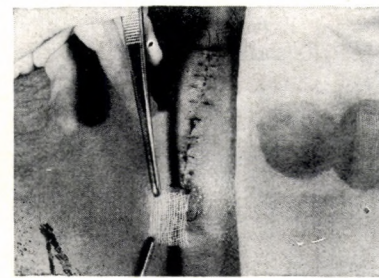
B and C. The site of the adapting stitches and the steri-strips are sprayed with Plastubol, while the suture line itself remains free. Sheets of gauze saturated with Plastubol are placed over the knots of the running suture.

D and E. Both rows of the running suture are removed at the same time if they are not longer than 6 to 8 cm. The knot is lifted at one end of the suture and both threads are cut off on the 14th postoperative day. The thread is then seized at the remaining other knot on the 18th to 21st day, while, by means of a piece of gauze held in the other hand, the skin is held or gently pulled in a direction opposite to that in which the thread is withdrawn.
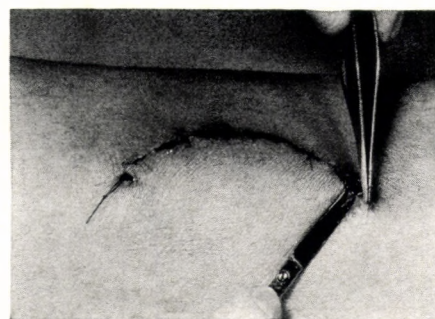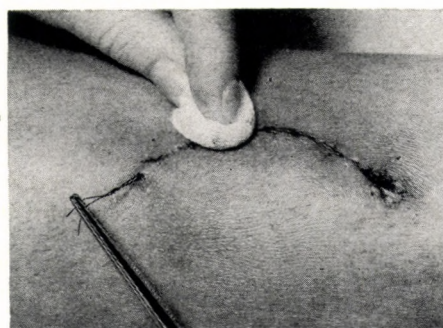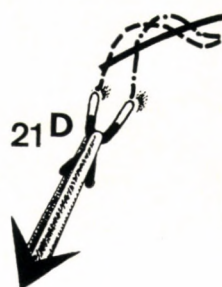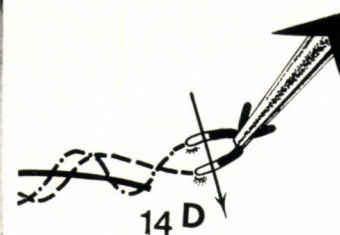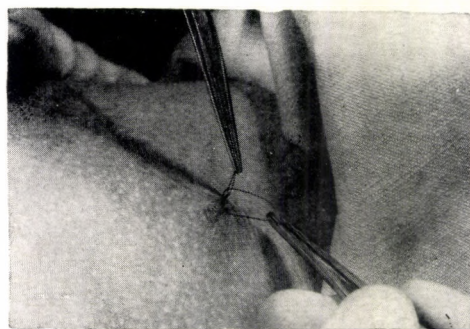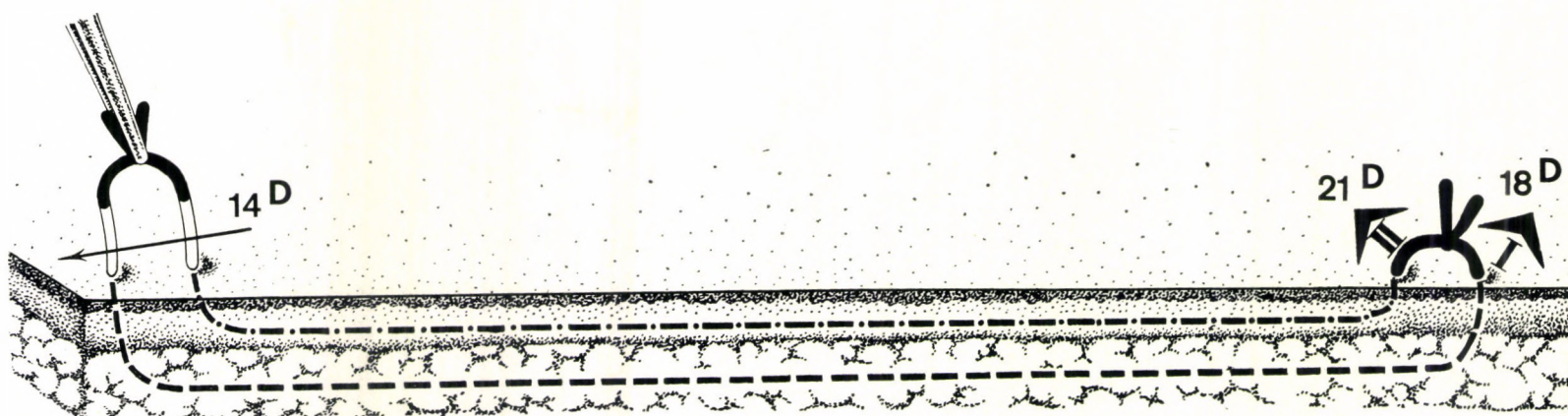
1
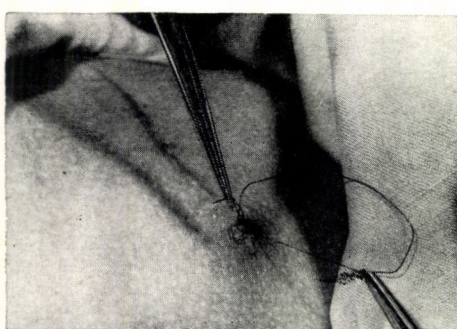
2

3
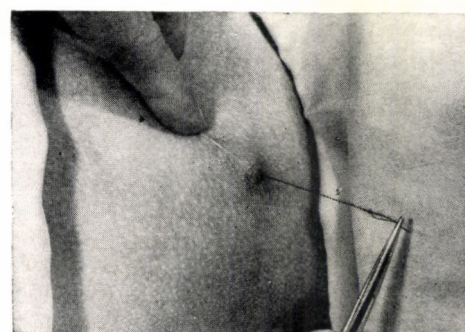
4

5

F

F. The two threads are not simultaneously removed if the suture has a length exceeding 10 cm. One end of both threads is cut off beneath one of the knots, as shown on the diagram, on the 14th postoperative day. Giving a slight pull to the remaining knot on the 18th day the subcuticular thread is withdrawn (1, 2) and cut next to the knot (3). The still indwelling intracutaneous thread is then simply pulled out on the 21st day (4). While pulling the thread the suture line is supported with the other hand and the skin is pushed gently in the opposite direction (5).
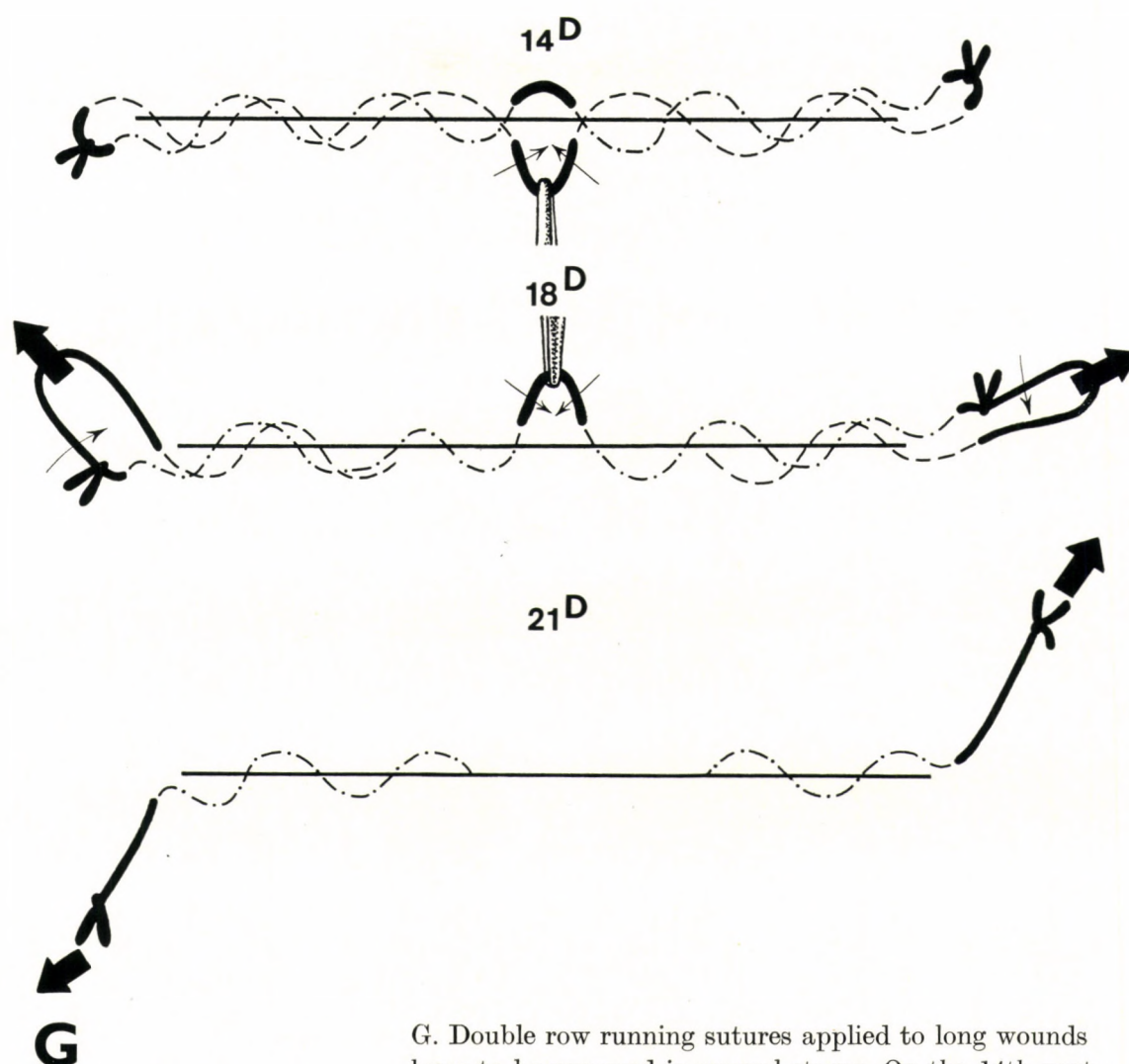
G. Double row running sutures applied to long wounds have to be removed in several stages. On the 14th postoperative day seize with a forceps and give a pull to that part of the subcuticular thread which had been brought to the surface of the skin. After lifting the loop, cut it on both sides of the forceps. The same manipulation is performed on the 18th day in respect to the intracutaneous thread. The knot at both ends of the suture is at the same time grasped and pulled to allow the subcuticular thread separately to be seized and pulled out. The thread is then cut off next to the knot. On the 21st day the two halves of the intracutaneous thread are pulled out in opposite directions.

The multistage removal of the running suture, as outlined above, cannot be carried out accurately unless the exact situation of the thread, the knots and the loops on the skin is known. It is, therefore, advisable to supplement this documentation by committing these details to paper by way of a drawing.

Principles
of Skin Replacement

Whether surgical or traumatic, skin defects should be replaced without undue delay. Replacement is particularly urgent if not only the skin but also the subcutis is defective and if locomotor, vascular or neural structures are injured or exposed. Their fate depends to a great extent on the manner in which the skin heals. The three different methods of primary skin replacement are shown on the drawing (A, B, C).
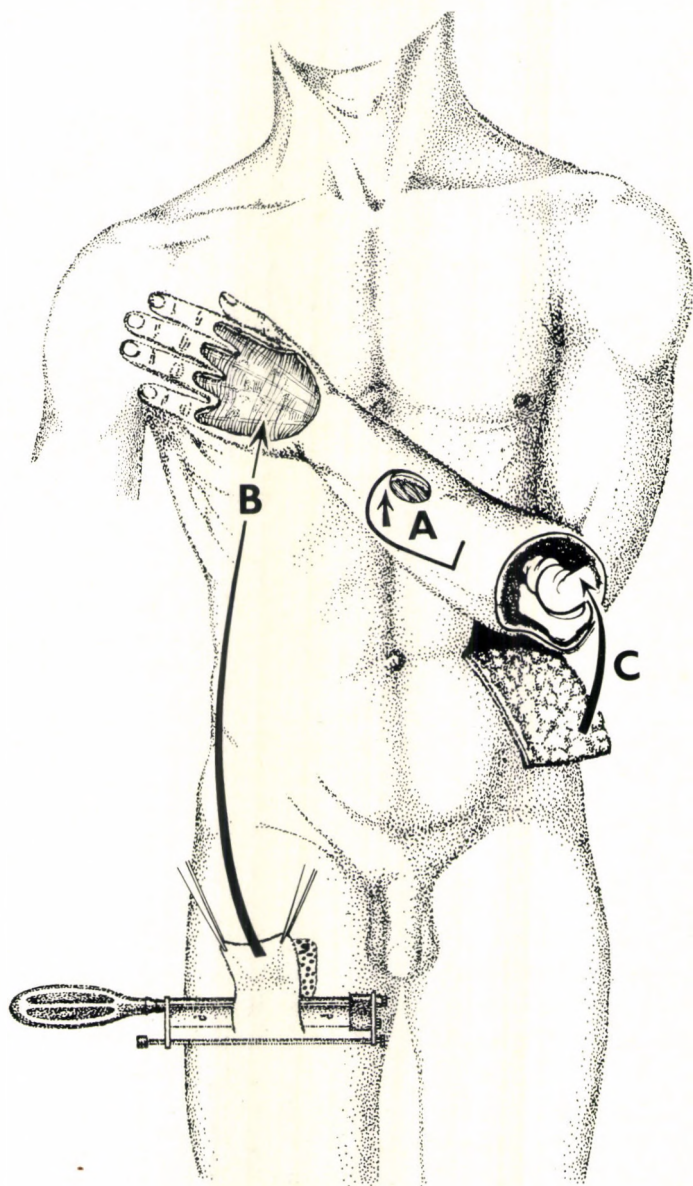
A. Utilization of the skin adjacent
to the wound by local flap plasty
is an ideal way of replacement.
Flaps of this kind give the best
functional and cosmetic results
because of the similar properties of
the replacing and the replaced skin.
The excision of the flap and the
remedy of the resulting secondary
defect must not damage the donor
site.
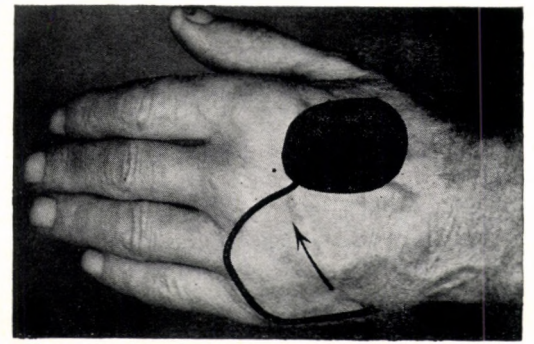
A

B. Skin defects are replaced by
grafting (mostly by split skin graft)
if at least a thin layer of the sub-
cutis is still present or if there is a
muscle base. Functional results are
satisfactory in areas where the skin
is not exposed to strong mechanical
stresses.

B

C

1

2

3
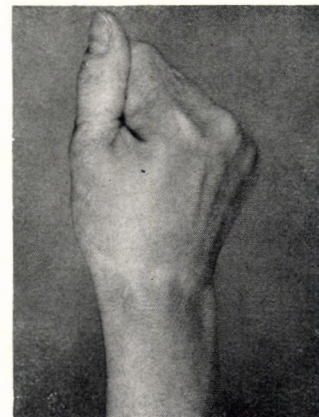
C. Direct flap plasty is appropriate if the subcutis is also missing and if the protection of the injured or denuded deep structures requires the transplantation of skin padded with adipose tissue.

4

Local Flap Plasty

A. Three principal types of pedicled local flaps are distinguished: bipedicled bridge flaps (1); monopedicled flaps (2); island or artery flaps whose pedicle contains only the artery and vein covered by the subcutis, and, in certain cases, the sensory nerve (3).
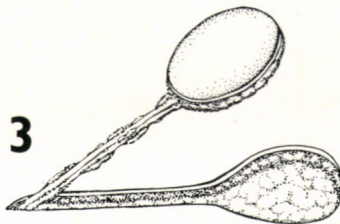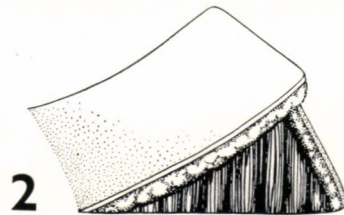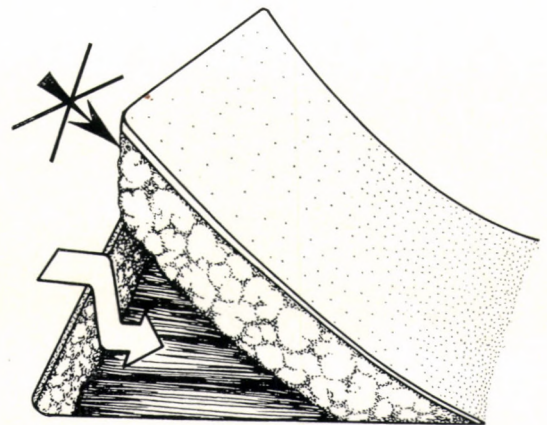
B. Pedicled flaps should be undermined above the muscular fascia since it is thus that the integrity of the subcuticular horizontal vascular bed is best maintained.
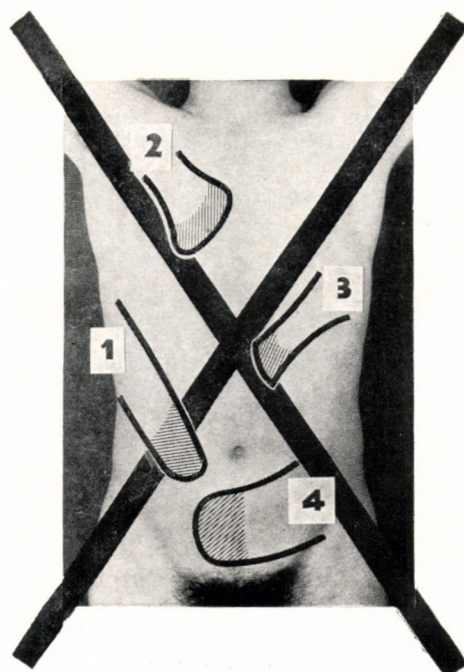
C. Disproportion of dimensions (1), irregularity of the lateral incisions (2, 3) or disregard of the special conditions of blood supply in a given region (4) may lead to necrosis of areas of the flap.

1

$y = 5x$

$y : x = ?$

x

y

$y = x$

$y = 2x$

2

D

$y = x$

$y = \frac{x}{2}$

3

$y = 2x$

$y = x$

$y = \frac{x}{2}$

$y = \frac{x}{4}$
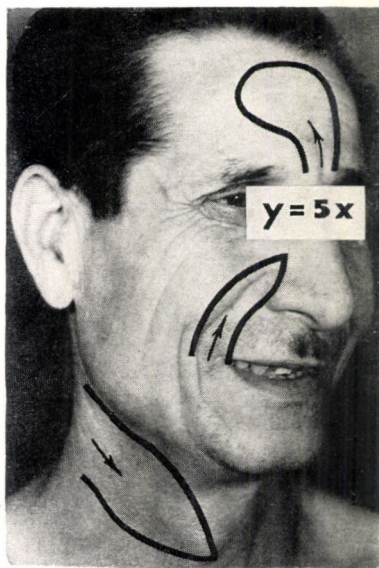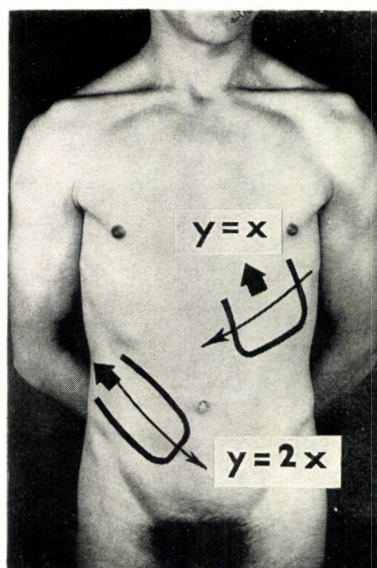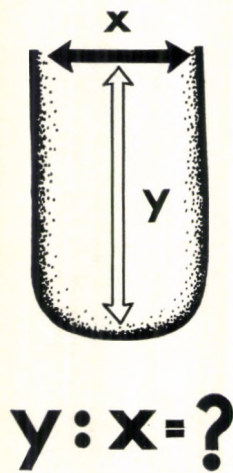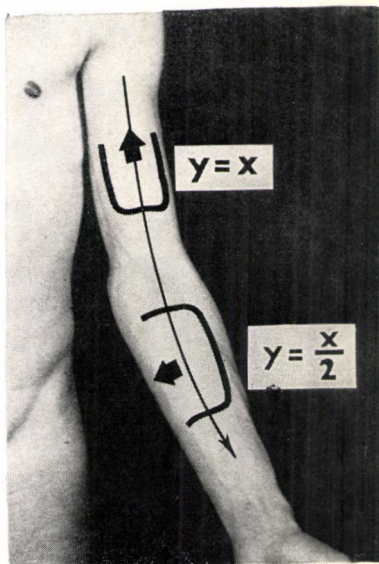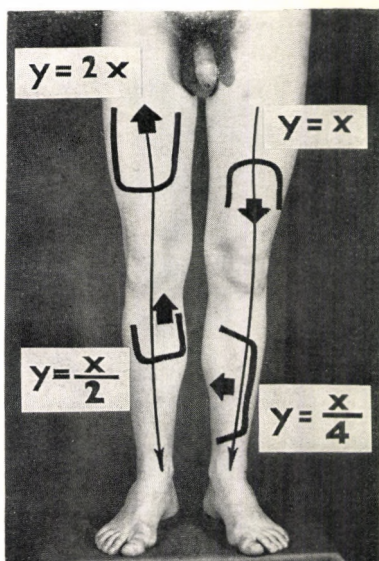
4

D. Flaps will survive only if the number and the capacity of the vessels running through their pedicle suffice to maintain circulation over the entire flap. The ratio between the width (x) of the pedicle and the length (y) of the flap shows quite different values in the different parts of the body. On the face (1) the length of the flap may be a multiple of the pedicle's width because of the presence of a dense vascular network, provided the direction of the flap is parallel with the course of a main nutrient vessel. On the trunk (2) the length of flaps running in the same direction as the vessels may be double the pedicle's width, whereas the length of flaps running in a direction different from the vessel's course may not exceed the width of the pedicle. The optimal ratio in respect to proximally based, pedicled flaps on the upper extremities is $y : x = 1$ (3), whereas the width of laterally or distally based pedicled flaps should always exceed the length. Distally, conditions of circulation are increasingly unfavorable in the lower limbs (4). Although on the thigh and in the vicinity of the knee the length of the flap may be equal to or greater than that of the pedicle, flaps on the foreleg are more reliable if their width considerably exceeds their length.

E. Characteristic examples of pedicled local flaps.
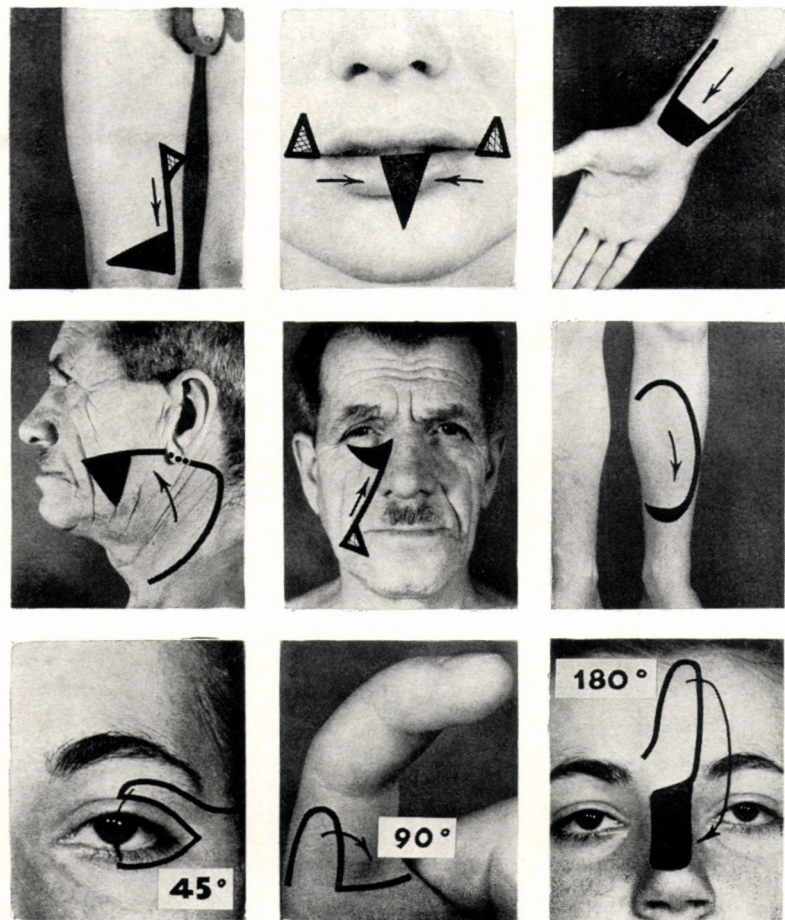
E
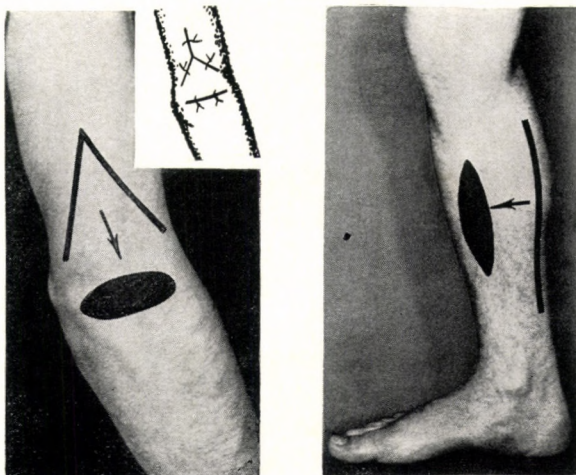
F

F. Two examples of lipedicled flaps.

Technique of Local Flap Plasty

Local flap plasty combined with free skin grafting must be carefully planned. The following are the successive phases and the most essential manipulations of the surgical procedure.

A. Preparation of the recipient site by wound toilet and determination of the size of the flap by means of a sterilized piece of linen as a pattern.

A
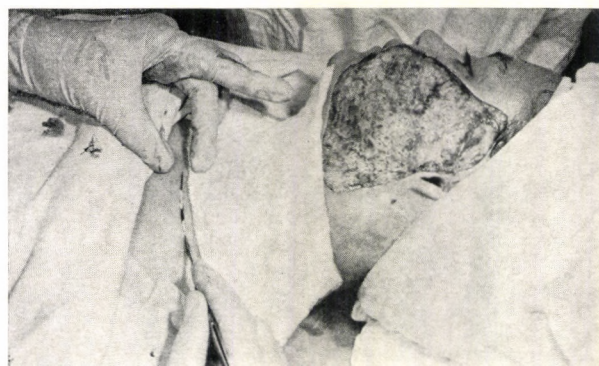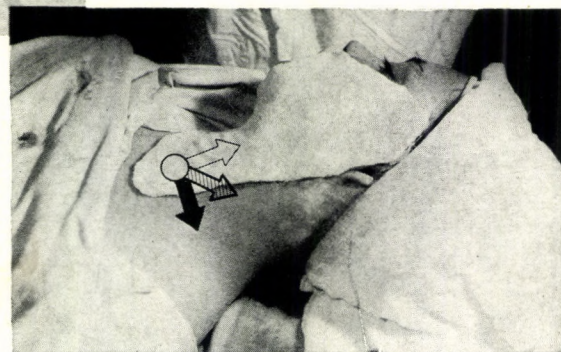
B. The flap is cut around the pattern.

B

C

C. Mobilization of the flap should always begin at its most distal part and advance towards the pedicle.
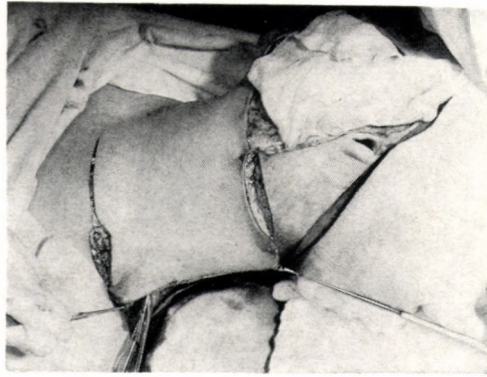
D

D and E. When mobilizing the flap, the appropriate deep layers must be sought. Dissection, half sharp and half blunt, must advance in that layer while the flap is held at an angle of about 45°. The wound at the donor site and the area of the primary skin defect must be covered during the dissection by gauze pads saturated with physiological saline to diminish bleeding and to prevent desiccation.
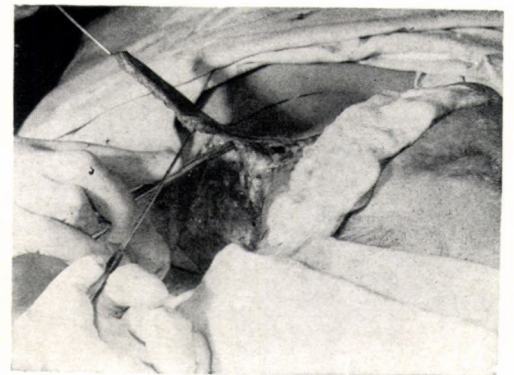
E

F

F and G. Mobilization of the flap is adequate if it can be fitted to the recipient area by means of two hooks without the slightest stretch.
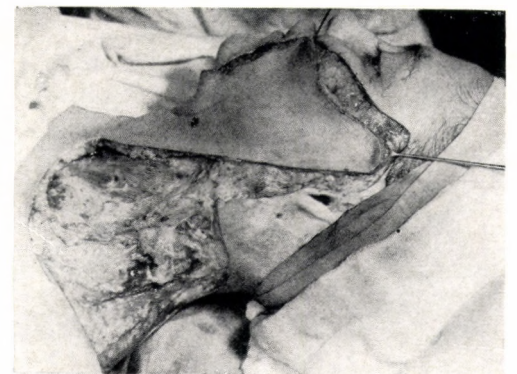
G
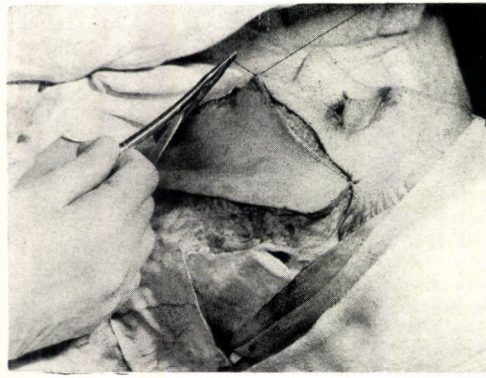
H
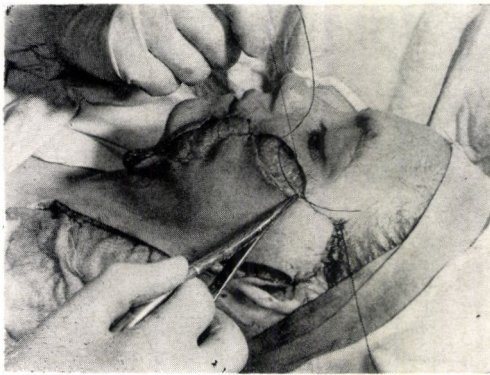
I

H and I. The flap is fastened in the principal directions by a few interrupted stitches after which its edges are united with those of the defect by means of a simple row of deep intracutaneous running sutures.

J

J. After attaching the flap at the host site, the secondary defect of the donor site is covered by split skin graft.

K. The dressing should be executed with particular care after the operation. The pedicled flap in the recipient area and the split skin graft at the donor site have to be dressed separately because the graft receives a pressure dressing while the flap must in no way be compressed, and also because the two dressings may be removed or changed at different times. The pressure dressing, to be placed on the graft, is padded with a more than usually thick rubber sponge. The protective dressing, to be placed on the pedicled flap, is considerably thinner than the rubber sponge. By this manner of dressing the free graft comes under a moderate pressure, while the flap remains free from any kind of compression.
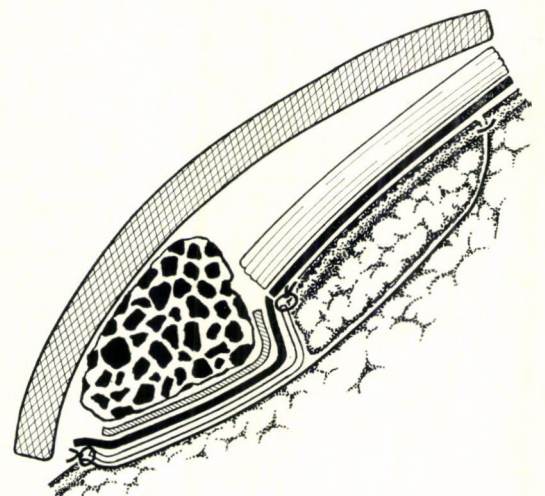
K

Grafting of
Full Thickness Skin

Full thickness grafts (Wolfe–Krause) are used when the transplanted skin has to satisfy higher mechanical or aesthetic requirements. Full thickness grafts require better vascularization than split skin grafts and are accordingly suitable only for fresh smaller wounds with adequate blood supply.

A. The use of full thickness skin grafts is indicated in the primary replacement of defects on the palm and fingers, provided there is a suitable recipient site. Further indications are the flexor surfaces of major joints, the malleolar region and the face (forehead, lower eyelid, nose, lips).

A
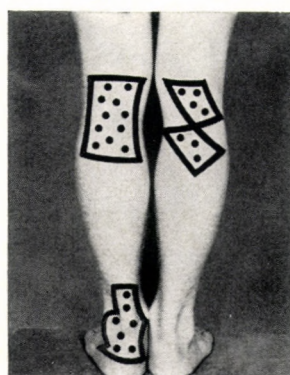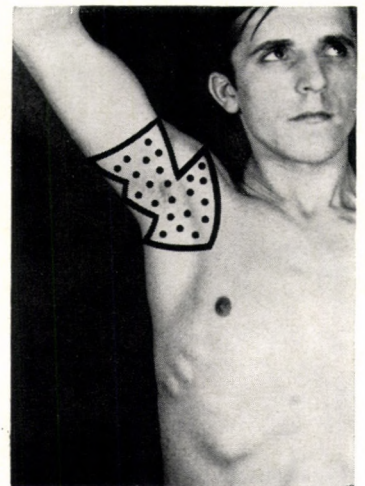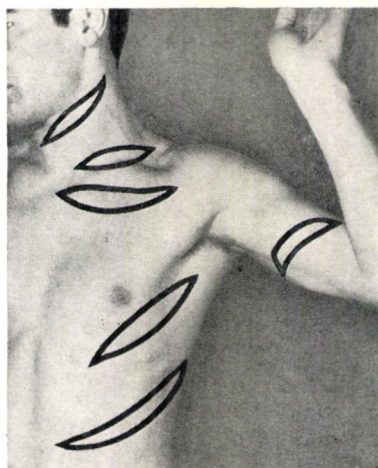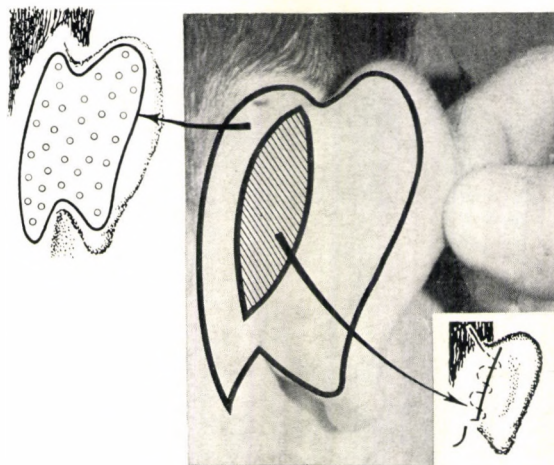
B. Grafts for facial skin replacement are usually taken from the retroauricular area. If the graft is small, the wound of the donor area is closed by sutures. If, however, all of the skin of the retroauricular area is used for grafting, the resulting defect has to be replaced by the transplantation of split skin. The neck, the supraclavicular and subclavicular areas, the lateral (hairless) portions of the upper arm and the trunk are possible donor sites for the replacement of skin defects.

