

ARTHROPLASTY OF THE ELBOW*

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I HAVE adopted arthroplasty of the elbow-joint in five patients: twice for bony ankylosis, and three times for marked limitation of motion following fracture.

TECHNIC OF THE OPERATION.—1. *Exposure of the Joint.*—The skin incision (Fig. 1)¹ begins on the external supracondylar ridge of the humerus, about 5 cm. above the joint, and is continued straight downward to the joint level where it is curved slightly backward toward the extensor surface of the forearm; its entire length is about 10 cm. This incision is carried down to the supracondylar ridge above the joint; below the joint level the deep fascia is exposed but is not incised. The soft parts are then cleared from the humerus: the brachioradialis and the extensor carpi radialis longior are displaced forward and the triceps backward, *thoroughly* exposing the external condyle, the anterior capsule of the joint, and the external lateral ligament with the origin of the extensor muscles (Fig. 2). The external condyle is then detached from the humerus by osteotome, the bone section entering the elbow-joint on the capitellar surface of the humerus. In most cases even when the ulno-humeral joint is ankylosed the radio-humeral joint is free, and the external condyle may be easily turned downward on the external lateral ligament as a hinge, exposing the joint (Fig. 3). If ankylosis is present between the radius and humerus it is easy to separate them by gouge without injury to the external lateral ligament. In order to turn the condyle downward sufficiently to expose the joint thoroughly, the capsule must be snipped with scissors in front of and behind the external lateral ligament.

2. *Dislocation of the Joint.*—If ankylosis exists between the ulna and humerus these bones are separated by a suitably shaped gouge, driven transversely across the joint by smart blows from a hammer. When the union has been almost completely divided, the remaining fibres on the inner side of the joint may be ruptured by abrupt, short, forceful movements of flexion and extension applied to the elbow-

* Read before the Philadelphia Academy of Surgery, April 5, 1915.

¹ The accompanying illustrations (Figs. 1 to 10) are from photographs of preparations in the Laboratory of Operative Surgery in the University of Pennsylvania.

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joint. If one fears injury to the ulnar nerve a small incision may be made over its course between epitrochlea and olecranon, and the nerve may be drawn away from the bones. Only in one case did I find this necessary.

Ankylosis having been overcome, or in cases where no ankylosis is present, the elbow-joint is dislocated by adducting the forearm around the internal lateral ligament, as a hinge, until the forearm lies almost parallel with the upper arm, causing the ends of the humerus, radius and ulna to come into full view (Fig. 4).

3. *Shaping the Bone Ends.*—As little as possible is done to the ulna, especially when the head of the radius is healthy. Reliance is placed on resection of the humerus for shaping the new joint (Fig. 5). If ankylosis exists in the upper radio-ulnar joint it is simpler to resect the head of the radius than to turn in a flap between radius and ulna. For shaping the humerus a Gigli wire saw mounted in a bow-shaped frame (the saw of Pierre Delbet) is the most convenient instrument; with this a series of cylindrical sections can be removed from the humerus until enough room is secured between the bone ends. Seldom is it necessary to remove any bone above the level of attachment of the internal lateral ligament at the base of the epitrochlea.

4. *Interposition of the Flap.*—The bones being temporarily restored to their normal relations, the original skin incision is extended backward from its upper end across the posterior surface of the arm (Fig. 6). The triangular skin flap thus outlined is raised, including a fair amount of subcutaneous fat, until the superficial surface of the triceps, or of the fat and fascia covering it, is fully exposed. An interposing flap of fat and fascia is then raised from the superficial surface of the triceps, with its base at the olecranon (Fig. 7). It is best to include some of the triceps aponeurosis and muscular fibres in this flap. The elbow-joint is then partially dislocated again, and the flap is attached to the internal lateral ligament of the elbow, and to the anterior and posterior capsules of the joint, by a few interrupted sutures of chromicized catgut (No. 0), thoroughly covering the articular surface of the humerus (Fig. 8).

5. *Closure of the Wound.*—The forearm is restored to its normal relation with the arm, and the external condyle is brought up in front of the pedicle of the interposing flap, and is fixed to the humerus (Fig. 9). For this purpose I prefer Lambotte's self-boring screws; in the accompanying illustration a nail was employed because at the time (in the Laboratory of Operative Surgery) no such screws were at hand. I have also used chromic gut and phosphor bronze wire

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sutures, but have found them inferior to the Lambotte screws in obtaining secure fixation. Two screws are better than one. If much bone has been removed from the humerus, it will be necessary to trim the external condyle to fit.

