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 subperiosteo-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

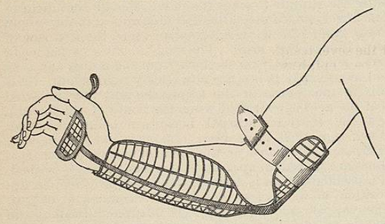

FIG. 4045.

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 prothetic 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 Resections," 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 ulnar. 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 anastomotica 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, prothetic 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 Opératoire," Farabœuf, p. 715). To the second belong those of Ollier ("Traité des Résections"), Stimson ("Operative Surgery"), Roux and Nélaton ("Manuel Opératoire," Farabœuf), 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 Opératoire," Farabœuf), the lateral incisions of C. Hueter ("Gelenksresectionen") and of Vogt (Löbker: "Operationslehre"), and the posterior triangular flap of Textor ("Manuel Opératoire," Farabœuf).

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.

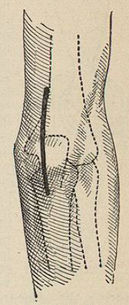

FIG. 4046.

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 Esmarch 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

process disappears in the shaft of the ulna (Fig. 4046). Usually this point is 4 to 5 cm. from the tip of the olecranon. This incision is carried down to the bones throughout. A retractor is placed in the external flap, and, with

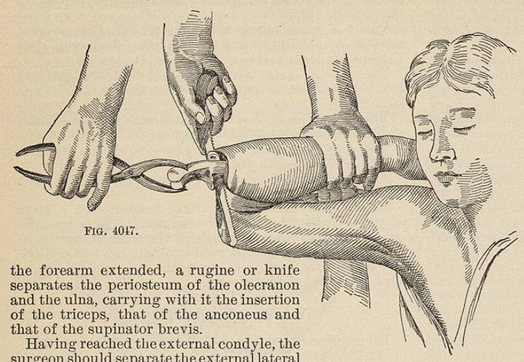

FIG. 4047.

the forearm extended, a rugine or knife separates the periosteum of the olecranon and the ulna, carrying with it the insertion of the triceps, that of the anconeus and that of the supinator brevis.

Having reached the external condyle, the surgeon should separate the external lateral ligament and the common origin of the extensors and supinators from the condyle subperiosteally or by removing with these structures a part of the epicondyle (P. Vogt). When this is sufficiently free and the humero-radial joint is exposed, the forearm may be flexed to complete the subperiosteal separation upon the anterior surface of the humerus. This completed, the internal flap is detached with the periosteum, while the forearm is extended until the internal surface of the olecranon is free and the coronoid process below and the internal condyle above are fully exposed. With the retraction of the periosteum of the humerus and olecranon, the ulnar nerve and the lateral ligament are carried away and are free from all danger. When the lower part of the humerus is sufficiently free, the forearm is again flexed and the ulna and radius are separated from it. The periosteum and capsule of the joint are separated from the anterior surface of the humerus as far as is necessary. The latter is then seized with the lion-toothed forceps and the bone is sawn transversely, just above the articular cartilage or, better, in a line joining the epicondyle and upper part of epitrochlea (Ollier, "Traité des Résections," t. ii., p. 203). The olecranon process is seized with the forceps and the periosteum and capsule are separated from the coronoid process to its base, as much of the insertion of the brachialis anticus as possible being saved. The anterior fibres of the annular ligament are separated with the periosteum of the ulna and are displaced downward so that the head of the radius can be removed close to the shaft if desired. The olecranon and coronoid process are now removed together from the shaft, if desired and if thought necessary (Fig. 4047). Otherwise, if sufficient bone can be left to form a new olecranon process, the bone is sawn as in Fig. 4048. This will give a projecting portion representing the former olecranon, which is very useful in preventing forward dislocation of the ulna during the after-treatment. After removal of the extremities of the bones the synovial membrane is dissected out completely, and such sinuses as appear are excised or curetted.

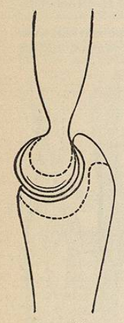

FIG. 4048.