B

C. The wound at the donor site is closed by the assistant with a single row of running suture and made secure by means of steri-strips.
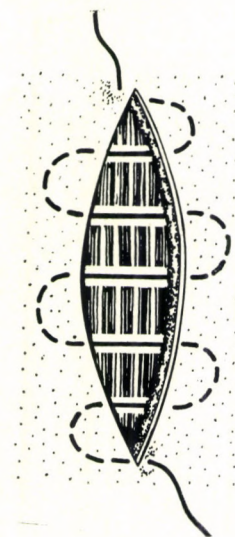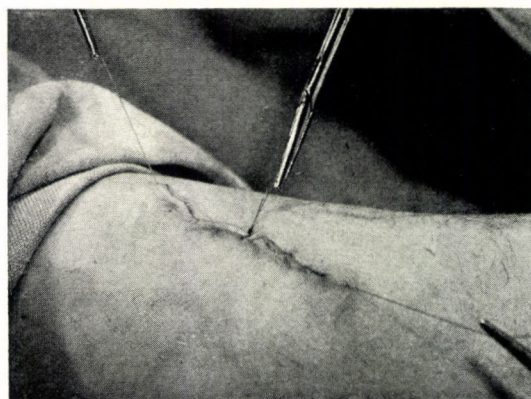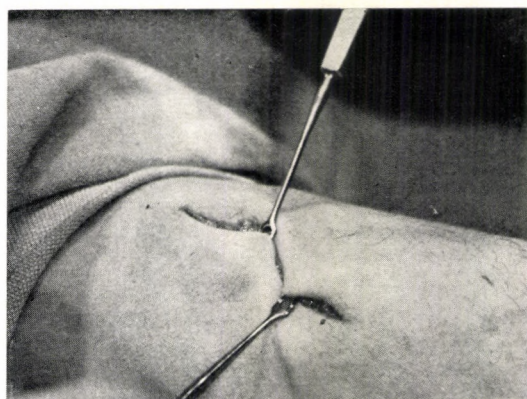
C
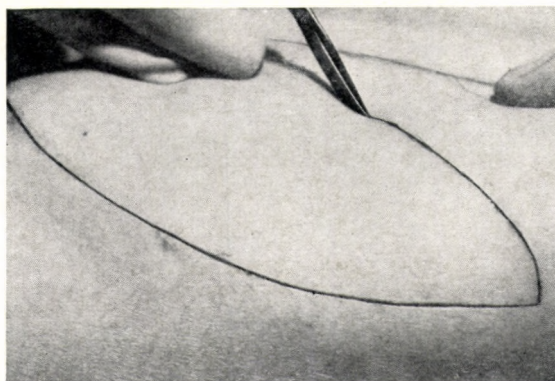
D

D through F. To excise a full thickness skin graft, an incision, extending to the lowermost part of the corium, is made at the premarked boundary of the skin to be transplanted. By means of a suture the skin is stretched over the surgeon's finger and mobilized by uniform strokes of the scalpel so that the adipose tissue is not raised with the graft.
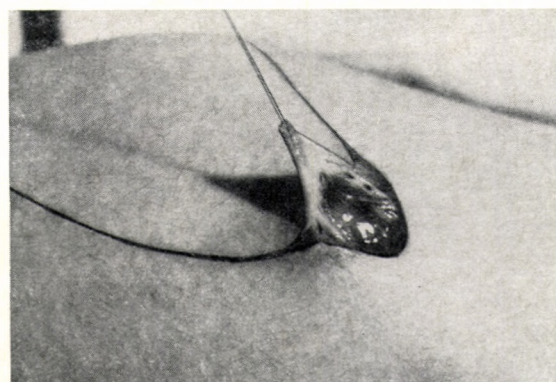
E

F
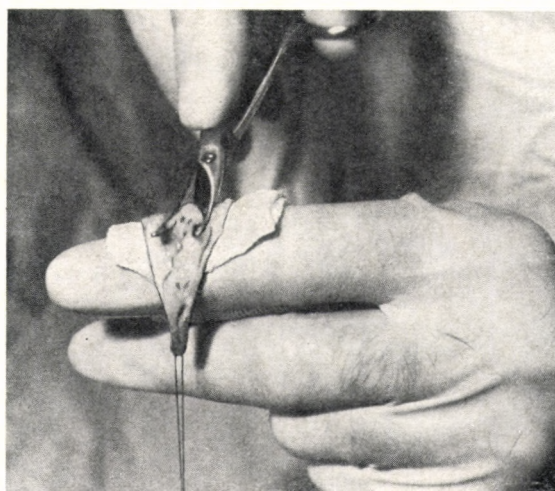
G

G. Meanwhile, the surgeon removes the rest of adipose tissue from the under surface of the transplant by means of a pair of curved blunt scissors, being careful not to pierce the graft and not to attenuate it unevenly.
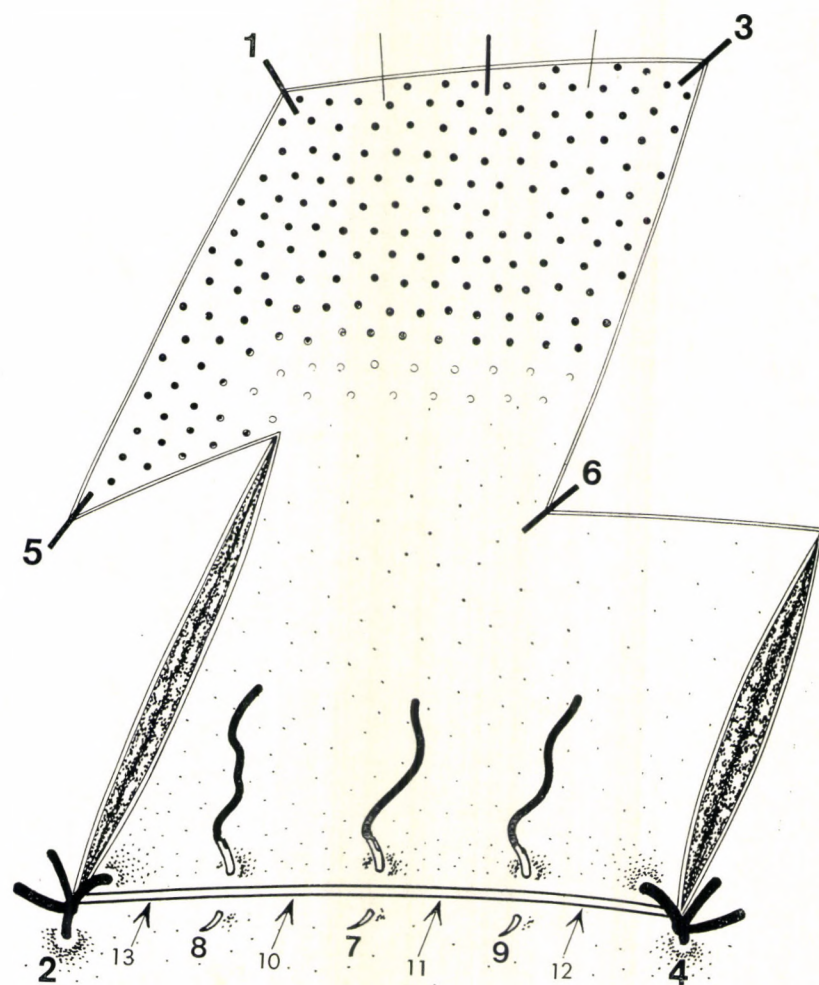
H

H. The graft, laid out over the primary defect, is first secured in the principal directions by a few interrupted stitches (at points 1 to 6). Each side is then sutured in succession by the halving method, i.e., the first stitch is made at the midpoint between the interrupted sutures (7), each successive stitch being inserted at the midpoint between two preceding stitches. Suturing must be carried out with precise adaptation.
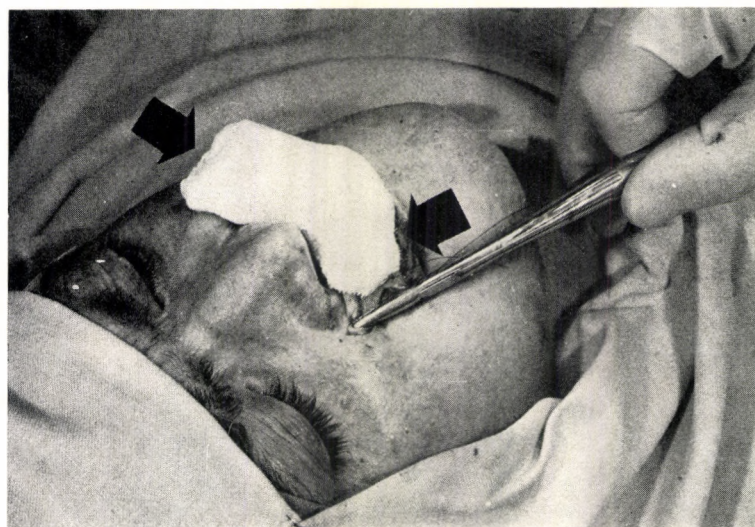
I

I. While being sutured, the graft should be protected from desiccation by means of a gauze pad saturated with physiological saline solution.
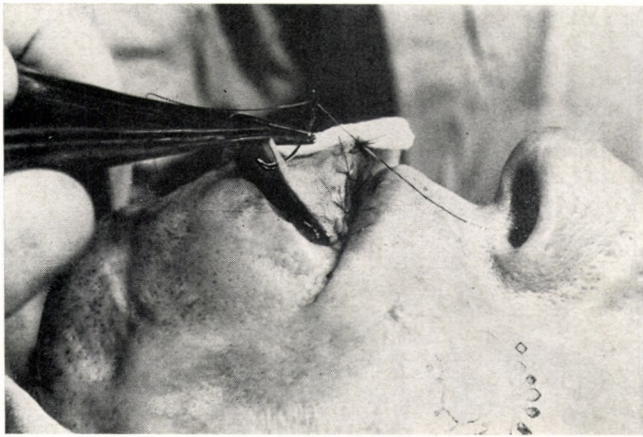
J
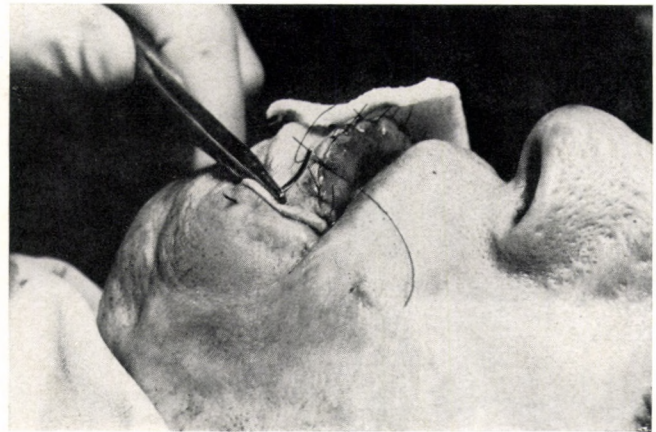
K
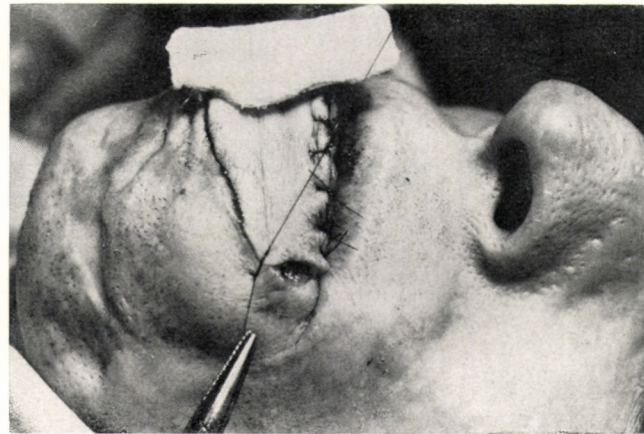
L

J through L. In general it is best to suture from
the graft to the recipient site. In order to achieve
precise adaptation, the graft is slightly lifted by
a forceps and pierced by the suture needle. Next,
that point of the recipient wound edge at which
the stitch should be made is sought with the
point of the needle. The suture is tied with a
needle holder.

Tools Used for the Excision of Split Skin Grafts

A
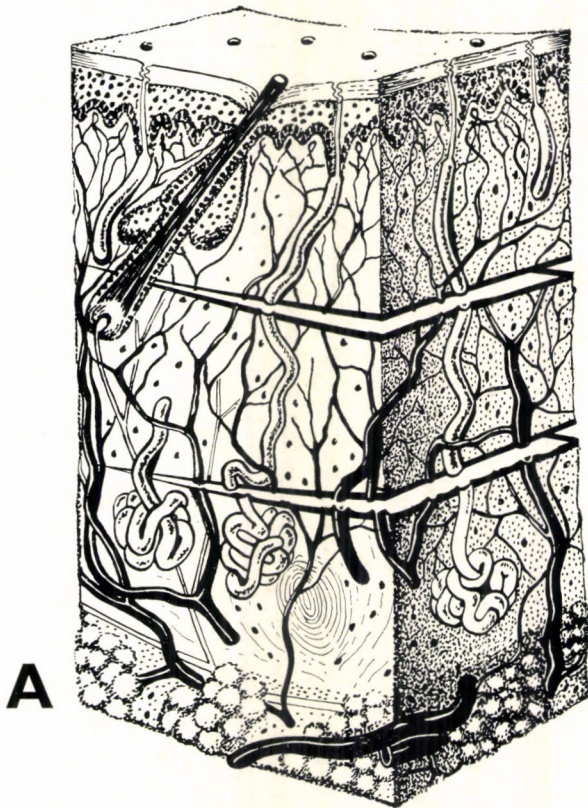
A. For obtaining split skin grafts, flat sheets are cut from the skin which contain the whole epidermis and part of the dermis. Such sheets conform and adhere well to the recipient site. The notable advantage of split skin grafting is that the wound at the donor site becomes spontaneously and quickly epithelized from the direction of the epithelial coat lining the efferent ducts of the transected sweat glands and hair follicles. The dermatome is the most important tool used for the transplantation of split skin. It divides the skin in the corium in a direction parallel to the surface. The common feature of all dermatomes is that they are capable of cutting uniformly coherent flat sheets from the skin.

B
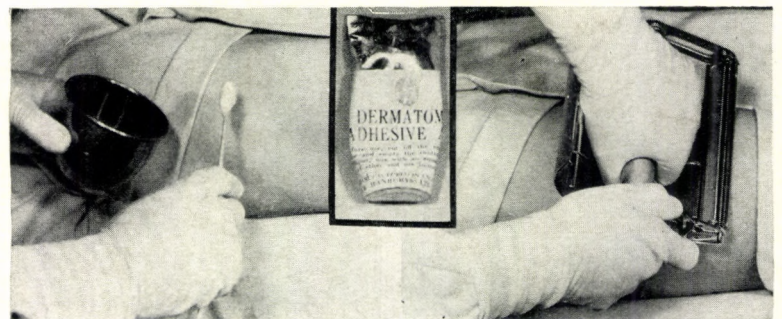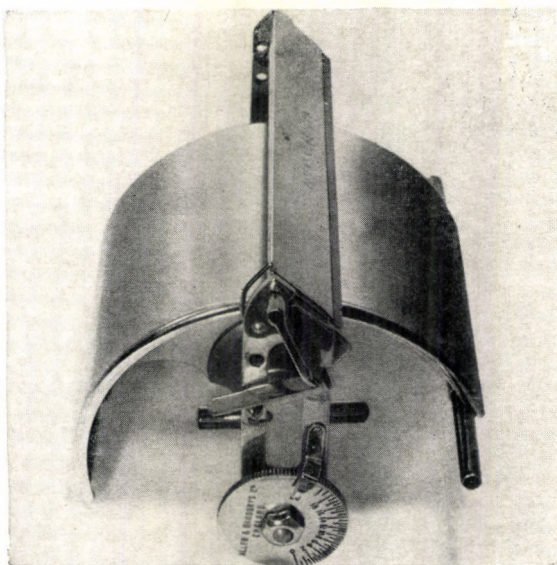
B. The dermatome of Padgett-Hood, the oldest tool of its kind, was constructed in 1926 for the elaboration of skin transplantation. It has numerous variants. The surface of the skin is glued to the drum of the dermatome, and the transplant is excised by the manual activation of a blade. The ability to regulate the size and shape with great precision is a great advantage of all manually operated dermatomes.

C. Electrodermatomes cut the skin without the use of adhesives; the knife is activated electrically. Compared with the manual instrument, it has the disadvantage that the width of the transplant is limited. It has, on the other hand, the advantage that grafts of great length can be prepared and that their thickness can be adjusted with extreme accuracy.
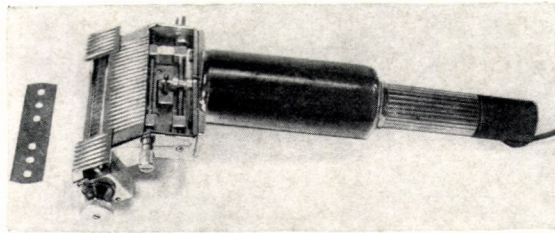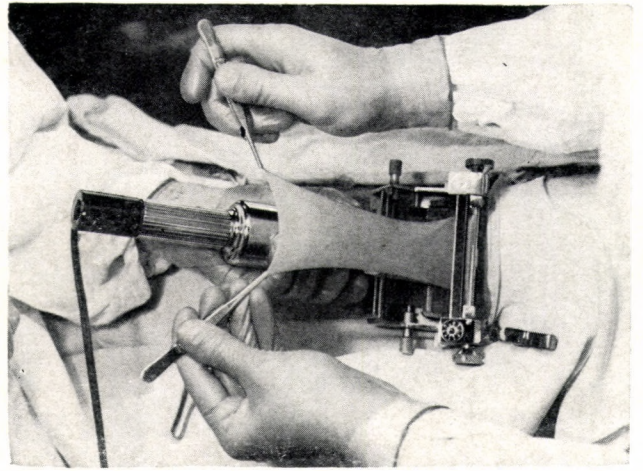
C

D. The simplest (and therefore most widely used) instrument for the cutting of split skin grafts is Humby's knife which, too, has several variants. A transversely grooved roller before and above the blade adheres to the skin and enables the surgeon to perform the excision by means of the manually activated blade. The distance between blade and roller is adjustable by means of screws so that the thickness of the layer can be determined at discretion. The skin should be tightened in order to facilitate the act of cutting. Flat pieces of wood and metal plates may be employed for this purpose. The skin-stretching device represented in the picture has proved highly satisfactory: in addition to stretching, it elevates the skin, thus preventing a secondary injury of the adjacent tissues. The variously wide incisures on the four sides determine the width of the graft.

D

E

F
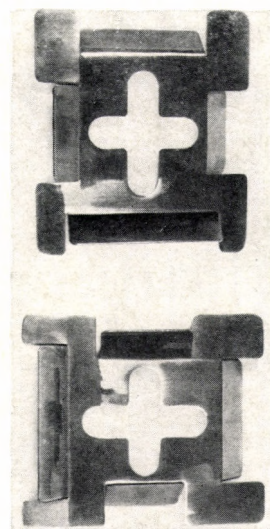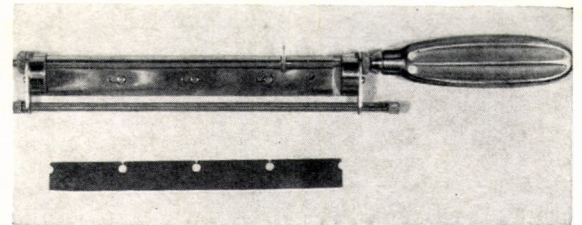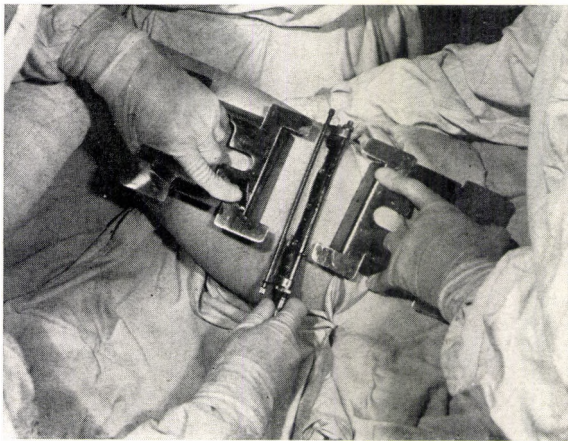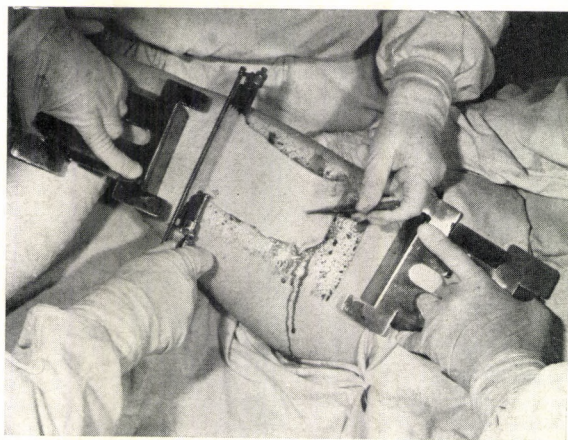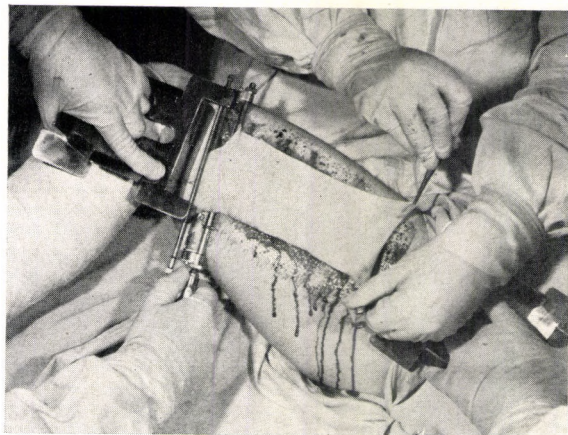
E through G. Procedure of excision. The assistant presses the skin-stretching tool upon the donor site at the starting point of the incision; the surgeon, holding the other tool with the left hand, draws it in front of the blade at a distance of a few centimeters, thus ensuring a uniform tightening of the skin (E). When the dissected transplant has outranged the knife, the assistant has to hold the dissected portion by a forceps without pulling it (F); otherwise the blade will cut it off (G).

G

Suturing
of Split Skin Grafts

A. It is best if the split skin graft is implanted soon after harvesting. Therefore, preparation of the host side (including hemostasis) may be accomplished before the excision of the skin at the donor site.

A

B. The graft is placed on the defect, fixed at a single point, spread over the base by means of fine tissue forceps, and its curling edges smoothed out.
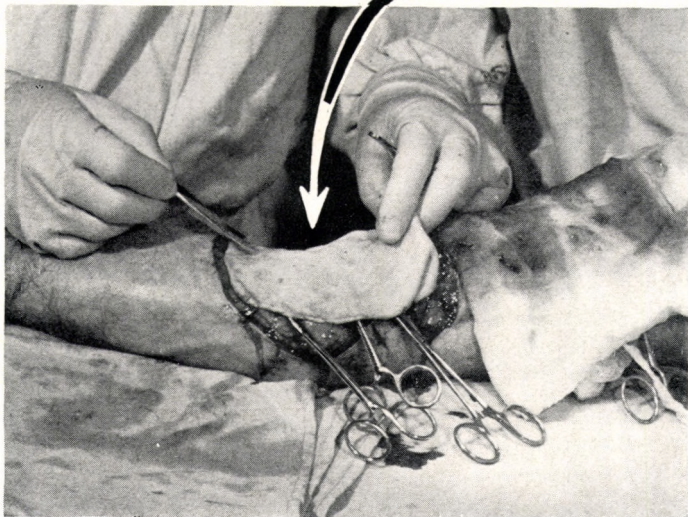
B
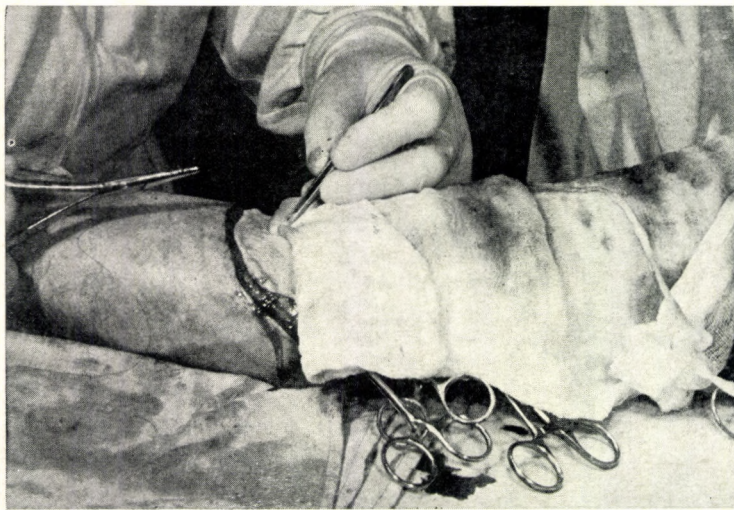
C

C. The implanted piece should be covered with a gauze pad moistened with physiological saline solution in order to prevent desiccation.
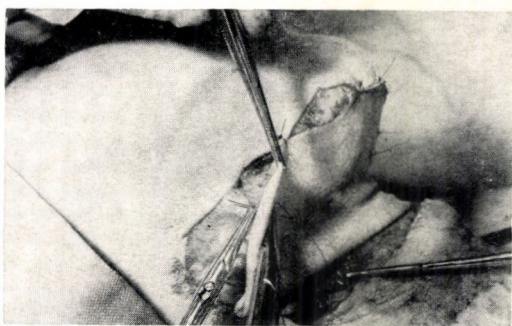
D
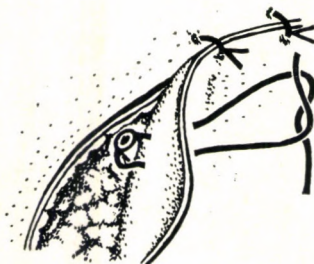
D. The major vessels of the host site are closed by transcutaneous pull-out ligature which can be removed later so that no foreign body is left beneath the graft. Ligature or coagulation beneath the graft leads to the isolation and necrosis of certain portions; therefore bleeding must not be arrested in this manner.*

E. Grafts spread over and extending beyond the edges of the defect are fastened to the latter by interrupted suture, if quite precise adaptation is not necessary.
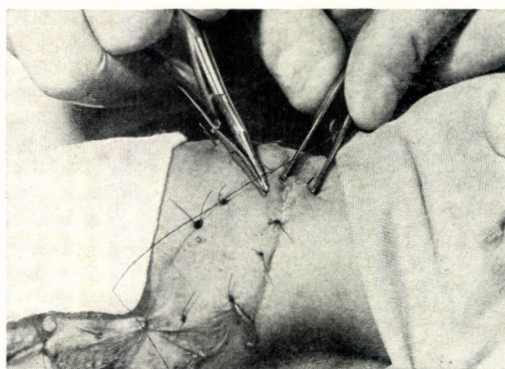
E
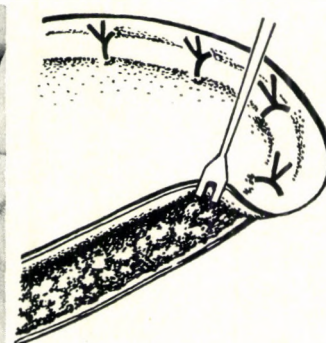
* The American editors have experienced no difficulty using electrocautery for coagulation on recipient sites.

F. When suturing the graft with precise adaptation, not even with a fine tissue forceps must we grasp the edge of the accurately tailored graft; it should be fitted to the margin of the defect with the point of the needle; both the edge of the graft and that of the wound are then transfixed with a single stitch. Any protruding part of the graft is eliminated by making an incision in its midportion where a stitch is inserted; the excess is then cut off by scissors on both sides of the stitch.
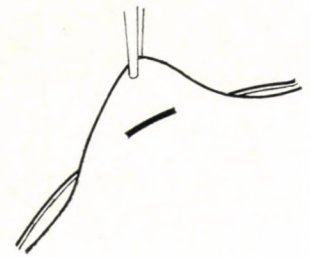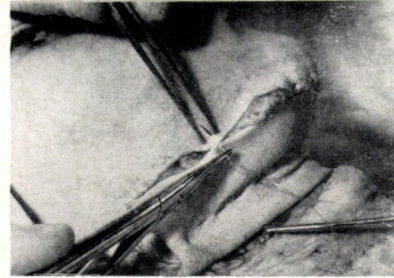
F
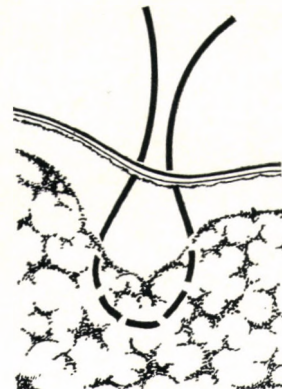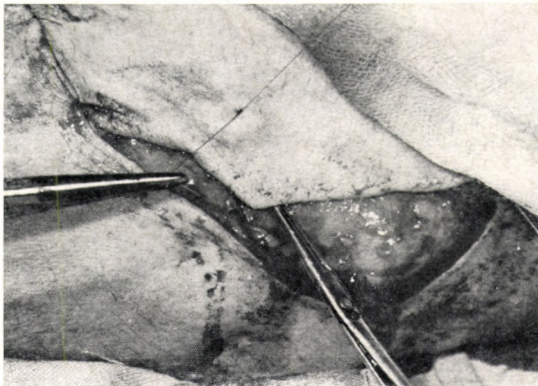
G

G. Large grafts should be anchored to the base at several points, in order to prevent hematomas or serous effusions. An anchoring stitch should be inserted in every depression if the recipient area is uneven.
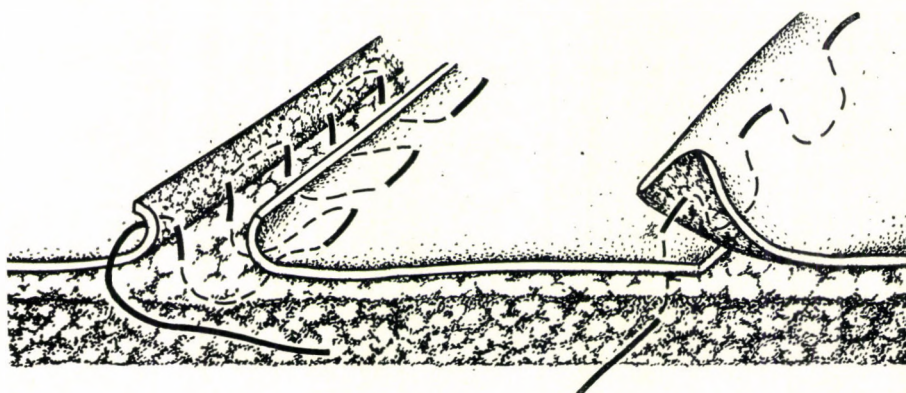
H

H. If the replacement of a defect requires several grafts, they must be sewn together. There are two ways of doing it. According to one method, the margins of the implants are so united by running sutures that also the base is taken up. According to the other method, one of the grafts (that with a more regular margin) is flattened and smoothed out over the base, the other graft is spread over the first and both are then fastened to the base by running mattress suture.

I. Before dressing the sutured graft, a roller bandage is rolled across it in order to eliminate possible blood effusions or air bubbles.

I

Pressure Dressing with the Threads of the Suture

It has been found expedient to utilize the threads of the suture for the immobilization of pressure dressings and for the maintenance of the required mild compression. This method is particularly useful if special features of the region involved or other factors (e.g., the risk of circulatory disorders) do not allow the application of a pressure dressing as represented on p. 86.

A. Employing synthetic monofilaments stronger than usual we attach the graft to the recipient area by symmetrically inserted bolster stitches. One end of the thread of these stitches, left free over a length of 20 to 25 cm, is tagged by a hemostat. The segments between the bolster stitches may be sutured by normal interrupted stitches.
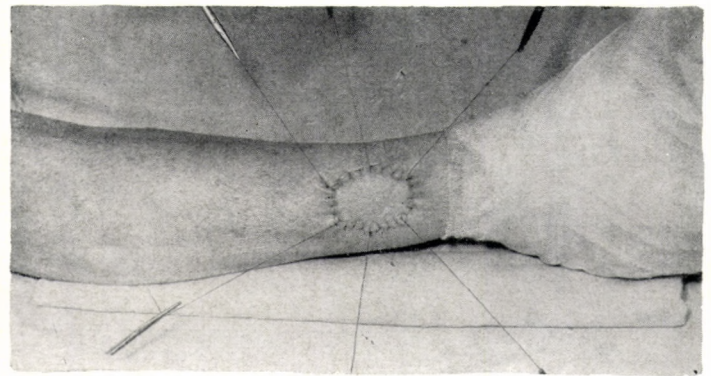
A

B. Layers of the dressing: a simple sheet of impregnated gauze which extends 1 cm beyond the edges of the graft (1), a gauze pad, composed of 8 to 10 smooth, dry sheets, which has exactly the same shape and size as the graft (2); a piece of rubber sponge, at least 3 cm thick, which also has the same shape and size as the graft (3); a covering sheet of gauze, somewhat larger than the rubber sponge (4).

B

C

D

C through F. The various layers are placed on the graft, in the order: impregnated gauze (C), dry gauze (D), sponge rubber (E), and covering gauze (F).

E

F

G. The dressing pad is immobilized by tying the threads over it. Pairs of threads which are exactly opposite are to be tied into knots; the assistant seizes the first knot with a smooth forceps to prevent its being undone while the second knot is being pressed upon it. The knot must not be stretched so tightly as to force the suture too high upward, as it might interfere with circulation.
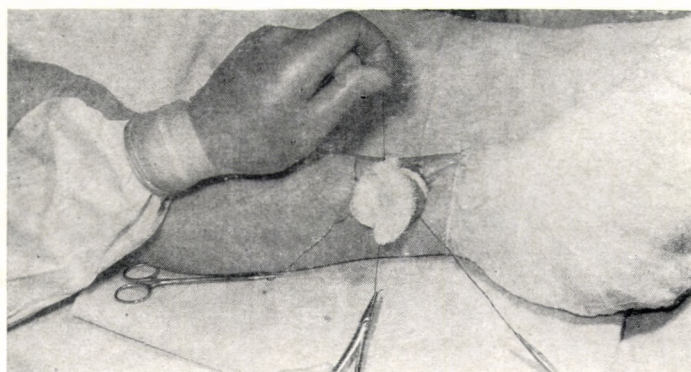
G

H. This dressing constitutes a firm cover over the graft. By pressing a finger on the dressing it can be ascertained that the rubber sponge is still slightly compressible, indicating that the pressure is not too strong. By cutting the threads above the pad, the dressing is removed on the 10th postoperative day.
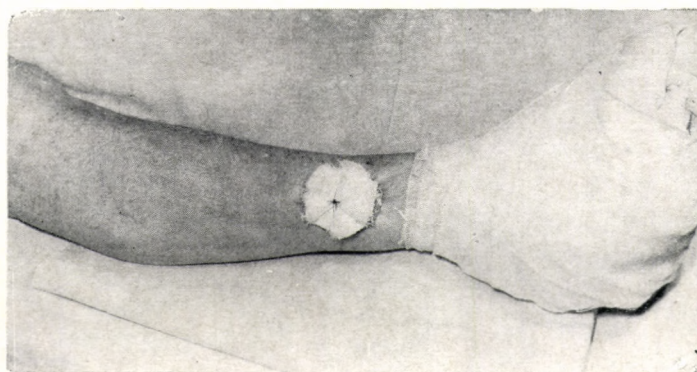
H

I. If the pressure dressing is immobilized with the suture threads on an extremity, the extremity should be placed in a plaster cast and propped up. (Braun's frame may be employed if the lower extremities are involved.)
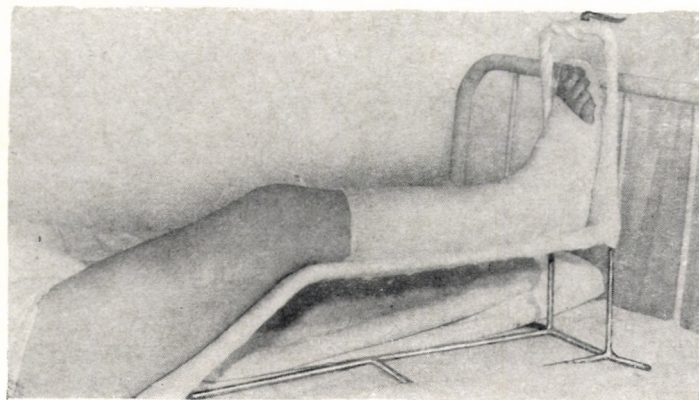
I

Management of the Donor Site of Split Skin Grafts

The grafting of split skin has the great advantage of allowing transplantation of large pieces of skin without damaging the donor site either functionally or cosmetically. This is only possible if the wound at the donor site heals by first intention: we find that open air treatn.ent yields the best result in this respect. If general anesthesia is employed in children, the donor site is sometimes provisionally dressed. The dressing is removed and the open air treatment begun 24 hours later.

A

B

C
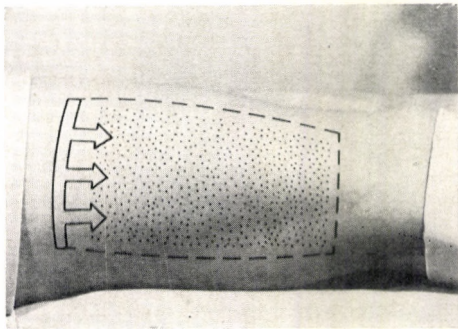
A. If the incision is made under local anesthesia, this should be performed in a centrifugal direction according to the rules set out on p. 12.
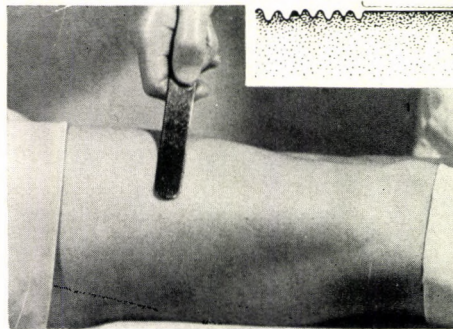
B. In order to achieve uniform distribution of the anesthetic fluid and to make the surface of the donor site level, it must be tapped with a spatula until the area becomes smooth and assumes a pink color. Tapping distends the vessels and may facilitate revascularization of the transplanted skin.

C. Before the incision is made, the area involved should be made slippery with physiological saline solution or some oil.

D. Excision of the skin to be transplanted is the next step. In order to arrest hemorrhage we place saline-saturated sponges upon the surface of the resulting wound while attending to the recipient area.
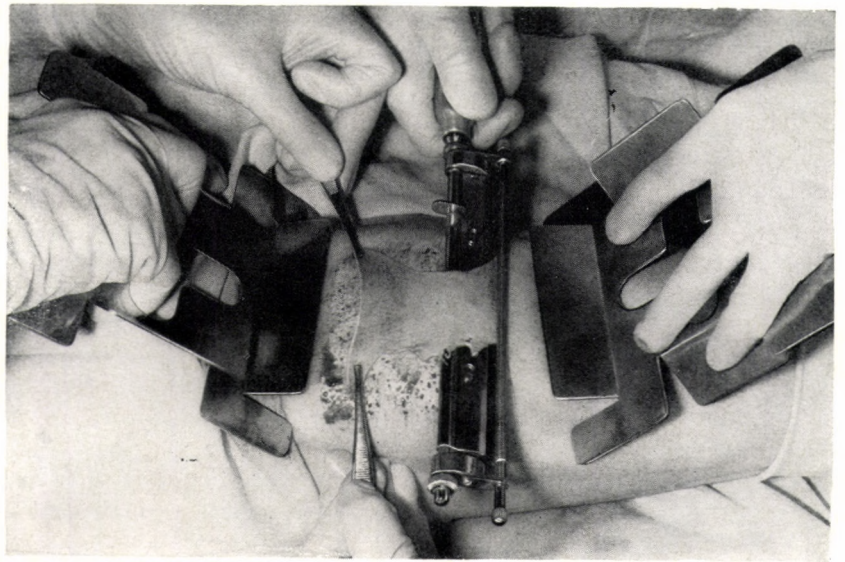
D

E. The operation having terminated, the wound is covered by a closely fitting simple sheet of impregnated gauze. Drying of the operated area by hot air begins in the operating theater.
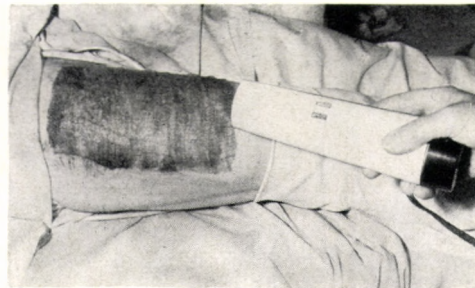
E

F. As soon as the patient is back in the sick room, the area of excision is bolstered up and immobilized (by Braun's frame). Cramer's splint or special metal structures protect the open area of the donor site from being contaminated by the bedding.
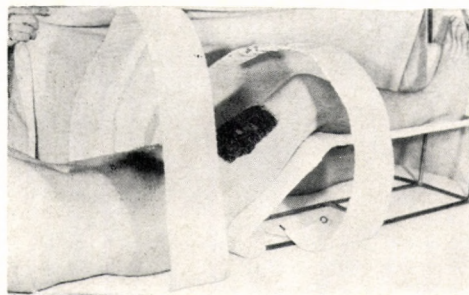
F

G. Blood, coagulating on the impregnated sheet of gauze, forms a dry and hard crust after 24 hours, so that on the 2nd or 3rd day the patient can put his or her pajamas over the site.

G

H
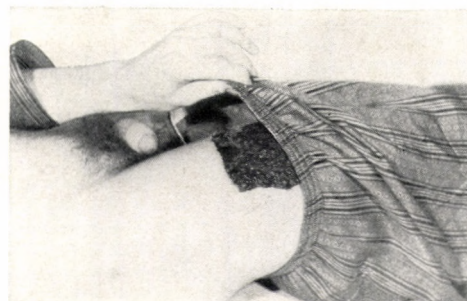
H. Closely adherent to the base of the wound, the crust constitutes a firm and yet elastic protective envelope.

I
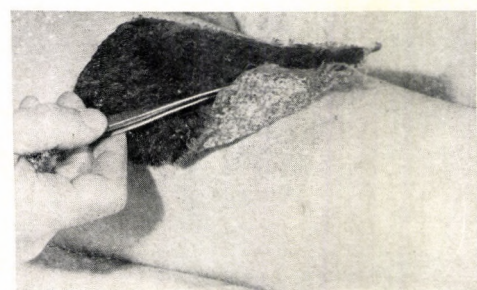
I. The area of excision starts epithelizing at the marginal portions. Progress of the epithelization is indicated by the gradual detachment of the crust.

J
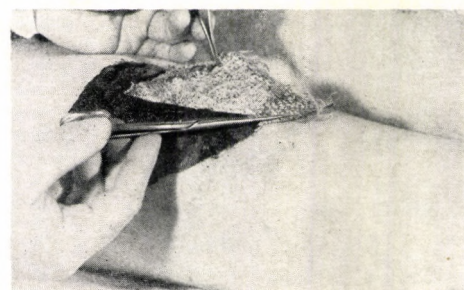
J. The detaching marginal portions of the crust must be cut off every day, lest the still adhering parts should be caught and torn off by the clothes, underclothes, or bed clothes, possibly resulting in bleeding and infection.
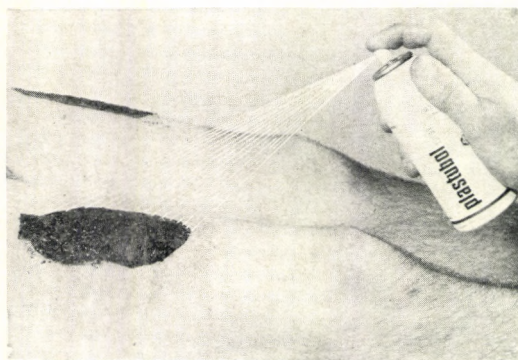
K

K. The adhering parts of the crust and the newly epithelized portions are sprayed with Plastubol.

L

L. Epithelization is accomplished and the crust is cast off on the 10th to 14th postoperative day so that only a bright spot can be seen at the site of the excised and transplanted piece of skin.