The triceps is then sutured accurately to the brachioradialis and extensor muscles, the deep and superficial fasciæ are accurately approximated, and finally the skin wound is closed (Fig. 10). No drainage is necessary. Interrupted chromic gut sutures (No. 1 or No. 2) are employed throughout. Rarely is a single ligature required.

The average time I have consumed in the operation is about one hour and thirty minutes.

CASE HISTORIES

CASE I.—Malunion of fracture of external condyle; limited motion and cubitus varus. James W., aged five years. Treated in Dr. Frazier's service at the Episcopal Hospital. Fractured the external condyle of his right humerus in July, 1908; and first came under my care in October, 1908, for limited motion (50 to 145 degrees) and cubitus varus (200 degrees). A skiagraph showed a fracture with outward rotation of the external condyle, but bony union. For six weeks subsequently light massage and passive movements were employed, but the range of motion improved only 10 degrees in flexion (40 to 145 degrees). Fig. 11 gives a photograph taken before operation.

Operation (November 18, 1908).—Usual external incision. Enough of the external condyle was removed (without detaching it from the humerus) to permit full extension of the elbow, as well as to overcome the cubitus varus. The olecranon fossa on the posterior surface of the humerus was also deepened. A fatty fascial flap from the superficial surface of the triceps was turned in over the denuded external condyle and the wound closed. The elbow was dressed in hyperflexion.

At the first dressing, ten days later, the wound was healed and the skin sutures absorbed. Motion was free and painless from 45 to 90 degrees. The arm was now carried in a sling. On December 5 there was motion from 40 to 140 degrees.

In May, 1912, three years and a half after operation, the boy was presented at a meeting of the Philadelphia Academy of Surgery, exhibiting perfect function, no varus deformity, full flexion, but extension only to 150 degrees (*ANNALS OF SURGERY*, 1912, ii, 647). Fig. 11 shows photographs made in March, 1915, more than six years since operation.

CASE II.—Malunion of fracture of lower end of humerus; limited motion and cubitus varus. William G., aged eighteen years.

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Treated in Dr. Harte's service at the Orthopædic Hospital. Referred by Dr. E. H. Kistler, of Lansford, Pa. When three years old this boy had fallen out of bed, landing on his left elbow. He recovered with Volkmann's contracture of the forearm, cubitus varus, and limited motion in the joint (40 to 110 degrees). When first seen, August, 1912, the Volkmann's contracture caused him no inconvenience, but the limited extension in the elbow was a serious handicap in his work in the mines, and his elbow was weak from the varus deformity and pained him if he used it much. Photographs made before operation (Fig. 12) show the distortion of the bony points at the elbow and the limit of extension (x indicates head of radius; the condyles and the olecranon are indicated by dots).

Operation (September 2, 1912).—Through the usual external incision the head of the radius, which projected far backward (Fig. 13), was exposed posterior to the external lateral ligament, and was excised. The external condyle was then detached, the joint luxated, and a curved section was removed from the humerus, with Butcher's saw, much more bone being removed from the radial than from the ulnar side of the humerus, so as to overcome the varus deformity. Fig. 14 shows the portions of bone removed, that from the humerus having been removed in three sections, until the sawn surface fitted the ulna and the varus deformity was abolished. A flap of aponeurosis and muscle was secured from the triceps in the usual way. The epicondyle was re-attached to the shaft of the humerus with chromic gut. A drainage tube was placed at each end of the incision. The tubes were removed after three days. It was not necessary to have employed them. The arm was dressed on a straight anterior splint, at an angle of 160 degrees.

September 5: Motion from 90 to 135 degrees is easy.

September 19: Out-patient. Sinuses (resulting from unnecessary use of drainage tubes) have healed. Motion 90 to 160 degrees is easy. He carries his arm in a sling.

October 3: Motion 65 to 135 degrees. Ordered massage and light passive movements three times weekly.

October 17: Treatment discontinued. Motion 65 to 160 degrees. Returns to work.

July 31, 1913: Eleven months after operation the patient was again photographed (Fig. 12), to show the range of motion (40 to 170 degrees). There was no cubitus varus and perfect function. The elbow is stable. He works on a breaker engine at the mines.

CASE III.—*Bony ankylosis from metastatic arthritis.* Gertrude T., aged twenty-three years. Treated in Dr. Harte's service

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at the Orthopædic Hospital. In May, 1912, when about seven months pregnant, but without any evident cause (such as preceding tonsillitis, influenza, vaginitis, etc.) this patient developed an acute polyarthritis and was confined to bed for seven weeks. The pregnancy terminated normally after convalescence, but the left elbow and right knee were ankylosed. When first seen at the Orthopædic Hospital, in March, 1913, about ten months after this attack of arthritis, the elbow was fixed in bony ankylosis at an angle of 110 degrees; fortunately the radio-humeral joint and the upper radio-ulnar joint were not involved, as rotation in the forearm was normal.

