

of the ulna, and passes behind but parallel to the flexor carpi ulnaris as far as the middle of the fifth metacarpal bone.

Which of these incisions is the best depends largely upon the position of the fistula or the degree of development of the disease. Where the disease is mainly upon the ulnar side, Kocher's incision is the best to commence with (Fig. 4040); if the disease is upon the radial side, Langenbeck's incision (Fig. 4041). If the disease is extensive and requires a complete arthroectomy, no method makes so perfect an exposure as the Ollier, *i.e.*, the two dorsal incisions. We will therefore describe first the Langenbeck and then the Kocher method, and will expect the reader, from these two descriptions, to imagine that of the double dorsal incisions.

Method by the radio-dorsal incision (Boeckel-Langenbeck): An Esmarch bandage is applied. The hand and wrist are placed upon a cushion with the thumb abducted and extended. The radio-carpal interspace is noticed by the position of the styloid processes. The tendons of the extensor indicis and the extensor secundi internodii pollicis are also seen.

The incision usually begins above the wrist between these tendons and descends along the tendon of the index finger to the middle of the second metacarpal bone. One-third of this incision is above the radio-carpal articulation; two-thirds is below it.

This incision is made through the skin and exposes the cutaneous terminal branches of the radial nerve, which are often cut. The external border of the tendon of the extensor indicis is recognized and is retracted with the inner flap out of the way. Incise toward the capsule of the wrist-joint and recognize the tendons of the extensor carpi radialis brevis attached to the third metacarpal bone. Above the joint carry the incision between the tendons of the extensor secundi internodii pollicis and the extensor indicis, separating them without entering their sheaths. The periosteum of the radius is now incised and the capsule of the wrist-joint is divided along the inner side of the extensor secundi internodii pollicis. Avoid cutting the tendons of the radio-carpal extensors. With the rugine (curved or straight), the periosteum of the radius and the capsular fibres of the wrist-joint (including the radio-carpal extensors) are respectively separated from the outer half of

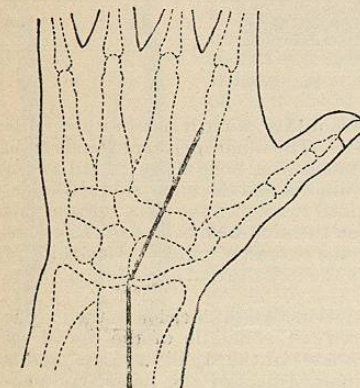


FIG. 4041.—Langenbeck's Incision.

the posterior surface of the radius and from the bases of the second and third metacarpal bones.

The capsule is now retracted outward and the scaphoid

and trapezoid are separated from their attachments to the capsule on their posterior surfaces. The trapezium is not detached until a later stage. The capsule is now retracted inward and the periosteum and capsule are separated from the inner half of the posterior surface of the radius, the triangular cartilage, and the posterior surface of the ulna. It is detached also from the posterior surfaces of the semilunar, cuneiform, os magnum, unciform, and the bases of the remaining metacarpal bones.

If the soft parts are not extensively infiltrated and the movements of flexion and extension can be made, the radius and ulna may be luxated and sawn at this time and before the carpal bones are removed.

If this can be done, the hand is flexed and pronated and the external flap is retracted. The rugine now separates the periosteum upon the anterior surface of the radius. The hand is now flexed and supinated and the remaining portion of the radius and the ulna are denuded upon their anterior surfaces. The hand is now forcibly flexed, the flaps are retracted, and the radius and ulna project through the wound. These can then be sawn transversely. This section should be as narrow as possible, usually within 2 cm. of the cartilage (Fig. 4042). A re-

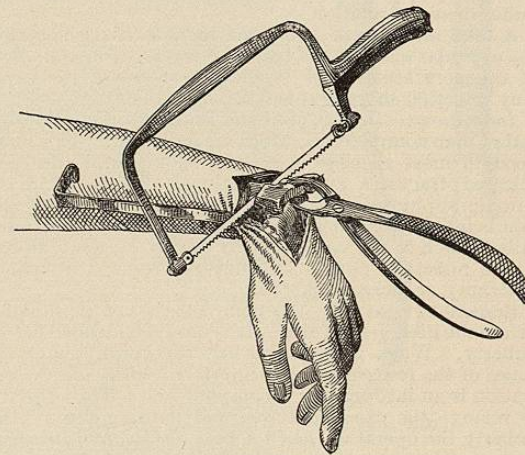


FIG. 4042.

tractor is now placed in the external wound, the wrist is flexed, the scaphoid bone is seized with the forceps, and its anterior and external surfaces are freed from the periosteum and ligaments.