Possibilities
of Direct Flap Plasty
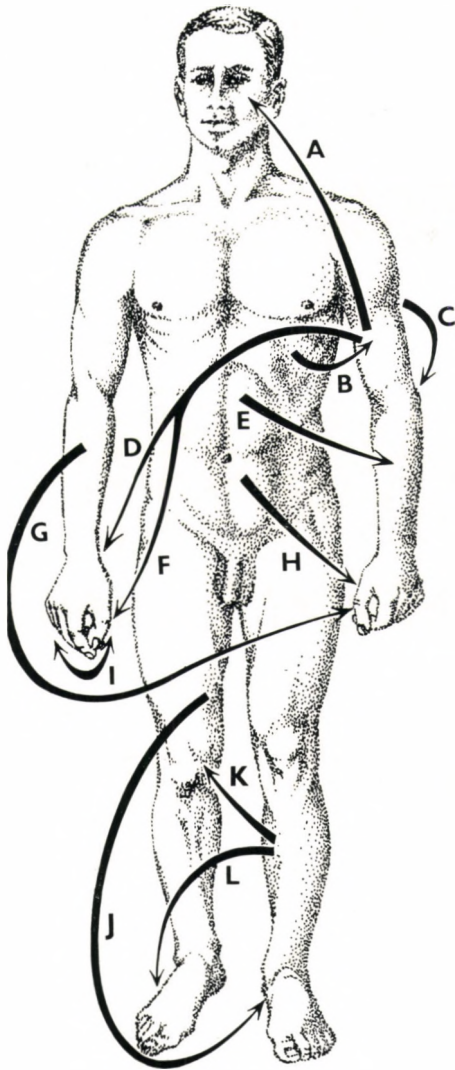
If a skin defect is to be covered by pedicled flap and the surrounding skin seems to be unfit for this purpose, the flap must be brought from a more remote part of the body. It must be a part which, by a suitable adjustment of the joints, can be brought in direct contact with the areas of the primary defect. (The letters of the diagram correspond to the respective capital letters of figures that follow illustrating the individual techniques.)

A

B
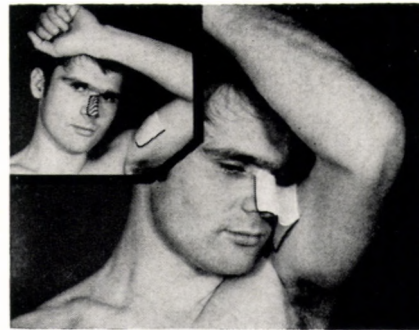
A. As it has a fine structure a thin subcutis and a comparatively suitable color, the skin of the medial and volar surface of the upper arm and the forearm is well utilizable for the replacement of facial skin defects. This is the so-called classic Italian flap plasty.
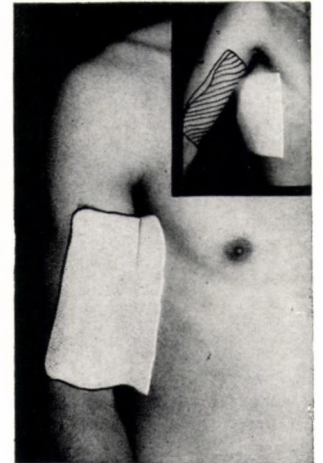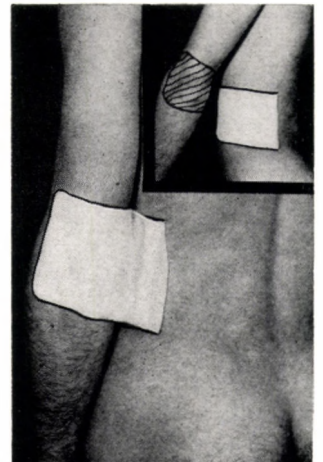
B and C. Defects on the upper arm and in the cubital region can be replaced by forward or backward pedicled flaps taken from the skin of the lateral thoracic wall.

C

D. Pedicled flaps excised from the upper arm without or with a minimum of subcutis, so-called "lambeau-greffe" of Colson, are eminently suitable for replacing skin defects on the palmar surface of the fingers. Such flaps make it unnecessary to remove in a second session the thick adipose layer of flaps originating from other parts of the body.

D

E
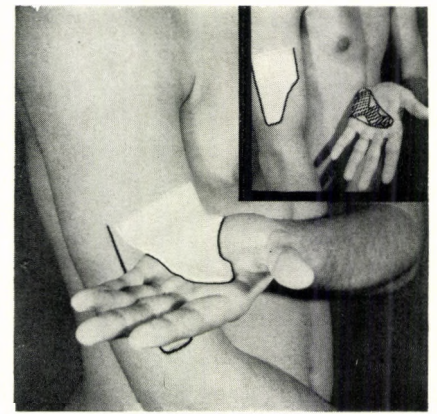
E. Defects on the forearm and the carpal region can be replaced by proximally or distally pedicled flaps taken from the abdominal wall.
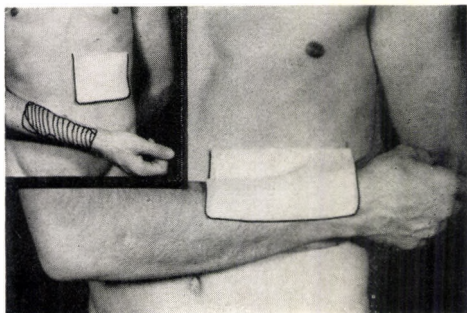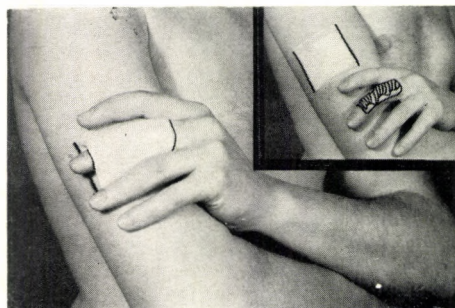
F

F. Bipedicled flaps, excised from the upper arm, are used if large defects of the fingers have to be covered. The duality of the pedicles guarantees adequate blood supply.
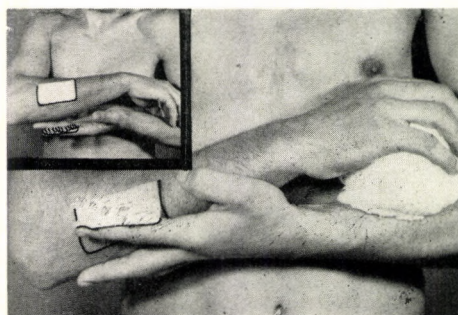
G

G. Flaps for the replacement of digital skin defects may be taken from the forearm also. This method has the disadvantage that, having the two forearms tied together, the patient is practically helpless.

H. The skin of the abdominal wall is often employed for the replacement of large defects on the hand. This applies to lean individuals in particular because the subcuticular fatty layer of their abdominal wall is not too thick. Bipedicled flap is preferable if the defect is unusually large in order to make the blood supply of the large flap completely reliable.
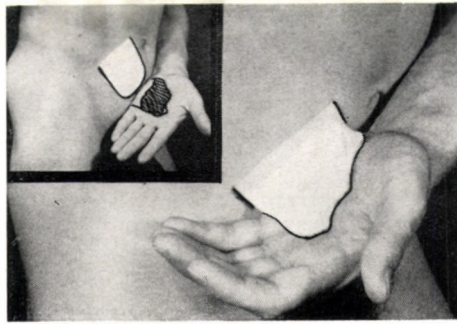
H

I. The so-called cross finger flap plasty, i.e., the employment of flaps taken from the dorsal aspect of the adjoining finger, is a frequent method for the replacement of skin defects of the finger pads or the volar aspect of the fingers.

I
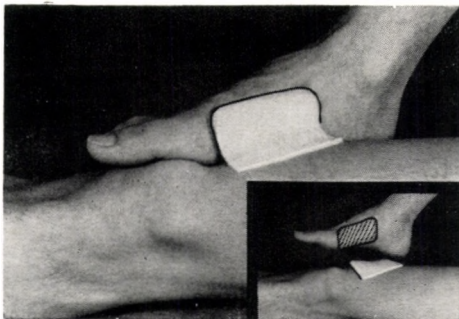
J
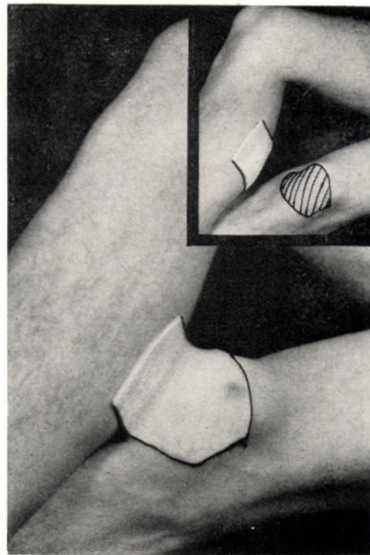
K
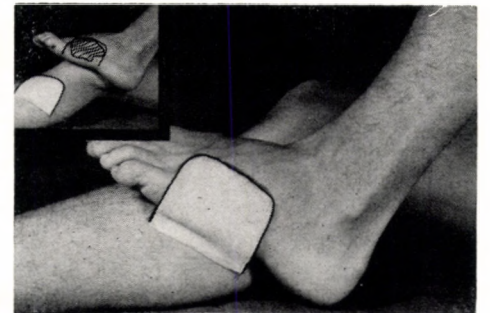
L

J through L. The so-called cross leg flap plasty, i.e., the replacement of a skin defect on either leg by a pedicled flap excised from the contralateral leg, is a method suitable for the replacement of large wounds.

Technique of Direct Flap Plasty

A.

A. Preparation of the recipient area is usually the first step. Cicatrices and other undesirable structures have to be removed, and bleeding controlled. The wound should be covered with a saline-saturated sponge until suturing the flap.*
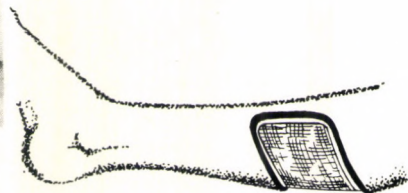
B. After laying the host site against the donor site as provided by the surgical plan, the exact shape and position of the flap is marked and outlined in the donor area by means of a suitable pattern.

B

C
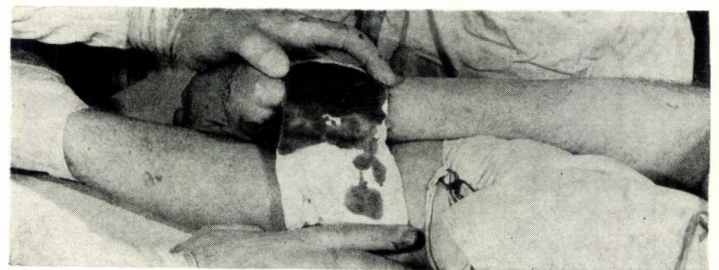
C. The flap is sharply and bluntly undermined immediately above the muscle fascia.

* The American editors feel that, if the flap viability is in doubt and a delay procedure may be necessary, it is better to prepare the flap first.

D

D. The flap is measured to see if it fits to the recipient area.

E and F. The defect at the donor site is covered by split skin graft. That portion of the flap pedicle between the flap donor site and the implanted portion of the flap must also be covered by a split thickness skin graft.
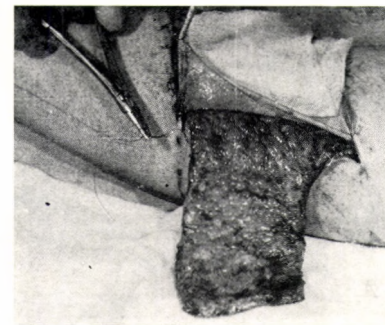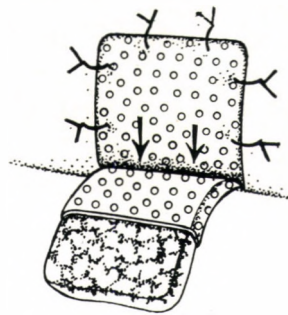
E
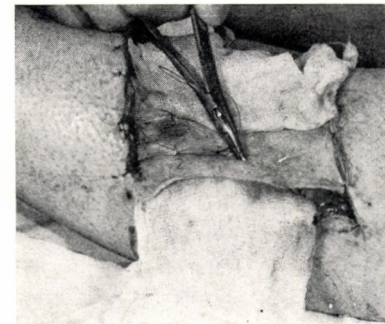
F

G. In order to prevent the formation of dead space, the split skin graft has to be anchored to the base in the angle between the flap and the donor site. The running suture, employed for this purpose, fastens the graft to the base of the wound of the donor site and not to the connective tissue of the pedicle.

G

H
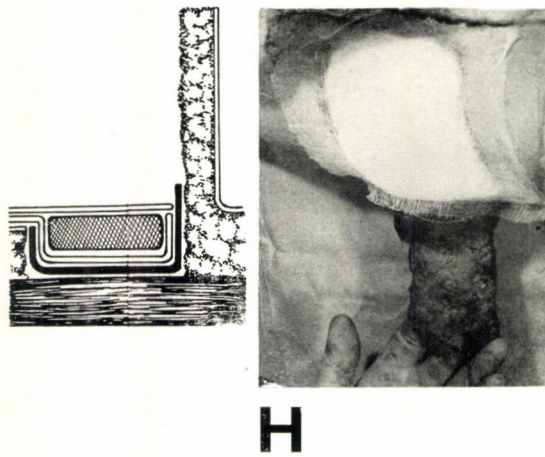
H. Before stitching the flap to the primary wound, the graft must be sutured and dressed into the donor site.

I

J
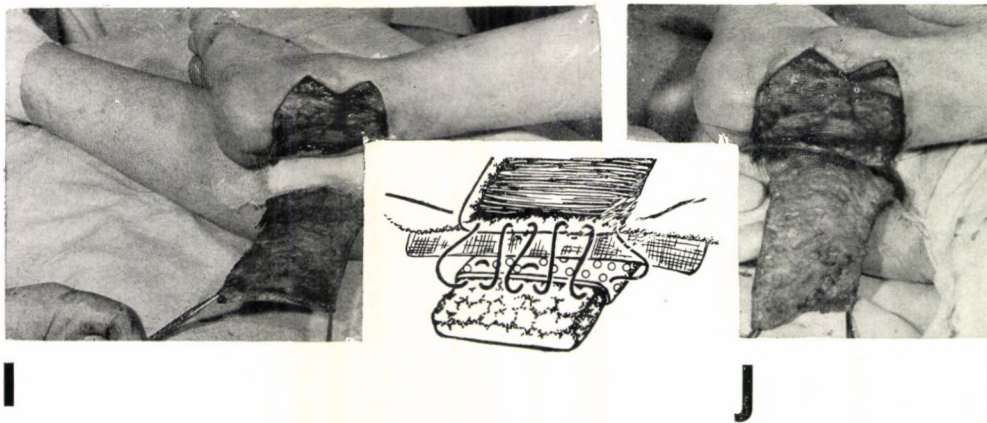
I and J. The first step at the implantation of the flap is to stitch the border of the graft which covers the pedicle of the flap to the near edge of the recipient wound. This is achieved by a running suture which, drawn through the free graft, takes up the thin subcutis of the flap and runs on the other side in the corium of the recipient wound. The gap between the near side of the host area and the pedicle of the flap is thus closed.

K

K. The margin of the primary wound should be so modeled that the line of the subsequent closure runs in the direction required to best serve that area of the body. The flap must be shaped accordingly.

L. In order to control its position, the sutured flap has to be visible during the application of the plaster cast.

L
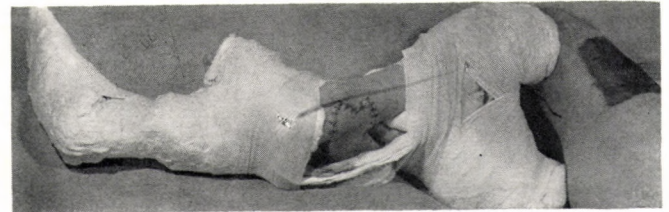
M

M. The extremities are immobilized by well fitted plaster dressings which leave the flap open for observation and care.
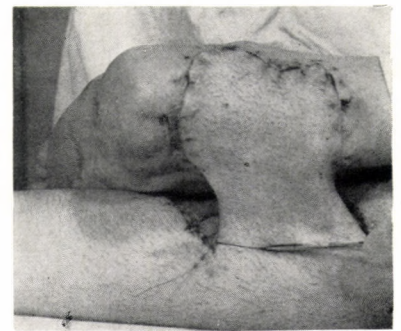
N

N and O. The pedicle of the flap is transected 3 weeks after the implantation. The lips of the wounds at the donor site and the recipient area are freshened and sutured. If the flap circulation is in doubt, it may be well to wait 48 hours before closing the pedicle edge.
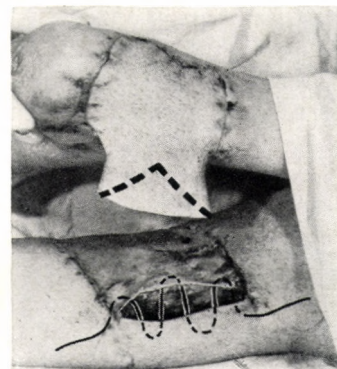
O

Immobilization Following Insertion of Distant Pedicle Flap

Immobilization of the affected part following insertion of a distant pedicle flap is most important. It is essential that little movement occur between the flap and the recipient bed; thus, any tension and kinking of the flap are avoided.

A
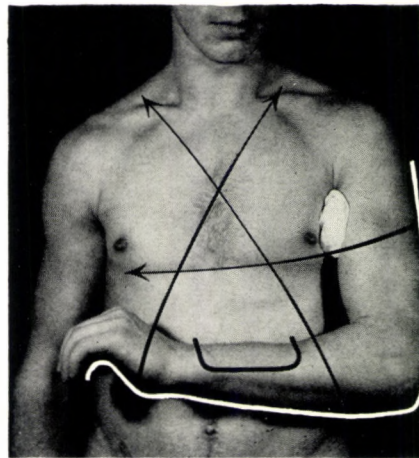
A. A plaster splint applied to the left upper forearm wrist and hand is shown, which maintains the left arm in a suitable position to receive the flap from the abdominal wall. Arrows demonstrate the direction of supported bandaging; notice the gauze dressing under the left axilla.
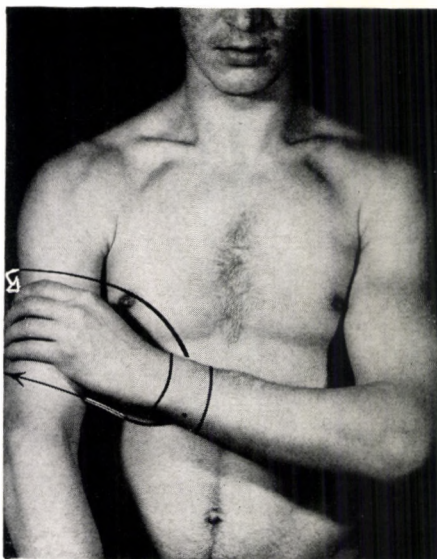
B

C

D

B through D. The position of the hand when applied to the contralateral upper arm to receive a pedicle flap to the hand. Notice that in this position both shoulders are allowed to move in the anterior direction.

E and F. Immobilization of
the cross leg flap.
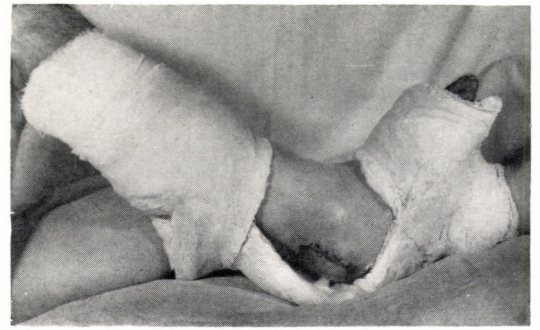
E

F

G. Principles of immobilization
for cross leg flaps in the correc-
tion of various lower leg defects.
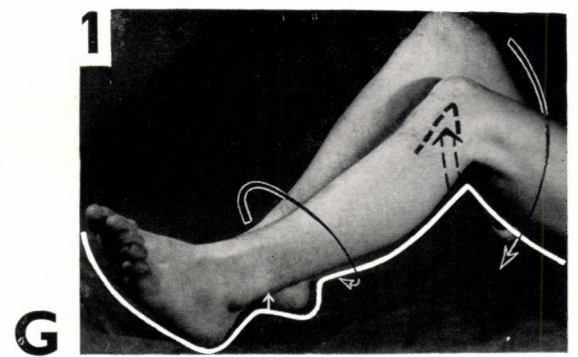
G
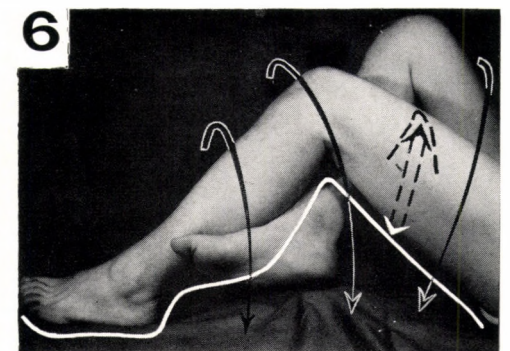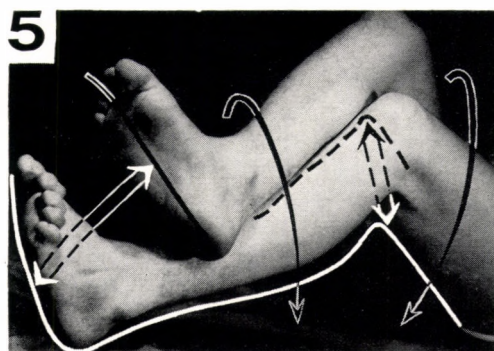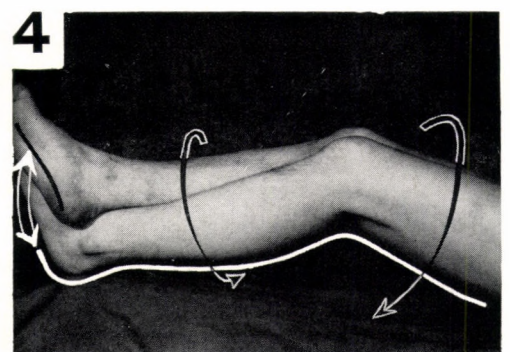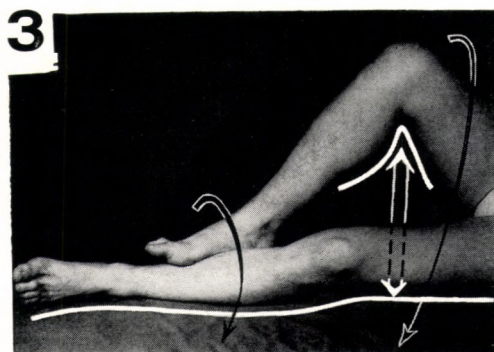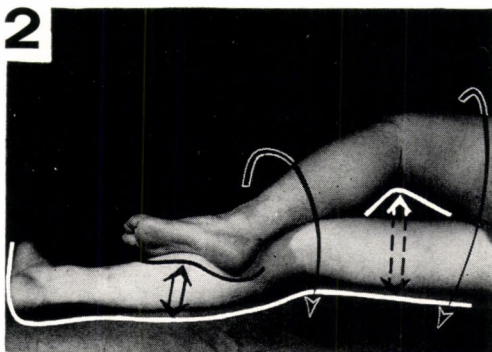
Cleansing and Draping the Face

When operating within or near the margin of the hairline, it may become necessary to shave some hair to prevent it from contaminating and interfering in the operative field. Often, however, this can be avoided if the patient shampoos his hair the night before surgery and the area involved is thoroughly washed. If hair gets in the way, it can be smeared with an antibiotic cream to make it lie flat. Eyebrows should never be shaved because a misalignment of the eyebrow can easily occur with resulting asymmetrical deformity, and because the eyebrow hair grows back very slowly.
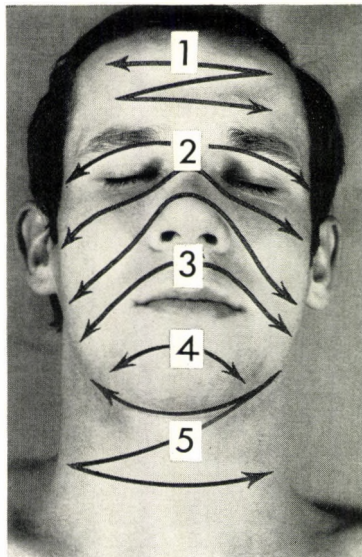
A

A. One method of cleansing the face by starting at the forehead and working down the face. Whenever possible, the whole face should be exposed during operation and, accordingly, the whole face should be cleansed.

B

C
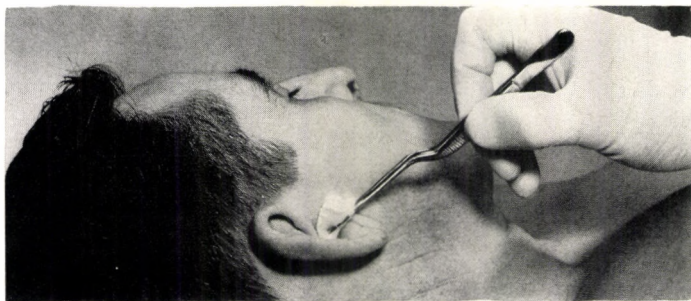
B. A cottonball placed in the external auditory canal prevents collection of fluid in the canal which might cause discomfort and possible problems later.
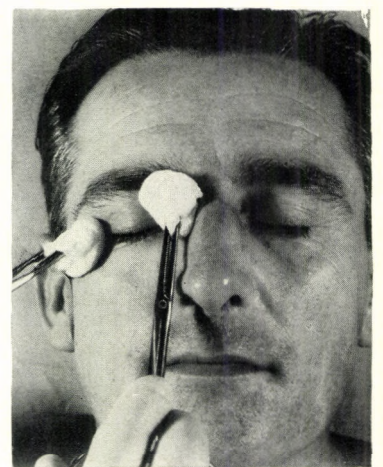
C. After cleansing the face, the area around the eyes is carefully dried.
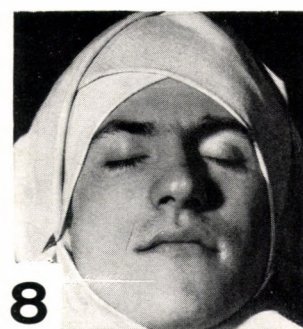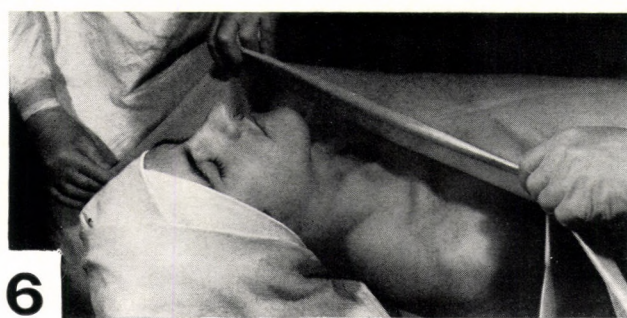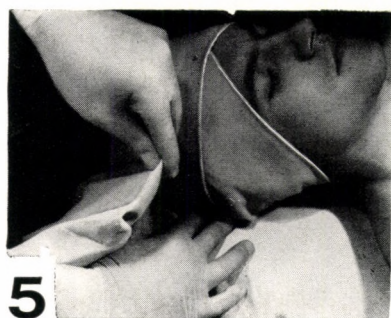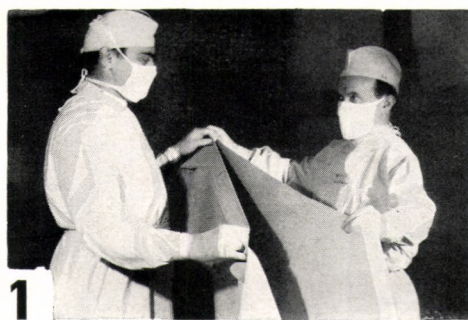
D. A good way of draping the
head by means of two sheets
or a towel and a sheet.

Direction of Elective Incisions on the Face and Neck
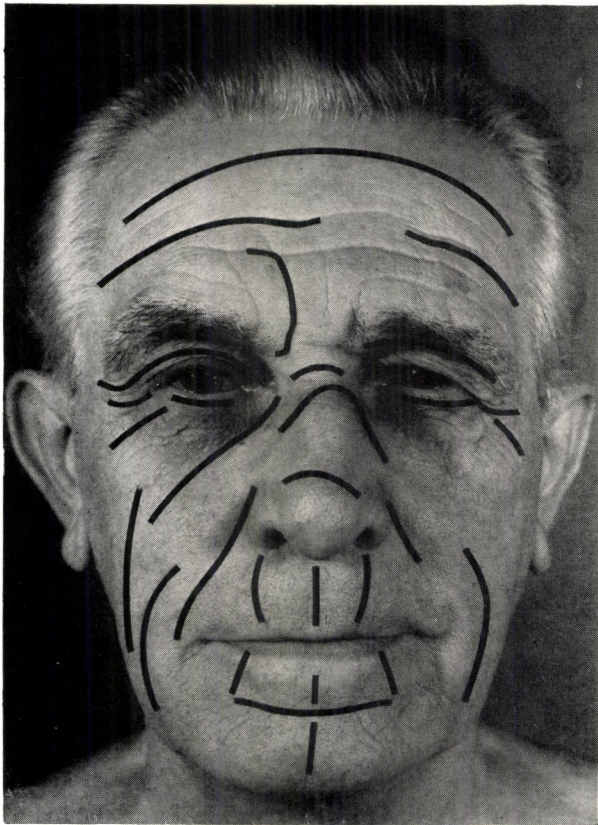
A
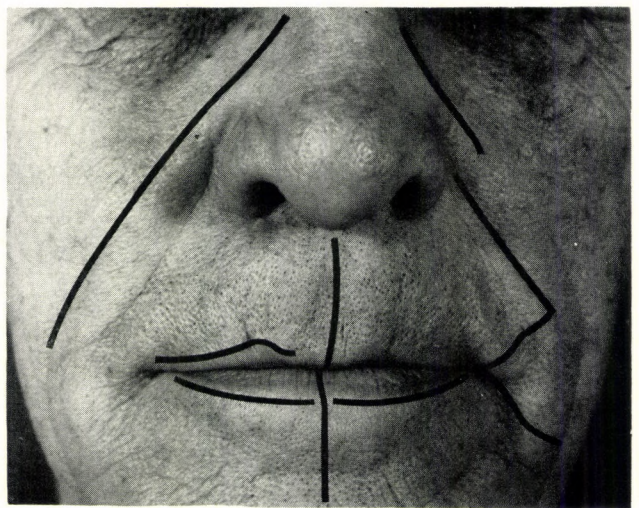
B
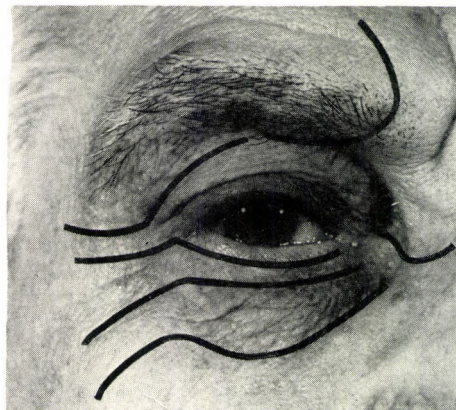
C

A through C. As a general rule, it might be said that elective incisions on the face should be made in the same direction as the wrinkle lines. These wrinkle lines or lines of facial expression almost always run at right angles to the direction of motion of the underlying facial musculature.
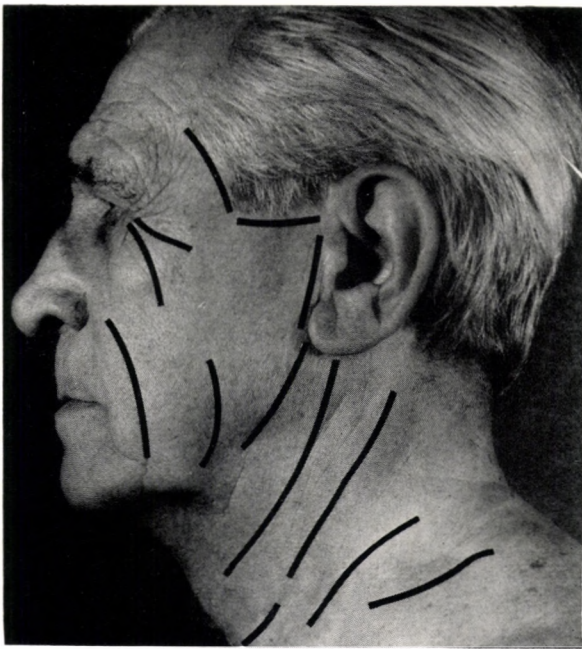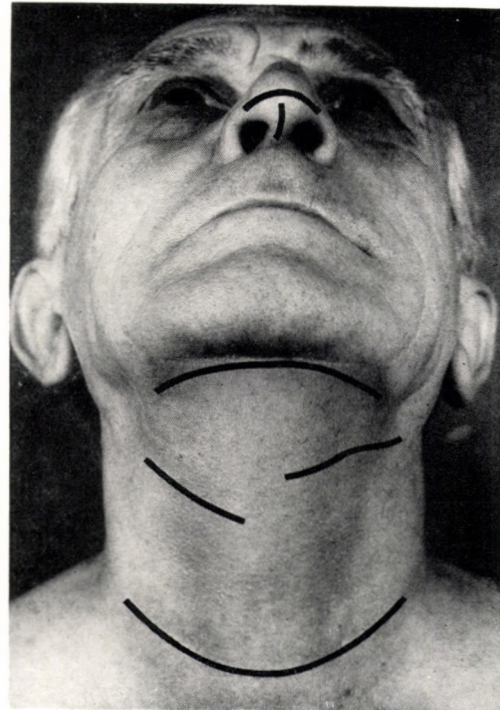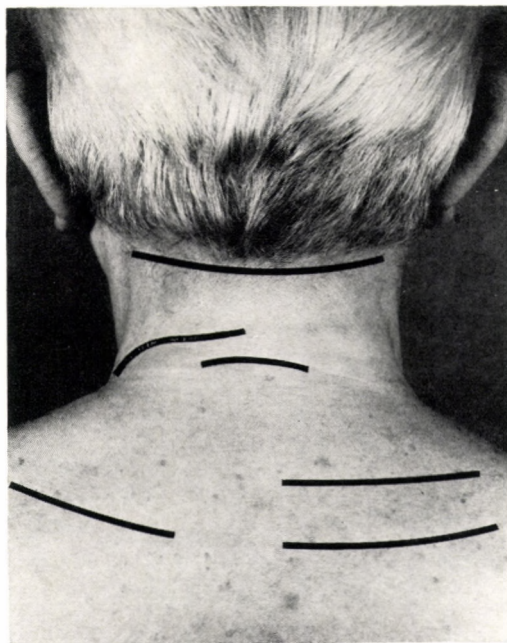
D through F. The lines of elective incision on the face and neck.

Excision of Minor Lesions on the Face and Neck

A. Types of incisions that can be made to remove appropriate lesions. Fine lines demonstrate the direction of wrinkle lines and the stippled area denotes the area to be undermined.
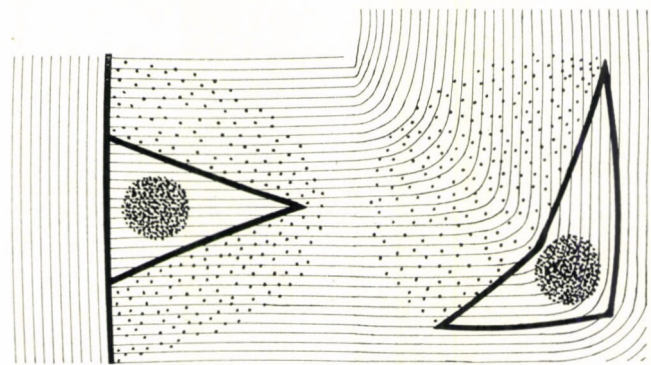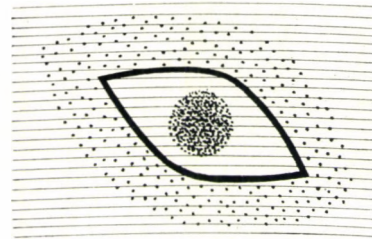
A
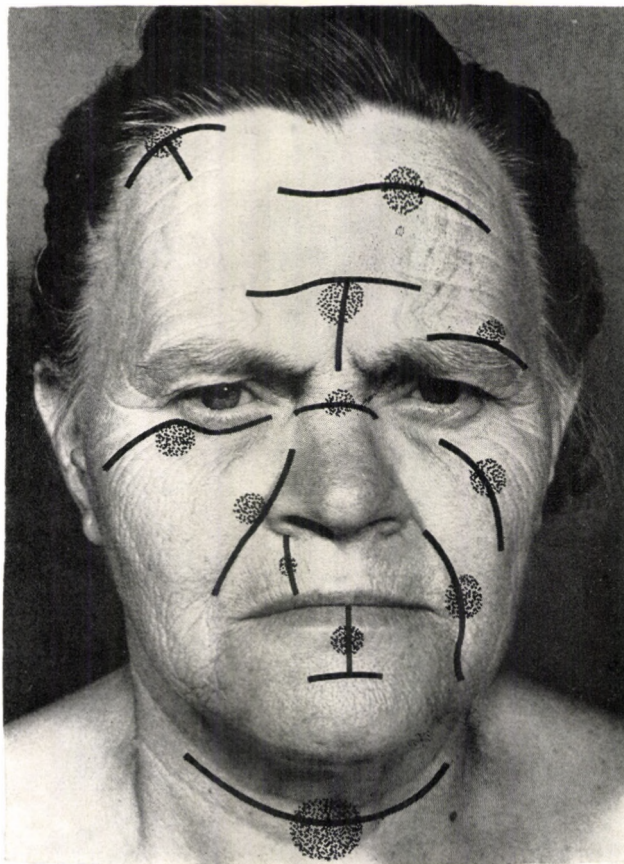
B

B. The elective lines of closure after excision of the demonstrated lesions. The lesions have been excised either in an elliptical shape or in a wedge shape with undermining of the surrounding skin. The size of the wound is shown to demonstrate the length of incision necessary to avoid the formation of dog ears.

C

D
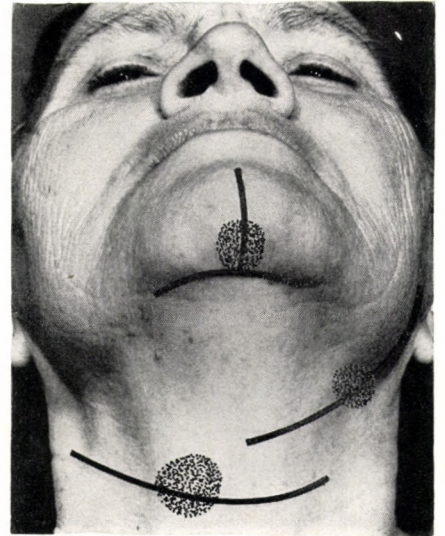
E
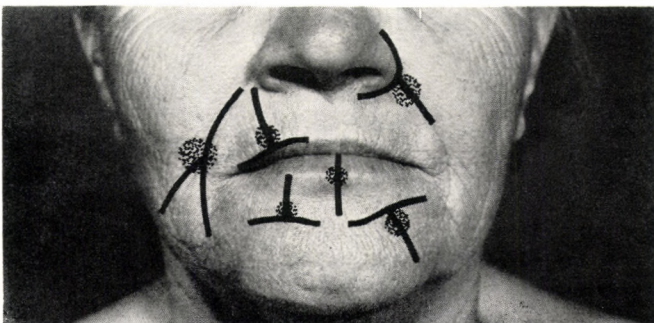
F
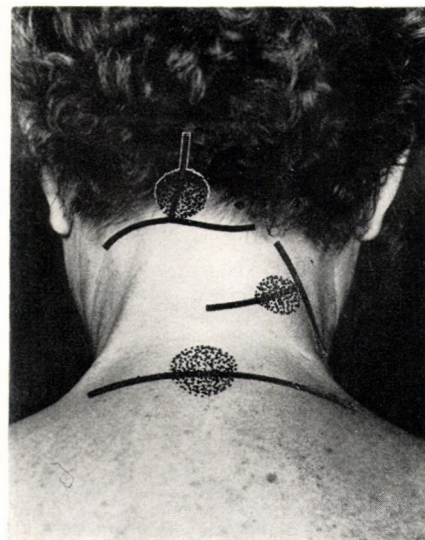
G

C through G. Note that in certain areas such as the border of the hairline, the midline glabella, and midline chin regions a wedge-shaped incision may be necessary for satisfactory closure in T-shape. T-shaped closure can also be used in the posterior neck and around the mouth region. Y-shaped closures are used around the lateral and medial canthal region and also around the mouth.

