SO-CALLED DISLOCATION OF THE LOWER END OF THE ULNA

HENRY MILCH, M.D.

NEW YORK, N. Y.

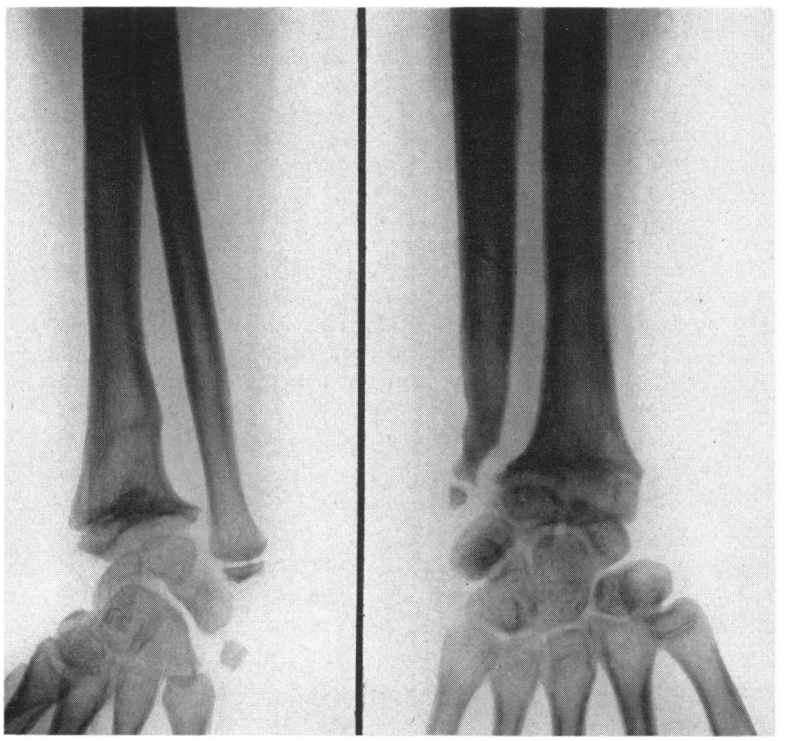
FROM THE HOSPITAL FOR JOINT DISEASES, NEW YORK CITY, N. Y.

"DISLOCATION of the lower end of the ulna" has been described as occurring after Colles fracture, in Madelung's deformity, in arthritis of the inferior radio-ulnar joint, as well as in a variety of other fundamentally dissimilar affections. Though the very diversity of the circumstances under which these so-called dislocations have been discovered should, in itself, have cast some doubt upon either the validity of the diagnosis or the unique nature of the underlying pathology, this has not been the case. Largely, it appears that the diagnosis depends upon the fact that dorsal prominence of the ulnar head, especially on pronation of the forearm, is a common and distinguishing feature of these different conditions. Yet when the roentgenograms of individual cases are studied closely, any conclusion justifying such a diagnosis seems to be open to very serious question. In one, there may be an abnormal disproportion in the length of the radius and ulna. In another, there may be a diastasis at the inferior radio-ulnar joint, without any change in the relative lengths of the bones. In a third, the most striking feature of the roentgenogram may be an axial malalignment of one or both of the bones, while in still another no bony abnormality whatsoever may be present.

The observations of these varied roentgenographic appearances becomes more significant when the effort is made to understand just what is meant by "dislocation of the inferior end of the ulna." If the term is employed in its usual connotation, it should imply a displacement of the inferior end of the ulna in relation to a more proximally located joint surface. Manifestly, this cannot be intended, since it does include the conditions under discussion. But even if its meaning were extended, so as to embrace displacements in reference to more peripherally located surfaces, the term would still describe no clearly definable anatomic concept. Because of the continuity of the ulnar shaft and the solid inclusion of its upper end in the elbow joint, dislocation of the lower end cannot occur, except as the result of fracture of the shaft. In fact, it seems there is no such condition as "dislocation of the lower end of the ulna." The term is a misnomer and is misleading, because it is not the ulna which dislocates in relation to the radiocarpal mass, but, on the contrary, the latter which becomes displaced in respect to the stationary ulnar head.