The bone is next separated from the semilunar and is torn away easily. The internal flap is then retracted to the inner side and the semilunar and cuneiform bones are separated and removed in the same way, leaving the pisiform. The os magnum is now seized with the forceps, its anterior surface is denuded with the rugine, and its connections with the unciform, trapezoid, and metacarpal bones are severed. The trapezoid is finally removed in the same manner.

With more extensive wound retraction, the unciform may be seized and its anterior surface denuded until the base of its process is reached. This process is now separated with the cutting forceps, and a freeing of the bone upon its internal surface allows its removal.

If the trapezium is to be removed, a retractor draws outward the external flap, the left hand seizes the thumb, and the rugine clears the posterior and then the anterior surfaces of periosteum. The trapezium is now seized with the bone forceps, its external border is denuded, and the bone is removed.

Provided the pisiform and the hook of the unciform are to remain, and provided also the synovial membrane has been removed, the Esmarch bandage should be loosened and the larger arteries tied. In many instances, where one is certain of not injuring the larger vessels, the bandage is not removed until after the first part of the permanent dressing is applied.

Sutures between the ends of the bones have always been used by me, because I have always believed that a mobile pseudarthrosis with mobility of the fingers was the best obtainable result. Two chromicized catgut sutures

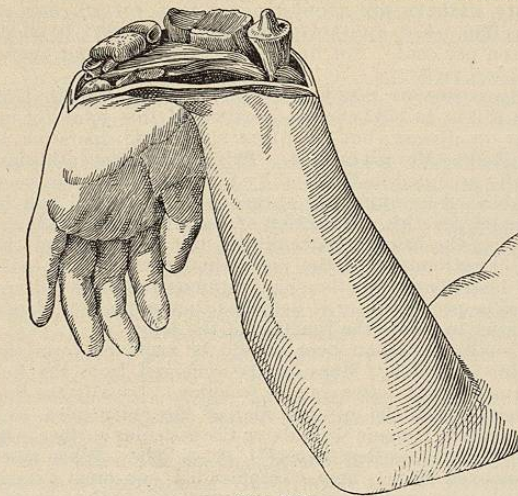


FIG. 4043.

are inserted, bringing the bones within one-fourth to one-half inch, or 0.6 to 1.25 cm., of one another. If the tendons of the extensor secundi internodii pollicis or the extensor carpi radialis longior and brevis have been divided, they are to be carefully resutured or reinserted if separated from their insertions.

The capsule is sutured with catgut. The skin is sutured with silk or catgut.

Provided the operative field is an aseptic one, catgut is employed for the skin. No drainage is used except that which occurs at the lower portion of the wound, near the index finger, where the skin and capsule are not sutured in order that any undue tension in the wound may be relieved. If the process is infective, drainage is employed through the incision by gauze packing.

The method by the dorso-ulnar incision (Kocher): The disadvantage of the preceding method, in Kocher's opinion, is the necessary separation of the radio-carpal extensors and the imperfect dorsal flexion, and possibly the volar subluxation resulting. The advantages of the dorso-ulnar incision are seen in the less important action of the extensor carpi ulnaris as a dorsal flexor and its greater importance as an adductor. Hence when it is separated its loss of action is favorable to the better position and action of the hand. Though the extensor tendon of the little finger is liable to be negative in action, this danger is not so great nor is its loss of function so important as that of the proprius pollicis in the preceding method. Hence he selects an ulnar and dorsal incision.

The incision is made as described above. It avoids the dorsal cutaneous branch of the ulnar nerve. The fascia and the dorsal annular ligament are divided and the sheath of the extensor minimi digiti is incised. This tendon is drawn outward, and, following its ulnar border, the capsule of the joint is divided, and with the insertion of the extensor carpi ulnaris it is loosened from the base of the fifth metacarpal bone. Along this latter tendon the incision is carried upward upon the ulna in the interstice between the extensor carpi ulnaris and the extensor proprius pollicis. The tendon of the extensor carpi ulnaris is now retracted inward and the capsule surrounding the ulna is separated by the rugine subcapsulo-periosteally, if possible and if indicated; but, if not indicated, it should be divided by the knife, which should sever the attachments of the capsule to the ulna and to the base of the fifth metacarpal bone, leaving the flexor carpi ulnaris attached. The joint is now entered and the articulation of the pisiform and cuneiform and the process of the unciform come into view.