Closure of
Facial Skin Defects
by Local Flaps

When a tissue defect that is too large for primary closure exists, repair can be obtained by either using a skin graft or a pedicle flap. In the following the use of local pedicle flaps is demonstrated. In all these cases, extensive undermining of the flap must be performed in order to produce the satisfactory result. Undermining is usually performed just below the subdermal layer to maintain the vascularity of the flap through the generous dermal plexus.
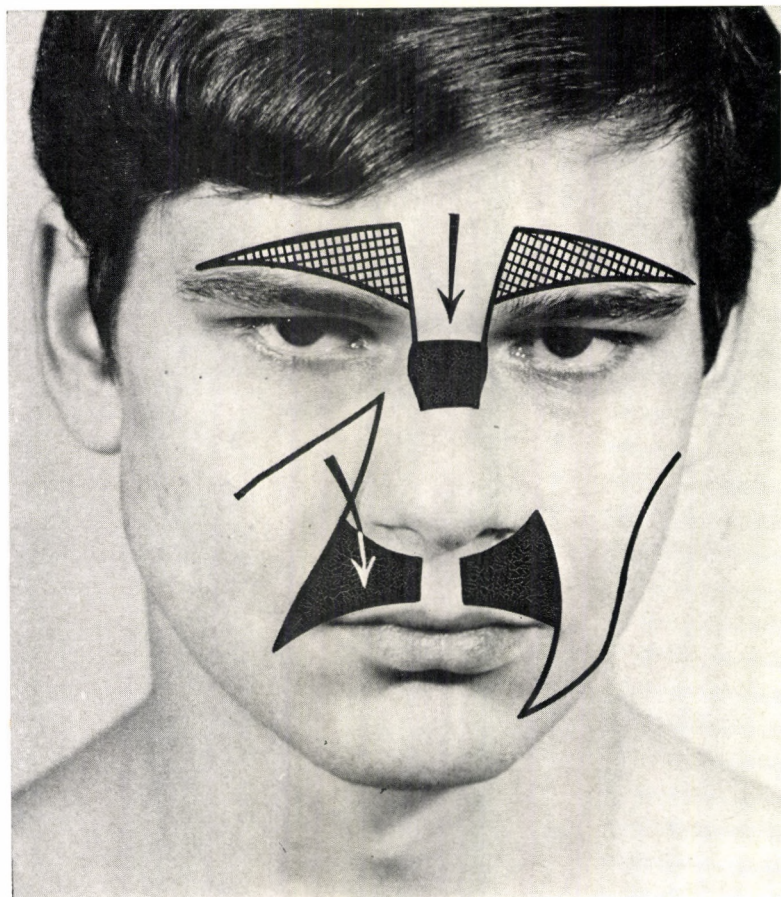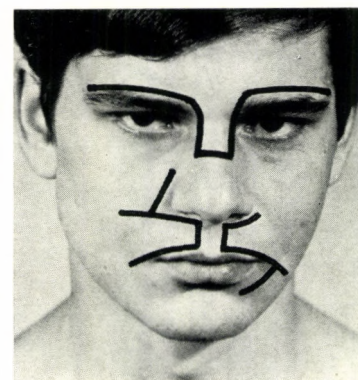
A. A defect in the glabellar region can be closed by an advancement flap after triangles of tissue are excised from the supraorbital region. Defects in the upper lip can be closed by means of transposition flaps.

A

B

C
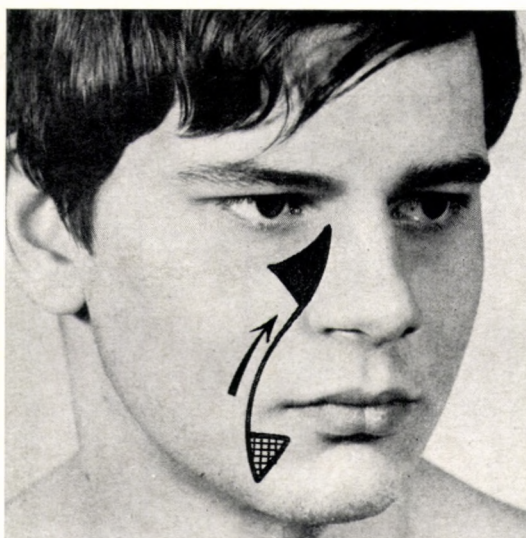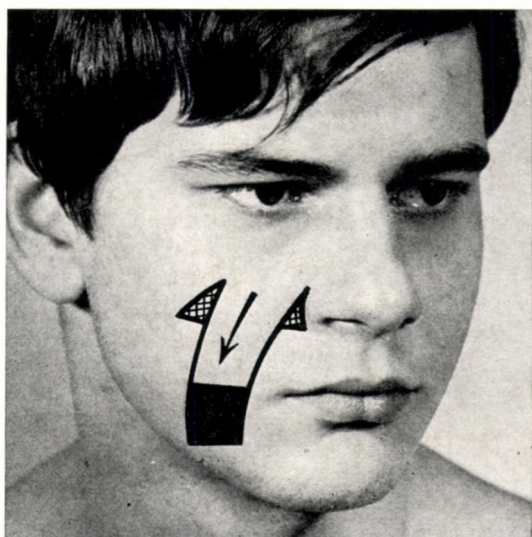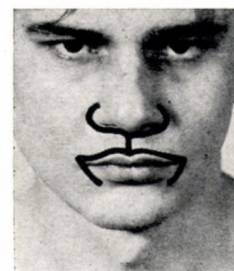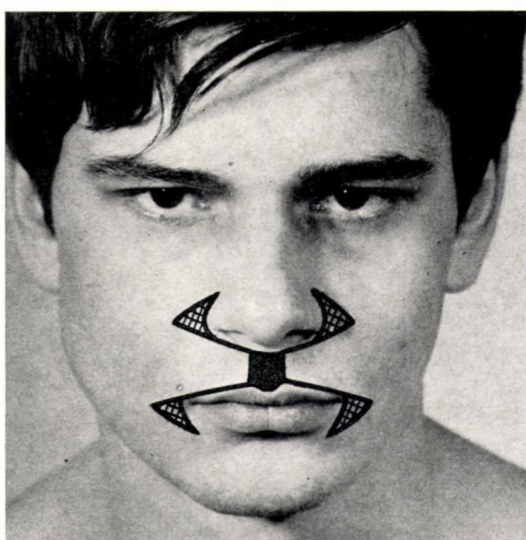
B through D. Further advancement flaps on the face. Note the triangles of tissues to be excised.

D

E

E. A defect on the face closed by rotation flap.
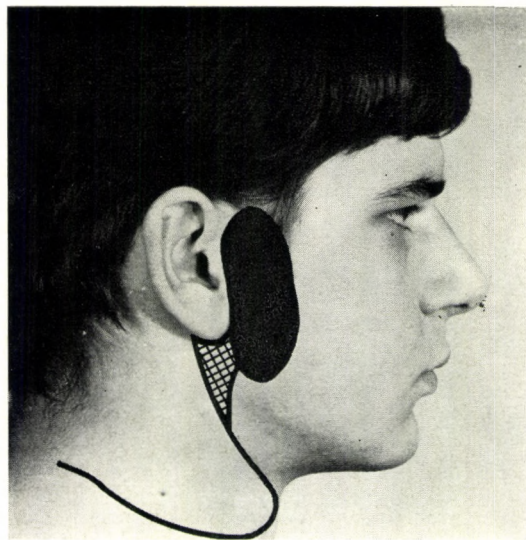
F
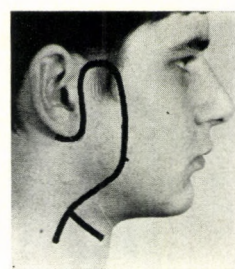
F through H. Further transposition flaps.
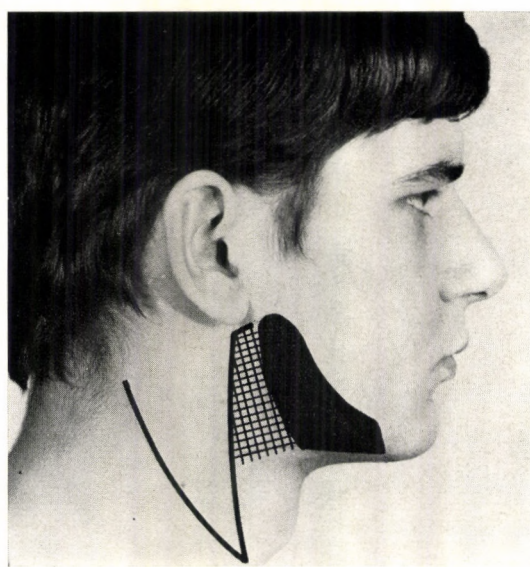
G

H
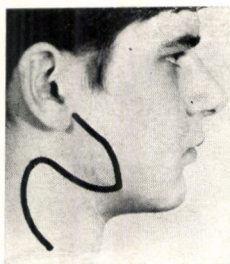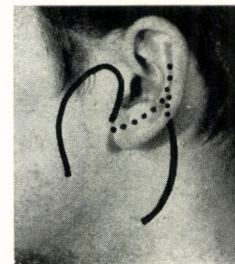
Closure of Facial Wounds
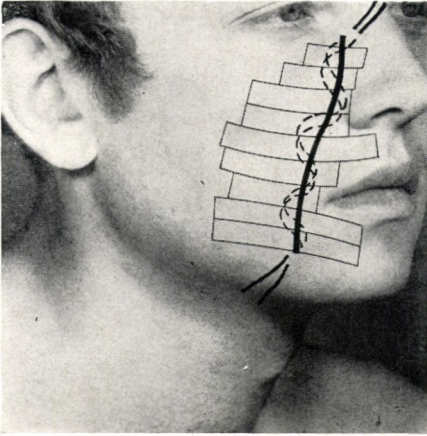
A

A. Usually facial wounds are closed in layers closing the dead space in a deeper part of the wound and then approximating the skin edges. Because of the underlying deep stitches, the skin suture can be removed early. This is especially so in facial areas because of the rapid healing that occurs; thus, there is little danger of "railroad tracking" in this region. However, two rows of running sutures can also be employed to close facial wounds. Steri-strips can be used to good advantage to take tension off the skin edges.
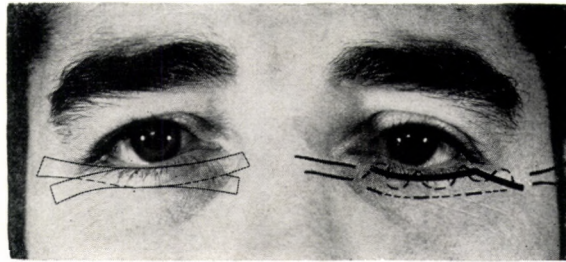
B

C

B and C. Instances in which either subcuticular or interrupted stitches have been used.

D

D. When closing a wound where the helical rim has been divided, the first stitch should be inserted as shown to ensure the accurate continuity of the anterior edge of the helical rim.

E
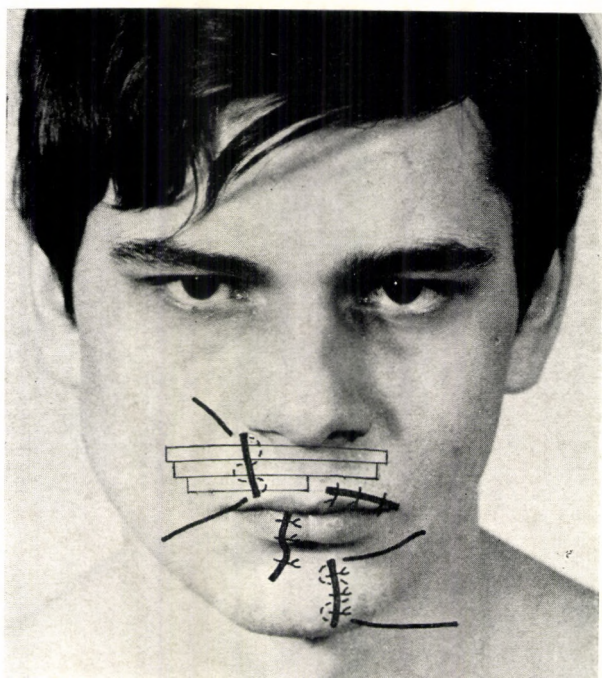
E. Interrupted sutures usually give better results in the region of the vermilion border and the lip itself.
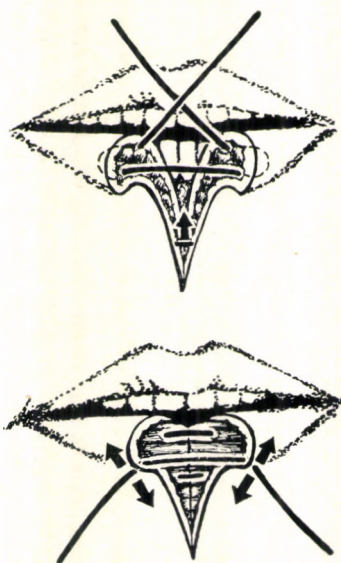
F

F. When a defects exists in the lip, deep sutures are first inserted to reapproximate the muscle layer. The first stitch in the vermilion should be at the vermilion-skin border to ensure accurate alignment of this region.

Local Anesthesia for Rhinoplasty

A. Fifteen to 20 min before surgery, the nasal mucosa is anesthetized by either spraying with a 10% solution of lidocaine (xylocaine) or using nasal packs soaked in equal parts of 10% cocaine and epinephrine 1 : 1,000. These packs should be well squeezed out before packing. An anesthetic block is then given, using 6 to 8 ml of 2% xylocaine with epinephrine solution. The aim is to produce a satisfactory anesthesia without distorting the areas of surgical correction by ballooning with local anesthetic. The main sites of injections are shown on the diagram.
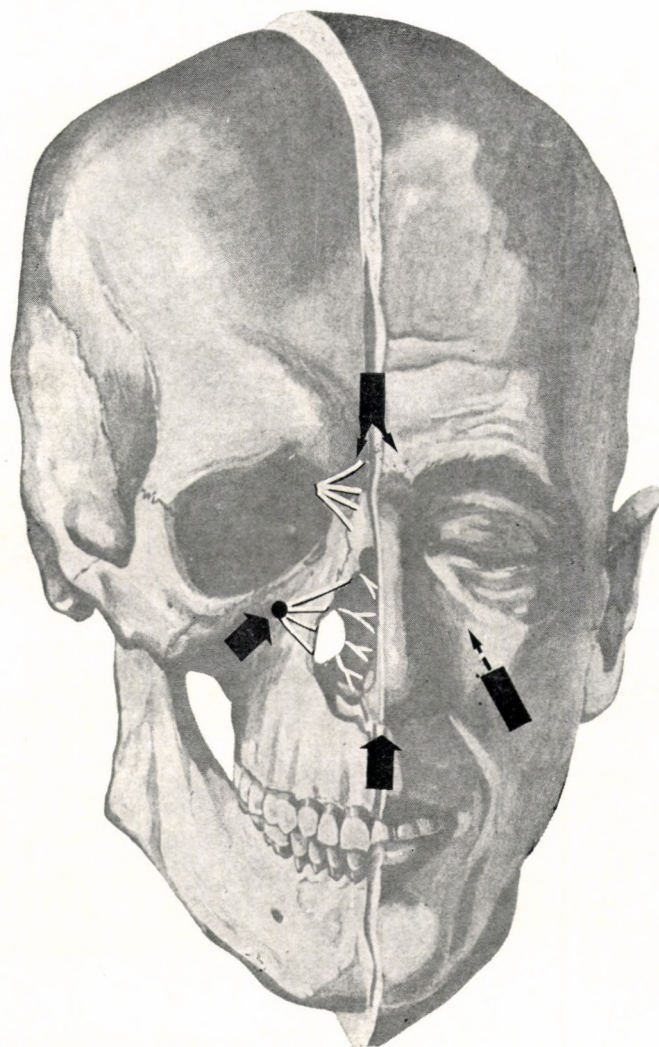
A
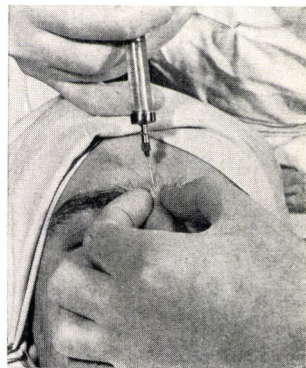
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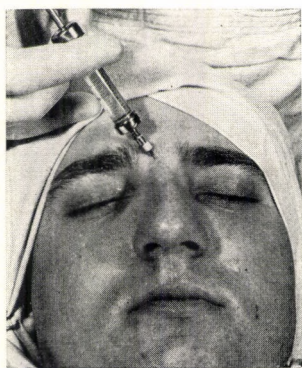
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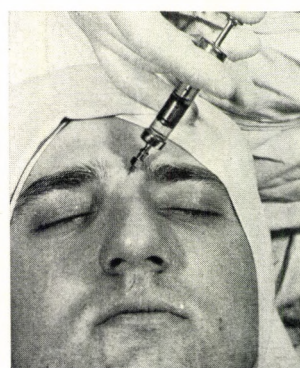
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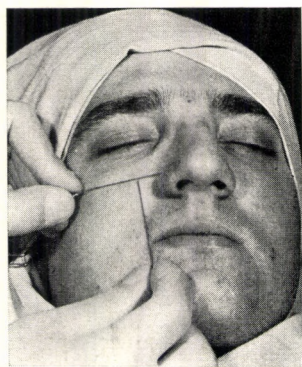
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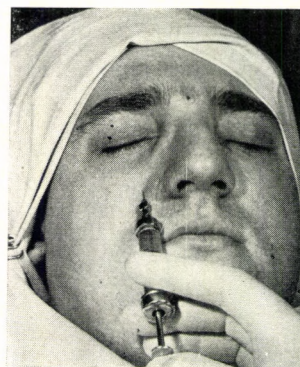
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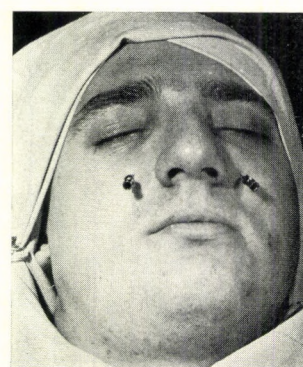
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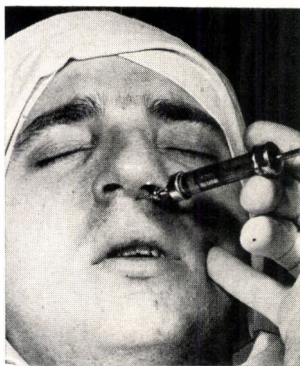
7

8

B

B. The technique of anesthesia: Pinch the glabella skin between two fingers. Using a 2-ml syringe and a number 25 needle, make a wheal (1), advancing the needle subcutaneously on either side of the nasal bone and as far as the medial canthal ligament. Then inject 0.5 ml of anesthetic fluid into either side to block the supratrochlear and infratrochlear nerves (2, 3).

The infraorbital nerves are then blocked. The region of the infraorbital foramen can be found by palpating the orbital rim with the index finger. The point of injection is approximately ½ inch lateral to the ala nasi and can be located by a vertical line from the corner of the mouth meeting a horizontal line from the alar crease (4). At these points, further wheals should be formed and the needle should be advanced subcutaneously to the orbital rim, in line with the pupil. Then 0.5 ml of fluid is injected into the region of the infraorbital foramen, and a further 0.5 ml is injected as the needle is withdrawn (5, 6).

Branches of the nasopalatine nerves are then blocked by injecting 0.5 ml of anesthetic on either side of the anterior nasal spine, at the point where the columella joins the filtrum (7). Anesthesia is then performed intra-nasally (8), to block the nasal mucosa and the terminal branches of the anterior ethmoidal nerves. Injections are performed at the border of the pyriform aperture and at the junction of the septum and wing.

Application
of Nasal Splint

1
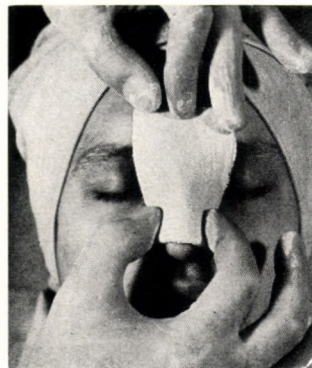
2

3
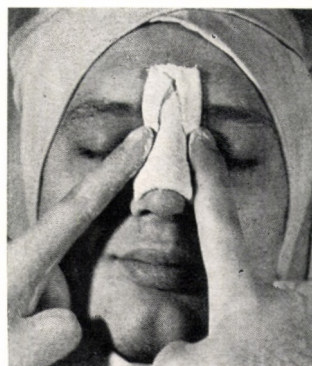
4

This is performed at the termination of nasal operations to prevent edema and to give stability. If an osteotomy has been performed, the splint is left on for 10 to 14 days. If an osteotomy has not been performed, the splint can be removed after 2 days, when edema has decreased. The method demonstrated shows the splint being prepared from plaster of Paris. A four-layered splint is gently molded to the nasal tip (1, 2). The upper lateral corners of the splint are folded forward and molded (3, 4). Notice that the splint extends onto the forehead. Gentle pressure is maintained digitally on the splint until it is hardened, and then the splint is immobilized by adhesive tapes (5, 6).

5

6

Reconstruction of Minor Defects of the Ear

It is often necessary to remove pathological lesions from the ear; for example, squamous cell carcinomas, basal cell carcinomas, and seborrheic keratosis. Depending on the pathology of the lesion and the depth of invasion, if any, the operation may or may not be restricted to skin excision alone, or it may involve taking cartilage or a full-thickness segment of ear. The type of reconstruction to be performed will also depend on the site and the size of the lesion.

A
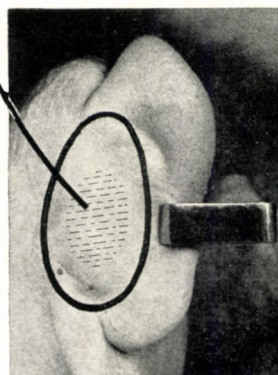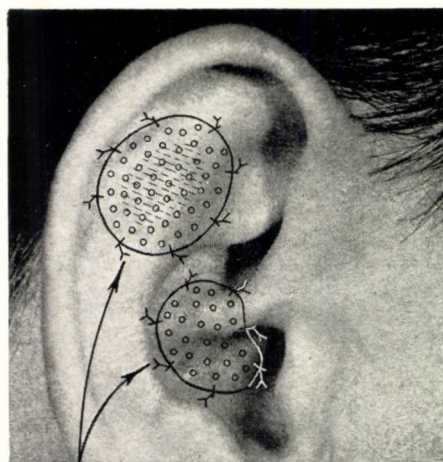
B

A and B. Defects in the antihelical and conchal region can be repaired by using full-thickness skin grafts removed from the posterior aspect of the contralateral ear. If the lesion removed involves the skin only, care is taken to preserve the perichondrium so that skin graft can be applied. If the cartilage is involved, it should be excised too and the defect replaced by a composite graft, i.e., a skin graft excised together with a suitably sized piece of conchal cartilage, since otherwise the auricle, having no supporting framework, will shrink and become deformed.
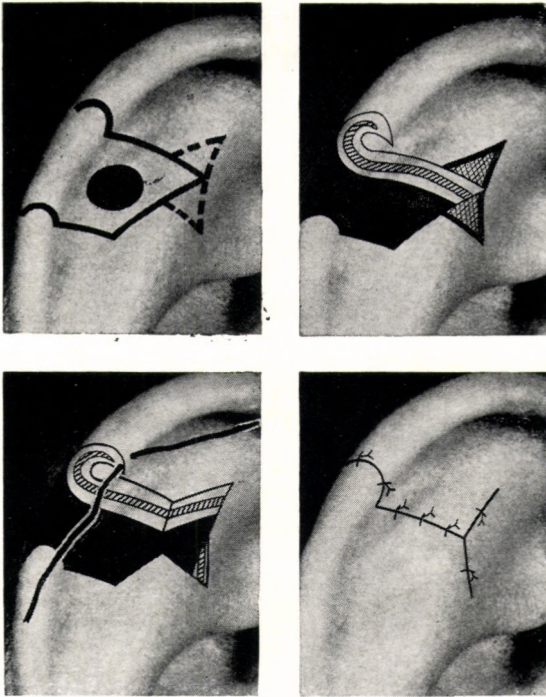
C

C. If the lesion is laterally placed and is relatively small, a wedge-shaped excision and primary closure can be performed. Note that additional triangles of tissue need to be excised to facilitate closure.
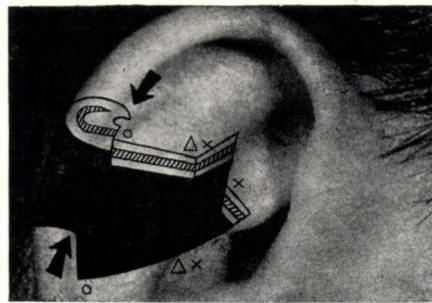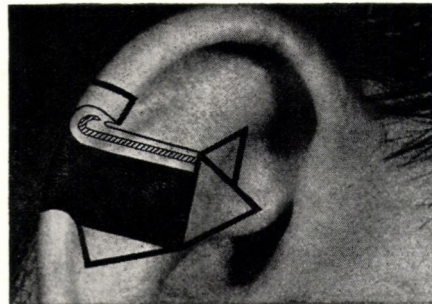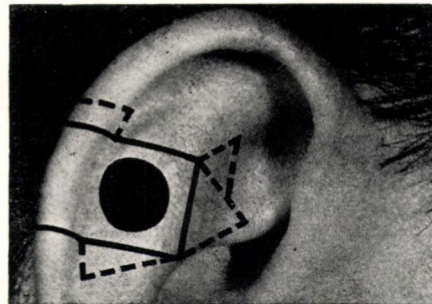
D

D. An alternative method of excision and reconstruction.
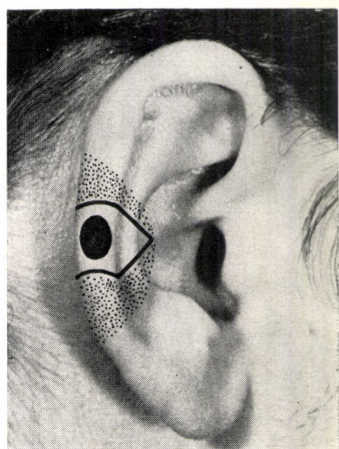
E
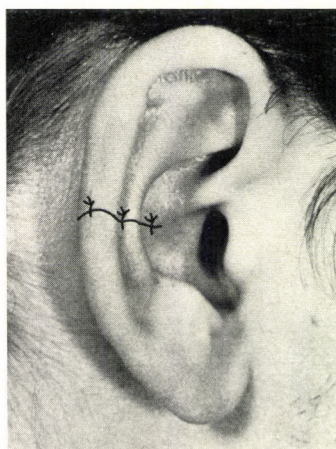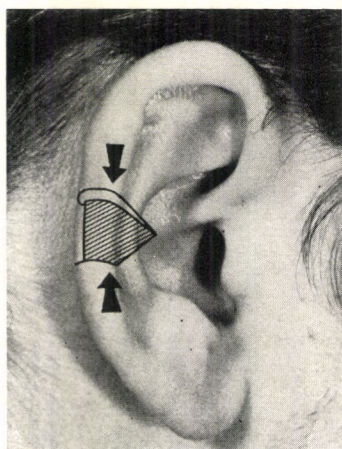
E. Smaller superficial defects on the helical rim can be closed by undermining and primary closure.

F
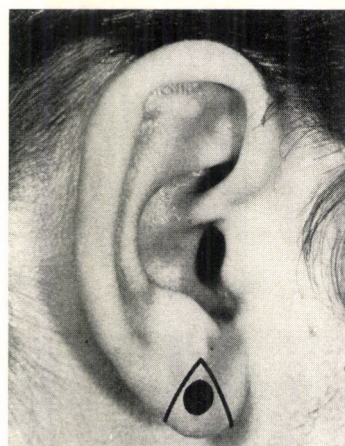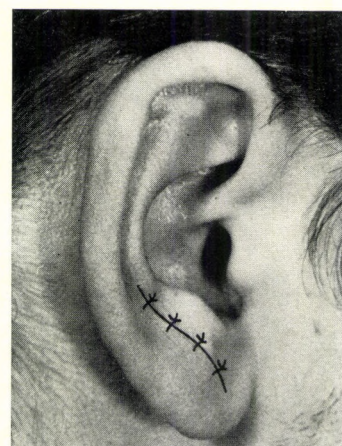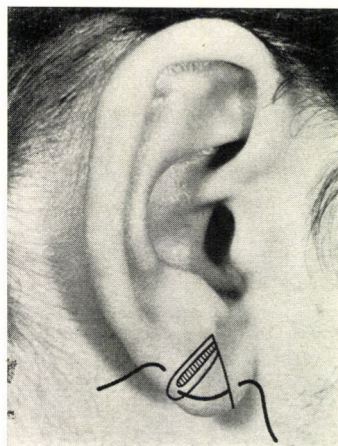
F and G. Lesions of the lobule can be reconstructed in two ways, depending on the localization of the lesion.

G

The ear is easily anesthetized by a circumferential injection of local anesthetic at the base (1 through 3).
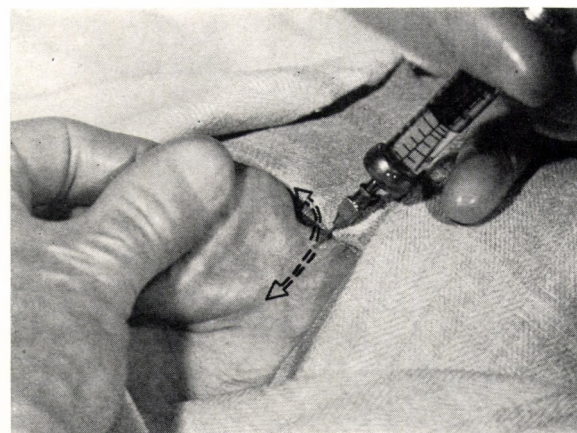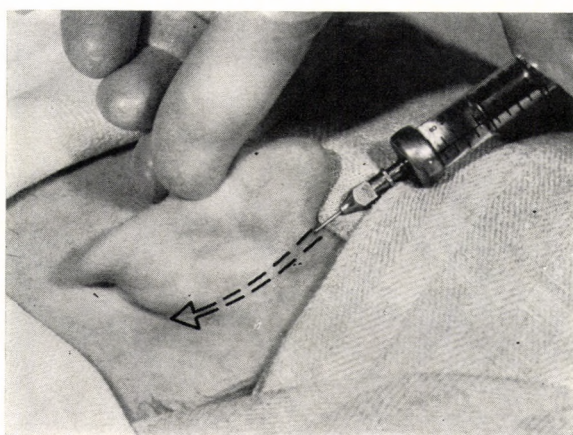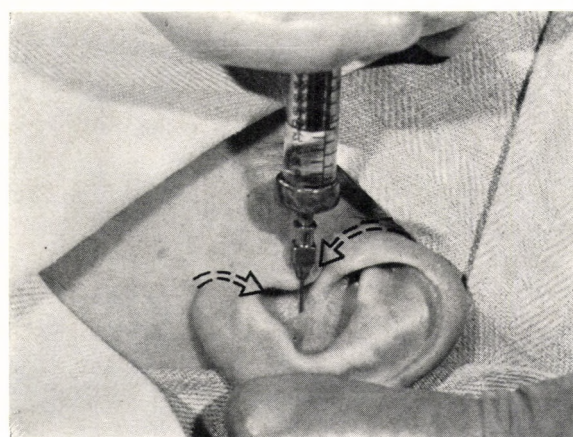
Dressing of
Postauricular Skin Grafts
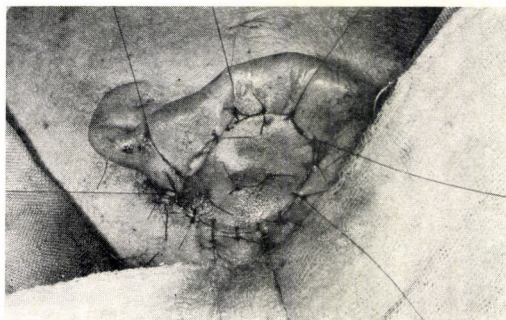
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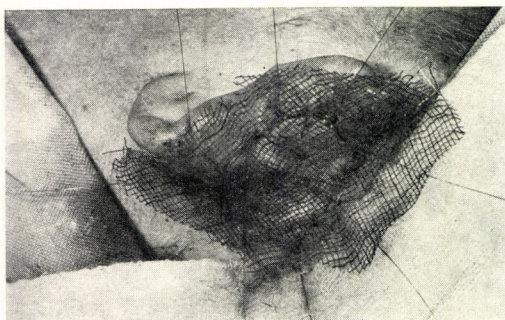
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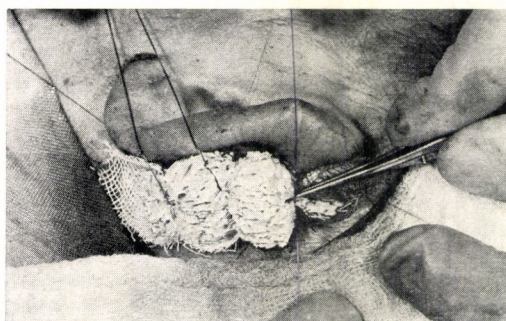
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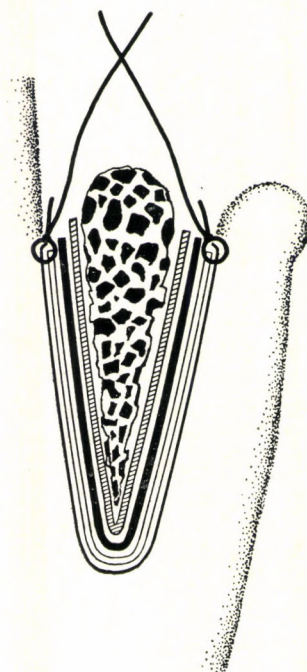
4

It is often necessary to use full-thickness postauricular skin in repairing facial or contralateral auricular defects. The resulting auricular defects can be repaired either by closing the wound primarily, and so producing a flattened appearance (although temporary) of the ear on that side, or by applying a split-thickness skin graft. The dressing of split skin graft applied to the retroauricular region is shown. The sutures of the skin graft sutured in position are left long at the periphery (1). On top of the graft a layer of nonadherent gauze (2) and then a wedge-shaped piece of sponge rubber are applied. The long ends of the sutures are tied over the sponge rubber to produce light pressure (3). The diagram (4) shows the dressing in cross-section.

Application of Ear Dressing
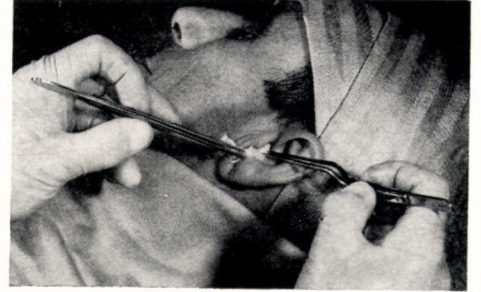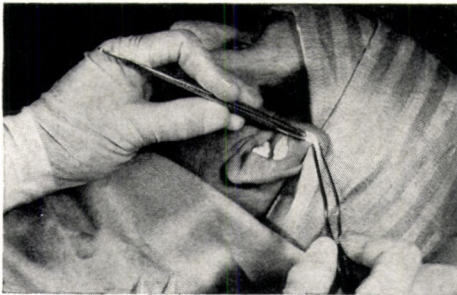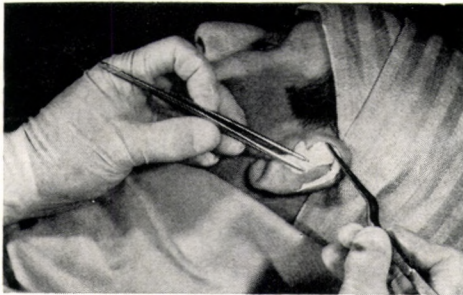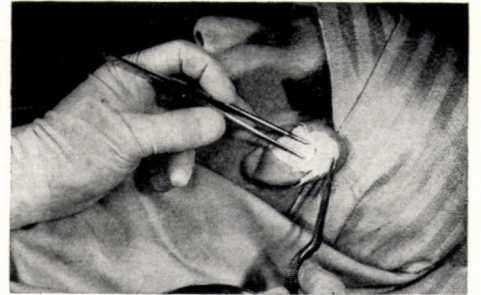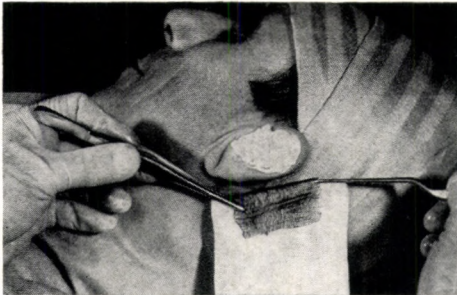
A very useful dressing which prevents the dangers of hematoma formation is shown in the above figures.

Soft sterile cotton rolls that have been soaked in tepid physiological saline and then compressed (1) are applied in strips (2) to the auditory canal (3) and then to the other depressions until the ear is completely filled (4, 5). After the cavity is filled so that it exceeds the height of the helix (6), a multilayered dressing is applied behind the ear (7). A sterile dressing is then placed over the ear (8) and the head dressing applied (9). If sutures are present on the surface, a layer of nonadherent gauze often is used for the initial layer.*

* Some surgeons prefer to soak the cotton in sterile mineral oil rather than saline.

Special Dressing of the Face
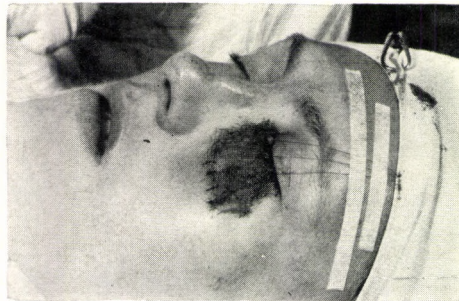
1
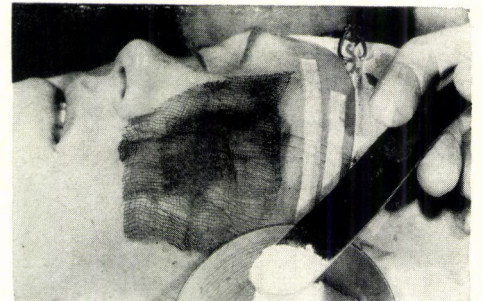
2
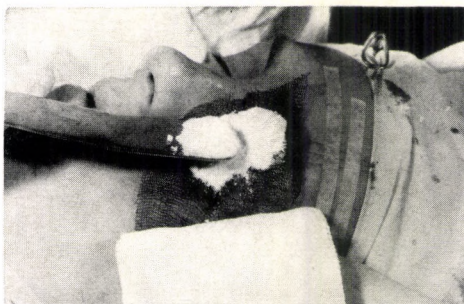
3

4
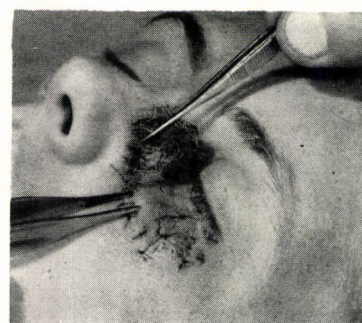
5

One area where a special dressing is required is to a lesion below the lower eyelid, where a split-thickness skin graft is applied (1). The author's method of applying the dressing is demonstrated. The ties from the superior sutures from the graft are left long and are brought up over the closed upper eyelid and attached to the supraorbital region by steri-strips. A layer of nonadherent gauze is then applied (2). Boric acid powder is then applied liberally (3). Final dressing, consisting of several layers of sterile 4×4-inch gauze pads, is then applied, and immobilized with a head dressing. The boric acid dressing is usually changed on the third postoperative day. On removal of the outer gauze dressing, it is found that the boric acid has soaked up any drainage, either from tears or blood (4). The dressing can be removed carefully and the eye can be inspected before a similar dressing is reapplied (5).