Since, as will be seen, prominence of the lower end of the ulna is typical of a numer of different affections, a more accurate designation, based upon their common symptomatology, appears to be desirable. In general, the whole group is characterized by weakness of the wrist, pain or tenderness on pressure, a clicking sensation on rotation of the forearm, and an abnormal prominence of the ulnar head. By analogy with the terminology used in

describing many injuries to the knee as "internal derangements," it seems reasonable to suggest a similar designation, "derangement of the wrist," for the disabilities here reviewed. This difference in terminology is of more than academic significance, because of the therapeutic consequences which each of the two concepts entails. The one leads to a search for and a



A B

FIG. 1.—Case 1: (A) The site of the earlier osteotomy of the radius is to be seen. The *lateral deviation of the hand* persists due to abnormal projection of the ulnar head below the level of the shortened radius. Note divergence of the forearm bones. (B) Following subperiosteal resection, the lower end of the ulna has regenerated. The head is smaller and there is *medial deviation of the ulna*. Because of this, the axial parallelism of the forearm bones has been restored even though the difference in length has not been corrected.

correction of the underlying pathology. The other leads quite naturally to the simple expedient of resection of the projecting end of the ulna.[2] In one case in which this method was applied, a very interesting observation was made:

Case 1.—T. S., age nine, was brought to the hospital in November, 1932, because of a painless swelling of the left wrist. The mother stated that the child's wrist had been "twisted" some two months before. Examination disclosed prominence of the left ulnar styloid. The hand was held in volar and radial deviation. There was no pain or tenderness. No limitation of motion was observed in the hand or fingers. Measured from the tip of the olecranon to the radial styloid, the left forearm was about one and one-quarter inches shorter than the right. Roentgenograms showed a separation of the bones at the wrist. The radius was short. The distal radial epiphysis was wide, mushroomed, and sclerotic. The plane of the articular surface inclined acutely forward and medialward.

In the face of the marked bony deformity, it was apparent that the recent history of trauma was merely coincidental and not of etiologic significance. In fact, the patient was considered as suffering from a Madelung's deformity, and a manipulative correction of the deformity was unsuccessfully attempted. In December, 1936, because of the progressive radial deviation of the hand, osteotomy of the radius above the epiphyseal line was undertaken. Despite this, radial deviation of the hand persisted. Roentgenograms taken one year later, in December, 1937, (Fig. 1 A) disclosed a marked disproportion in the relative length of the forearm bones. The ulna projected not only below the level of the radial styloid but well beyond the proximal row of carpal bones, and even with the hand in radial deviation impinged against the carpal cuneiform. In October, 1938, a subperiosteal resection of the lower end of the ulna was performed, and the forearm was immobilized in plaster for a period of eight weeks. Thereafter, physiotherapy was instituted. The patient has noted complete return of power and has no limitation of motion. She notes occasional pain on change of weather. Examination discloses but slight prominence of the ulnar head on pronation. The wrist is wider than on the opposite side. Roentgenograms (Fig. 1 B), taken in December, 1939, disclosed the explanation of these phenomena. The lower end of the ulna has regenerated. Though its level with relation to the carpus has been changed but slightly, the ulnar head is definitely smaller and has clearly been deformed by medial pressure of the carpus. The fact that radial deviation of the hand disappeared after medial displacement of the ulna occurred seems to indicate clearly that it was the carpus and not the ulna which was "dislocated."

Though resection of the lower end of the ulna may indeed effectively eliminate the distressing prominence of its lower end, the possibility of injury to the ulnar collateral ligament with resultant disability is a danger to which Darrach has himself called attention.