The sawn surfaces of the radius, ulna, and humerus are placed in apposition and at an angle of 135°—*i.e.*, in nearly complete extension. In this position the tendency to forward dislocation of the radius and ulna through contraction of the flexors is avoided. If firm ankylosis is desired, the humerus and ulna are drilled and sutured with two-weeks chromicized catgut sutures. If a mobile pseudarthrosis or a nearthrosis is desired, chromicized catgut sutures are used only for the purpose of retaining the position of the bones during the application of the primary dressing. Such sutures should not last longer than a few days. The Esmarch bandage is removed and the larger arteries are ligated.

The capsule and the periosteum are sutured with catgut in position over the ends of the bones. The skin is sutured with catgut, providing the case is an aseptic one, and a small portion of the wound (2 cm.) at its highest point is not sutured, in order that leakage of blood may take place easily during the next few hours. If one so desires, a small piece of rubber tissue may be inserted through this opening to prevent its closure. What I prefer is to hold apart this small opening in the wound by two catgut sutures, one upon each side of the wound. These sutures will be absorbed within a few days (Maas' method) and will allow the wound to close before the first dressing is changed. The forearm is slightly flexed and semipronated. It is retained in this position by a splint, either plaster of Paris reinforced by sterilized basswood strips or the Esmarch's wire splint (Fig. 4049). With either of these the arm and forearm are elevated and retained in this position by suspension.

Kocher's Method.—By the Langenbeck incision, disease in the radio-humeral articulation is not so easily attacked as by the Ollier bayonet incision. Ollier's incision, which passes in the interstice between the external head of the triceps and the anconeus, must divide the nerve supplying the anconeus, since it is a branch of the division of the radius supplying this portion of the triceps. Hence Kocher planned an incision which avoids this nerve division and does not negative this portion of the triceps.

The forearm is flexed at an angle of one hundred and fifty degrees, and a stirrup-shaped incision is made, which begins 3 to 5 cm. above the epicondyle and over the external border of the humerus, and descends to the head of the radius. From this

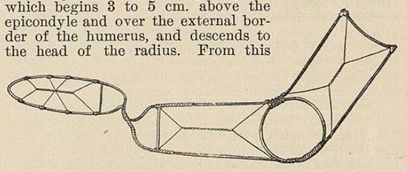

FIG. 4049.

point it descends downward and slightly inward, following the external border of the anconeus until it reaches the ulna at a point from 4 to 6 cm. from the tip of the olecranon. From this latter point it curves over the posterior surface of the ulna inward and upward for a distance of from 1 to 2 cm. (Fig. 4050). This incision above the epicondyle passes in the interstice between the supinator longus, extensor carpi radialis longior, and the common tendon for the supinators and extensors of the hand and wrist and fingers in front and the triceps and anconeus behind. From the epicondyle to the lateral surface of the ulna, the incision passes in the interstice between the anconeus and the extensor carpi ulnaris until it reaches the ulna at a point 6 cm. below the tip

of the olecranon. The latter part of the incision usually divides the lowest fibres of the anconeus, as they often extend a longer distance up on the shaft of the ulna. This incision passes in the interval between those muscles innervated by the posterior muscular branch of the musculo-spiral and those supplied by the external muscular and posterior interosseus branches of the same nerve. The external ridge of the humerus, the epicondyle, the radio-humeral joint, and the supinator brevis muscles are now exposed, and the capsule of the radio-humeral and humero-ulnar joints are in view.

If the olecranon is diseased, the chisel may be placed upon its base and the process be removed from the shaft together with the attached triceps and anconeus muscles. This flap is retracted inward and the joint is exposed to its full extent. If the olecranon is not diseased, the periosteum beneath the external head of the triceps and the capsule are separated from the posterior surface of the humerus. In like manner the anconeus is separated from the epicondyle and the outer surface of the ulna, including with it the posterior humero-ulnar ligament. This dissection is continued over the ulna and olecranon, separating the triceps from the olecranon and a small part of the flexor carpi ulnaris from the internal surface of the ulna. The epicondyle is now fully exposed by separating the common tendon of the supinators and extensors subperiosteally and retracting the flap inward. This exposes the external lateral and the anterior ligaments passing from the condyle to the annular ligament of the superior radio-humeral joint. These are divided. The forearm is now extended and adducted. The joint is then brought into full view and the internal lateral ligament can be loosened from the inner surface of the ulna and of the trochlea (Fig. 4051). With this separation, the humerus is easily cleared of all muscles anteriorly and posteriorly and the bone section made as recommended in the preceding operation.