Dressing for Lesions on the Scalp

It is often difficult to obtain a satisfactory head dressing when a lesion has been excised from the scalp. The method demonstrated obviates the need for any large dressing.

A. After suturing the wound, further sutures are inserted outside the line of repair and left untied. Usually, a much larger needle than that normally used is needed for these sutures.
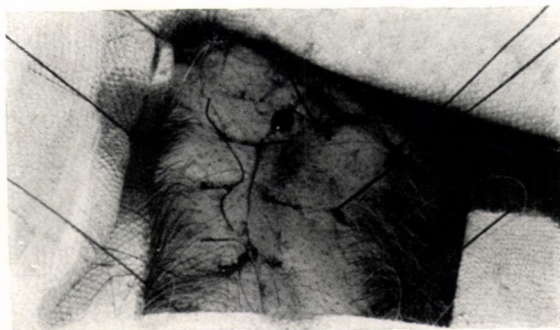
A

B and C. After a layer of non-adherent gauze is applied, several gauze pads, 4 × 4 inches, are rolled into a cylinder and are placed on the wound and tied in position.

B
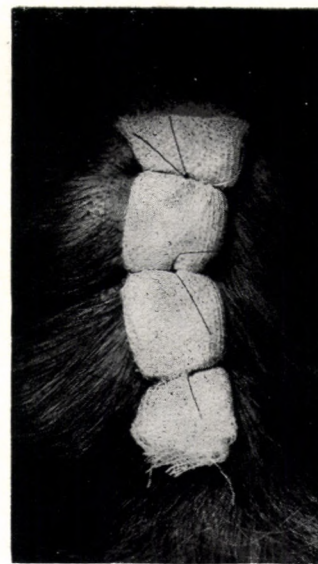
C

D. This technique is demonstrated on the diagram.
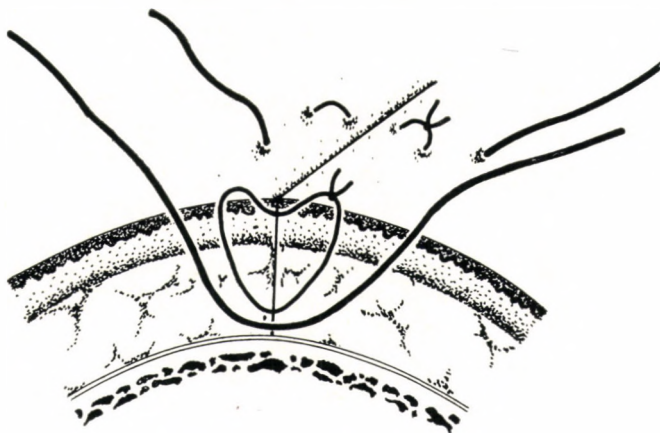
D

Lines of Elective Incisions on the Trunk

A
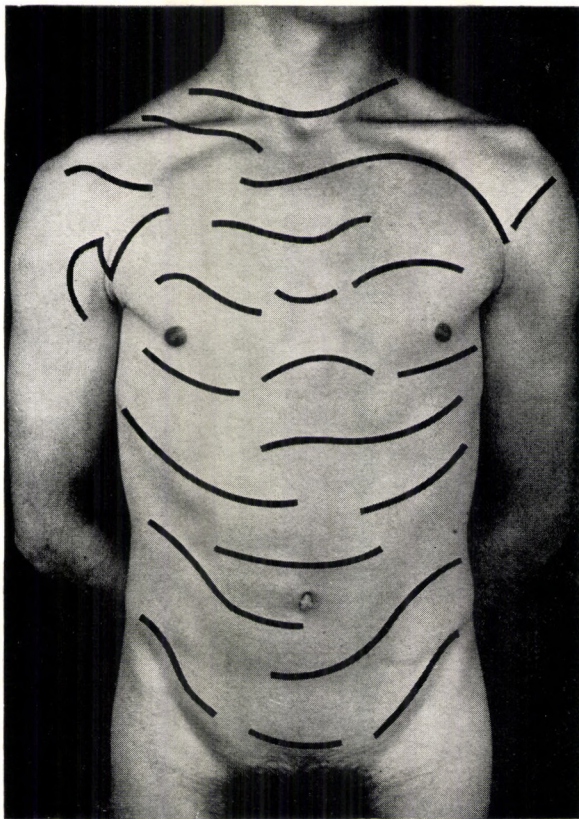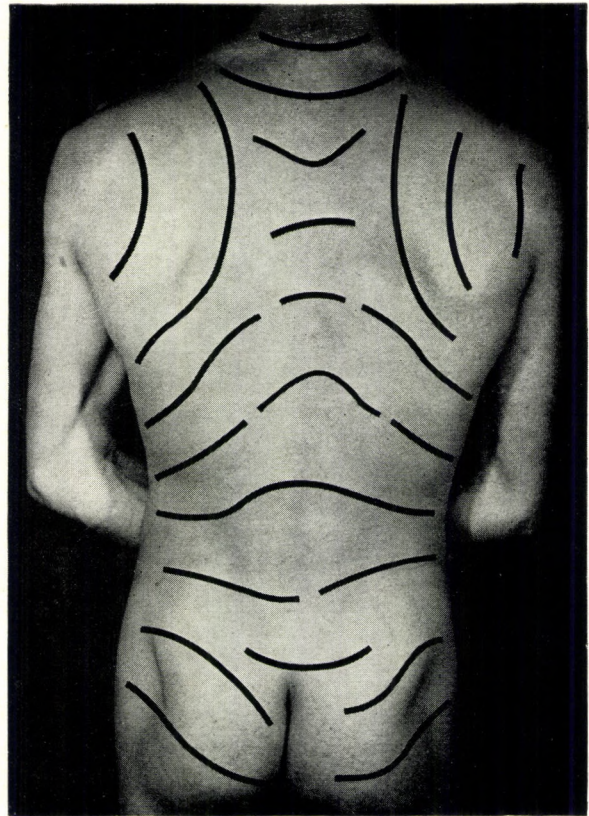
B
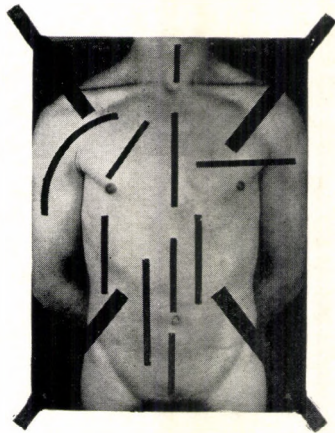
C
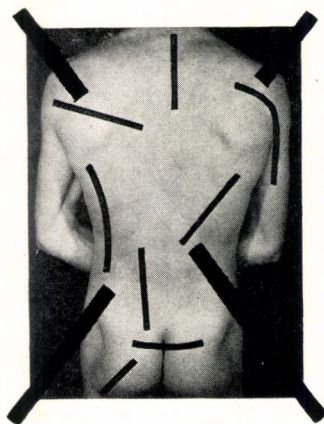
D

A through D. The most suitable lines of elective incisions are shown in A and B. Incisions made in these lines usually heal with a better scar than those made in directions shown in C and D.

E. Both eliptical excisions incorporating triangular patterns, which result in a Y-shaped scar, can be used for excision of skin lesions.
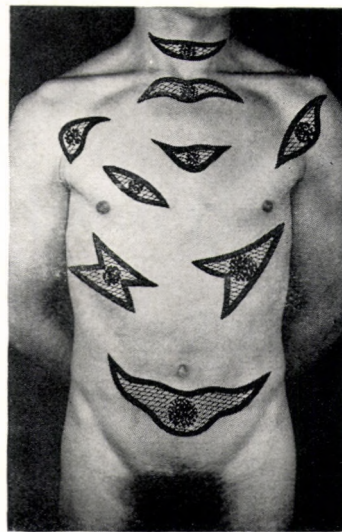
E

F through H. When a pathological skin lesion is excised, the resulting defect can be closed in a number of ways: by using rotation flaps and bilateral rotation flaps (F); with bilateral advancement flaps in case of a central defect (G); and by bipedicle flaps and transposition flaps (H).

F

G

H
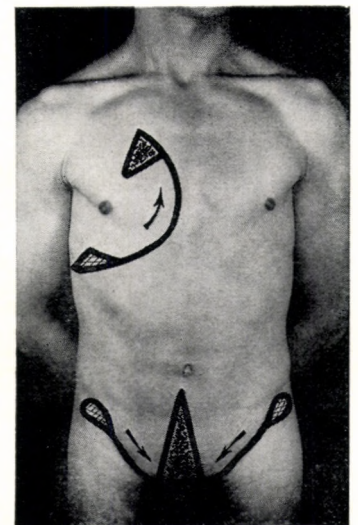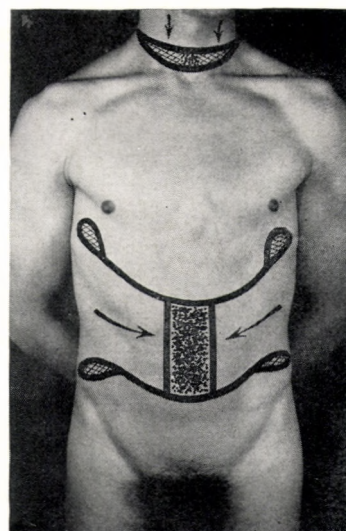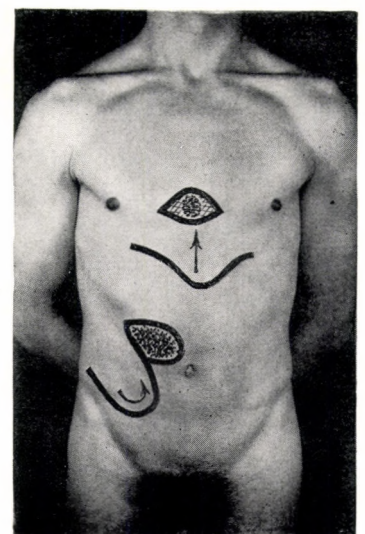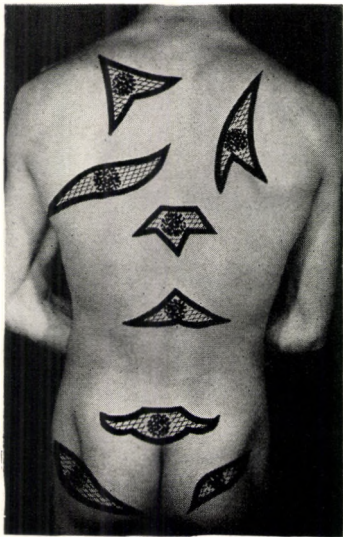
I. Various combinations of eliptical and triangular excisions on the dorsal surface of the trunk.

J

K

L
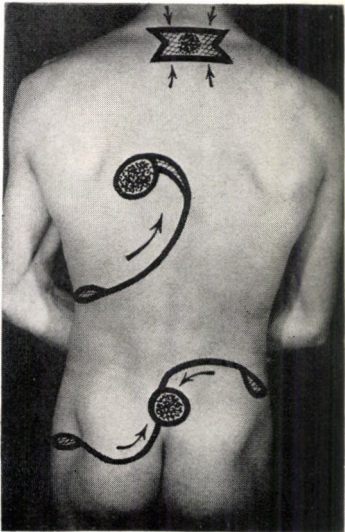
J through L. Bipedicle flaps, advancement type flaps, transposition flaps, rotation flaps and bipennate rotation flaps can be used to close skin defects resulting from excision of pathological skin lesions on the dorsal surface of the trunk.
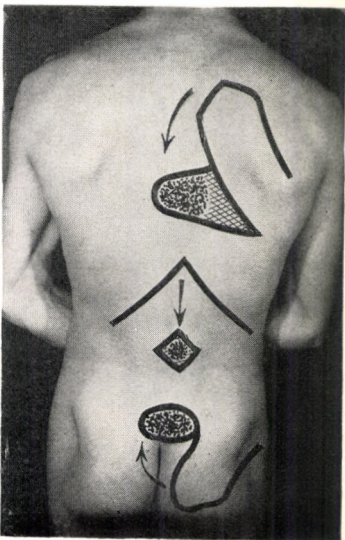
Fundamentals
of Breast Surgery

A
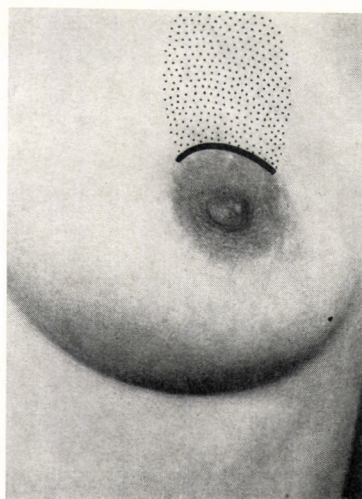
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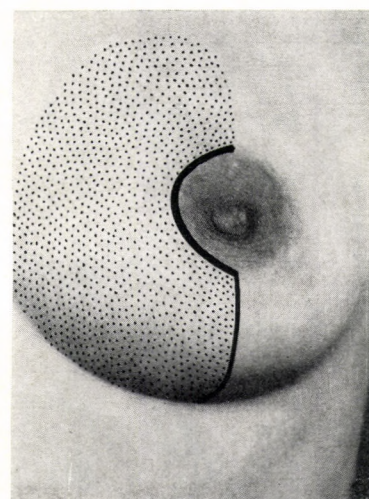
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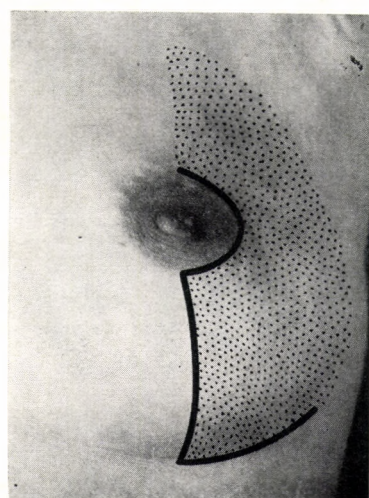
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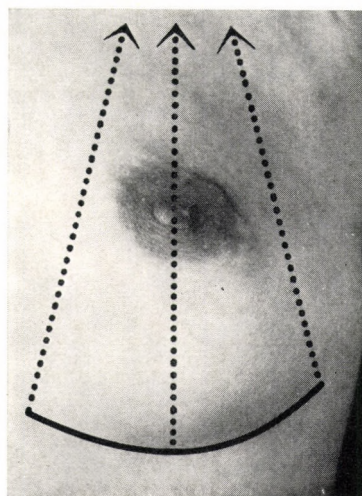
4

A. Unsightly scars will result from radial incisions in the two upper quadrants of the breast. Periareolar incisions and submammary crease incisions are utilized when feasible in the breast. Biopsy in the upper hemisphere of the breast may be made through an upper periareolar incision (1). The two medial quadrants can be conveniently exposed by making the incision around the inner margin of the areola, continuing the incision vertically as far as the mammary fold if necessary (2). The mirror image of this incision will expose the two outer quadrants, and the incision may be continued along a longer stretch in the mammary fold (3). Incisions made in the mammary fold are suitable for all resections that may be necessary in the deeper (pectoral) part of the mammary gland (4).
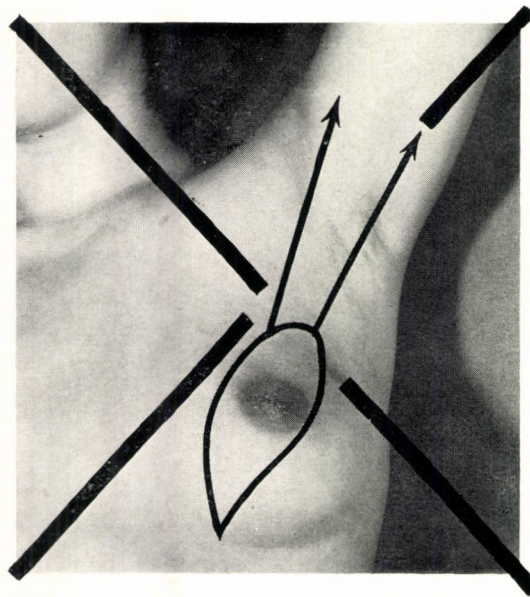
B

B. If amputation or ablation is necessary because of carcinoma, incisions which run from the mammary area along a straight line in the axillary fossa or the anterior axillary fold to the upper arm should be avoided. Scars of this description undergo contraction which may restrict shoulder motion.
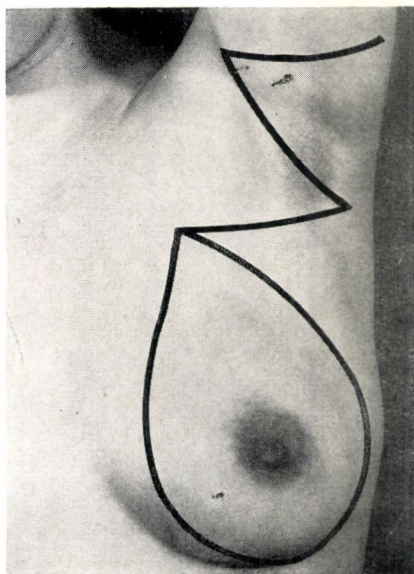
C
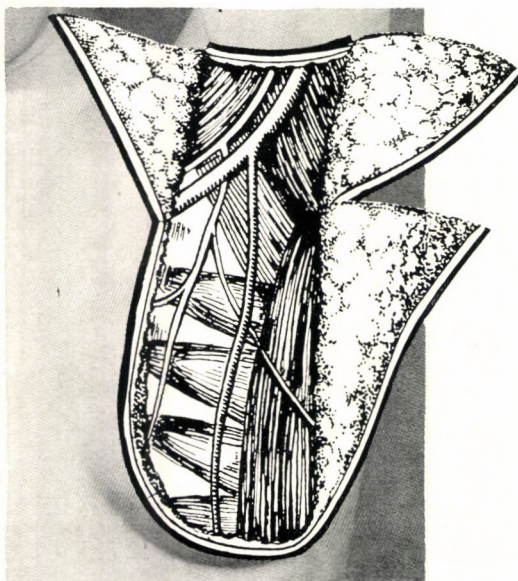
D

C and D. This incision is ideal for the resection of the breast because it has Z-shaped continuation for the exposure of structures lodged in the axillary fossa. Incisions of this kind allow ample exposure and avoid contracture.

E. When extirpating breast cancers the question as to whether the edges of the resulting wound can or cannot be reunited should be disregarded. An adequate margin of resection overrides all other considerations. The defect must be replaced if the margins of the wound are to be reunited without tension. No local methods of replacement should be applied in these cases.
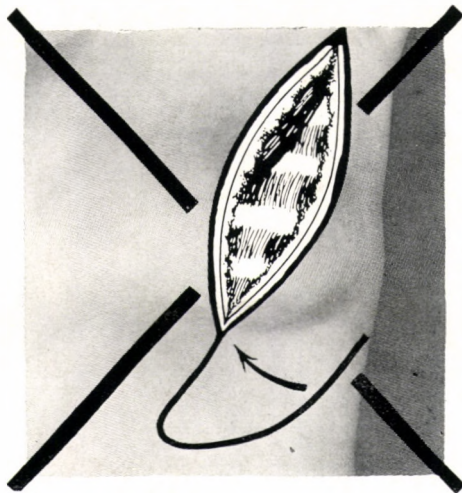
E

F. Generally a free split-thickness skin graft is preferred for this replacement. Such grafts heal quickly and smoothly so that postoperative irradiation can be instituted early. Moreover, they are strong enough to resist the chafing of clothes and thin enough to permit early detection of a local recurrence.
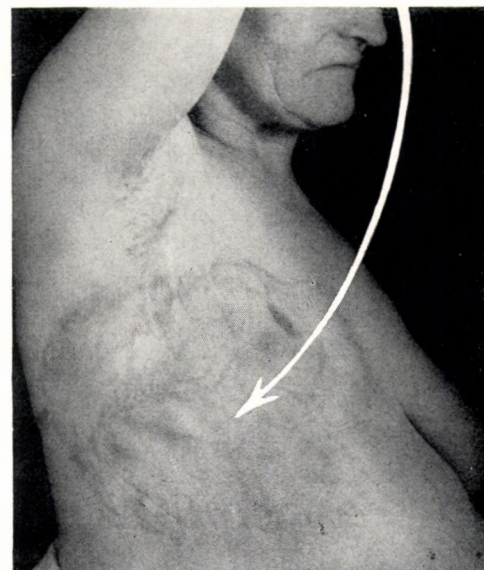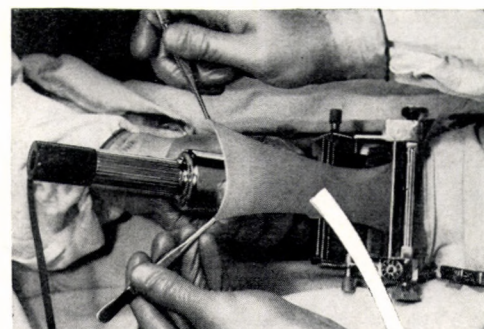
F
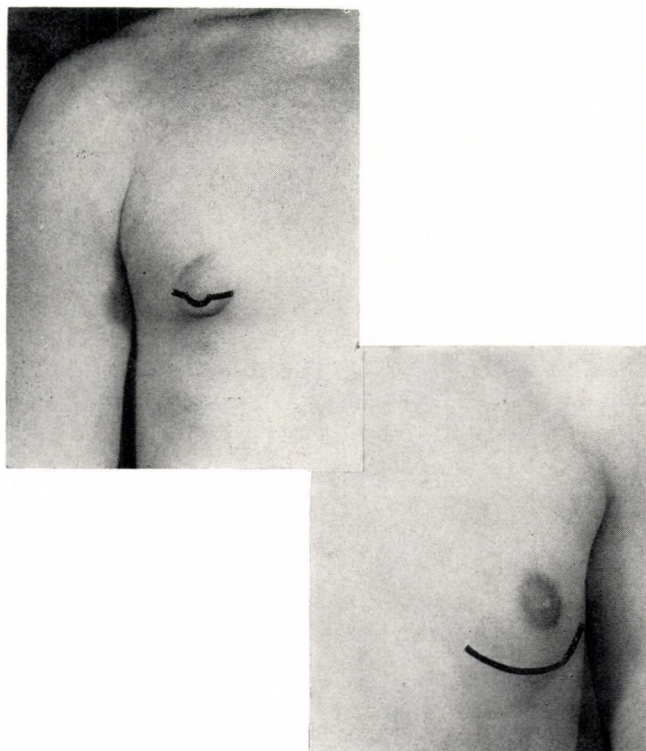
G

G. Transareolar incision is advisable for operations in cases of gynecomastia.

Exploratory Excision of the Female Breast
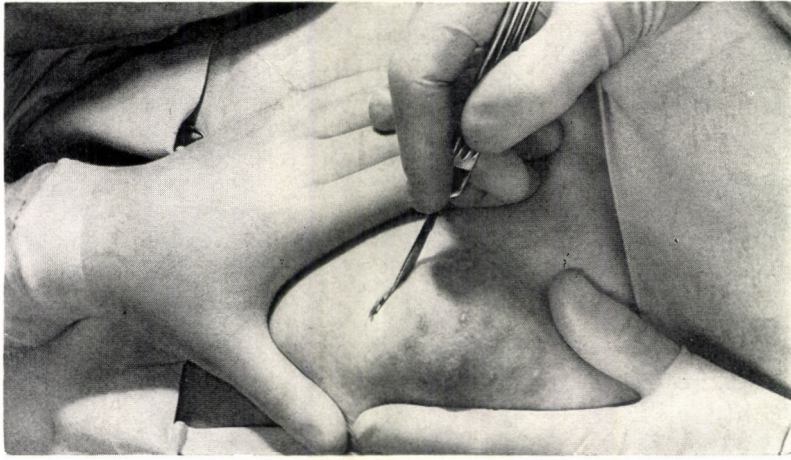
A and B. A periareolar incision is made for the extirpation of a tumor from the upper quadrant of the mammary gland.

A
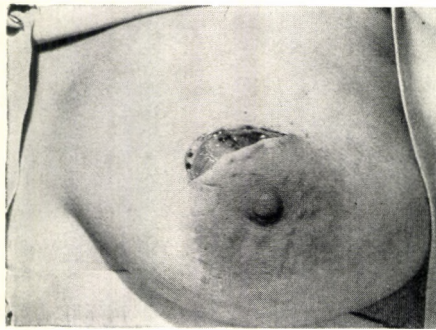
B
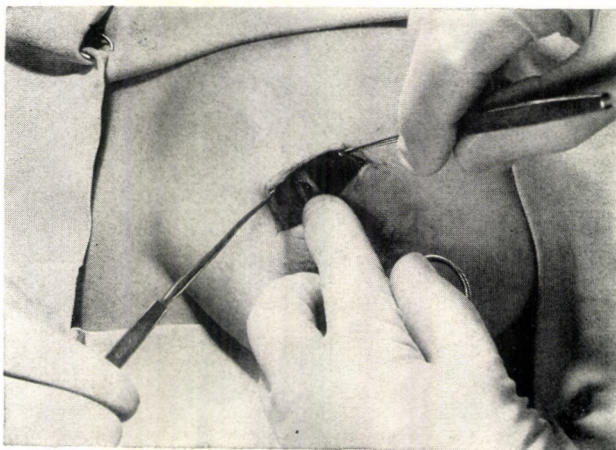
C

C. The concave lip of the wound is lifted by means of two sharp double hooks, while the skin is bluntly detached from the mammary gland by means of a pair of curved dissection scissors.
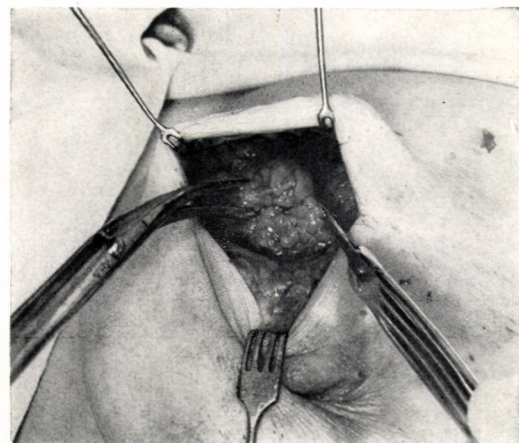
D

D. A good exposure of the tumorous area is gained in this way. The portion to be excised is grasped with Museux's instrument and cut out with a sharp scalpel.
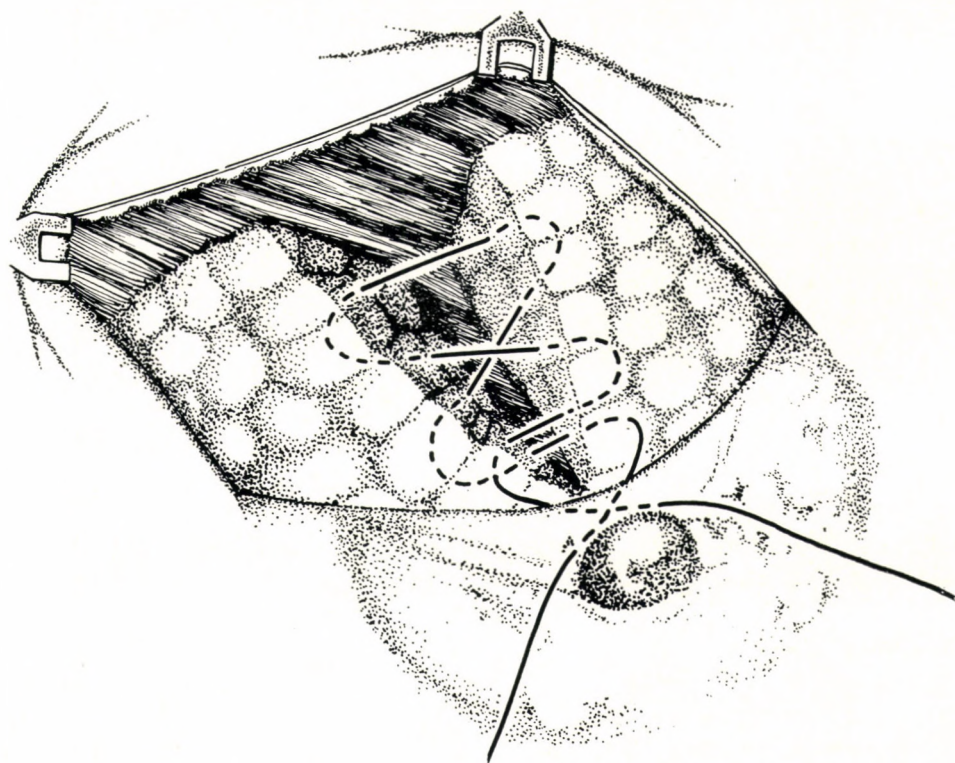
E

E. The wedge-shaped defect of the breast is not closed by buried interrupted stitches but by a running suture brought to the skin surface. Beginning at the nipple, the suture penetrates the breast in the areolar area in a cranial direction, takes up crosswise the cut surfaces of the gland and emerges anew to the surface next to the insertion of the first stitch. Bleeding vessels may be managed with the same suture, dispensing with buried interrupted stitches.
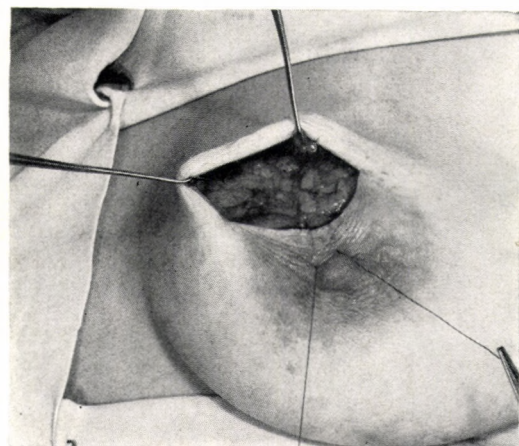
F

F. The transcutaneous pull-out suture used by the author to close the wound of the gland is tied on the surface. It has to be removed on the 10th postoperative day: one end of the thread is cut immediately below the knot, and the thread, grasped by the knot, is then pulled out in the opposite direction.

G
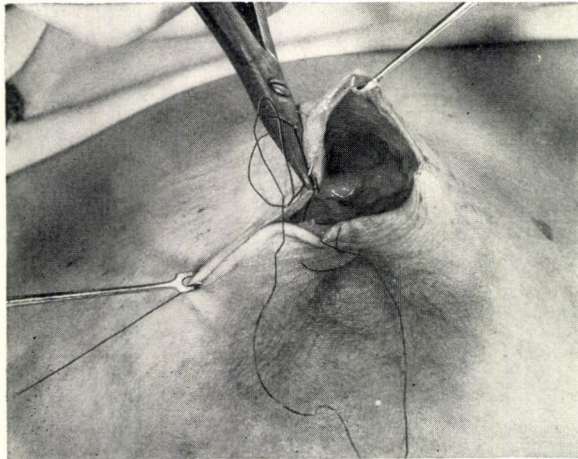
G. The lips of the wound should be closed by a simple row of intracutaneous running suture.
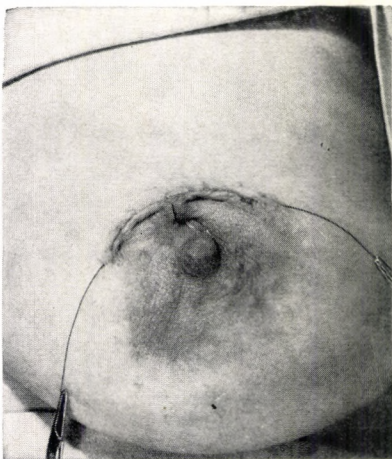
H

H. By pulling the thread at the ends of the running suture the wound lips are precisely coapted.
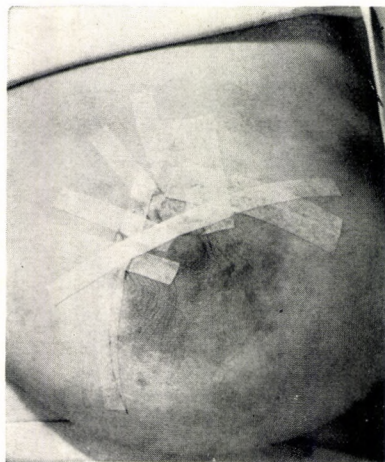
I

I. While continuing the pull on the two ends of the thread, steri-strips are placed on the skin at right angles to the suture line, a measure which improves coaptation and reinforces the union of the wound lips. The steri-strips are removed on the 7th, the transcutaneous suture of the gland on the 10th, the intracutaneous running suture on the 12th to 14th day.

Excision of the Mammary Gland with Skin Reduction

Superfluous skin that may accumulate after the resection of innocent major mammary tumors must be removed in order to prevent distortion of the breast.

A

B

C
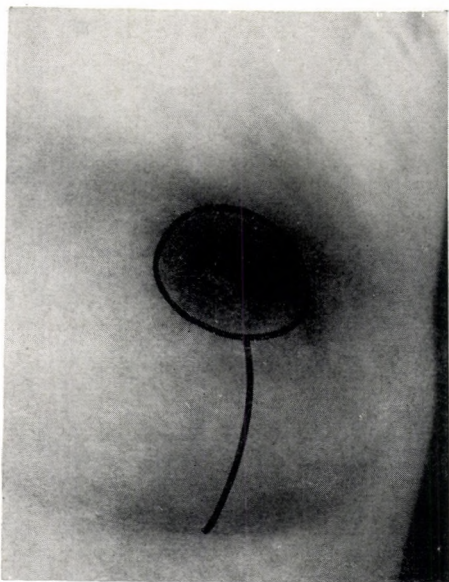
A. The picture represents an approach from the periareolar incision which is radially elongated from the lower midpoint to the mammary fold.
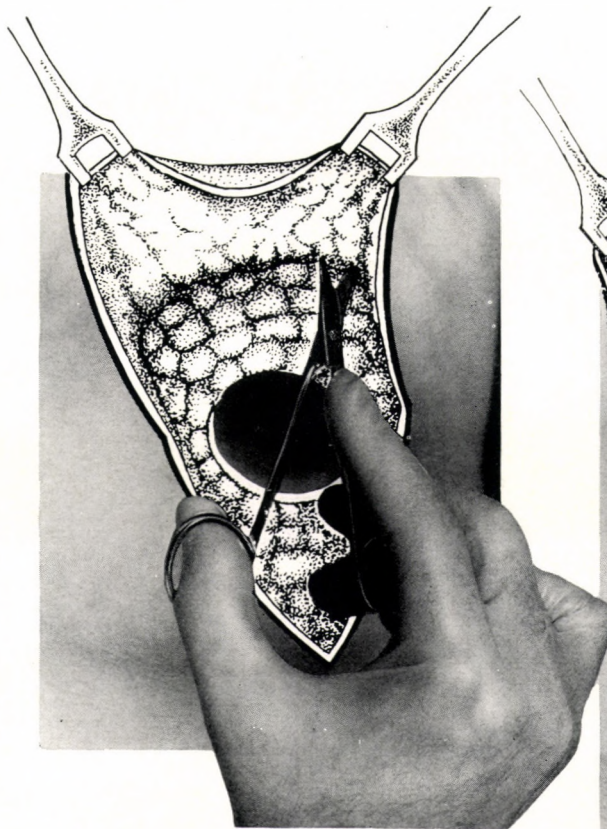
B. Using curved dissecting scissors, the skin is detached half sharply and half bluntly from the entire surface of the mammary gland.
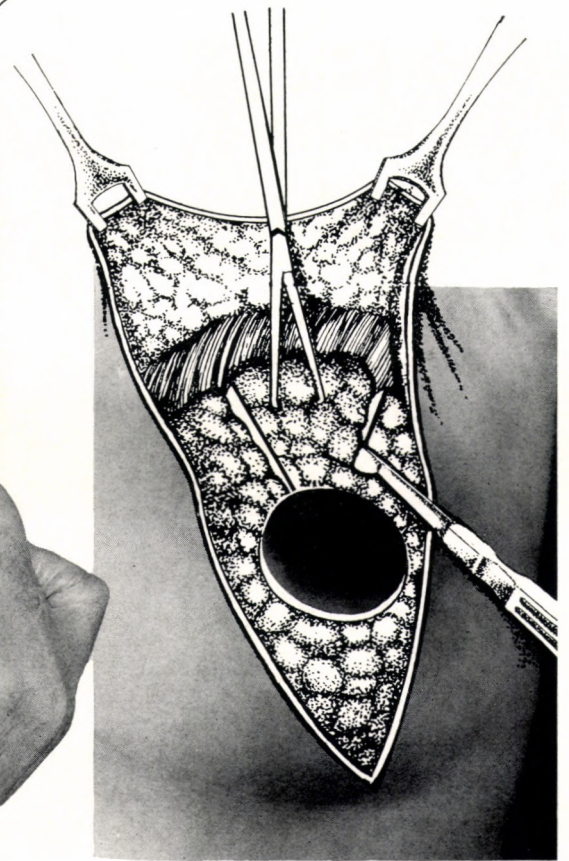
C. The tumorous portion of the gland is removed. The excision must be sharp, made in the intact tissue and tapering toward the nipple. Excisions of this kind remove also the lactiferous ducts so that the possibility of postoperative cysts is diminished.

D
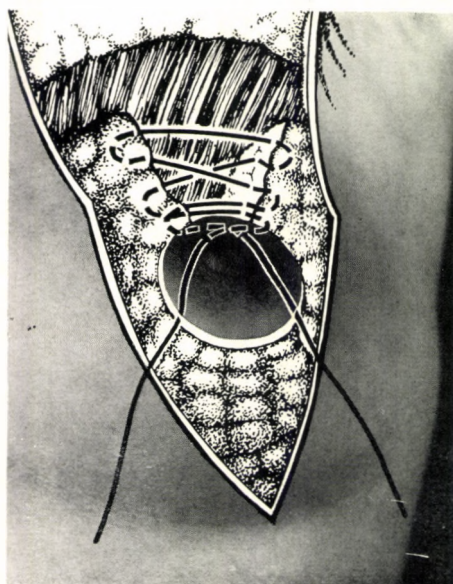
D. Method of closure of wounds on the cut surface of the gland by intracutaneous running suture brought out to and tied in the areolar area.

E

E. The skin is so placed back on the diminished mammary gland that the surplus amount is lifted to form a fold in the midline. The excess is first removed on one side by incising it around the half circumference of the areolar wound and elongating it vertically as far as the submammary crease.

F

F. The incision is closed around that half of the areola by a single row of intracutaneous running suture. This done, the other half of the excess skin is spread out and excised in perfect symmetry with the first half.

G. After closing the remaining areolar incision, the midline incision is closed by a row of subcuticular and another row of intracutaneous continuous suture which should run from the areola toward the mammary fold.