From the functional point of view, the wrist is a compound joint, composed of the radiocarpal, the intercarpal, the meniscocarpal, and the radio-ulnar joints. In this complicated apparatus the head of the ulna forms a truly pivotal point. It is the point in relation to which the normal position of the other bony landmarks are determined and about which all of the motions of the wrist must be conceived of as occurring. It is the point to which are attached the ligamentous structures which fix the radiocarpal mass and thus insure free and forceful wrist motion. These ligaments comprise, roughly, three separate groups, which diverge fan-like from their ulnar origin. The first, the triangular fibrocartilage, is attached to the inferior surface of the ulnar head and serves to unite the ulna with the sigmoid notch at the lower end of the radius. The second, the ulnar collateral ligament, arises from the styloid tip, is firmly united to the base of the triangular fibrocartilage, and is inserted by two fasciculi into the cuneiform and pisiform bones. The third includes the anterior and posterior inferior radio-ulnar ligaments which arise from the lateral aspect of the ulnar head and bind it firmly into the ulnar notch on the radius. Loss of the integrity of either of these results in decreased fixation of the radiocarpal mass, with resulting prominence of the lower end of the ulna, and constitutes an indication for repair or reconstruction of the damaged ligaments, rather than ablation of the keystone upon which the functional integrity of the remaining structures depends.

The ulnar collateral ligament is probably the most important of these ligaments in stabilizing the wrist joint. Though the literature seems to indicate that injury to the triangular fibrocartilage is the primary cause of the weakness of the wrist joint,[9] it seems much more likely that this is frequently only coincidental to the more serious detachment of the ulnar collateral ligament.

The following case seen shortly after the reports of Mitchell,[8] and Gibson[4] is of interest in this connection:

Case 2.—J. J., age 17, was first seen in June, 1926, complaining of weakness and pain in the left wrist. The pain began on the ulnar side of the left wrist and radiated up into the forearm and down into the fingers. It was made worse by typewriting, so that the patient was forced to stop his work. He occasionally complained of weakness in the fingers and a clicking sensation on rotation of the forearm.

On questioning, it appeared that during a baseball game in 1924, the patient had suffered an injury while sliding into base with the outstretched left hand in full pronation. He complained of immediate pain and a marked prominence over the lower end of the left ulna. One of his friends "pulled his wrist out" and the patient felt something snap into place. Shortly thereafter he was seen by a physician, who stated that the patient had suffered a fracture of the wrist. Treatment consisted of splinting for a period of two months, after which the patient returned to work. In the early part of 1926 the patient began to notice pain and a gradual prominence of the lower end of the ulna.

Examination disclosed what appeared to be a marked hypermobility of the ulna, both forward and backward. On pronation, the ulna became definitely prominent on the dorsum of the wrist. As the hand was pronated and supinated, a soft click could be felt and heard over the head of the ulna. There was no limitation in motion of the wrist. On the right side, a radial deviation of the hand to 20° was possible. On the left side, this was possible to 35°. When the hand was examined in this position, there was a distinct depression to be felt just beneath the ulnar styloid. The whole hand could be abnormally displaced forward and to the radial side. There were no weakness or sensory disturbances in the hand or fingers. Clinically, there appeared to be no change in the position of the bony landmarks.

The roentgenograms were reported by Dr. A B. Ferguson as follows: "The styloid process of the ulna is separated from the shaft at its base. This condition is believed to be a developmental abnormality. No other variation from the normal is noted at this examination." However, it is to be noted that there is a definite anterior dislocation of the carpus and that the head of the ulna articulates with the radius at its normal level (Fig. 2 A and B).