The annular ligament is now divided and the head of the radius is removed separately from the ulna. If pos-

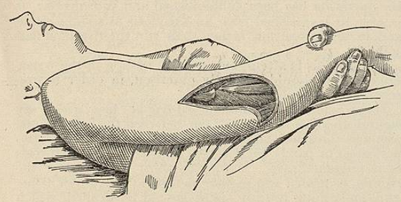

FIG. 4050.

sible, the section of the ulna should be such as will leave a process simulating in slight degree the olecranon. Such a method is useful in preventing the anterior subluxation of the ulna. The section is the same as is shown in the former operation.

When the disease is tuberculous, it is best not to incise the synovial membrane until the dissection of the soft parts is completed and the dislocation of the radius and ulna from the humerus is ready to be made. When the synovial membrane has been completely removed and the sinuses, if any, are excised or curetted, the parts are brought into apposition and sutured. Drainage, if necessary, is made with gauze at the lower angle of the wound beneath the anconeus. If drainage is necessary for only a few days, the Maas method is the preferable one (see Langenbeck's operation).

Sutures, both deep and superficial, are made with catgut if the wound is to be an aseptic one and if it is to heal under one dressing; if not, silk is used for the skin. If ankylosis is desired, suture the bone with two-weeks chromicized catgut. If a nearthrosis or a mobile pseudo-arthrosis is desired, suture with catgut, which will last but a few days and will simply retain the bones in position during the application of the primary dressing. The extremity is placed in such a splint as has been previously recommended and is suspended and elevated.

These two methods are undoubtedly the methods of choice for both injury and disease in the vast majority of cases.

There is a method very similar to Kocher's, except in the skin incision and in some of the minor details, which

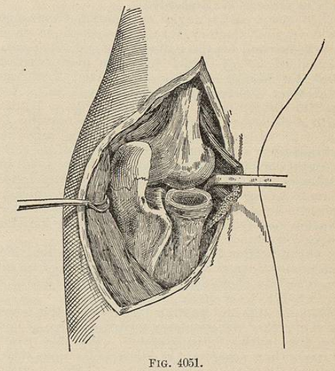

FIG. 4051.

may be used for it in cases of exploration, partial resection, and synovial extirpation. This is the method of Cavazzani. In two of my cases of synovial arthrectomy this method was found to be exceedingly valuable.

Method of Cavazzani.—Three landmarks are taken—one the tendon of the biceps, one the head of the radius, and the third the olecranon process. Two centimetres below the epicondyle upon the outer border of the tendo bicipitis an incision through the skin and subcutaneous tissue begins and passes transversely outward parallel to the interarticular line of the joint. At the outer side of the forearm it passes obliquely from behind upward and ends at the inner border of the ulna near the tip of the olecranon (Fig. 4052). During the first half of this incision the forearm is extended. During the last half it is in half-flexion. This stretches the skin and prevents slipping. The upper flap is dissected up sufficiently to expose the interval between the anconeus and the muscles arising from the epicondyle, *i.e.*, the interstice between the anconeus and the extensor carpi ulnaris.

The epicondyle being exposed, the aponeurosis covering this interstice is divided over the neck of the radius and above the epicondyle. The epicondylar muscles are now loosened subperiosteally and are retracted inward. The capsule is thus exposed as far as the coronoid process. Upon the posterior surface the anconeus is also separated subperiosteally from the humerus and the ulna together; the tendon of the triceps is separated over the external half of the olecranon process. If one wishes to disregard the anconeus nerve supply, one may cut transversely in the interstice of the triceps and anconeus from the epicondyles to the outer surface of the ulna. The posterior capsule is now exposed. The joint is next opened by dividing the external lateral

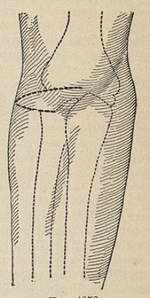

FIG. 4052.

ligament from the coronoid process anteriorly to the tip of the olecranon posteriorly. A movement of adduction will now dislocate the forearm from the arm.

After the operation is finished, the forearm is replaced, the lateral ligaments are sewed, and the muscles about the epicondyle sutured in place. No vessels or nerves are injured. The radial nerve is not stretched. The tendon of the triceps is preserved in half its detachment. The epicondylar muscles are preserved.

For exploration and synovial extirpation, Cavazzani's method is very satisfactory, for the reasons above stated.