G

H

H. The line of suture after the intervention.
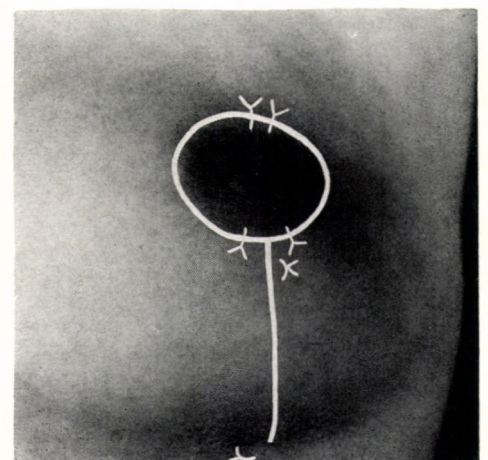
I. Since the excision of the excess skin as well as the suturing are always performed in a direction running from the areola of the nipple toward the mammary crease, some excess skin may pile up also in the lower corners of the suture, requiring excision along the line of the submammary crease. The resulting suture line is shown in the figure.
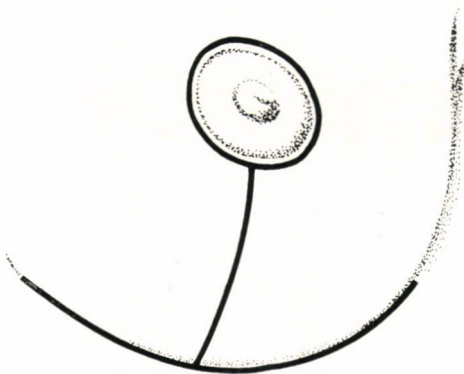
I

Abdominal Skin Reduction
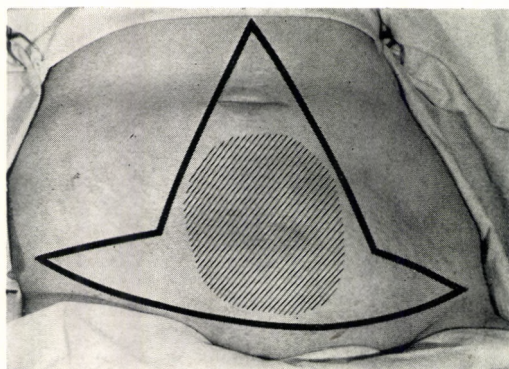
A
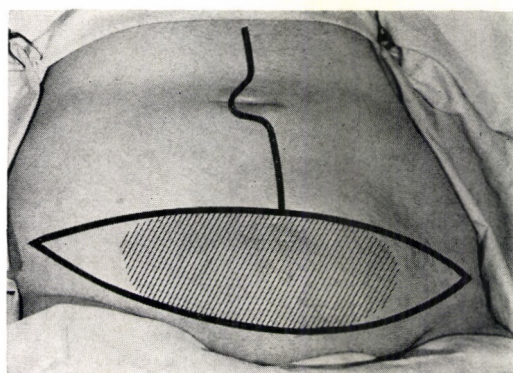
B

A and B. Excess amounts of skin and fat are sometimes present on the abdominal wall of elderly individuals in particular. If excessive, they may be removed in the course of operations for abdominal hernia, not merely for cosmetic consideration but also because skin reduction is an integral part of the reconstruction of the abdominal wall. Removal of the excess skin and fat saves the patient from bearing its weight and prevents intertrigenous dermatitis. The excess amount of skin may be needed for dermal grafts required for the closure of large hernias. Excision of the dermal graft may be longitudinal (A) or transverse (B) according to the size and position of the excess skin and the course of already existing cicatrices.
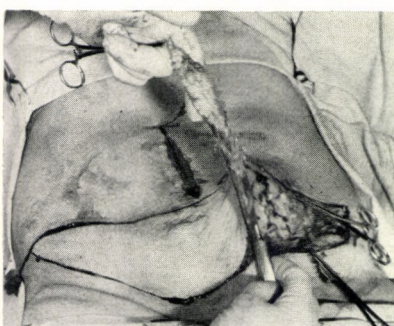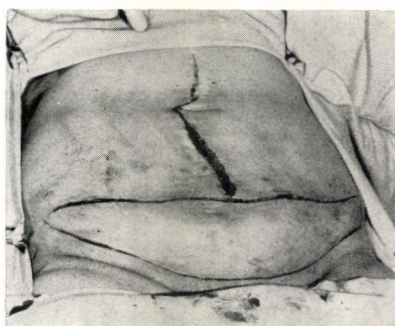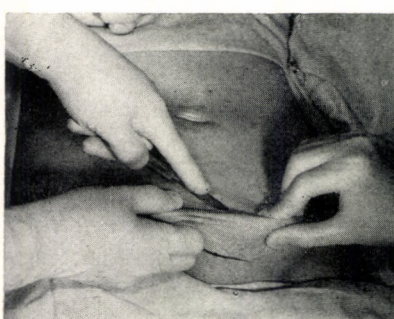
C

C. Excision of the corium for the purposes of dermal graft applying transverse excision as shown in B. The skin to be removed is picked up at the base of the abdominal wall; the boundary of the intended incision is marked by a short stroke of the scalpel at the lower and the upper margin of the fold; this done, the redundant skin serving as a graft is cut round, and it is to this incision that the periumbilical incision in the midline is then added.

D through F. The technique is different if the redundant skin of the abdominal wall is not to be employed as graft. The abdominal wall is incised in the shape of an inverted T, the vertical shank of which corresponds to the incision in the medial line, while its crossbar follows the line of Pfannenstiel's incision. The entire abdominal skin is mobilized above the aponeurosis on both sides half sharply and half bluntly. The edges of the undermined flaps are then grasped with hemostats and evenly stretched over the base. The skin of the flaps is now incised along the lines of the first incision as deep as the subcutis. The stretching has to cease before the fatty layer is cut lest the adipose tissue become shorter in the area of incision, which would cause the cut surface of the flap to slope obliquely inward.

D

E

F
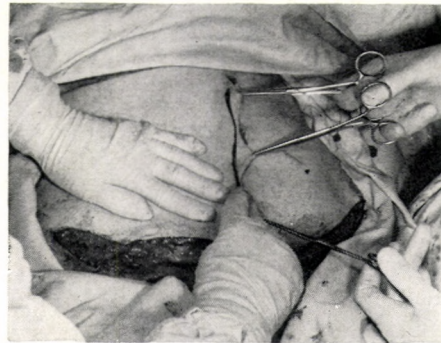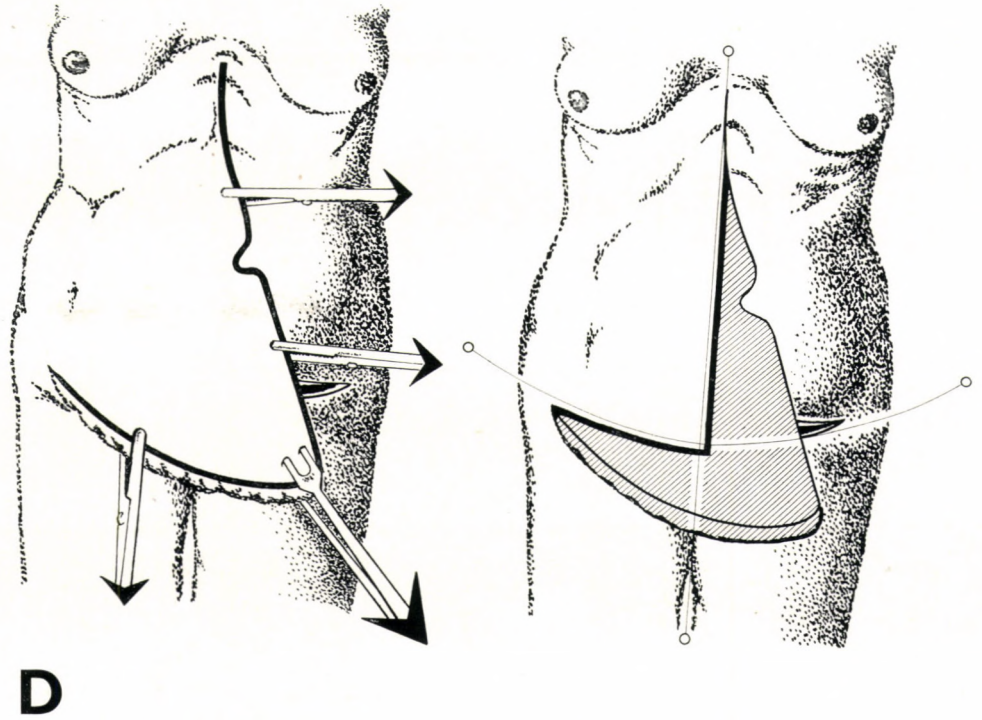
G. Since the abdominal wall is highly sensitive, it must be protected against being traumatized by the surgical tools, and against becoming desiccated during the operation. To this end its fatty layer must be covered with sponges soaked in physiological saline.

G
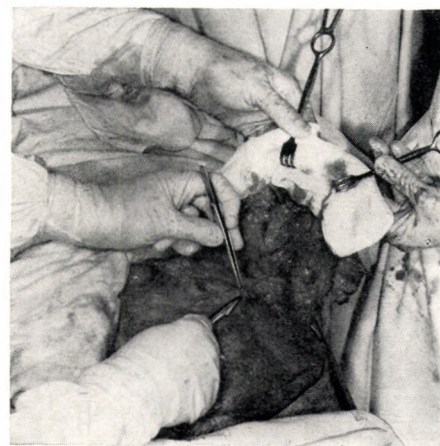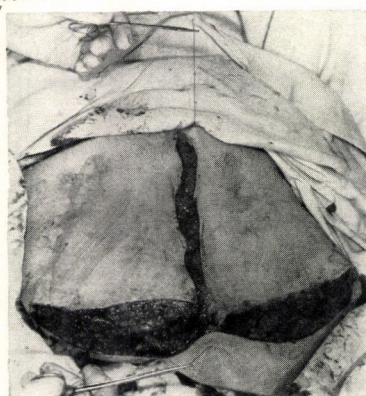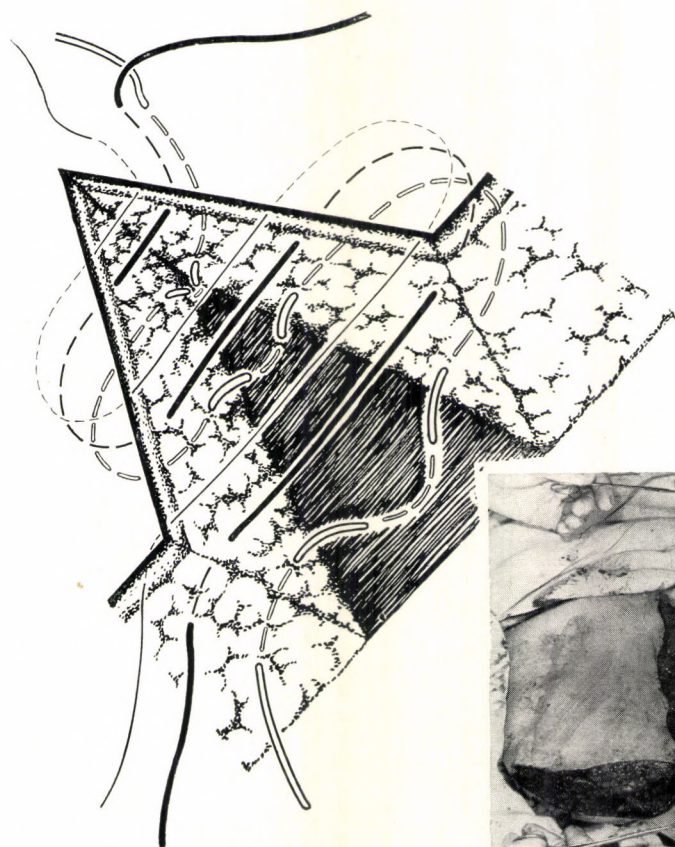
H

I
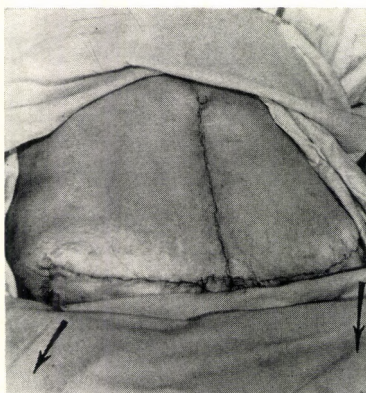
J

H through J. It is wrong to reunite the skin of the abdominal wall by interrupted suture, especially by buried stitches. The thick and poorly vascularized adipose tissue of the abdominal wall might undergo necrosis along the sutures and give rise to infection and possibly dehiscence. Correct closure of the abdominal wall is by continuous suture running in two or three layers and finally brought to the skin surface. Two rows of stitches (a subcuticular and an intracutaneous row) are inserted if the fatty layer is relatively thin, whereas three rows are necessary (a deeper and a more superficial subcuticular suture as also an intracutaneous, precisely adapting suture) if one is dealing with a thick layer of fat. Irrespective of whether two or three rows of sutures are applied, the deepest subcuticular thread has to take up the fascia in the median line in order to prevent the formation of dead space.

A drain tube is inserted next to each of the two ends of the transverse suture in order to drain the effusion of fluid from the large wound surface between the fascia and the adipose tissue.

The Axillary Region, Incisions, Flaps, and Grafts

A through C. In the axillary region, incisions must be planned to run in a transverse direction. Longitudinal incisions across flexion creases invariably lead to contracted seams.

A

B

C
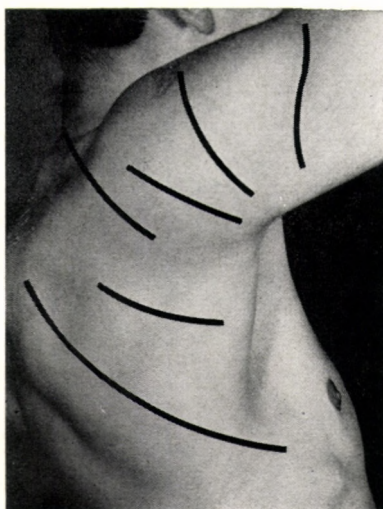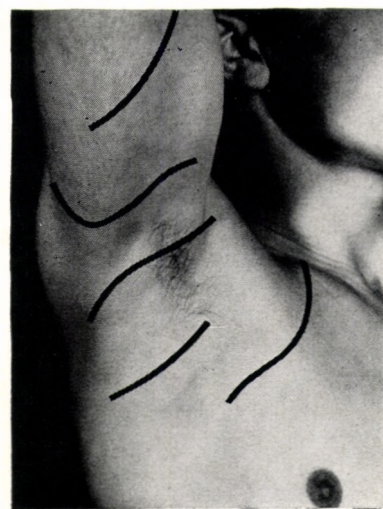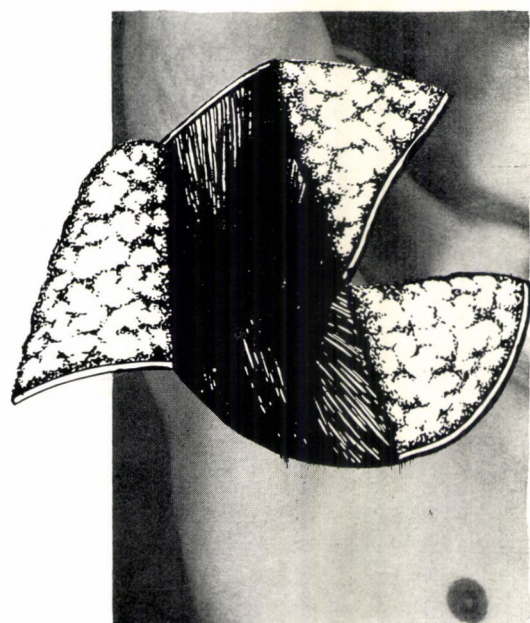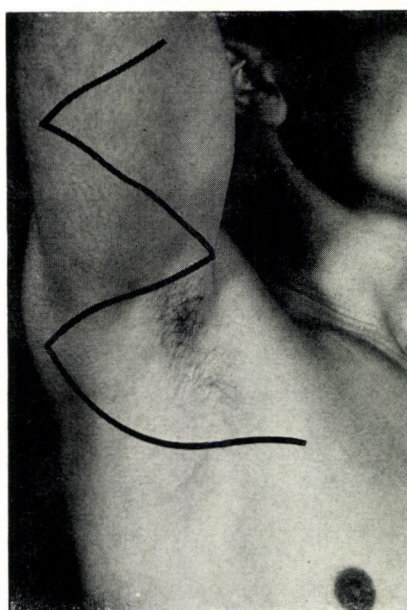
D

D and E. If wide exposure is needed to approach the axillary structures, a zig-zag will be satisfactory, in which all lines run more or less in a transverse direction.

E

G
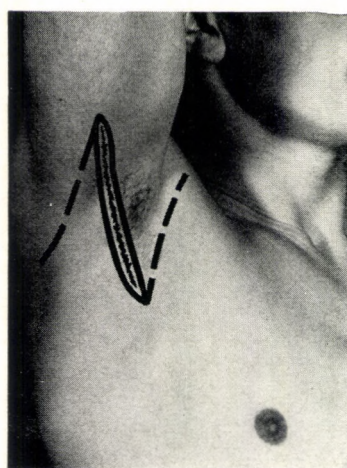
F

F through H. A longitudinal scar or wound may be converted easily to a better scar by means of a Z-plasty.

H

I

J

I through K. Skin defects may be closed with the use of local rotation flap and split-thickness skin graft (I, J) or skin graft alone (K). Care must be taken to leave a suture line which is not in the longitudinal direction.
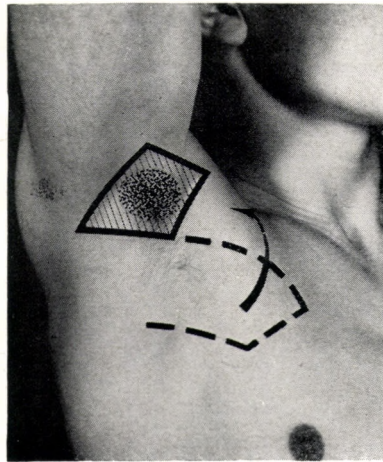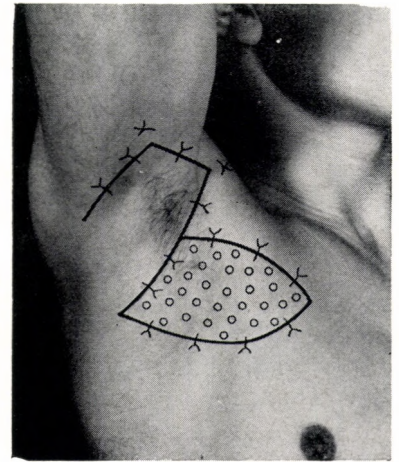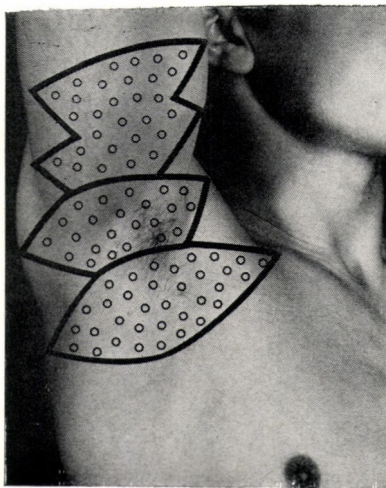
K
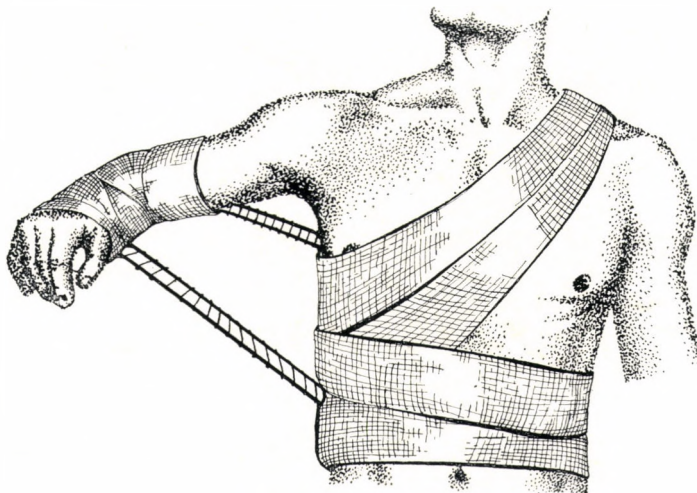
L

L. After major surgery in this region, the limb must be adequately immobilized. The use of the airplane splint is recommended.

Incisions in the Scapular Region and Arm
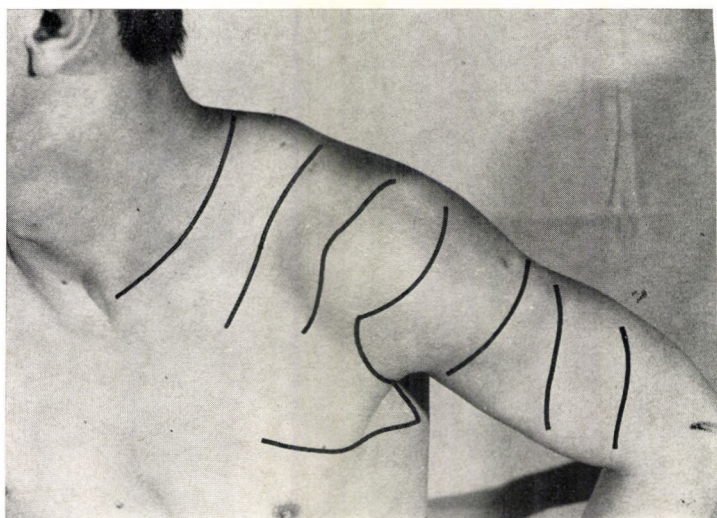
A

A. In general, incisions in the scapular region and upper limb should be perpendicular to the axis of the arm. Adherence to this principle will prevent contracted scars in these regions.
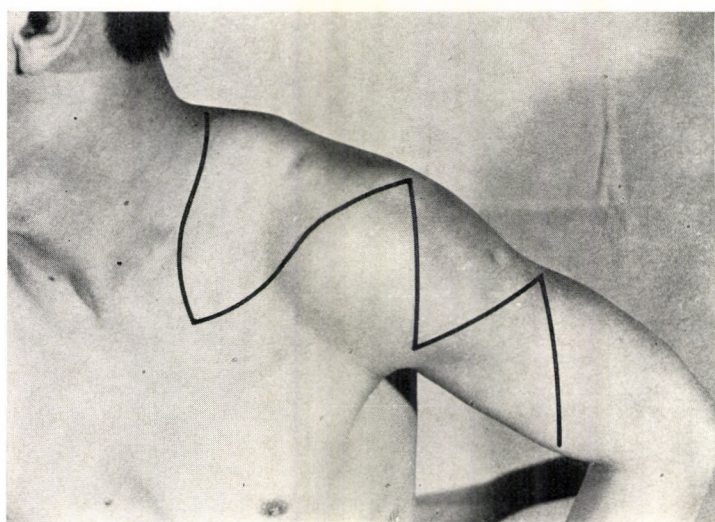
B
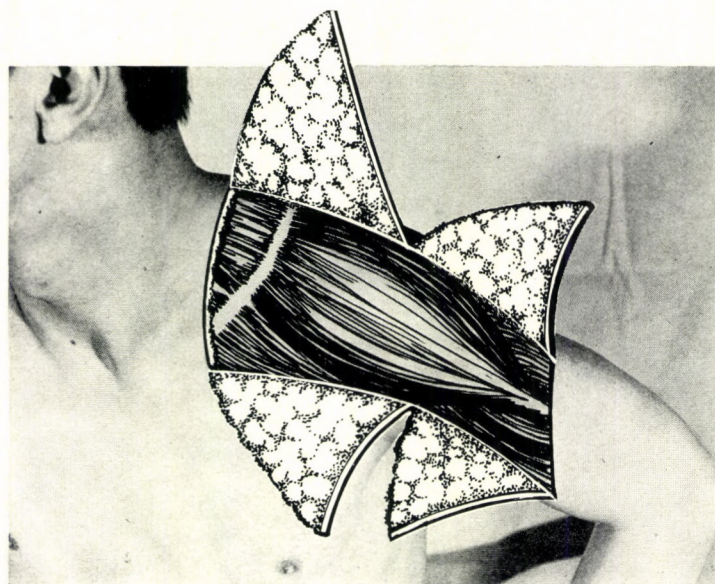
C

B and C. If wide exposure is needed, a zig-zag approach is suitable.

178

D. In the posterior aspect of the shoulder, small incisions can be made.
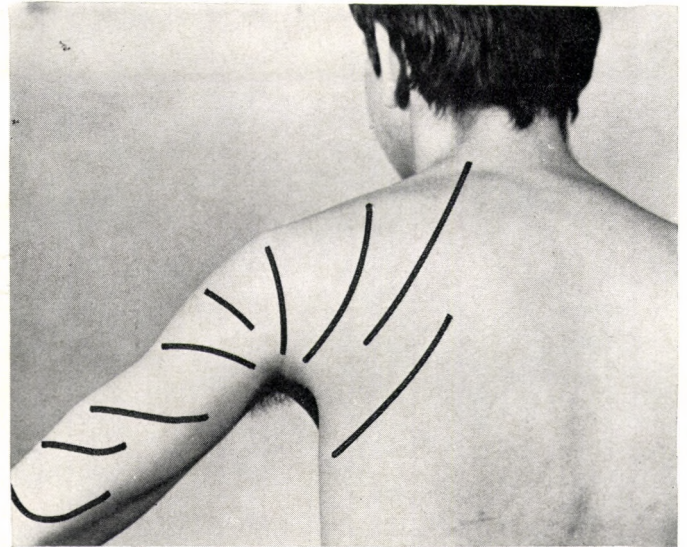
D

E. For wider exposure an incision such as that shown in the picture would be satisfactory.
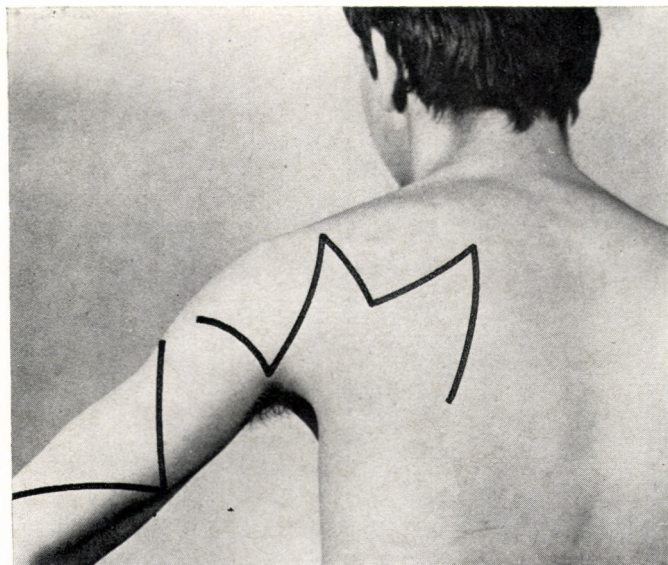
E

F. With reference to the upper limb, the transverse line generally will give the best result.
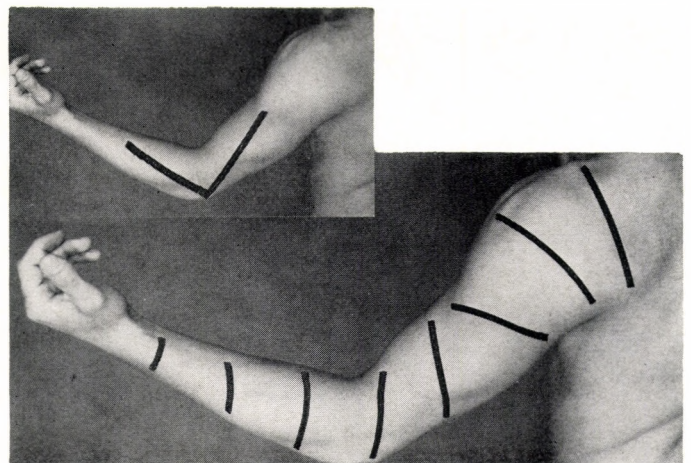
F
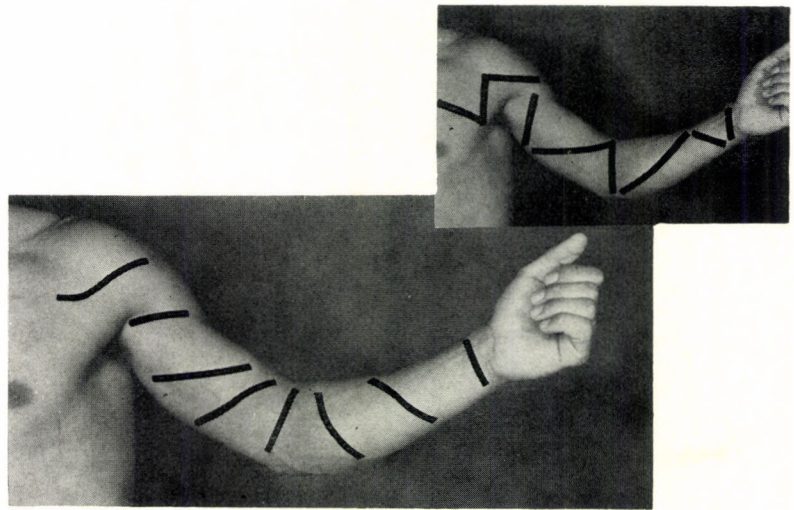
G
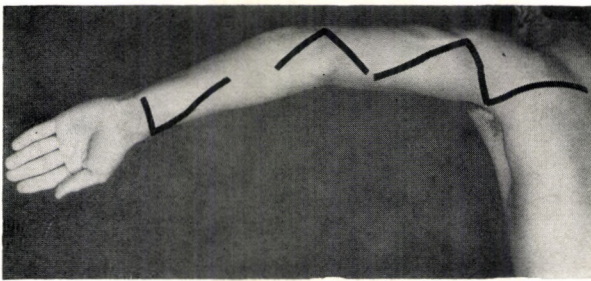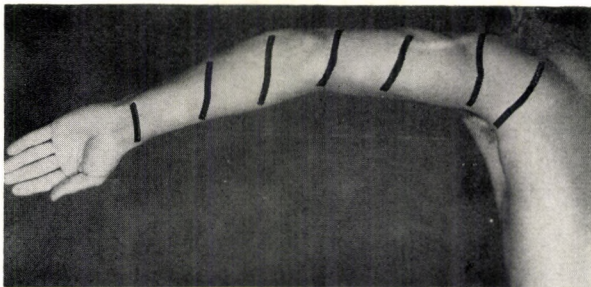
H
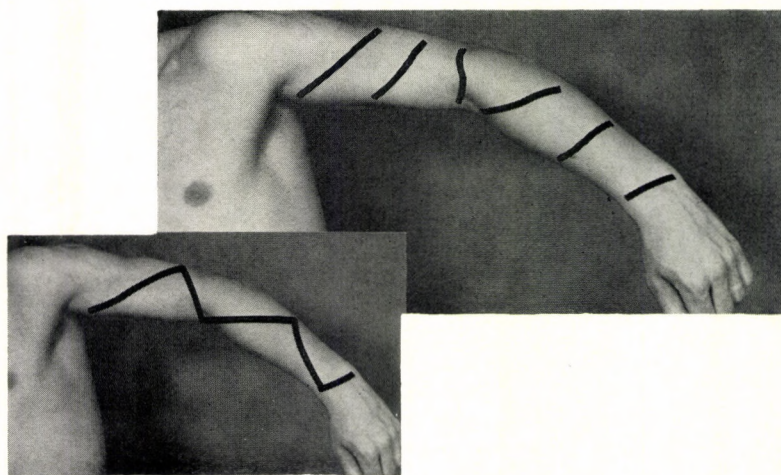
I

G through I. For limited exposure, the transverse incision will suffice. If more extensive exposure is needed, the transverse incision can be joined by oblique incisions, creating a zig-zag line.

Local Flaps
in the Shoulder Region
and Extremity
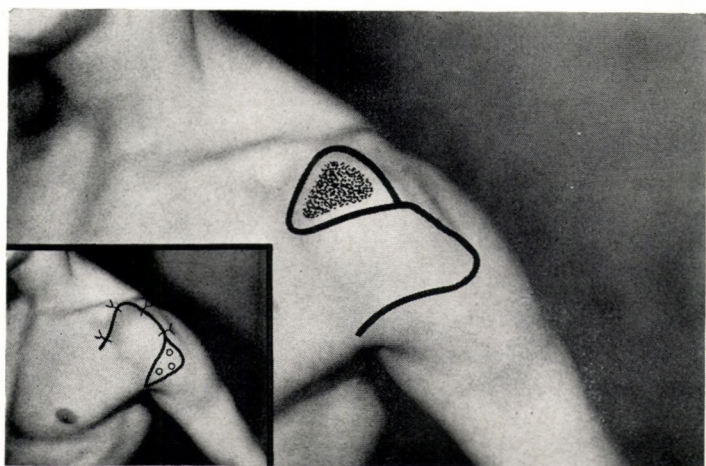
A
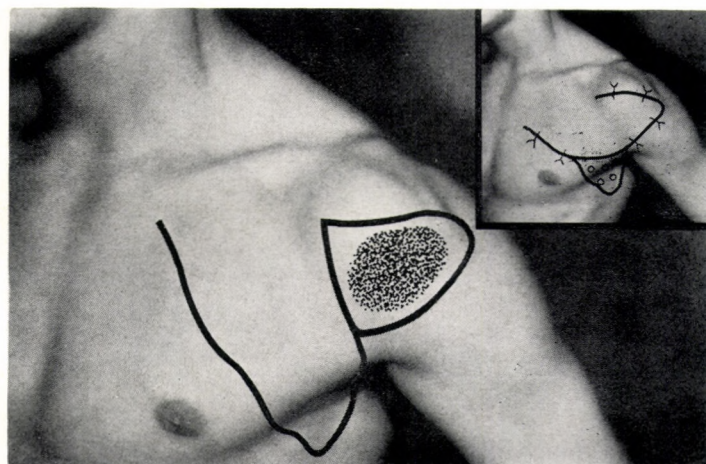
B
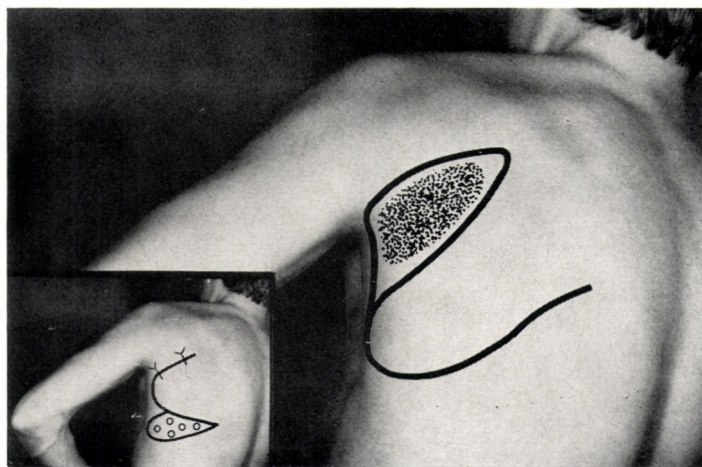
C

A through C. When full-thickness skin and subcutaneous tissue are needed to cover defects on the shoulder, local rotation flaps from the shoulder or thorax offer a satisfactory means of coverage. The resultant defect must be covered by a split-thickness graft.
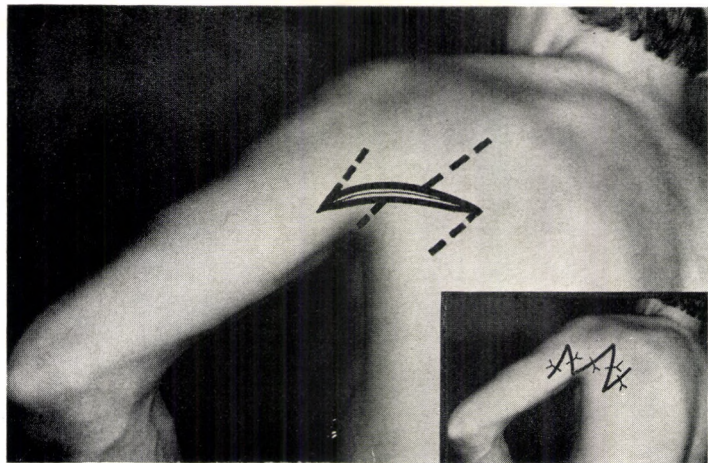
D

D. As illustrated previously, poorly located wounds or scars of the axillary folds may be converted by Z-plasty to satisfactory suture lines.
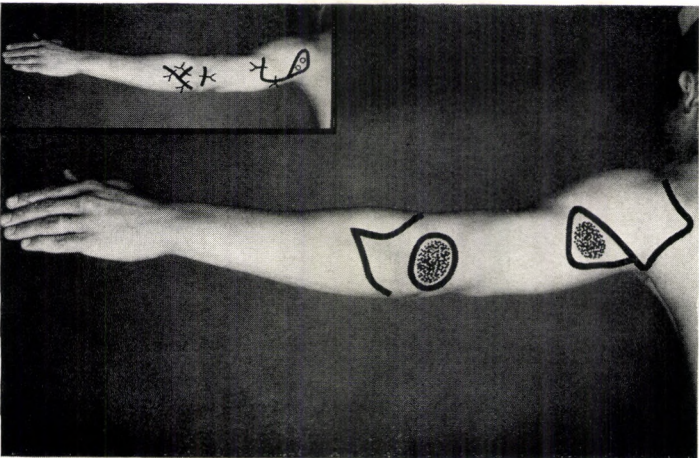
E

E. The V–Y-plasty is useful for closing skin defects in the cubital region, because it has the advantage that no skin graft is needed for closure.
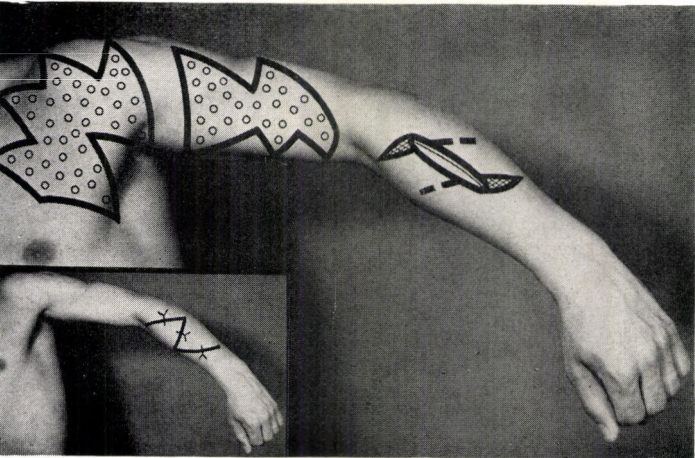
F

F. Suture lines of free skin grafts have to be broken in the shoulder region.

G. If using local flaps in the elbow region, the longitudinal edge must be angulated.
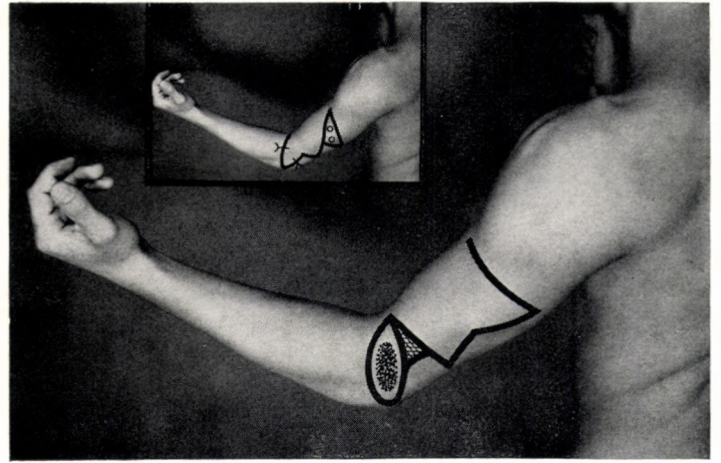
G

H. Burow's double triangle skin advancement, which yields good results in the upper arm. Also illustrated is volar advancement in the distal forearm.
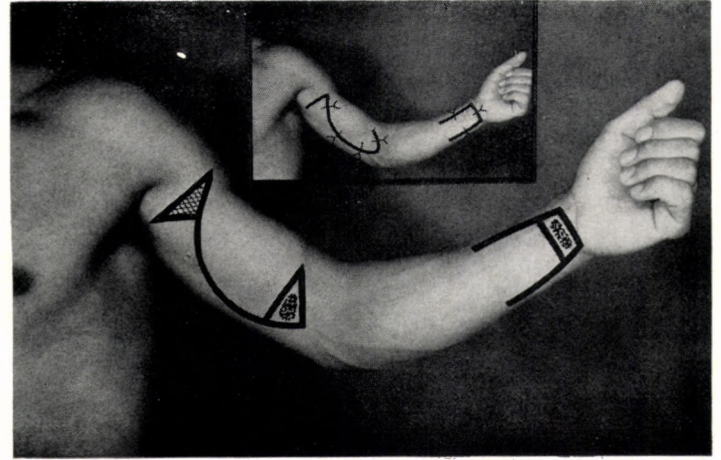
H