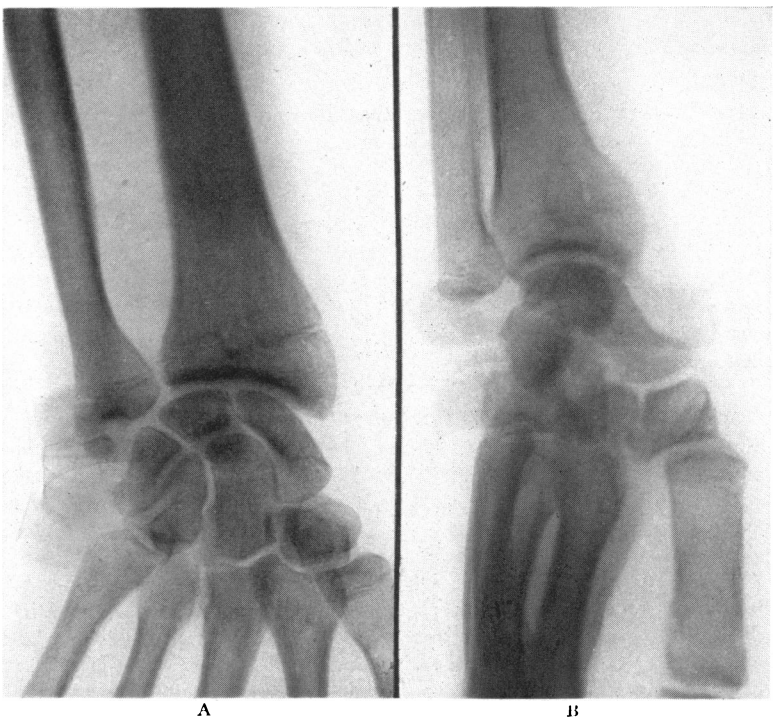
Despite this, it was felt that the patient had probably suffered a fracture of the ulnar styloid, with rupture of the ulnar collateral ligament and the attachment of the triangular fibrocartilage. Since the fracture of the styloid did not seem to be the cause of the symptoms, it appeared likely that the disability was to be attributed to the soft tissue injury and exploration of these structures was undertaken.

Operation.—July, 1936: Through a longitudinal ulnar incision, the course of the ulnar collateral ligament was exposed. The ligament was found attached to the tip of the styloid process. The triangular fibrocartilage, still partly attached to the ulnar styloid, was completely torn away from the inferior surface of the ulnar head. The relationship of the head to the radius appeared undisturbed. An effort was made to suture the fibrocartilage to the edge of the ulna, and a heavy chromic suture was taken through the styloid process to unite it and the attached ulnar ligament to the tip of the ulna. The wound was closed in the usual manner and a plaster of paris bandage

was applied. At the end of four weeks this was removed and gentle, active motion was begun.

The patient made an uneventful recovery and shortly after reported the return of normal use of the wrist.

Somewhat similar experiences have been reported in regard to isolated injuries to the inferior radio-ulnar ligaments. Disabilities due to disturb-



A B

FIG. 2.—Case 2: (A) The bones are of relatively normal length. There is a slight diastasis of the radio-ulnar joint but the ulnar head articulates normally with the notch on the radius. There is no radial deviation of the hand. (B) Lateral view discloses the dorsal prominence of the ulnar head, "so-called posterior dislocation of the ulna" simulated by anterior displacement of the radiocarpal mass.

ances in these structures present essentially the same symptoms and signs as are characteristic of the whole group of wrist joint derangements. In addition, however, the roentgenograms disclose a diastasis at the inferior radio-ulnar joint, the bones being of normal length. This, of course, is the pathognomonic sign, and the one which indicates the necessity for repair or reconstruction of the involved ligaments.

In 1926, the writer[6] devised a fascial loop operation designed to accomplish this purpose. The procedure seems to have met a definite indication, in the opinion of other surgeons. With but slight modification, it is almost identical with the operations later described both by Eliason,[3] and by Lowman.[5] However, attention must be called to the important fact that this technic is indicated, when and only when, the luxation occurs without loss of the normal bony alignment. It is intended strictly for repair of the