The tendons upon the volar surface are retracted and the attachments of the capsule to the fifth, fourth, and third metacarpal bones are divided. The attachment of the flexor carpi radialis to the base of the second metacarpal bone is preserved. In like manner the attachment of the capsule to the radius is separated.

Upon the dorsum, the extensors of the fingers are easily exposed and the capsule beneath the radio-carpal extensors and the extensors of the thumb is loosened from the radius. The two radio-carpal extensors attached to the bases of the second and third metacarpal bones are not separated from their insertions.

The hand is now carried outward and in slight flexion until the thumb touches the radial side of the forearm. The lower ends of the radius and ulna appear in the wound to the inner side, while externally is seen the first row of carpal bones (Fig. 4043). The removal of the carpal bones and a removal of thin sections from the radius and ulna and metacarpal bones are now easily carried out. It is only in the region of the trapezium and the trapezoid that the field is restricted when the bones of the forearm and the third metacarpal bones are being removed. When the bones have been removed and the capsule extirpated, the bones of the forearm and the metacarpal bones are placed in apposition if a nearthrosis is wished. If a pseudarthrosis is desired, the bones are held in apposition more or less closely by chromic-acid catgut. The capsule and skin are now sutured. Drainage in aseptic cases is secured by leaving a small portion (1 to 2 cm.) of the incision open; or, if the wound be septic or hemorrhage be imperfectly stopped, by gauze packing through some portion of the incision.

When the disease is upon the radial side of the carpal or metacarpal bones, or when the radial side of the joint is exclusively the seat of the disease, the radio-dorsal incision is the incision of choice. When the disease is confined to the ulnar side or the joint as a whole is involved but not greatly infiltrated and swollen, the dorso-ulnar incision is the incision to be selected. When the whole joint is involved and the tissues are greatly infiltrated in front and behind the joint, both dorsal incisions are preferable to either singly. Hence we would select for these cases the incisions recommended by Ollier. These incisions are the same as those already mentioned as Langenbeck's and Kocher's. The direction of the skin incision varies somewhat, but the route to the joint is between the same structures. Excellent results have been obtained by Drs. Mynter and Taylor by means of a method suggested by Professor Stuckgaard, of Copenhagen, in 1891. This method consists in splitting the hand between the second and third fingers. The incision is both palmar and dorsal. The incision upon the dorsum begins at the radius and extends to the interdigital fold between the second and third fingers. The palmar incision extends from the interdigital fold not farther than the superficial palmar arch.

The dorsal incision divides the skin and the subcutaneous tissue, but no tendons. It avoids, in passing between

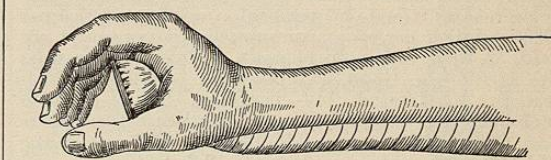


FIG. 4044.

the metacarpals the annular volar ligament, the flexor tendons and the superficial arterial arch. The wrist is now split between the trapezoid and os magnum in the second row and between the scaphoid and semilunar in the first row. Retraction of each side now allows of a complete exposure of the wrist-joint (*Annals of Surgery*, September, 1900). This operation has never been performed by the author upon the living. Upon the cadaver it is feasible and gives an excellent exposure without

injury to the dorsal tendons. It is here mentioned because of its apparent value.

No matter which method of resection may be chosen, (1) the trapezium should be saved if possible, so that the motions in the metacarpo-carpal joint of the thumb may be preserved; (2) the section of the bones of the forearm should be made within 2 cm. of their articular cartilages; (3) in so far as is feasible the operation should be a subperiosteal-capsular one.