Operation (May 1, 1913).—Arthroplasty of elbow by usual technic. A small incision was also made over the ulnar nerve and this was drawn away from the internal condyle until the bone ends were properly shaped. Flap obtained from triceps as usual, and epicondyle reattached to humerus by wire suture. No drain. Dressed on internal right-angled splint.

May 12: First dressing. Inner incision healed; outer incision healed all but one spot, between two sutures at upper end, over the cavity resulting from cutting the triceps flap. A little serous ooze occurred at this point. Motion of 30 degrees free and painless. Can get hand to mouth. Arm carried in sling.

May 15: Motion from 70 to 120 degrees without pain. Rotation in forearm normal. Can put hand to back of neck.

May 23: Passive motion from 65 to 160 degrees without pain. Active movement from 70 to 120 degrees. Arthroplasty of the knee was done to-day (*Trans. Coll. Phys. Phila.*, 1914, xxxvi, 236), and on this account the patient had to remain in the hospital longer. Fig. 15 shows the condition on admission, and Figs. 16 and 17 show respectively the limits of flexion and of extension in elbow and knee three months after operation. Figs. 18 and 19 are from skiagraphs made before and after arthroplasty of the elbow.

October 17, 1914: Eighteen months after operation there was motion in the elbow from 45 to 150 degrees, there was active power of extension in the triceps, and the joint was quite stable. She does all her own housework, and finds it a very useful arm.

CASE IV.—Malunion of fracture of lower end of humerus, with limited motion. Benjamin F., aged fourteen years. Treated in Dr. Ashhurst's Orthopædic Service at the Episcopal Hospital. In the summer of 1912 this boy fell on his elbow and sustained a fracture-dislocation of the type Posadas (diacondylar fracture of the humerus with forward displacement of the lower fragment and posterior dislocation of both bones of the forearm). Neither the fragments of the humerus nor the dislocation of the elbow had been reduced, and 16 months later the boy applied to the



FIG. 1.—Arthroplasty of elbow; skin incision.

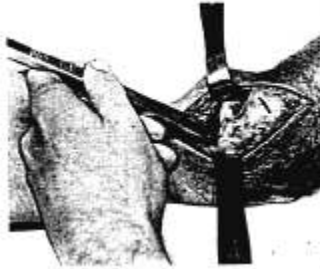


FIG. 2.—Arthroplasty of elbow; external condyle (X) and head of radius (—) exposed, and osteotome applied to external condyle.



FIG. 3.—Arthroplasty of elbow; external condyle turned down, exposing joint.



FIG. 4.—Arthroplasty of elbow; joint luxated around internal lateral ligament as a hinge.



FIG. 5.—Arthroplasty of elbow; articulating surface of humerus removed with saw. Joint is viewed from outer side; the external supracondylar ridge and the surface from which the external condyle has been detached face the reader, and the joint surface of the humerus (freshly sawn) is directed toward the right of the picture.



FIG. 6.—Arthroplasty of elbow; bones replaced; dotted line indicates extension of primary skin incision, to expose triceps.



FIG. 7.—Arthroplasty of elbow; fat and fascia pedicled flap cut from surface of triceps.



FIG. 8.—Arthroplasty of elbow; flap turned into joint covering articular surface of humerus. Same view of joint as Fig. 6.



FIG. 9.—Arthroplasty of elbow; external condyle has been replaced and fastened by a screw or nail.



FIG. 10.—Arthroplasty of elbow; skin sutured.



FIG. 11.—Case I. *A* is a photograph taken in 1908, just before operation, showing cubitus varus. *B* and *C* are photographs taken in 1913, showing restoration of carrying angle and limits of extension and flexion.