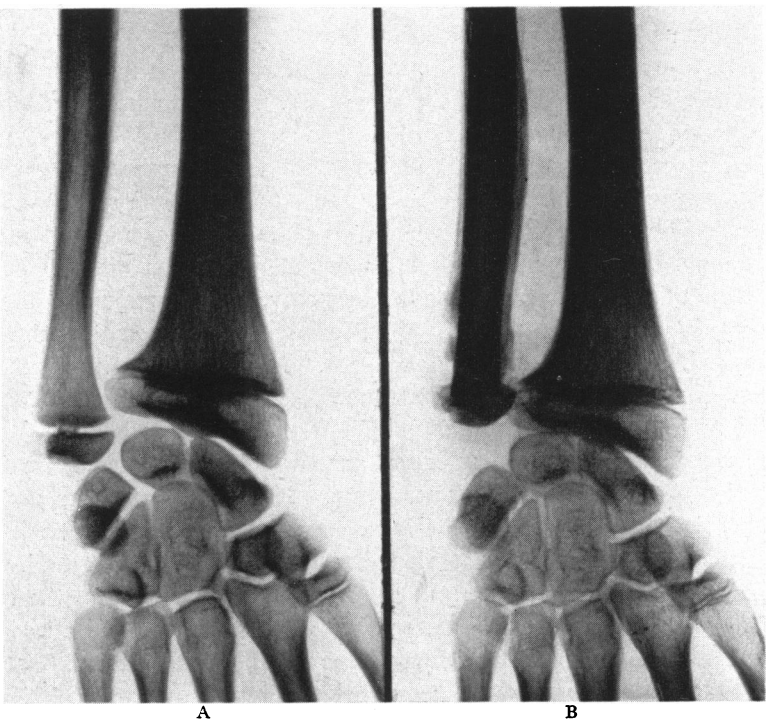
ligamentous apparatus and can have no successful application unless the bony disproportion has been previously corrected. Indeed, the necessity for reestablishing normal bone relationships before undertaking any ligament reconstruction, formed the basis of the conversation to which Lowman referred in his report of 1930.

The bone disproportions which may be found in derangement of the wrist fall into three main groups. Each presents the general features of the larger class of wrist derangements and, in addition, at least one distinguishing sign, which justifies its special consideration. The first of these groups is characterized by a loss of parallelism, an angular deviation in the axis of one or the other of the two bones of the forearm. Most commonly the radius is the site of angulation such as is found in Madelung's deformity, or in a malunited fracture. Occasionally, however, the deformity may be caused by disease or malunion in the ulna. As regards the inferior radio-ulnar joint, the effects from the involvement of either of these bones may be identical and the only difference will be in the point of application of the corrective forces. In this type of case, simple osteotomy, for correction of the malalignment, is usually, but not invariably, sufficient to overcome the disability, as Campbell,[1] and others have pointed out. In those cases in which additional repair of the ligaments is necessary, the osteotomy constitutes an essential preliminary step.

The second group is characterized primarily by a disproportion in the relative lengths of the two forearm bones. Normally, the ulnar notch on the radius is approximately at the same level as the ulnar head, while the radial styloid projects at least one-half inch beyond the ulnar styloid. As a consequence of the greater length of the radius, the lower end of the ulna is at some distance from the carpus, so that any interference with pronation and supination is avoided. However, when this arrangement is disturbed and the ulna projects beyond the level of the radius, the ulnar head impinges against the carpus, with resultant limitation of rotation and subsequent relaxation of the ligamentous fixation of the wrist. This may occur in other conditions (see Case 1), but it is typically an end-result of improperly reduced Colles fractures and seems to be the cause of the disability to which so much attention has recently been directed.

With the object of determining this point, a number of cases of Colles fracture were examined. In those in which symptoms of weakness persisted, it was found that a relative shortening of the radius was an almost invariable finding. Careful examination of the radiographs in such cases demonstrated that the ulnar head projected well down over the shadow cast by the carpal bones. The impression was gained that in rotation of the wrist, the carpal bones impinged against the projecting ulnar head and forcibly caused its dislocation. It seemed reasonable to believe that the cause of the so-called luxation lay primarily in the bone block, and that elimination of the osseous disparity would lead to disappearance of the symptoms.

The opportunity for testing the validity of this conception was offered by several patients, who presented themselves for the treatment of post-fracture "ulnar dislocations." Though specifically admitted with the intention of performing a fascial graft reconstruction, roentgenographic study suggested the desirability of preliminary shortening of the ulna by a cuff resection[7]. The following typical case proved that no ligamentous reconstruction operation was necessary:



A B

FIG. 3.—Case 3: (A) The hand is displaced radialward. The ulnar head projects below the level of the radial notch and clearly impinges on the carpal cuneiform. (B) Union has occurred after subperiosteal cuff-resection through epiphyseal line, with shortening of the ulna. The head articulates with the radial notch and no longer impinges against the carpus.