For *ankylosis* and for the reduction of *old dislocations*, the method of Jeffrey, which has been more precisely described by Marangos (Thèse de Lyon, 1883), and that of Hueter ("Gelenkskrankheiten," vol. ii., p. 552) are undoubtedly the best. This is especially so in fractures with dislocation, where the reduction requires the removal of the callus with or without a partial resection; in old dislocations which require the removal of the callus and the adhesions in order to effect reduction; in all impractical ankyloses following disease, injury, or operation, which are to be made practical ankyloses or in which arthrolysis is to be attempted; and, lastly, in cases in which redislocation has followed the operative reduction of an old dislocation (Bunge, *loc. cit.*).

With the posterior incision or the single lateral incision, one comes upon the joint at a disadvantageous side for the correction of an ankylosis or for the removal of callus.

In ankyloses it is not possible to dislocate the bones, and the removal of the necessary wedge or piece of bone must be done without displacement. For this reason, Hueter and others accepted the bilateral incisions which Jeffrey formerly used in all resections. These incisions have been greatly modified by subsequent operators, but the method here described will, I think, be found to approach the ideal method. It consists of the radio-humeral incision of Kocher and the ulnar incision of the bilateral methods. The incision upon the radial side commences 5 or 6 cm. above the external condyle, and penetrates between the triceps and the supinator longus and extensor carpi radialis longior, until it reaches the external humeral border and descends to just behind the epicondyle. It here passes obliquely downward and inward in the interstice between the anconeus and external carpi ulnaris for a distance of from 2 to 3 cm. Unless the radius is involved, the annular ligament is avoided. Now clear the anconeus and the triceps from the capsule or tissues beneath them and retract them inward. Clear the supinator and extensor group from the epicondyle and retract them inward.

An ulnar incision is next made upon the internal border of the epitrochlea or at the place where it had been broken off or displaced. This incision is from 8 to 10 cm. in length. The ulnar nerve is freed and displaced backward. The pronator and flexor groups of muscles are displaced outward and in front after being freed from the internal border of the humerus and the epitrochlea. These incisions descend to the bone, and one separates subperiosteally with the rugine, or supraperiosteally with the knife, the soft parts from the bone upon both surfaces of the humerus. In the reduction of old dislocations, the method pursued must be extraperiosteal (Bunge, *Archiv für klin. Chir.*, No. 60, p. 557). A blunt retractor is now inserted in front of and behind the humerus, for the purpose of guarding and lifting the soft tissues from the bone. If one desires, the bone section may now be made with the saw. If it is thought better, the adhesions between the humerus, olecranon, ulna, and radius may be divided, and the humeral extremity first and the radius and ulna afterward displaced through the external incision. They may then be sawn and replaced. If the case be an old dislocation, the fibrous bands between the internal condyle and olecranon must be divided. The epitrochlea, if torn off and displaced, must be loosened and returned. The trochlea of the humerus and the sigmoid cavity of the olecranon must be cleared of all fibrous or bony tissue. When this is accomplished, a movement of adduction of the forearm will expose the humeral extremity in the external wound and allow the removal of the new formation in the olecranon fossa. When this is finished the radius and ulna may be exposed in the same manner and the process of clearing their articular surfaces completed. With the completion of the work upon the bones the extremities are apposed, sutured if desired, and immobilized at an angle sufficient to prevent dislocation. In the reduction of old dislocations, this is usually a right angle, with the forearm in full pronation to prevent redislocation. In resections in which motion is desired, the position is one of nearly complete extension, with semipronation. In cases in which an ankylosis is desired, the forearm is left at an angle a little less than a right angle.

The After-Treatment.—It is to be borne in mind that there is always a tendency to displacement of the fragments, that too wide a distance between the extremities of the bone tends to a flail joint, and that too close a distance tends to ankylosis. The usual distance for obtaining a false joint is between 1 and 2 cm. In children ankylosis is to be especially feared; consequently, as soon as possible passive motion must be enforced. Usually upon the third day passive motion is begun, and is repeated daily in the wrist and fingers. On the twenty-first day the forearm is moved in flexion every second day, and returned to the original position of extension. In from four to five weeks the forearm can be easily moved to ninety degrees and returned to the original position of extension.

The movements of supination and pronation are made at the same time as those of flexion and extension.

At the end of from six to eight weeks a splint can be dispensed with, when massage and electricity are used. The daily use of the arm must be secured. At four months the movement in the new joint should be sufficient to allow the patient to feed and dress himself and to carry quite heavy weights. It will require one year before one can see the best results in motion and stability.