The After-Treatment.—The limb is to be placed upon a properly padded splint in such a manner that the hand shall be sustained in the position of dorsal flexion (Figs. 4044 and 4045). These splints fix the wrist-joint but allow

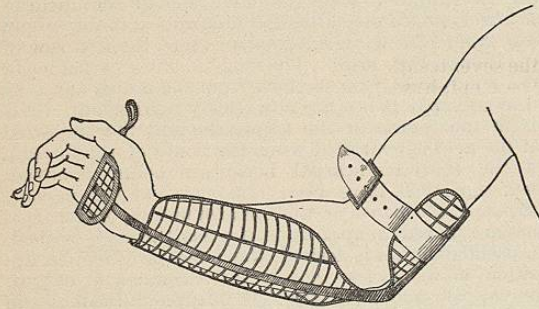


FIG. 4045.

passive motion of the fingers. They pass from above the elbow to the fingers and thumb. The latter pass beyond the splint and can be easily grasped for passive motion.

Where the wounds are aseptic and no drainage is required, as in a case of simple injury, the wound usually heals in from ten days to two weeks.

Where the operation is done for disease, the cavity is often packed with gauze, and, as it requires often two or three revisions with the curette, the healing of the wound may be delayed for from four to six weeks.

As soon, however, as the tissues are solid, though the splint is to be continued for a long period to prevent palmar dislocation and adduction, passive motion at the wrist must be assiduously practised if we desire a nearthrosis or a mobile pseudarthrosis (Ollier, "Traité des Résections," 1888). If we desire an ankylosis at the wrist, passive motion may be interdicted.

Passive and active motion of the fingers is practised as early as possible, in some instances at the third to fifth day after operation. After removal of the splint, a prosthetic apparatus must be worn. This apparatus should allow flexion and extension at the wrist if desired.

From this time on, the patient's aim must be to increase the range of motion in his fingers and in the wrist. Much depends upon his own exertions in securing a good result.

The functional results after this operation vary. Culbertson, in 58 cases of gunshot wounds, reports the following results: Good, 1.7 per cent.; indifferent, 27.5 per cent.; bad, 13.7 per cent.; amputated, 3.4 per cent.; not stated, 53.4 per cent. In 14 cases of injury the results were as follows: Good, 28.5 per cent.; indifferent, 57+ per cent.; not stated, 14+ per cent. In 79 cases in which resection was performed for disease the results were: Good, 7.5 per cent.; indifferent, 45.5 per cent.; bad, 13.9 per cent.; amputated, 12.6 per cent.; not stated, 20.2 per cent. In our own civil war ("Med. and Surgical History of the War of the Rebellion," part ii., vol. ii., Otis), 6 cases of complete resection gave an indifferent result in 83.3 per cent.; amputation and death in 16.6 per cent. Gurlt's statistics of military surgery gave ideal results in 6.25 per cent.; good results in 50 per cent.; indifferent results in 37.5 per cent.; bad results in 6.25 per cent. Nepveu (*Revue de Chirurgie*, 1883, p. 321) gives a collection of 36 cases. The results were satisfactory in 41.6 per cent.; indifferent in 36.1 per cent.; bad in 22.2 per cent. Ollier (*Gaz. méd. de Paris*, 1882,

"Traité des Résections," 1888) believes, and has shown in two cases following a traumatism (partial resection), that ideal results may be obtained by carefully performed operations and long-continued after-treatment. The mortality statistics are about ten per cent. for all cases of resection. For gunshot wounds the mortality is about fifteen per cent. For disease, a death following operation is a rarity.

RESECTION OF THE ELBOW-JOINT.—Wainman in 1759 and Filkin in 1762 excised portions of this joint for injury or disease, but the first methodical operation is ascribed to Moreau in 1794. This method was enthusiastically accepted in England by Syme, and has since been established by numerous surgeons both in civil and in military practice. Resection of the elbow consists in removing the inferior extremity of the humerus and the upper extremities of the radius and ulna. In all cases the insertions of the brachialis anticus and of the biceps must be preserved, or if detached they must be replaced in order to insure the function of the joint.