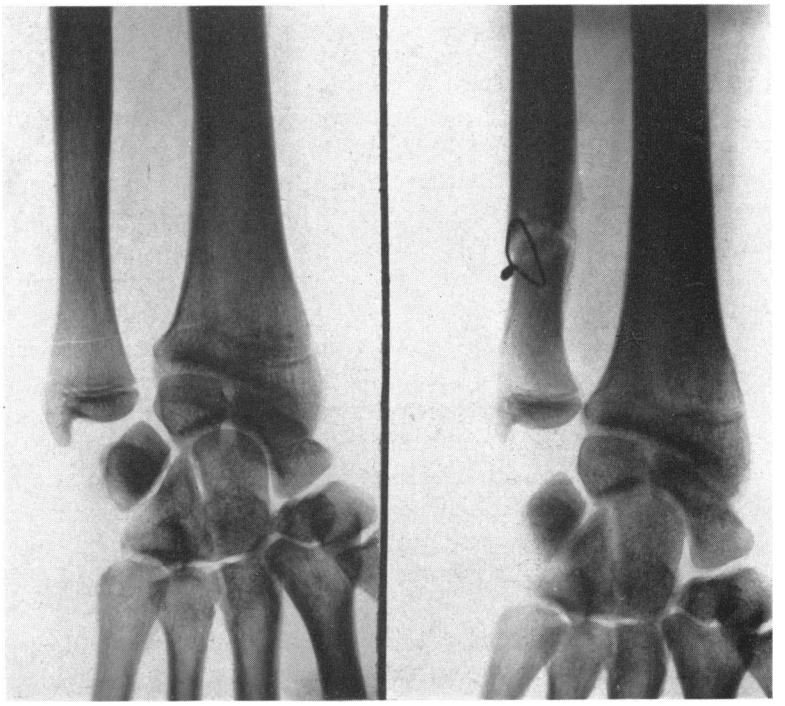
Case 3.—T. H., age 16, appeared in the Out-Patient Department, in April, 1939. complaining of weakness in grasp and difficulty in rotating his left forearm. In January, 1926, while sleigh riding, the patient had suffered a fracture of the left wrist, but no attempt at reduction had been made. The patient noted no trouble with his wrist until several months ago, when he began to observe a decreasing power of grasp and prominence of the lower end of the ulna.

Examination disclosed a radial deviation of the hand. The lower end of the ulna was prominent and at a level below the normal in relation to the radial styloid. Extension at the wrist was normal. Flexion was limited at 55°. Supination was about three-fourths normal. On pronation of the hand, the prominence of the lower end of the ulna became markedly exaggerated. Both ulnae measured 9¼ in. The right radius measured 9¼ in.; the left only 8¾ in.

Roentgenograms, taken May 8, 1939, (Fig. 3 A) showed "an old oblique fracture of the anterior aspect of the distal end of the left radius, just proximal to the epiphyseal

plate. There is a slight separation of the distal end of the left radius, just proximal to the epiphyseal plate. There is a slight separation of the distal epiphysis of the ulna and a separation of the distal radio-ulnar joint. There is a definite disproportion in growth between the ulna and the radius, with the ulna projecting below the radius. The epiphyseal lines are not closed."

Operation.—May 22, 1939: Under general anesthesia, a two-inch incision was made over the lower end of the left ulna. The bone above the epiphyseal line was exposed subperiosteally. A block of bone, including the epiphyseal plate, measuring about three-



A B

FIG. 4.—(A) Case 4, previously reported.[7] As a result of fracture, the articular plane of the radius is abnormally inclined medially and the ulnar head projects below its normal level. (B) After subperiosteal cuff-resection, above the epiphyseal line, the ulna has been shortened so that its head articulates with the radial notch. Despite the abnormal medial angulation of the articular surface, normal function of the wrist was restored.

quarters of an inch, was resected. Holes were drilled in distal and proximal fragments, which were then drawn together, with chromic sutures. The periosteum was reunited, and then the skin wound was closed. A plaster of paris bandage was applied from the fingers to the midarm, with the elbow fixed at right angles and the forearm in mid-pronation.