Preoperative Preparation of Extremities
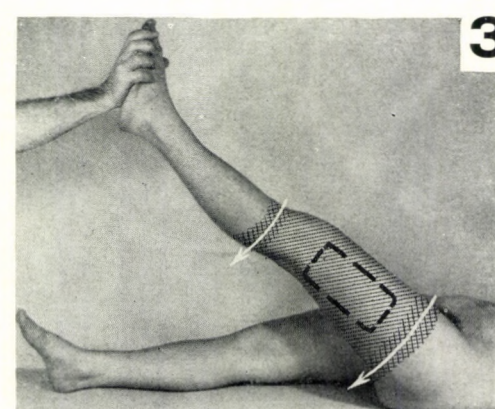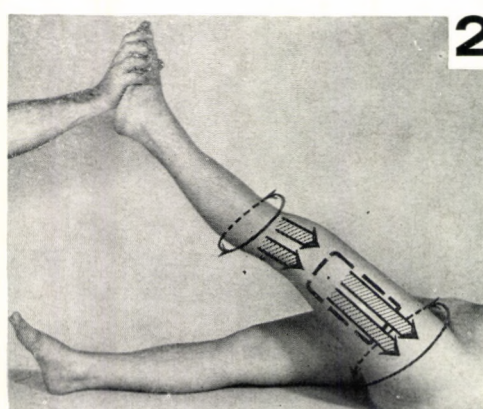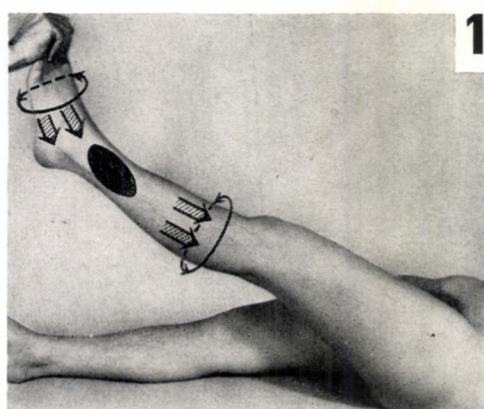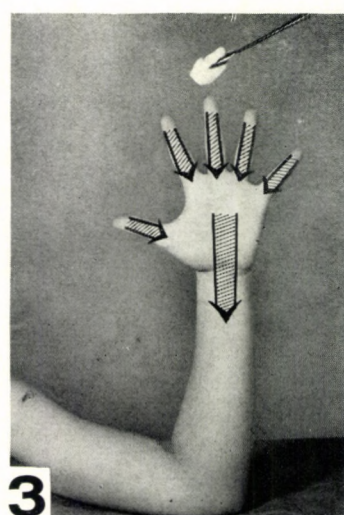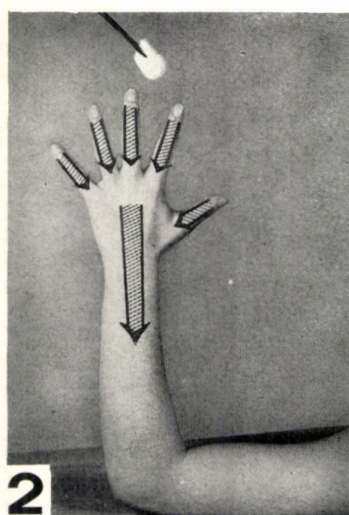
Conduction Anesthesia
of the Hand

Conduction anesthesia is satisfactory for many operations on the hand.
If the entire hand is involved, anesthesia of the major nerves at wrist level
is necessary, while a digital block is sufficient if only the fingers are involved.
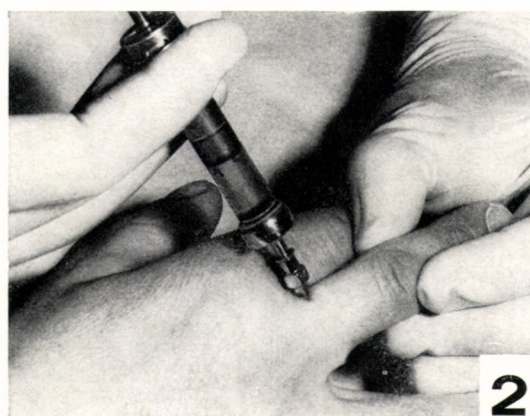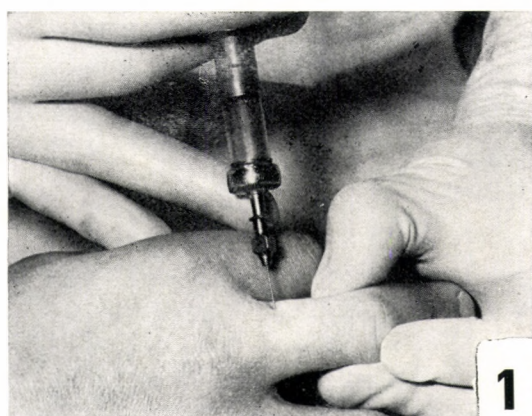
A
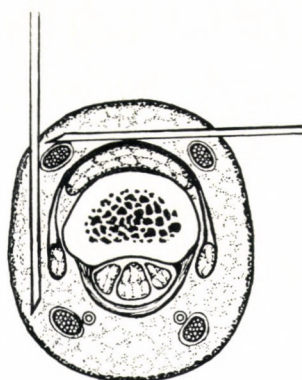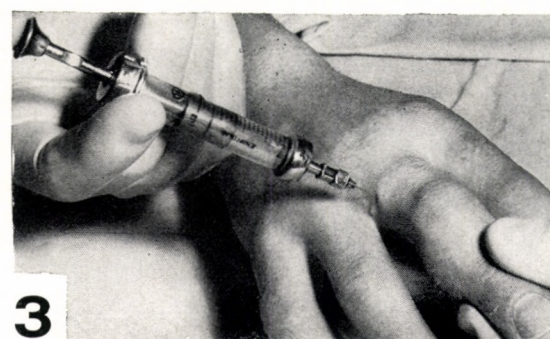
A. Digital anesthesia may be obtained by blocking the proper digital nerves
at the base of the finger at the interdigital web. Adrenalin is not conven-
tionally used at this level.
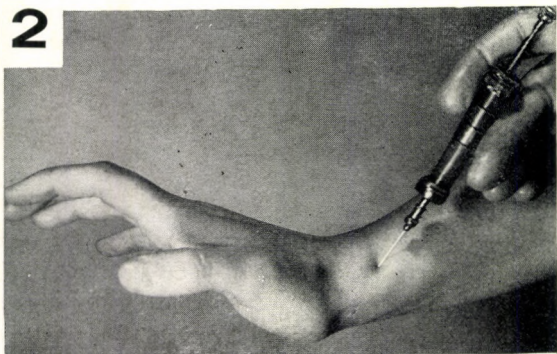
B. The major nerves at the wrist level can be located by a knowledge of surface anatomy. The needle is placed between the flexor carpi radialis and palmaris longus for median nerve block. The maneuver helping the accurate placement of the needle is shown (1). The radial nerve block is shown in 2. For anesthesia of the ulnar nerve the needle is placed beneath the flexor carpi ulnaris (3).
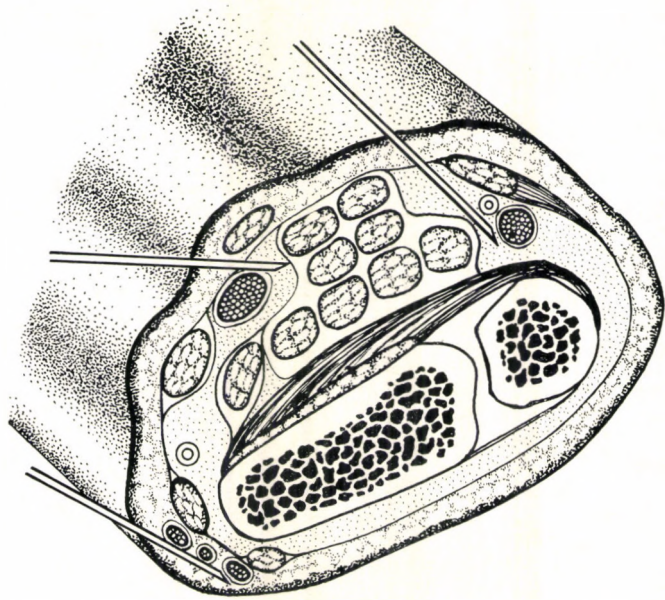
Incisions on the Hand

A

B
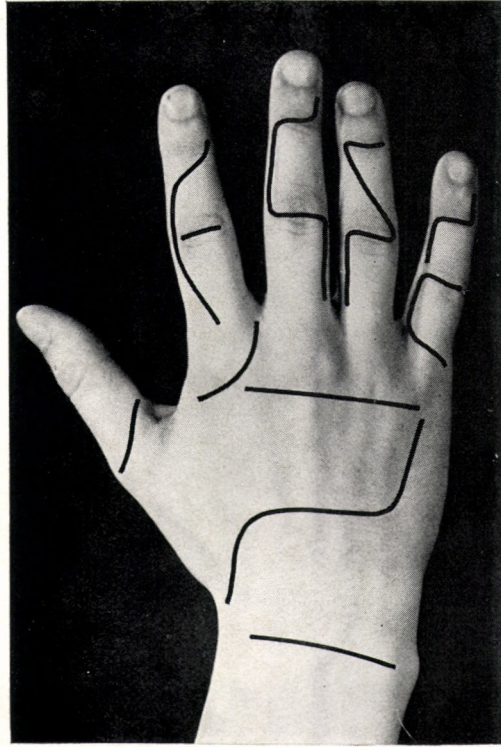
A and B. Many incisions are suitable for exposure of the hand. Fundamentally, all incisions should not cross flexion and extension creases and should run parallel with the creases.

The safe transverse, oblique, or arched incisions which may be used on the dorsum of the hand (A) and on the palmar surface (B) are shown.
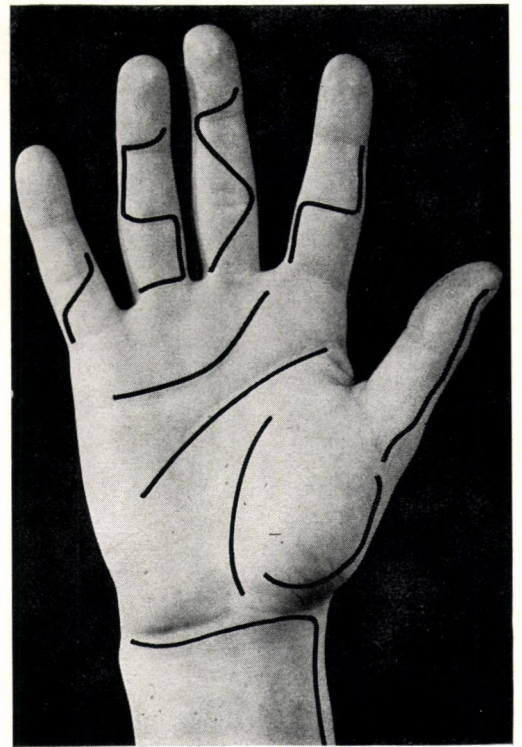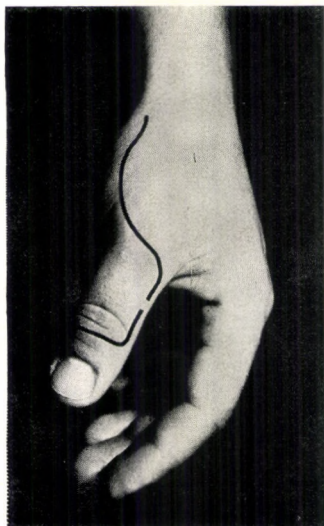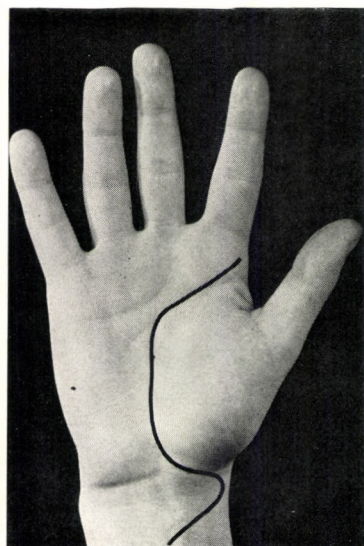
C. Palmar incision coursing proximally to cross the wrist in a zig-zag manner.

D. Incision to expose the dorsum of the thumb.

E. The popular and safe mid-axial incision. This incision is made to connect the mid-axis of the joint.
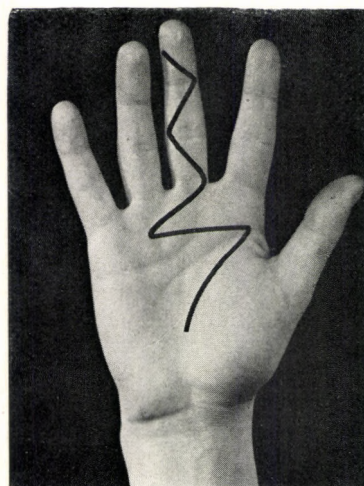
F. The zig-zag volar incision.

Incisions Affording Wide Exposure of Joints (e.g., on the Wrist)

A. When there is a necessity for extensive exposure of the loco-motor structures near an articulation (represented here by the dorsal wrist region), the incision must be planned with care.

A
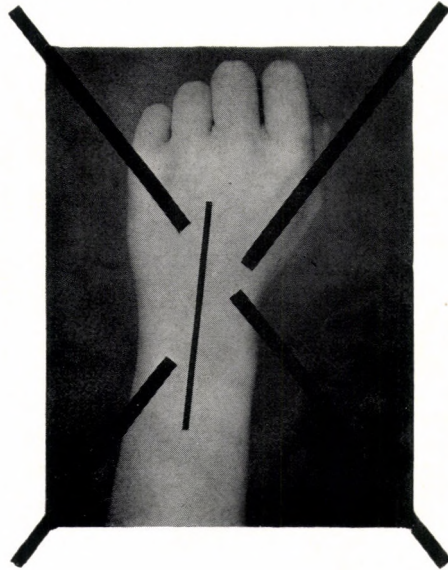
B

B. The longitudinal incision will heal with excessive scar because it violates a crease at right angles.
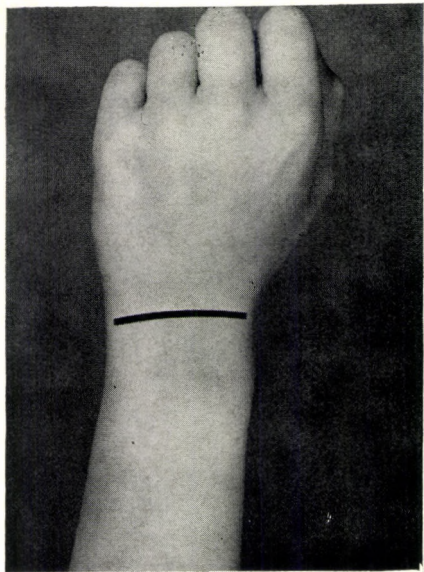
C

C and D. The transverse incision, while technically correct, affords only a limited exposure of the region.
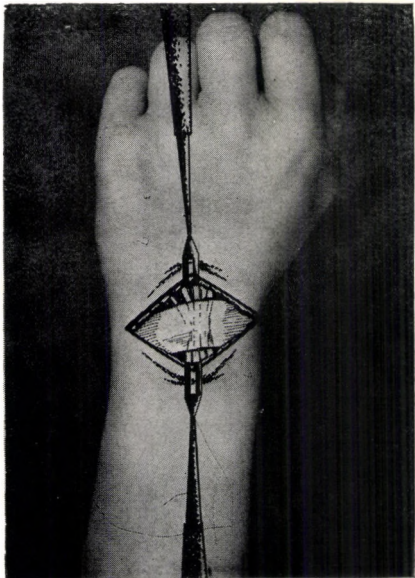
D
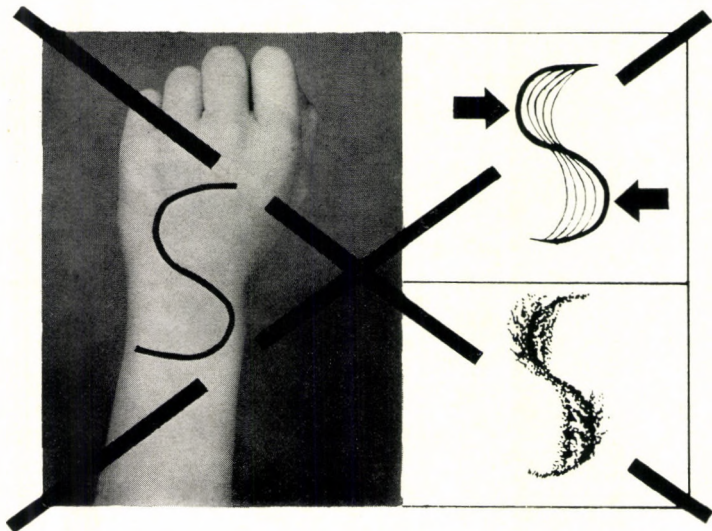
E

E. To obtain extensive exposure, another incision must be developed. The S-curve frequently heals with hypertrophic scar because the effective line is a longitudinal one.
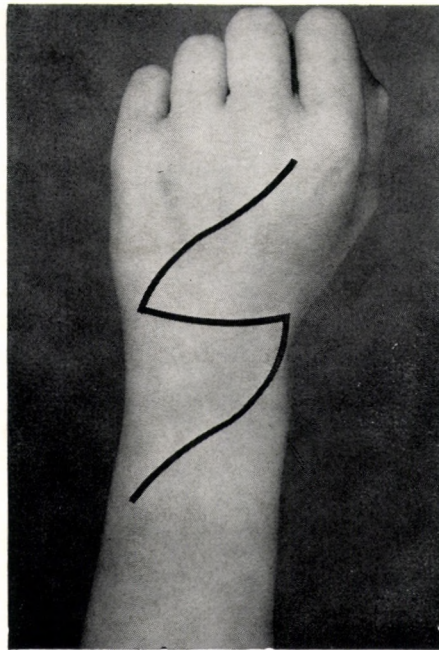
F

G

F and G. A large, Z-shaped incision allows extensive exposure while affording a satisfactory cosmetic result. The surgeon must take care to make the angles at least 60 degrees to ensure adequate blood supply to the flaps.
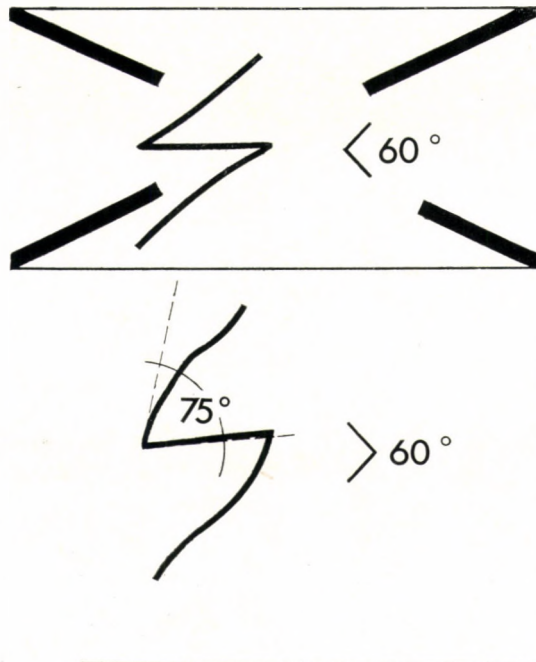
Skin Replacement on the Dorsal Surface of the Hand

A

B
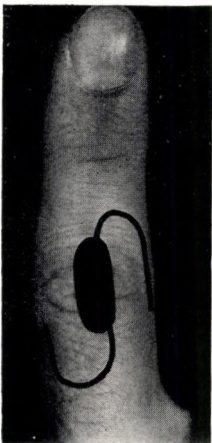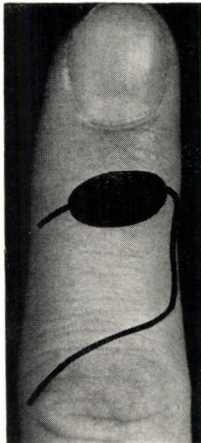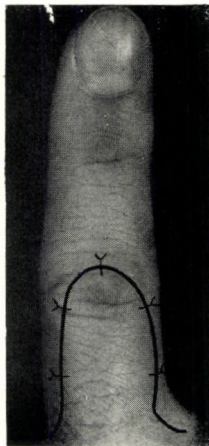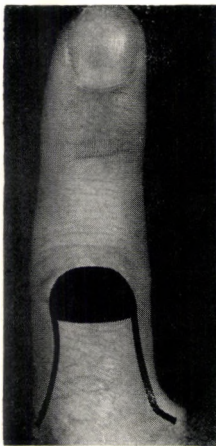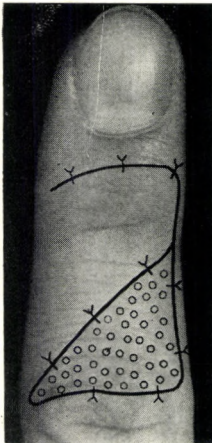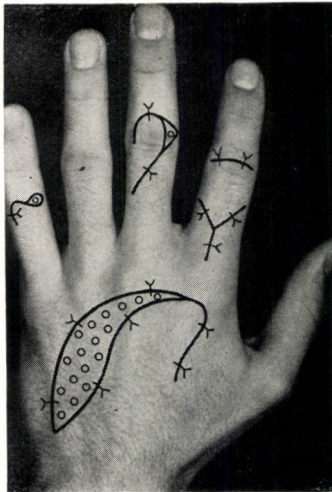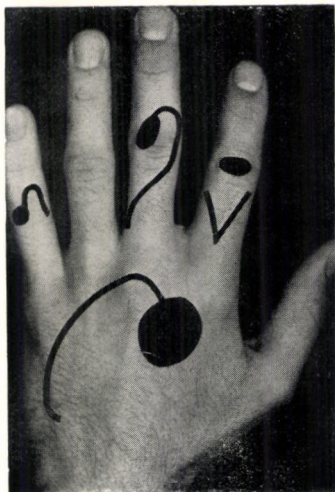
A through D. The techniques of local rotation flaps, advancement flaps, and V–Y-plasty to provide full-thickness coverage of small joints are useful procedures. These can be combined with small skin grafts.

C

D
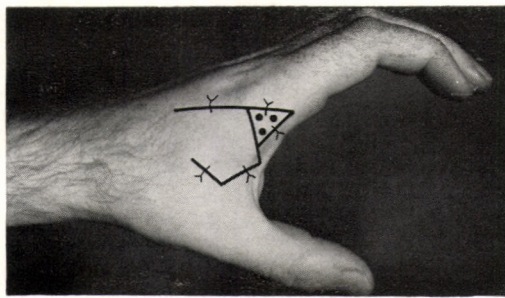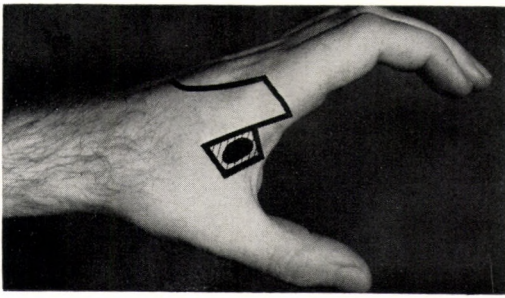
E

E. The thumb web must be preserved and can be closed suitably with a dorsal rotation flap.

F. Small rotation flap for interdigital webs.

F
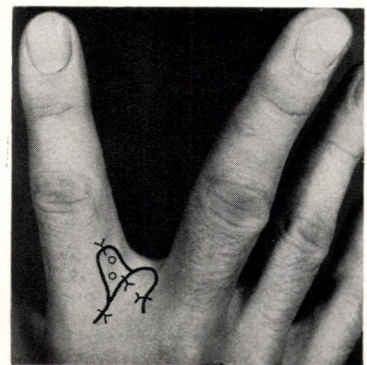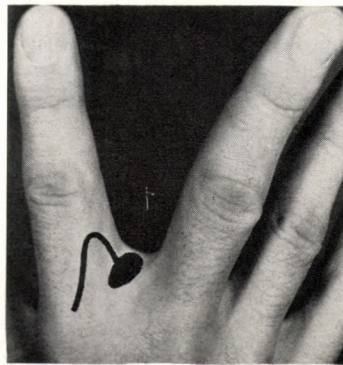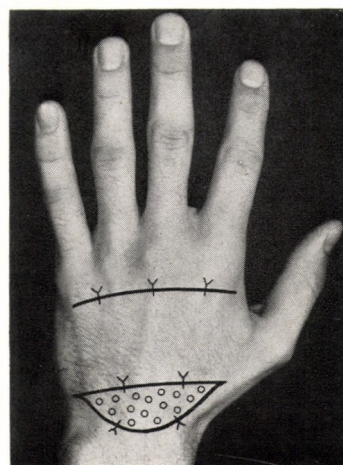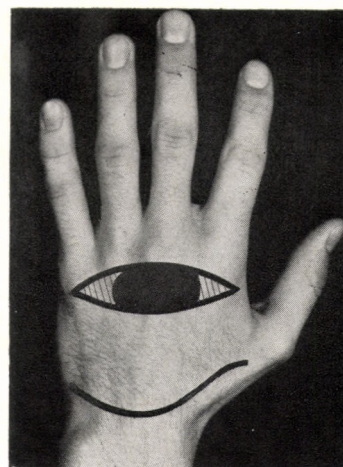
G. A bipedicle flap occasionally may be used to cover the metacarpal phalangeal joints.

G
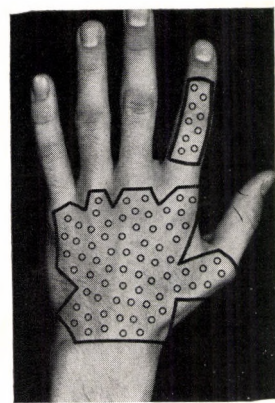
H
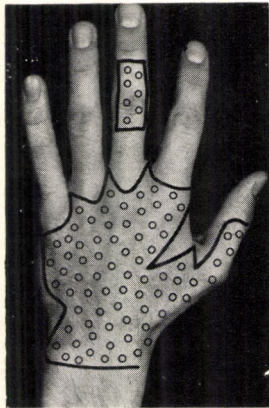
I

J

K

H through K. Split-thickness grafts may be used to resurface the entire dorsum of the hand and fingers. These also can be used in the inter-digital areas. Care must be taken to ensure that all suture lines are in appropriate places.

Skin Replacement on the Palmar Surface of the Hand
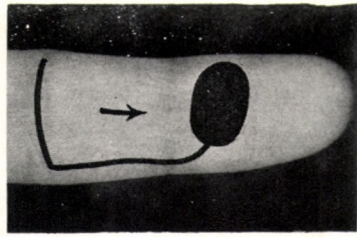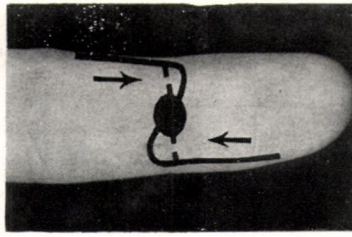
A   **B**   **C**
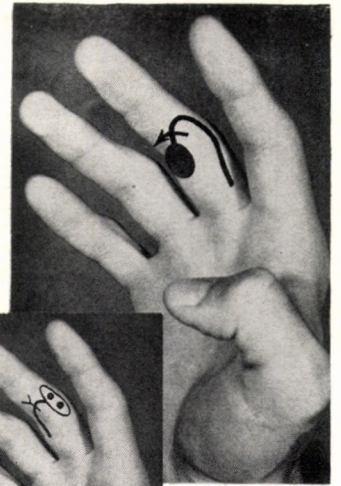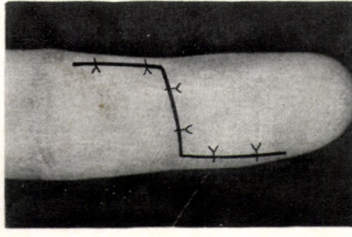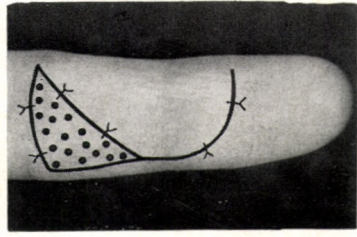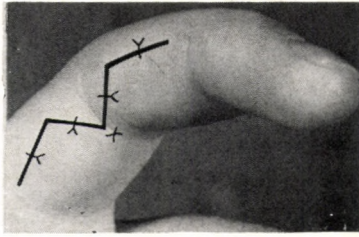
D

A through D. There is no excess skin on the palm and palmar surface of the fingers. Consequently even small defects must be replaced by various techniques. Local rotation flap with careful incision planning can be used.
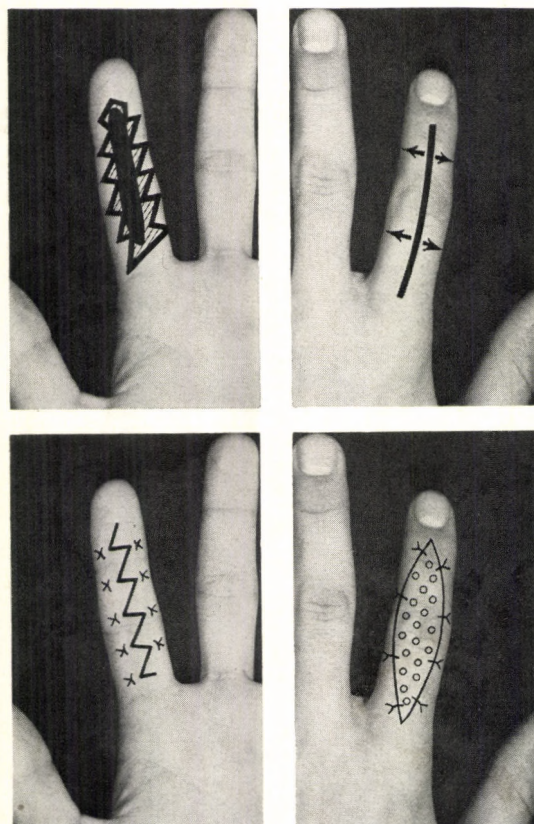
E. Closure of a longitudinal defect on the palmar surface using the rest of the skin as bipedicled flaps. The defect caused by the incision on the dorsal surface is covered by a skin graft.

E
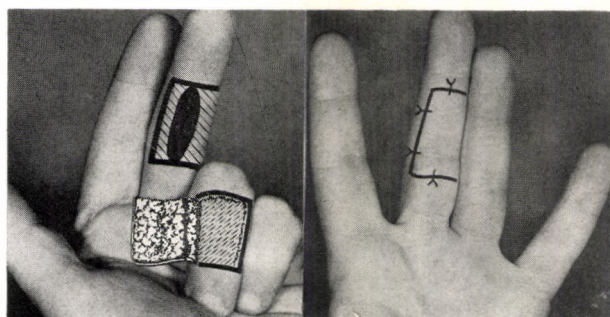
F. The cross-finger flap, a most useful technique to supply coverage to a large palmar defect.

F
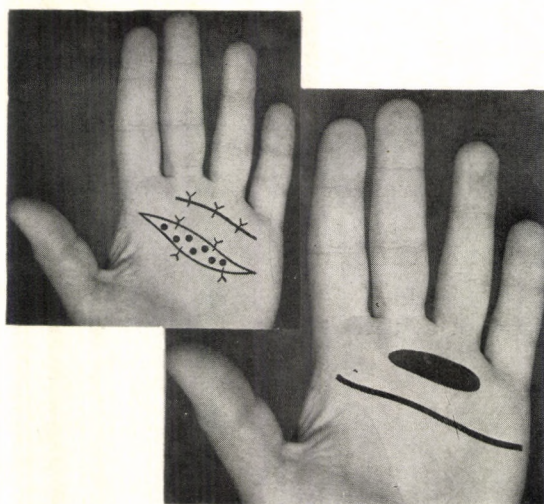
G. The bipedicled flap will afford coverage in the distal palm where a tender scar would be unsuitable, as this is the heavily used part of the palm.

G

H. Neuro-vascular flap from the ring finger will
supply sensitive skin for a thumb defect. This
flap is rarely used and must be planned carefully.
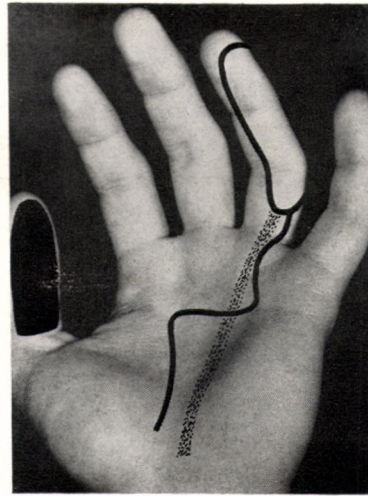
H
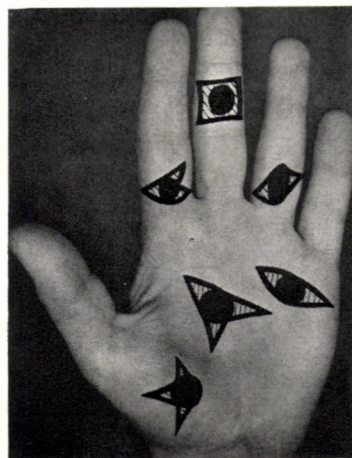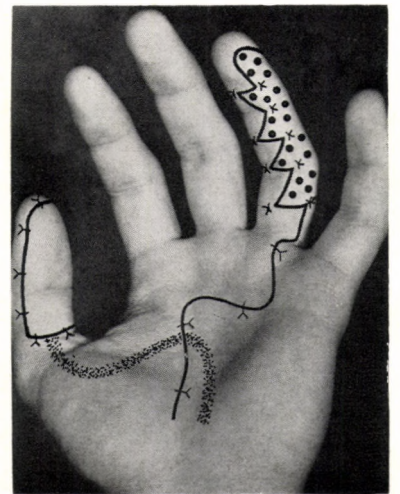
I

I. Small defects in functionally less important areas may
be covered with full-thickness grafts taken from the wrist
crease. These hold up well and are quite useful.

Skin Replacement on the Hand by Distant Pedicle Flap
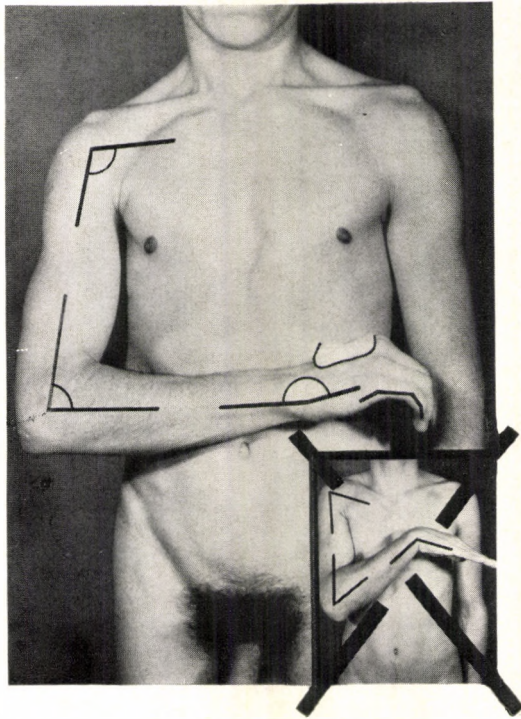
A

A. When planning a distant pedicle flap, it must be kept in mind that the extremity to be immobilized must be in a functional and comfortable position. No joint can be kept in acute flexion. The flaps must be designed with adequate blood supply.
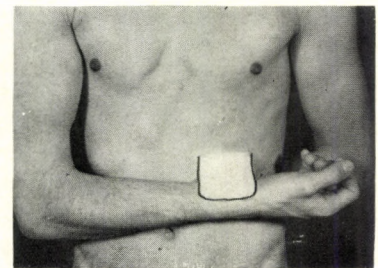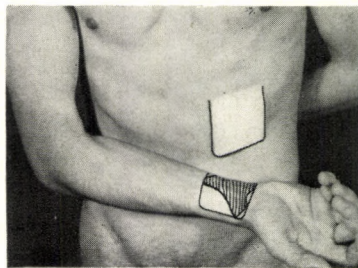
B

B. Flap for the volar carpal region.
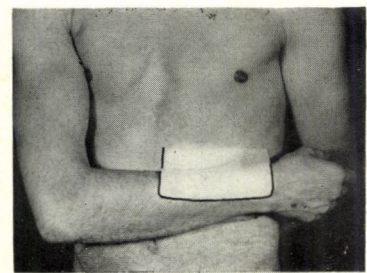
C

C. Flap for the distal forearm.

D. Flap for the palm. Hairless skin without too much fat must be used. The technique of Colson, removing all excess fat is the technique of choice, as all flaps survive on the subdermal vascular network.
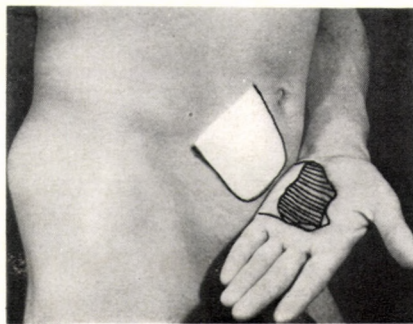
D
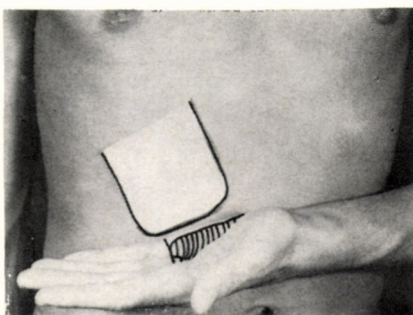
E

E and F. Oblique thoracic flaps are useful on the radial and ulnar side of the hand, particularly on the thumb web.

F

199
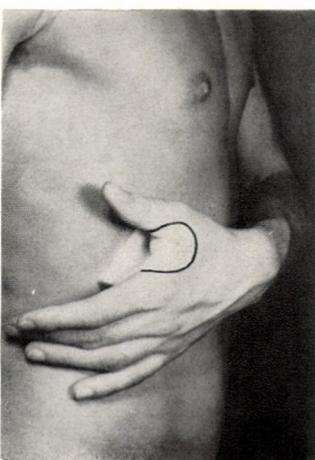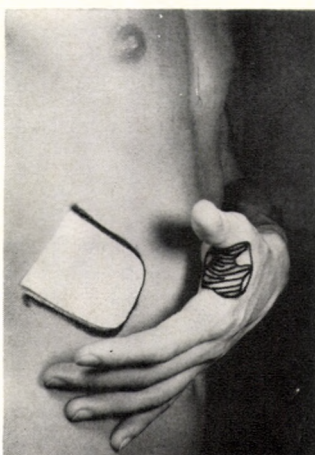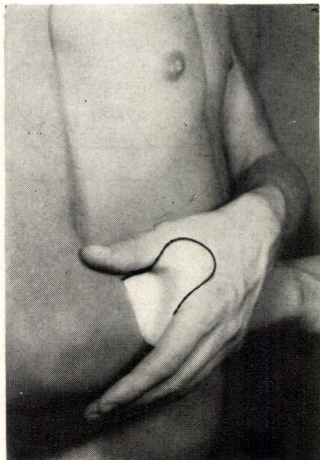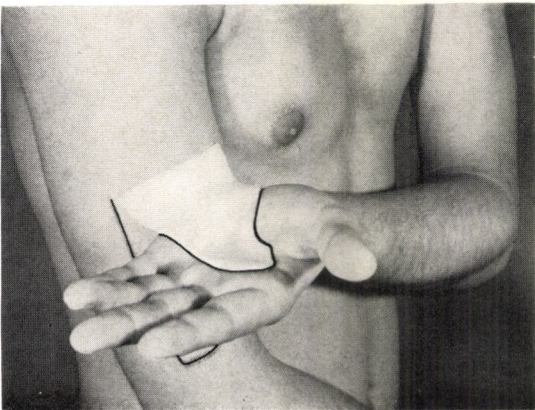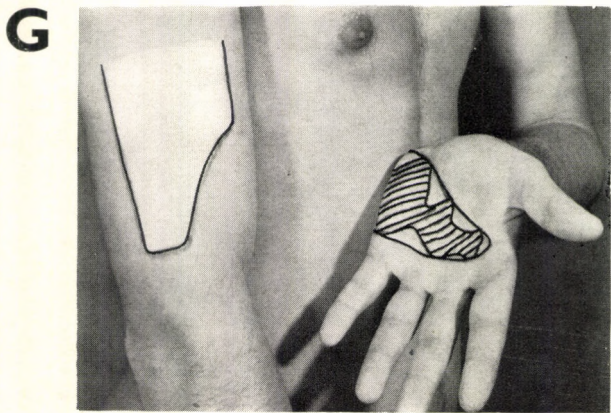
G and H. The contralateral arm may be used as a donor for the cross-arm flap to cover the palmar thumb web. This involves immobilization of both arms and is rarely used.

Skin Replacement
on the Fingers by Pedicle Flap

A and B. To replace major defects on the dorsum of single or multiple fingers, a bipedicled flap can be used. This coverage is rarely necessary but should be kept in mind.