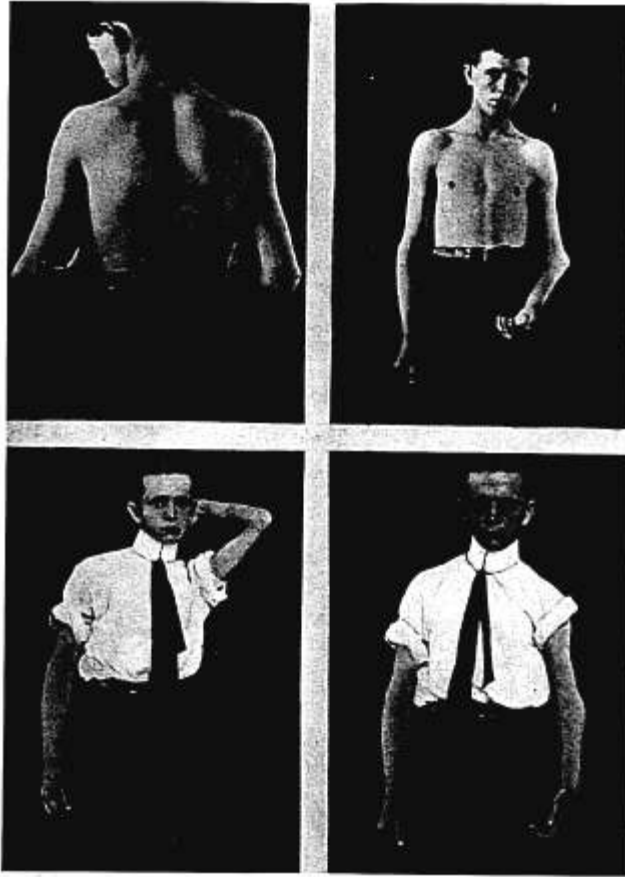


FIG. 12.—Case II. The first two photographs were made before operation, showing distortion of bony landmarks (X indicates head of radius) and limit of extension. The other two photographs were made eleven months after operation, showing range of flexion and extension, and restoration of carrying angle.



FIG. 13.—Case II. Skiagraph before operation, showing marked cubitus varus and limitation of extension.



FIG. 14.—Case II. Arthroplasty of elbow; portions of humerus and head of radius excised (September, 1912).



FIG. 15.—Condition of Case III on admission.



FIG. 16.—Showing amount of possible flexion in Case III on discharge.



FIG. 17.—Showing amount of extension possible in Case III on discharge.

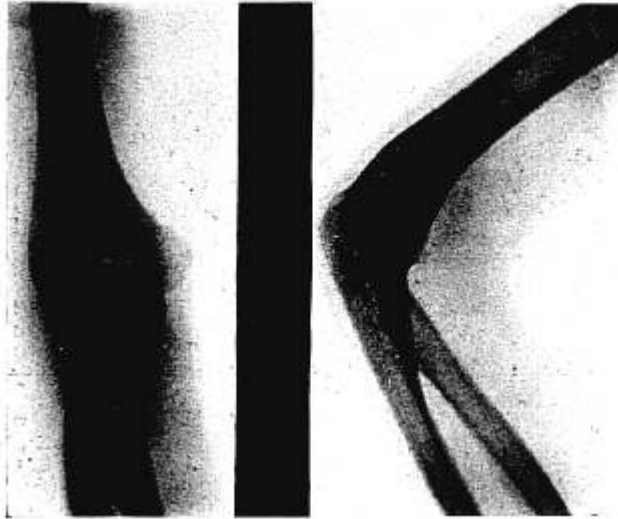


FIG. 18.—Case III. Skiagraphs showing ankylosis of elbow before arthroplasty.



FIG. 19 —Case III. Result of arthroplasty. From skiagraph seven weeks after operation.

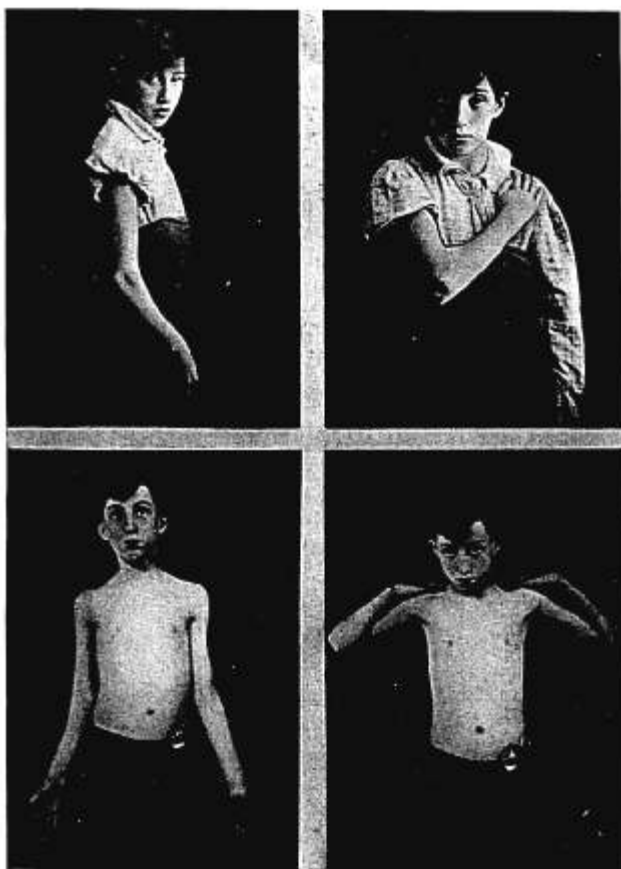


FIG. 20.—Case IV. Upper photographs show limits of extension and flexion before operation. Lower photographs were made five months after operation, showing results of arthroplasty.