On June 22, 1939, the plaster encasement was removed. Roentgenograms taken at this time (Fig. 3 B) showed union of the fragments. The longitudinal alignment was good, but there was a moderate rotation of the ulnar fragment. The patient was given physiotherapy. In October, 1939, it was noted that the correction was excellent. There was no evidence of "so-called" dislocation of the distal end of the ulna and no weakness, despite the rotation of the distal ulnar fragment.

Case 4.—This case has been previously reported[7] (Fig. 4).

In Case 3, the cuff-resection was purposely planned so as to include the epiphyseal plate. Except where it is intended to prevent further growth

of the ulna, it is better to perform the operation about one inch or one and one-half inches above the head of the ulna. This facilitates the fixation of the lower fragments and precludes the possibility of interference with radio-ulnar motion by excess callus formation, at the joint level. The plane of the resection may be right angles to the shaft (Fig. 4 A and B) or may be made oblique.

Experience in the treatment of Colles fracture has shown that the disproportion in the lengths of the forearm bones which is due to impaction and relative shortening of the radius is of the most serious consequence. The limitation of motion which is occasioned by improper alignment of the inferior radial surface is of comparatively slight importance. While every effort should be made to correct all deformities during the initial setting of the fracture, far too much attention is devoted to reposition of the articular surface and far too little to restoration of the relative length of the radius. Where this is overlooked, "dislocation" of the ulna, pain, weakness, and limitation of rotation result from the impinging of the ulnar head against the carpal cuneiform.

In young children the disproportion in length between radius and ulna may be prevented or partly overcome by fusion of the lower ulnar epiphysis so as to arrest its growth. However, in adolescents near the age of normal epiphyseal closure, and in adults in whom the epiphyseal line has already been obliterated, the growth arrest operation is, of course, not applicable. In such instances simple shortening of the ulna to restore the anatomic proportion between the bones is sufficient to obviate the symptoms and usually precludes the necessity of any further operative reconstruction of radio-ulnar ligaments.

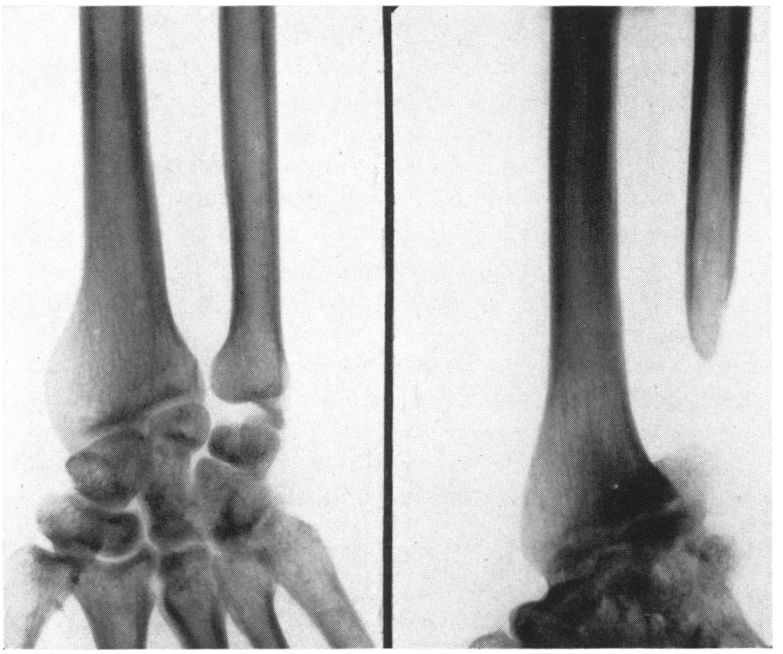
The third group is that in which the ulnar prominence is due either to arthritis at the radio-ulnar joint, or to disease of the ulnar head. In this event, of course, the hope of retaining the function of the radio-ulnar joint is illusory and resection offers the most expeditious form of therapy. Under certain circumstances, however, it may be desirable to preserve the ulnar head and its attached ligaments. In such cases, fusion at the radio-ulnar joint, with the subsequent formation of a pseudo-arthrosis by cuff-resection of the ulna, just above the head, is suggested. This principle of treatment was employed with success in the following case:

Case 5.—M. W., female, colored, age 28, entered the Out-Patient Department, December 31, 1934, complaining of a painful swelling of the right wrist of four days' duration. Gonococcal infection was denied. There was a history of influenza two weeks before the onset of symptoms, and it seemed reasonable to believe this was the origin of the infectious arthritis of her wrist. Neverthless, in the course of routine investigation, the patient was found to be suffering from a bacteriologically established endocervicitis. A moulded plaster of paris cock-up splint was applied to the hand and forearm, with much relief to the patient.

In May, 1935, it was noted that ankylosis of the right wrist had occurred, with the hand in 15° of flexion. Rotation of the forearm was markedly limited. Supination was possible to only 15° beyond the neutral position. The lower end of the ulna projected

posteriorly and appeared to be subluxated. Roentgenograms showed absorption of the articular cartilage covering the carpal bones, the wrist, and the radio-ulnar joints (Fig. 5 A). To correct the palmar flexion and the pronation deformity, open operation was decided upon.

Operation.—December 19, 1935: Through a dorsal incision, the wrist joints and the lower end of the ulna were exposed. The ulnar head was dislocated posteriorly and the radio-ulnar joint was filled with connective tissue. The radiocarpal joint was the site of a destructive arthritis. The radio-ulnar joint was cleaned out and the dislocation of the ulnar head was overcome. The lower portion of the ulna was subperiosteally exposed and one and one-half inches of the bone above the head was



A B

FIG. 5.—Case 5: (A) Arthritis of the wrist with dorsal prominence of the ulnar head. The carpus is elevated and impinges against the ulna. The relative length and axial parallelism of the bones is retained, with barely any radio-ulnar diastasis. (B) Postoperative. The radiocarpal and radio-ulnar joints have been fused. To restore the power of rotation, a cuff-resection of the ulna has been performed.

resected. The ends of the bone were covered with a muscle flap. The wrist joint was then opened and thoroughly curetted. The wrist was brought into dorsal extension and the position was maintained by sutures taken through the adjacent bone surfaces. The wound was closed without drainage, and a plaster of paris bandage was applied, with the forearm in supination and the wrist in 25° dorsal extension. The postoperative reaction was uneventful and the patient was discharged one week after operation.

The usual ambulatory treatment was carried on in the Out-Patient Department. As early as May, 1936, it was noted that the patient had solid fusion of the wrist, with return of excellent pronation and supination. The prominence of the ulnar head had completely disappeared. Roentgenograms, in December, 1936, revealed the fusion and the area of ulna resected (Fig. 5 B). Examination, in April, 1939, disclosed the persistence of painless rotation. The only complaints were directed to pain and stiffness in the fingers, which were involved in the arthritic process.

CONCLUSIONS

So-called dislocation of the lower end of the ulna is a misnomer. Prominence of the ulnar head is a characteristic of a number of different conditions, which are more accurately to be designated as derangements of the wrist joint.

The head of the ulna may be considered as a fixed point about which the motions of the wrist joint occur. To it are attached the ligamentous structures which stabilize the wrist and which are necessary to its normal function.

Prominence of the ulnar head may be caused by:

1. Injury to the triangular fibrocartilage.
2. Injury to the ulnar collateral ligament.
3. Rupture of the radio-ulnar ligaments.
4. Axial deviation of either of the forearm bones.
5. Disproportion in length of the forearm bones.
6. Enlargement or disease of the ulnar head.

Except for specific indications, the ulnar head should be spared and surgical attention should be directed toward repair or reconstruction of the ligamentous apparatus.

Repair of the soft tissues of the wrist can only be undertaken successfully if the bony relationships are normal, or have been previously restored to normal by appropriate types of osteotomy. For axial malalignment, simple linear osteotomy of the involved bone is sufficient. For disproportion in length, shortening of the ulna has proven extremely satisfactory.

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