A

B
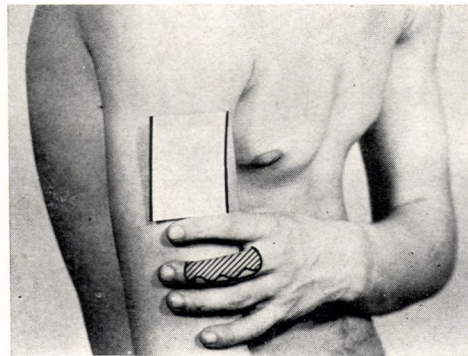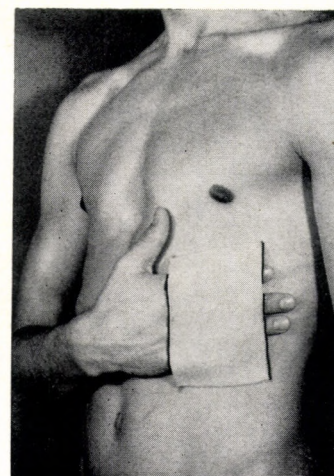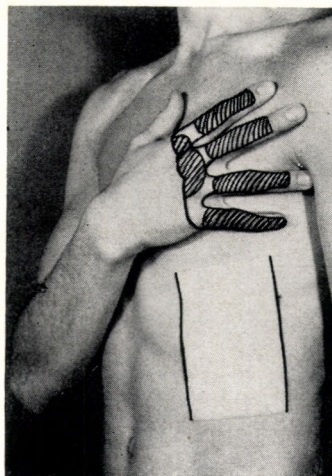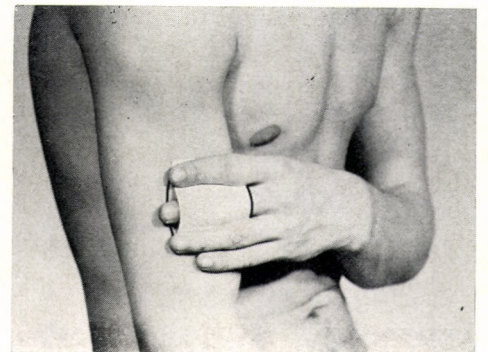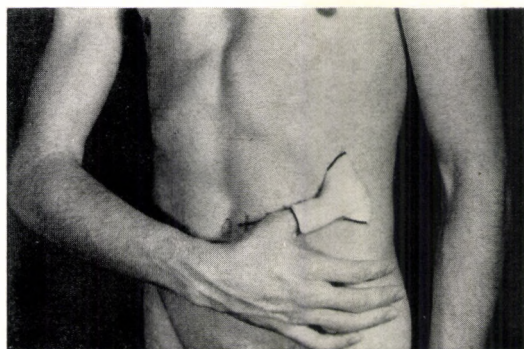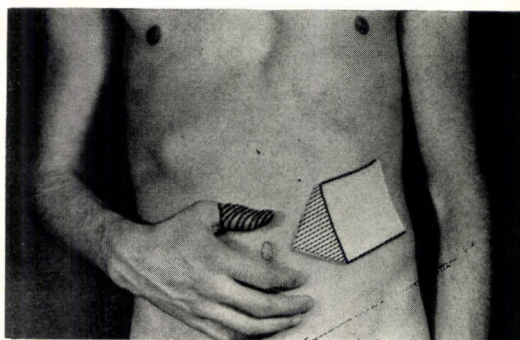
C. Circumferential defects of the thumb must be covered by a tubed pedicle. The width of the flap must equal the circumference of the thumb, usually three inches. A tube is then formed into which the skinless thumb is inserted.
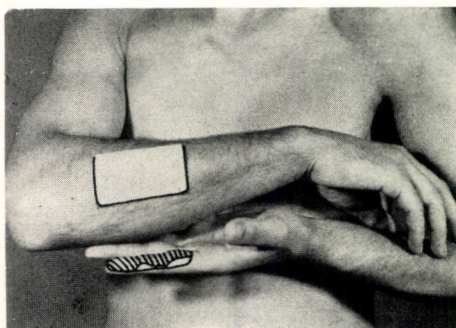
D. A single digit may be covered by a cross-arm flap.
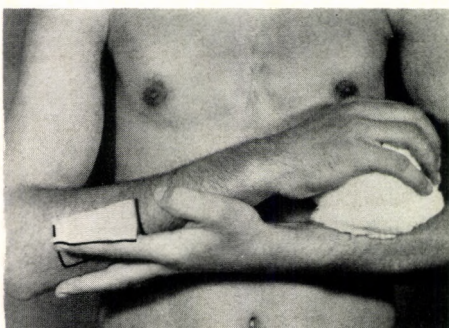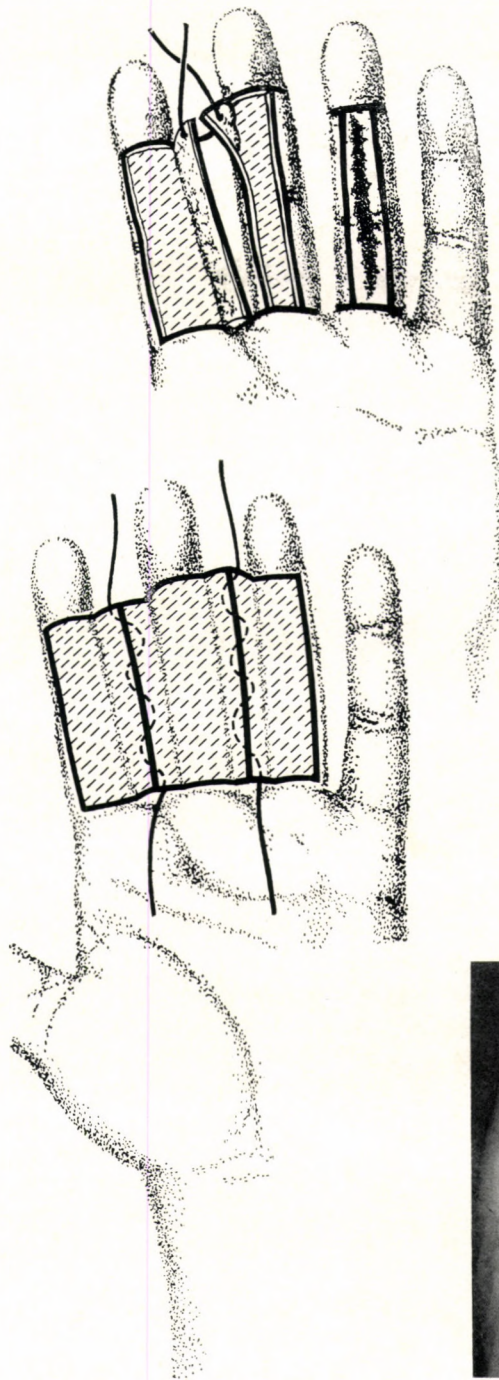
E. When multiple fingers are involved, the fingers are joined by dorsal skin, and then a large abdominal flap is placed over the fingers, effectively making a mitt. This effect makes a surgical syndactylia which must be separated at a later stage. These flaps must be thin, of the Colson type.
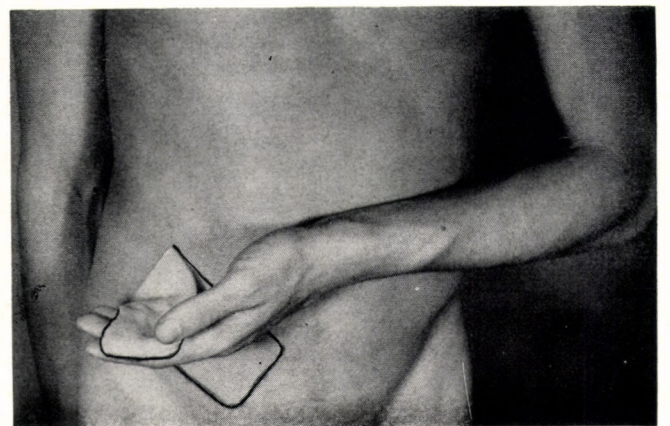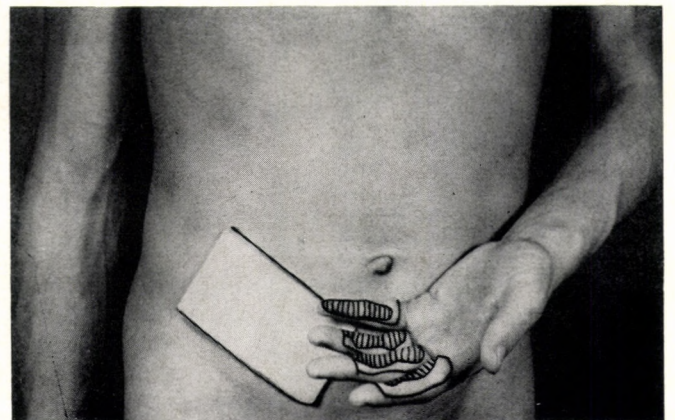
E

# Incisions and Skin Replacement on the Lower Extremity
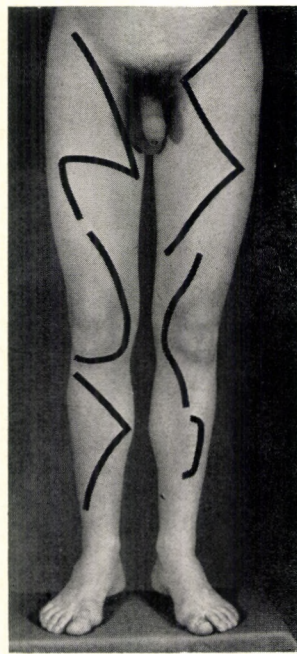
A

B

C

A through C. In general, the principles of incisions previously outlined should be followed on the lower extremity. The usefulness of transverse incisions, longer oblique incisions, zig-zag incisions and combinations is shown in the figures. A long mid-axial incision is permissible as well (C).
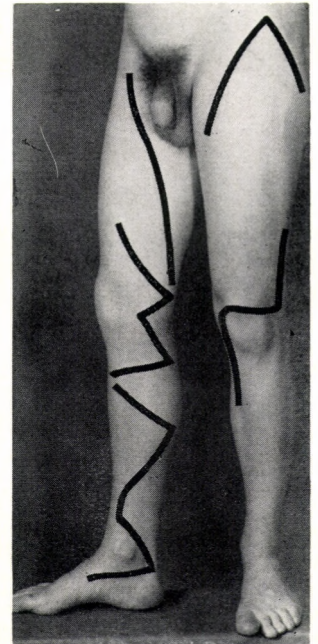
D

D. On the anterior surface, the common principles hold.
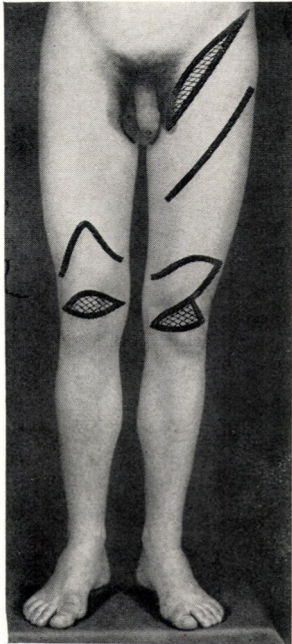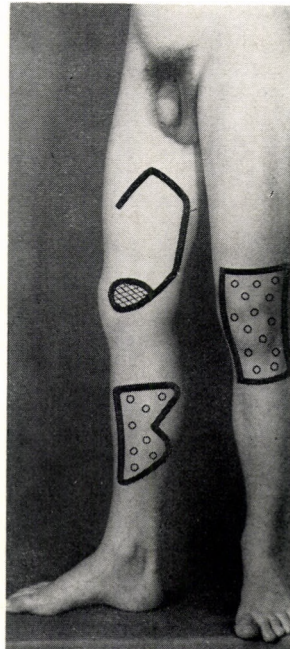
E   **F**

E and F. Local rotation and bipedicled flaps can be used to cover defects over joints. Skin grafts are also useful.
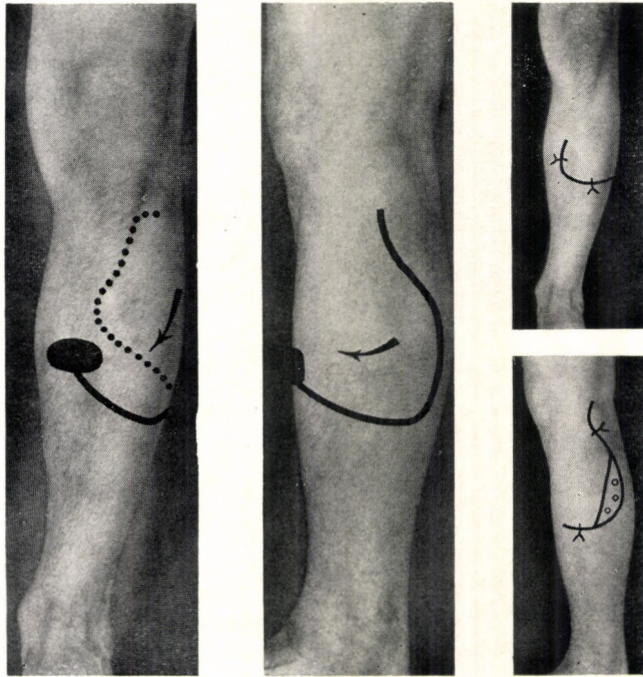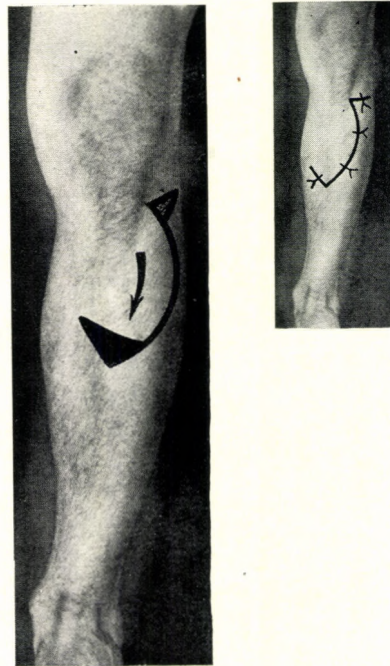
G and H. Rotation flaps are useful in the gluteal region.
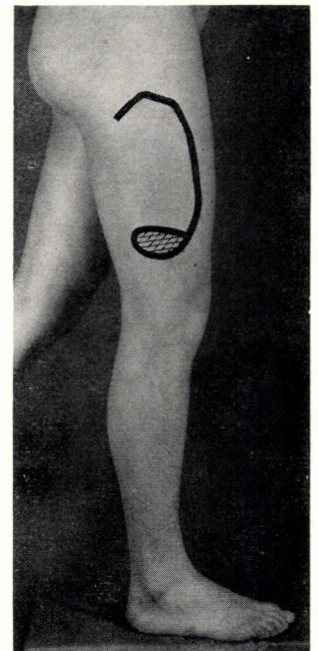
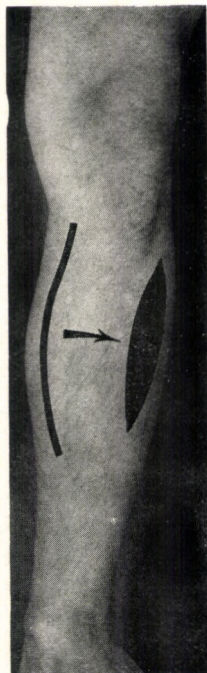**G**   **H**

Local Replacement of Skin Defects on the Leg


A

B

C

A and B. Coverage of skin defects in the lower extremity by local tissue is a useful and adequate tool. Because of the relatively poor blood supply in the skin of this region, large flaps must be designed. Care should be taken also not to allow dependent edema to form.

In the proximal tibial region rotation flaps are useful. Skin grafts may have to be used to cover the donor area.

C. Bipedicled flaps are used to cover longitudinal defects.

D   **E**
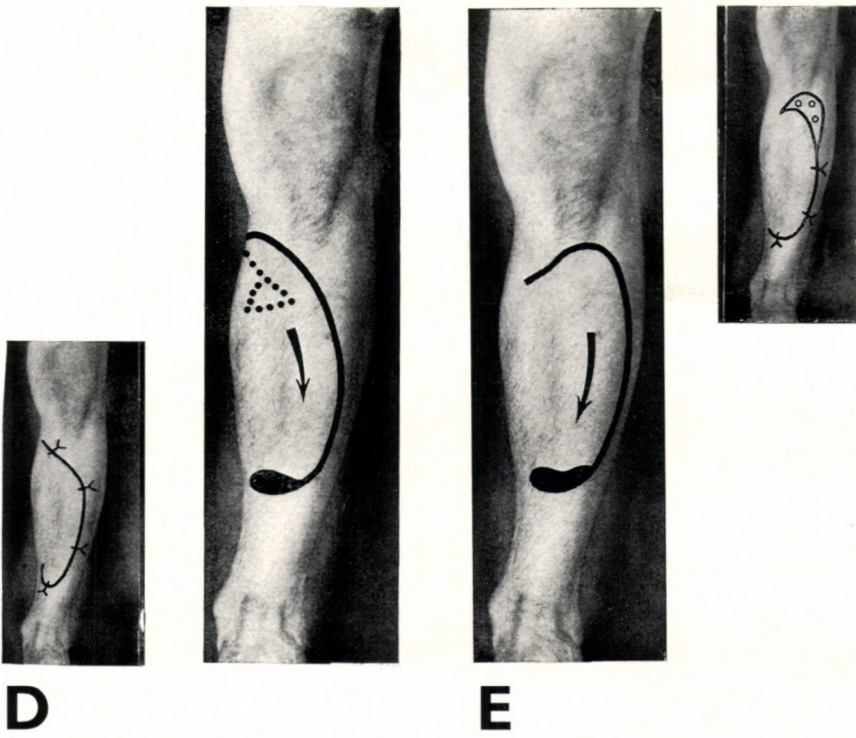
D through F. In the more distal region rotation flaps are useful.
Again, skin grafts must be used in the donor region because
there is no excess skin available.

F
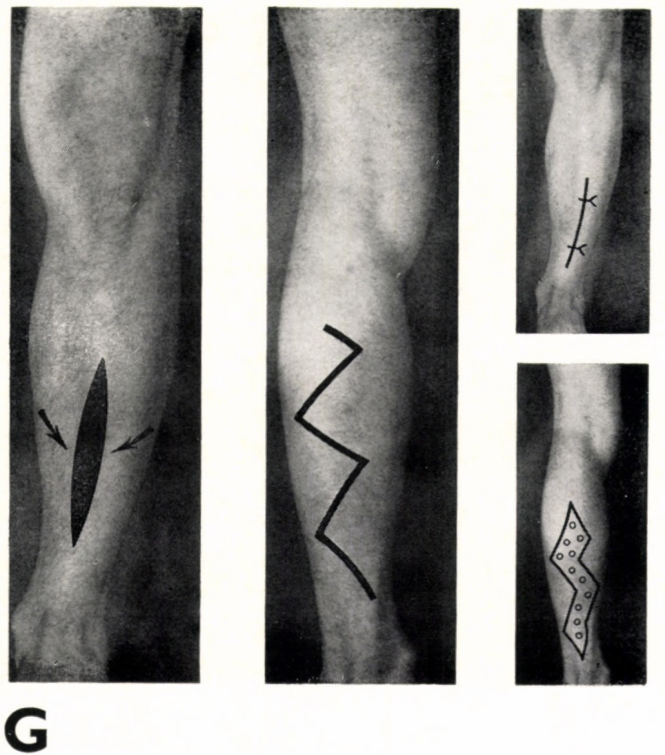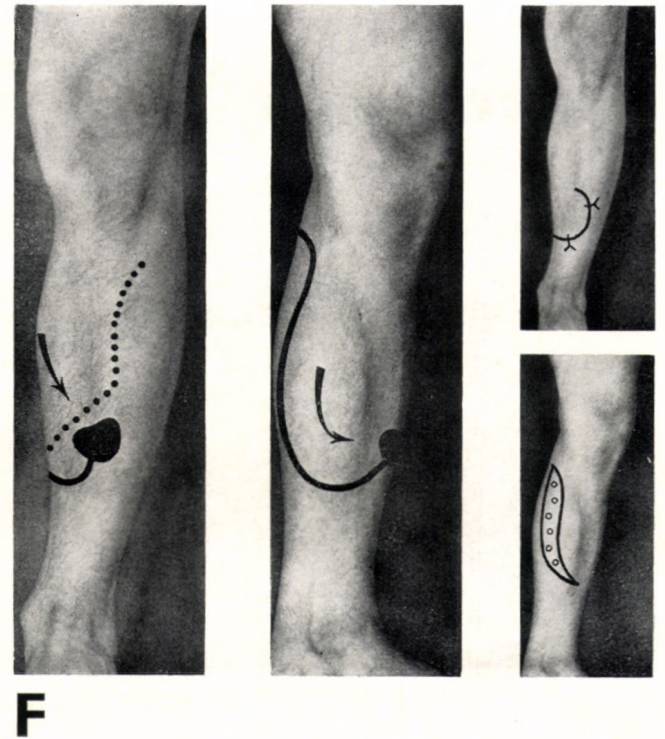
G. By making a zig-zag incision on the posterior leg, two
bipedicled flaps can be mobilized to close an anterior defect.

G

Incisions on the Foot

A

A. As a rule, incisions on the sole of the foot should parallel the transverse flexion creases. The heel should be avoided because painful scars would interfere with weight bearing.
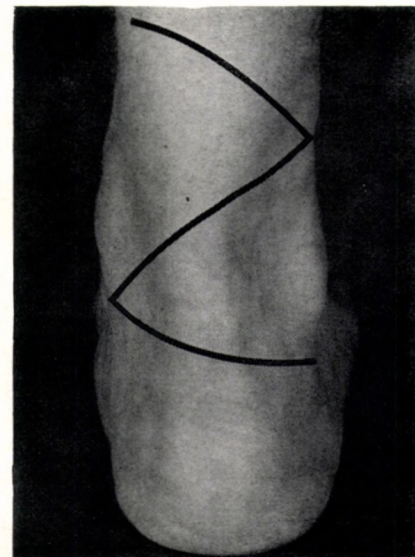

B

C

D

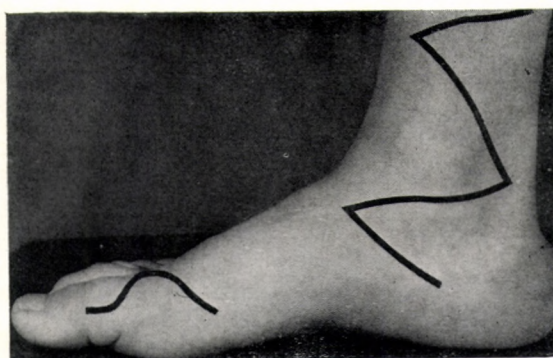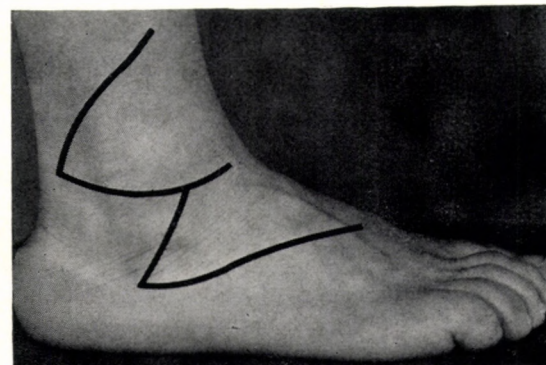B through D. Acceptable incisions for the dorsum of the foot.
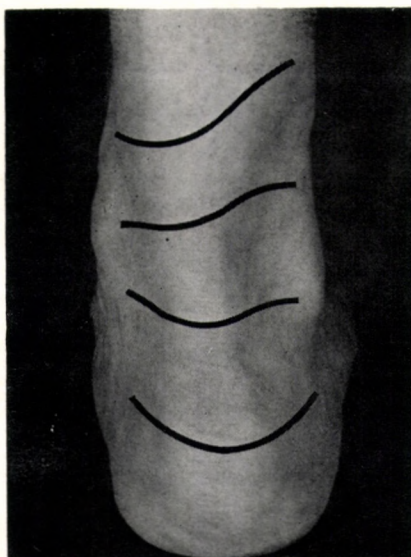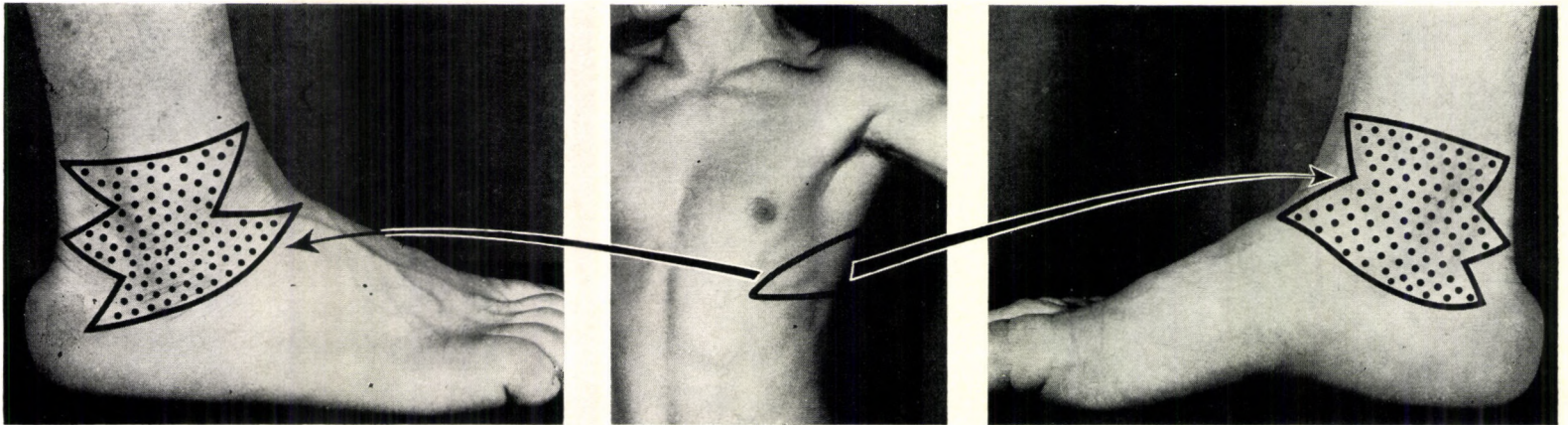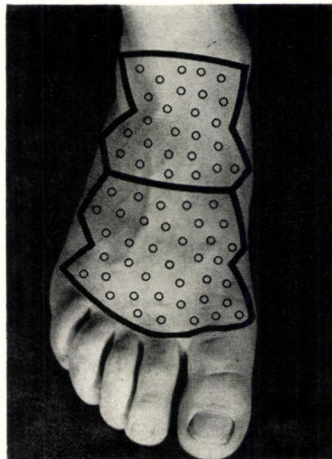
E

F

G

H

I

J

E through J. Acceptable incisions for the posterior region and lateral aspects of the ankle and foot.
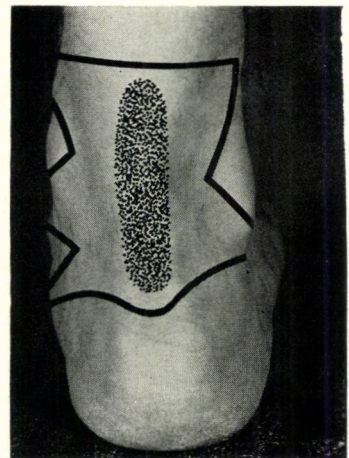
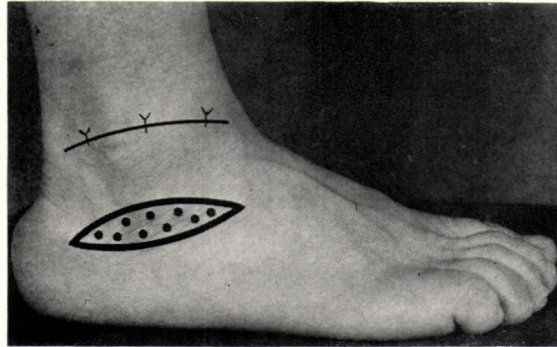# Skin Replacement on the Dorsum of the Foot and Talar Region

A

B

C

A through C. The lateral and medial ankle regions lend themselves to full-thickness or split-thickness skin grafts, as do the dorsum of the foot and posterior ankle. The grafts should be thick, i.e., 0.015 inch.
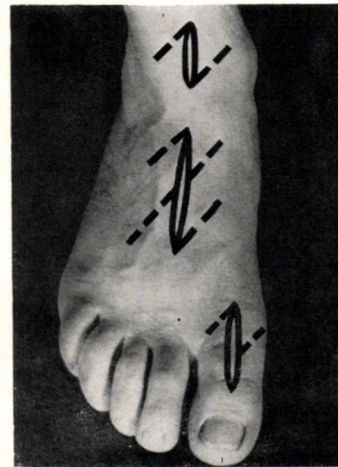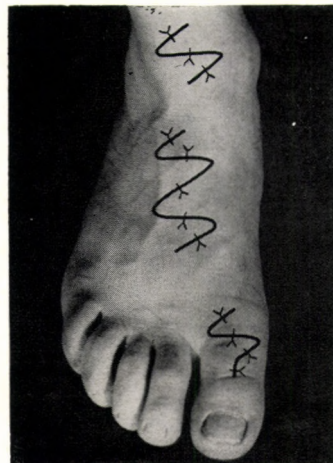
D. The bipedicled flap is also useful
if full-thickness coverage is necessary.

E. Incisions on the dorsum of the
foot should be converted to Z-con-
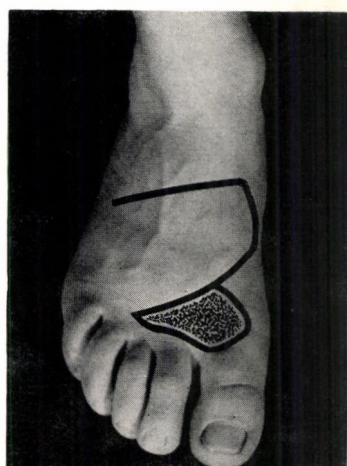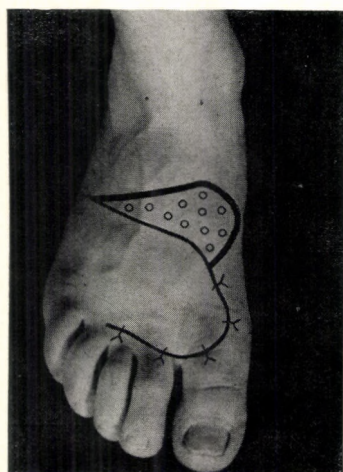figuration from a longitudinal
direction.

F

F. Incomplete coverage may be supplemented with skin grafts.

G

G. Local rotation flap and skin graft are used to cover the regions of the toe joints.
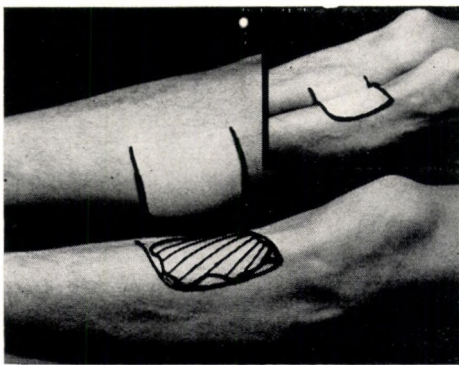
Cross-Leg Flap

The cross-leg flap is a technique used to provide stable coverage of exposed tendons and bones on the foot, ankle, and lower leg from the opposite leg.

The calf is most frequently used as the donor site, but there may be occasions when the thigh is more suitable. It is important to plan the length of the flap to be as close to one-half the width of the base as possible. Usually, it is not necessary to "delay" the flap, since it is raised and immediately applied to the recipient site. The flap may be based on the anterior medial or posterior medial surface of the donor leg, with the base as far as possible proximally. When anteriomedially based, it should be placed approximately 1 inch medial to the tibia to try to avoid injury to the long saphenous vein.

Careful preoperative planning is very important to insure an adequate size of flap for the defect involved.

Once the flap has been sutured into position, the legs are immobilized by cylindrical plaster casts that extend from the toes to the upper thigh. Often, it is more convenient to apply the cast before surgery and to create windows at the operative sites. The cast is then removed and put back again at the end of the procedure when it is joined together with plaster and the help of wooden struts.

Cross-leg flaps seldom should be performed on patients over the age of 60 because of the dangers of joint stiffness and thromboembolic complications.
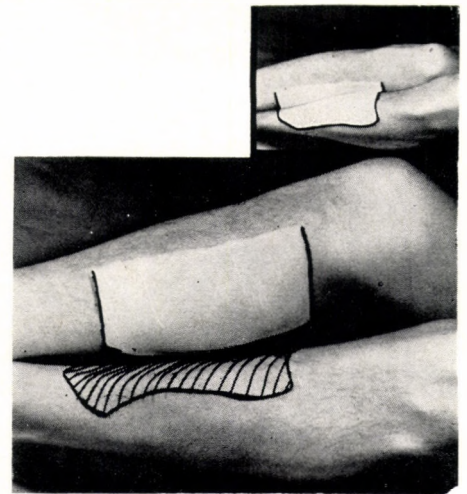
A

B

C

A. A cross-leg calf flap from the anterior medial right leg and its application to the defect on the upper anterior tibial region.
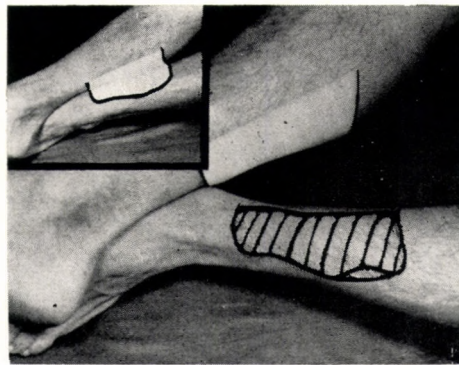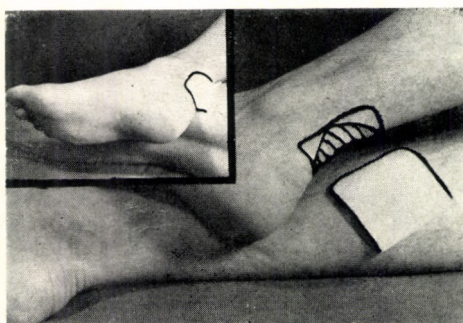
B. A flap from the lower right calf and its application to a defect on the lower lateral left leg region.

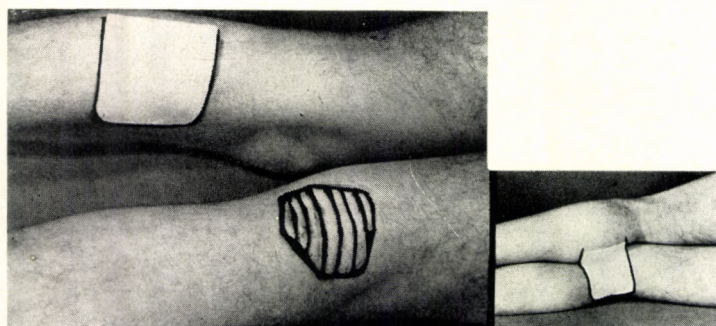C. A larger defect on the anterior tibial region of the middle of the left lower leg and the flap from the right leg and its application.
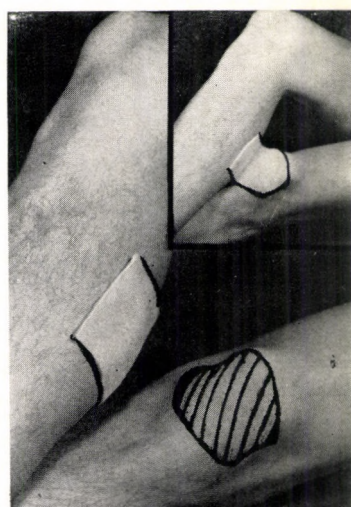
D

D. A flap from the posterior right calf and application to the defect in the Achilles tendon region of the left leg.
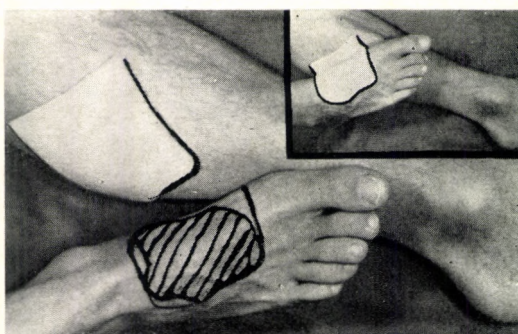

E

E. A flap from the posterior left calf and its application to the popliteal region of the right lower leg.
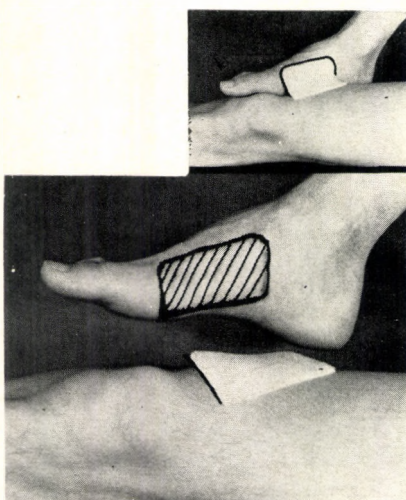

F

G

F. A cross-leg flap to the left knee region.

G. A flap from the left calf to the dorsum of the right foot region.


H

H. The application of a flap from the medial aspect of the right thigh to a defect on the medial aspect of the right foot region.

I. A similar defect on the medial aspect of the right foot, being covered by a flap from the posterior aspect of the left calf region just below the popliteal area.
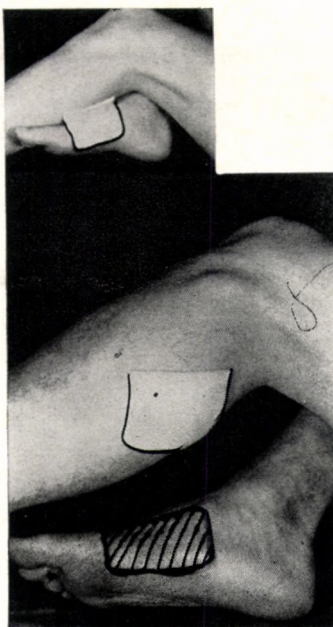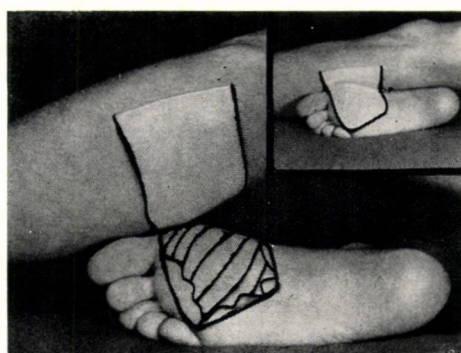

I

J. A defect on the lateral aspect of the left foot being covered by a flap from the medial aspect of the right calf region. Notice that the base in this instance is placed distally. This will mean that the blood supply will not be as good as in one proximally medially based.
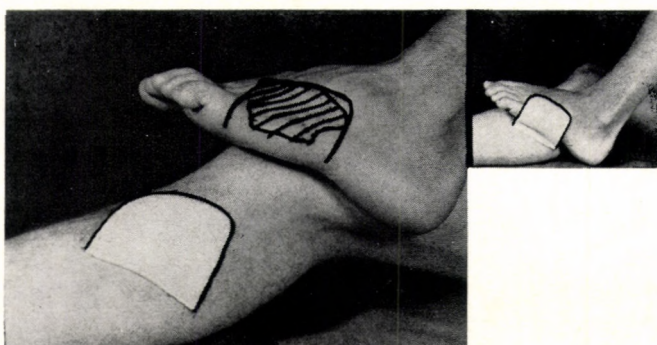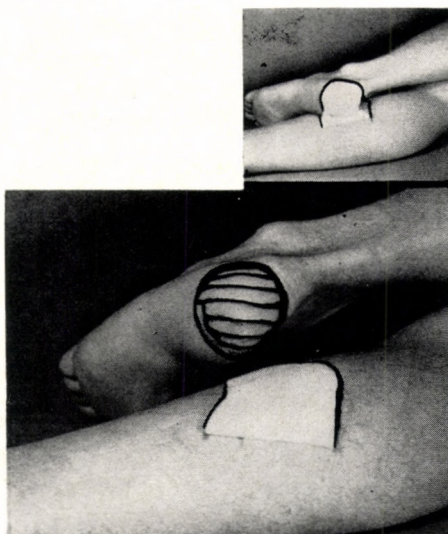

J

K

K. A defect on the ball of the right foot being covered by a posterior calf flap from the left calf.

L. A defect from the point of the left heel being covered by a flap from the posterior right calf.

L