If large quantities of bone have been removed and the operation has been subperiosteal and subcapsular, it is best to be satisfied with an ankylosis at a right angle and in semipronation rather than run the risk of a flail joint.

If ankylosis is attempted, passive motion in the wrist, fingers, and shoulder is daily practised, in order to preserve their full power.

If the amount of bone removed has not been great, say enough to allow from 1 to 2 cm. between the bones of the arm and forearm, and if the operation was subcapsulo-periosteal or partly so, it is best to attempt a nearthrosis or a pseudarthrosis. After the third week, when the wound is healed and passive motion at the elbow is begun, an angular hinged splint should be applied, which will prevent, during the exercises of flexion, extension, supination, and pronation, any lateral displacement of the bones. Very great care must be given by the patient and the surgeon to obtain the ideal result.

One factor must not be lost sight of during the after-treatment, and that is that an angular ankylosis with movement at the fingers, wrist, and shoulder is more useful to a laborious occupation than the excessive mobility often resulting from these resections. Another fact to be borne in mind is that in the young motion is to be begun early. In the adult, in whom there is less danger of ankylosis than there is of a flail joint, passive motion need not be begun until some firmness is present in the joint.

The mortality, according to Culbertson, is as follows: *Gunshot wounds:* Partial resection, 27.02 per cent.; complete resection, 25.30 per cent. *Injury:* Partial resections, 7.4 per cent.; complete resections, 21.05 per cent. *Disease:* Partial resections, 11.11 per cent.; complete resections, 9.94 per cent.

In the Franco-German war (1870–71), resections for gunshot injuries gave a mortality of 27.41 per cent. (Gurlt). In our own civil war, gunshot injuries, when resected, gave a mortality of 23.70 per cent. Salzman, quoted by Ollier, gives the mortality of resections for

ankylosis as 1.47 per cent. Functional results are in the main good, especially in civil practice.

For disease, Culbertson gives 6 perfect and 32 useful joints in 40 cases of partial resection, and 32 perfect and 196 useful joints in 290 complete resections.

Gurlt's statistics, obtained from the German wars (1848–77), gives 5.63 per cent. as very good, 23.66 per cent. as good, 53.24 per cent. as moderate, 14.37 per cent. as bad, 3.09 per cent. as very bad.

Nepveu ("Bulletin et Mémoire de la Société de Chirurgie," 1883, p. 591) presents 21 cases with extensive restoration of the parts. The general form of restoration is brought about by the osteophytic growth of the condyles of the humerus.

In Kocher's Klinik, 1872-97 (Oschmann, "Über die operative Behandlung des tuberculösen Ellenbogengelenks und ihre Endresultate," Berlin, 1897), where a large number of good functionating joints were obtained, it was noticed that rotation at this joint was better than flexion and extension. It was observed that much value is to be placed upon the preservation of the anconeus for obtaining full power in extension of the forearm. It was also observed in three cases that repeated resections were necessary to secure good function. Hence the importance of a thorough removal at the first operation is plainly seen in these cases. After healing had taken place, the most frequent impediment to flexion seemed to be enlargement of the internal condyle or of the coronoid process. For these cases secondary resections, removing the impediment to motion, are properly indicated.

The functional results of resection for old, unreduced dislocations show that 70 per cent. have good results, 30 per cent. have bad (Cuhorst, *Beit. zur klin. Chir.*, Bd. xx.), while the bloody reposition of these old dislocations gave 76.9 per cent. of excellent results, with 23 per cent. of bad results, no one of which can be considered due to the method of operation (Bunge, *loc. cit.*, p. 594).

Resection of the Superior Radio-humeral Articulation.—This operation is occasionally made use of in old dislocations, in fracture of the head of the radius, impeding the motions of rotation, of flexion, or of extension.

Operation.—An incision of from 5 to 7 cm. is made in the same manner as the Kocher incision for the resection of the elbow-joint. This incision passes in the interval between the anconeus postero-internally and the extensor carpi ulnaris antero-externally. After their attachments to the epicondyle have been loosened, the tissues are retracted and the capsule is exposed. This is incised and the head of the bone is removed as close to the shaft as possible. The section should be at the point where the annular ligament is closely applied to the neck of the radius. With this incision there is no danger to the musculospiral nerve anteriorly. The posterior interosseous nerve, as it crosses within the fibres of the supinator brevis muscle, is distant from the epicondyle of the humerus 4 cm. on the external surface of the forearm. On the posterior surface, where it meets the interosseous artery in the interval between the supinator brevis and the extensor ossei metacarpi pollicis, the distance from the epicondyle is usually 6 cm. or over. Hence it is difficult to injure it unless the incisions are prolonged further than recommended. After the head is removed, the capsule and ligaments are sutured and a nearthrosis or pseudarthrosis is attempted.