Usually less than 2 cm. should be removed from the radius and ulna. More can be removed from the humerus without destroying its function. Usually the line of section is at the upper border of the epitrochlea, *i.e.*, the section is made well above the articular surface (Ollier, "Traité des Résections," t. ii., p. 203). When more is removed than is here recommended, one must expect a flail joint, unless special precautions against it are taken. When the section is below the epitrochlea—*i.e.*, just above the articular cartilage—one can expect a nearthrosis, a pseudarthrosis, or an ankylosis. If ankylosis results, the bones must be placed at a right angle with the radius in semipronation. This will give a very useful and serviceable extremity. If a nearthrosis follows, then the following condition most frequently occurs: The bones become fashioned so as to fit one another. They become smooth, polished, and shaped so as to allow flexion and extension. The lateral ligaments prevent any lateral displacement at the new articulation, and the movements of supination and pronation, though limited, are sufficiently supplemented by rotation at the shoulder-joint. The movement of the elbow, hand, and fingers is sufficiently strong for all ordinary work. Such a condition is the best result attainable, and should be considered ideal.

If pseudarthrosis exists, the union of the bones is by means of connective tissue. Such a union, if the bond is not too long, gives a good result. Where the union is short and where no lateral displacement at the point of union occurs, if the muscular power is sufficient, quite as useful a limb can be obtained as by the development of a nearthrosis.

The Indications.—For gunshot injuries in young and healthy persons in whom the articular cartilages are intact and in whom the tissues about the joint are not extensively damaged, the conservative treatment or at the most restricted operation should be made use of.

In severe bone injuries of the elbow-joint, including the articular cartilages with slight or no injury to the vessels and nerves, a partial or a complete resection is indicated, provided the age of the patient or his general condition does not demand an immediate amputation.

In severe injuries of the articular cartilages and of the bones, with severe injury to the vessels and nerves, amputation is required, especially in the aged.

In old injuries to the joint, resulting in ankylosis or pressure upon the main vessels or nerve trunks, a complete rather than a partial resection is indicated, because the tendency to secondary ankylosis is great by reason of the marked reparative power in all the tissues set up by previous injury. In old dislocations it has been my practice to reduce the dislocation by operative means, unless the contracture of the soft tissues demands a resection rather than a reduction. The earlier the old dislocation comes into the surgeon's hands the more successful will be the reduction by operative interference.

Ankylosis in a faulty position, resulting from injury or disease, is curable by complete resection only when the age

of the patient (from twenty to thirty-five), the condition of the muscles, the presence of cicatricial bands about the joint, or the new bone production in and around the joint, will not interfere with the after-result.

In cases in which these conditions exist and the tendency to new bone production is a marked one a partial operation with a correction of the faulty position is alone indicated.

Tuberculosis.—After conservative treatment has failed, a complete resection is usually indicated. During the first three or four years of life resection is not recommended. At this time curetting is sufficient. After three years, make partial operation, if possible, or a complete one if necessary. In either case, however, we must remove the disease. Resection is indicated in some cases of *suppurative arthritis* (chronic), in *arthritis deformans* in a single joint, and in *tumors* involving the bones of the joint (exostoses).

It must be remembered that only one-tenth of the total growth of the arm and forearm is contributed by the epiphysis at the elbow (Ollier), so that earlier resections may be attempted here than elsewhere. In general we say that in injury and gunshot wounds, partial rather than complete operations are indicated. For disease, complete rather than partial operations are indicated. For ankylosis, complete rather than partial operations are indicated.

In youth much can be expected in the production of pseudo- or nearthroses. In the adult, unless some chronic irritation (inflammation) is present or the amount removed is small, the joint is liable to be a flail one.

Anatomy.—The elbow is a pure hinge-joint. The re-establishment of its function demands that the bones be so shaped as to flex and extend easily while in contact, that the lateral ligament holding the joint be short and not yielding, and that the attachment of the muscles which move the joint in flexion and extension, as well as in supination and pronation, be preserved.

As the anterior portion of this joint is not used for entrance into the joint, we will consider only its lateral and posterior aspects.

The posterior branch of the radial nerve, which is a motor nerve for the extension of the hand and fingers and for extension and abduction of the thumb, enters the supinator brevis muscle about 2 cm. below the articular surface of the head of the radius and passes obliquely through its fibres around the radius until it emerges 3 to 4 cm. below the interarticular line in the posterior interosseous space. Upon the inner side the ulnar nerve passes behind the internal condyle between the extensor carpi ulnaris and the periosteum covering the internal lateral surface of the ulna. These two nerves are to be avoided. Both the brachialis anticus and the biceps are attached at points sufficiently removed to be saved in the more typical and complete operations. The supinator longus, because of its attachment to the external intermuscular ridge, can be preserved in its attachment even when a large extent of the humerus is removed.