FIG. 22.—Case V. Skiagraph six weeks after arthroplasty.

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orthopædic department for disability from limited flexion and extension (65 to 150 degrees) (Fig. 20).

Operation (November 26, 1913).—Arthroplasty by the usual technic. After trimming the end of the humerus to proper shape with the bow-saw, it was found the ulna tended to stay in posterior luxation; so the olecranon was removed, preserving the periosteal attachments of the triceps. The radial head and the greater sigmoid cavity of the ulna were not disturbed. A flap from the triceps was inverted as usual, and the epicondyle was re-attached by chromic-gut sutures. No drain. Dressed on internal right-angled splint.

November 29: Discharged from ward. Skiagraph shows subluxation backward of radius and ulna.

December 1: Out-patient. First dressing; some sloughing of edges of skin flap turned back to expose triceps. Wound is clean. Elbow dressed in hyperflexion.

December 15: Skin granulating well. Free motion from hyperflexion to right angle. Arm in sling.

December 22: Motion 45 to 120 degrees. Out of sling.

January 5, 1914: Incision healed. Motion 40 to 145 degrees.

January 12: Motion 40 to 150 degrees.

January 19: Motion 40 to 160 degrees.

March 9: Motion 10 to 160 degrees.

April 27: Five months after operation (Fig. 20). Motion 10 to 180 degrees. In full extension radius and ulna luxate backward. There is free lateral motion in elbow, though external condyle is firmly attached to the humerus. Very slight power of extension in elbow, good power in flexion.

June 29: Seven months after operation. Can chop wood holding axe in both hands, indicating a considerable improvement in the stability of the elbow.

CASE V.—Bony ankylosis of elbow from septic arthritis. Sarah M., aged twenty-seven years. Dr. Ashhurst's service at Episcopal Hospital (orthopædic). In December, 1913, this patient suffered from a "heavy cold" with cough; she was in the habit of carrying her eighteen months' old baby on her left arm, which gradually became stiff and painful. In less than a week matter formed, and an abscess on the inner side of the joint was lanced by her family physician. She was admitted to Dr. Frazier's service in the Episcopal Hospital on January 8, 1914, and on January 20 Dr. Frazier opened the sinuses more freely and put in drainage tubes. Cultures of pus at this time gave a pure growth of streptococcus pyogenes. The elbow became stiff. She went home in the end of February, and the sinuses were all healed early in March, 1914. Since then there has been no pain or tenderness.

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Examination in May, 1914, showed ulno-humeral ankylosis at an angle of 110 degrees. She could not get her hand to her mouth, nor even to the top of her head. Rotation in the forearm was about half normal, supination being lost. Fig. 21 is from a skiagraph before operation.

Operation (May 30, 1914).—Arthroplasty by the usual technic. All told, sections about 0.5 cm. in thickness were removed from the humerus by the mounted Gigli saw. A flap from the triceps was interposed, and the external condyle re-attached by a screw. No drain. Dressed on internal right-angled splint.

June 6: First dressing. Wound healed. Can put hand to face with ease.

June 8: Went home.

June 15: Out-patient. Motion 70 to 100 degrees. Massage ordered.

July 13: Motion 85 to 110 degrees causes pain at limits named.

August 31: Free and easy motion 90 to 120 degrees. Rotation normal. Refuses to have forceful motion under an anæsthetic. Fig. 22 is from a skiagraph made six weeks after operation.

SUMMARY OF RESULTS IN FIVE CASES OF ARTHROPLASTY OF ELBOW

Case	Before Operation			After Operation		
	Flexion	Extension	Deformity	Flexion	Extension	Deformity
I	40°	145°	Varus	35°	150°	None
II	40°	110°	Varus	40°	170°	None
III	110°	110°	Ankylosis	45°	150°	None
IV	65°	150°	Posterior dislocation	10°	180°	Posterior dislocation (only in extension)
V	110°	110°	Ankylosis	90°	120°	None