At ten or fourteen days passive motion is begun and continued for several weeks. It has usually required three months to obtain the best results, and great assistance has been derived, as I believe, from the daily use of the hot air by means of the Sprague apparatus. In three cases of fracture of the head of the radius with abolition of supination and pronation in marked degree, removal of the head and conservative after-treatment have given almost perfect results.

Resection of the Shoulder-Joint.—*History.*—James Bent, England, 1774, probably did the first excision; the elder Moreau probably the first complete excision, 1786.

In the Schleswig-Holstein campaign (1848), in the Crimean War (1855), and in our own civil war (1861–65) the operation gained greatly in prominence and has since then become fully established.

To obtain a nearthrosis or a good pseudarthrosis, the line of section in the humerus must be below the tuberosities to which are attached the rotators and above the adductors. In all cases as little is sacrificed as is possible, in order that the functions of the forearm and hand may be preserved in their entirety. In children, in whom the growth is almost finished, operations with sacrifice of the muscular attachments and with little loss of the humerus give good functional results with either a nearthrosis or a pseudarthrosis. In adults, especially if the periosteum is not saved and the muscular attachments have been sacrificed, ankylosis or a flail joint will result, for the periosteal activity in adults is often wanting and no reproduction takes place.

In all cases the constant tendency to forward displacement of the humerus must be avoided. In all cases the humerus must be held in contact with the scapular border or the glenoid cavity in order to obtain a fixed but movable joint upon which the muscles may move the humerus. The mobility of the scapula compensates in great measure for immobility at the gleno-humeral union.

Indications for Resection of the Shoulder-Joint for Injury.—In slight injuries and in gunshot wounds, expectant treatment and at the most a partial resection are indicated. In severe injuries to the head of the humerus, and in comminuted fractures from gunshot wounds with the nerves and vessels intact, a primary resection is indicated. In severe injury to the head of the humerus and to the acromion process and the scapula, the operation is not necessarily contraindicated, provided the nerves and vessels are intact. In case the latter are involved, amputation is in all probability the only successful issue. In case the nerves are injured, the main vessels escaping, and provided the injured nerves can be sutured, amputation should give way to resection of the joint and suture of the nerves.

In some cases of compound dislocation or of old unreduced dislocations, with or without fracture through the surgical neck of the humerus, resection has been made necessary; yet these cases are becoming more and more infrequent, owing to the aseptic treatment and to the earlier reductions by incisions (confer here Dollinger, *Deut. Zeitschrift für Chirurgie*, No. 66).

1. I can quote no better authority on the unreduced dislocation of the shoulder-joint than Souchon (Trans. Amer. Surg. Association, 1896, p. 409). He maintains: I. That operation is justifiable only in recent cases in full-grown subjects of sufficient age to insure no great shortening from want of growth in the bone. II. That resection should be performed in all instances except when the head and glenoid cavity are in good condition; when reduction can be accomplished without great effort or extensive dissection; and when the head, once reduced, readily remains in place.

2. In fracture of the upper part of the surgical neck of the humerus and dislocation of the head reduction of the dislocated head and suture of the fracture will be preferable to resection in a recent case (McBurney, *Annals of Surgery*, 1894, vol. i., p. 399); but when union fails and the joint becomes useless, or if the dislocated head cannot be reduced without too extensive interference with its nutrition, it must be removed.

3. In recurrent dislocations resection has been performed not infrequently, yet attempts at more conservative methods are recommended (Burrell and Lovett, Trans. Amer. Surg. Association, 1897, p. 293). Such a conservative method is described in the above paper.

For Disease.—Here partial and complete resections are indicated, although the functional results are not much better than in cases of ankylosis following expectant treatment. 1. In tuberculosis and in the destruction of a joint following epiphysitis and suppuration, gonorrhœal infection, injury and infection, or from suppurative subdeltoid bursitis, partial or complete resection is indicated