The short supinator, which is so necessary for supination, is rarely injured because of its ready separation from the humerus with the periosteum. Such is the case with the muscles attached to the internal and external condyles of the humerus, which can with care always be separated from the bone and kept in relation with the periosteum of the humerus and the fascia, forming the intermuscular septa and the lateral ligaments of the joint. The triceps, however, is an important muscle. The major part of its tendon is inserted into the olecranon process of the ulna. It has, however, lateral attachments connecting it with the deep fascia of the posterior surface of the forearm. Of these connections, that with the fascia covering the anconeus and the posterior surface of the forearm is very strong, while that with the fascia covering the internal surface is thin and not strong. It is necessary, therefore, to maintain this connection with the deep fascia of the forearm when the attachment to the olecranon is removed, if we wish to obtain after resection the full power of extension.

The arterial supply of this joint is carried on by the

circle formed by the radial and ulnar recurrents, the interosseous recurrent, and the anastomotic magna. These may be avoided by the subperiosteal method.

The interarticular line of the elbow-joint is represented by the middle two-thirds of a line joining the tips of the two condyles.

The humero-radial articulation is represented by a horizontal line; the humero-ulnar, by an oblique line, passing from without inward and above downward.

The external condyle of the humerus is less than 2 cm. above the articular line. The internal condyle is more than 2.5 cm. above it.

The lower epiphysis of the humerus joins the shaft at the seventeenth or eighteenth year.

The epiphysis of the radius joins the shaft at the sixteenth or seventeenth year.

The epiphysis of the ulnar (olecranon) joins the shaft at the seventeenth year.

These epiphyseal cartilages have finished their growth by the seventeenth year, and resections of large portions may be made at this age, although the muscles mentioned as important must be preserved to obtain the best results. When they are sacrificed, prosthetic apparatus must be used to supply the deficiency.

THE METHODS OF INCISIONS.

The incisions used in resections of the elbow joint may be divided into: (1) those which enter the joint upon the ulnar side; (2) those which enter upon the radial side; (3) those which enter upon both sides or from behind. To the first belong the incisions of Liston, Langenbeck, Gurlt, and Jaeger ("Manuel Opérateur," Farabeuf, p. 715). To the second belong those of Ollier ("Traité des Résections"), Stimson ("Operative Surgery"), Roux and Nélaton ("Manuel Opérateur," Farabeuf), Kocher (*Archiv für klin. Chir.*, No. 37, p. 787), and Cavazzani (*Centralblatt für Chir.*, 1889, pp. 708 and 1121). To the last belong the H-shaped incisions of Moreau and Dupuytren ("Manuel Opérateur," Farabeuf), the lateral incisions of C. Hueter ("Gelenksresektionen") and of Vogt (Löbker: "Operationslehre"), and the posterior triangular flap of Textor ("Manuel Opérateur," Farabeuf).

Of all these incisions we find that four are sufficient for all resections, complete or partial. In ankylosed joints and in old dislocations a combination of the Kocher's radial incision and the ulna incision of C. Hueter will be found in the severer cases to be most satisfactory. In injury and in disease other than the above the Langenbeck, the Cavazzani, and the Kocher incisions are preferred.

These latter incisions are superior to the rest because they do the least injury to the fibrous expansion of the triceps insertion and no injury to the nerves supplying the triceps or the anconeus muscles.

The Langenbeck or dorso-internal incision is recommended when the disease involves particularly the internal segment of the joint.

The Kocher, or dorso-radial, incision is especially useful when the disease involves more especially the radio-humeral in addition to the humero-ulnar articulations.

The bilateral incisions above recommended are useful in old dislocations and in severe ankylosis following disease, injury, or operation. I will describe these methods.

I. Langenbeck's Method.—The Es-march bandage is to be applied, if not contraindicated. The top and crest of the olecranon process having been determined, an incision is commenced 4 to 5 cm. above the olecranon, passing through the tendon of the triceps and along the inner border of the crest of the olecranon to a point where the

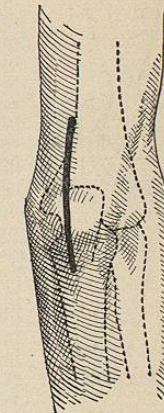


FIG. 4046.