

DISLOCATION AND ELONGATION OF THE LONG HEAD OF THE BICEPS BRACHII*

AN ANALYSIS OF SIX CASES

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DISLOCATION and elongation of the tendon of the long head of the biceps brachii were mentioned as belonging to the symptom-complex previously described.²⁹ This lesion is supposed to be rare unless accompanied by severe injuries to the shoulder girdle. Many cases found at autopsy have been reported in the literature.^{1, 5, 12, 16, 22, 63, 67} Numerous others have been recorded as having been seen clinically,^{3, 13, 17, 20, 30, 34, 39, 46, 50, 52, 69} but not operated upon. Up to the beginning of this century the opinions of the various authors have frequently been in disagreement, some citing cases which, without doubt, were clinical instances of traumatic simple luxation of the tendon^{13, 17, 19, 20, 24, 30, 31, 32, 34, 39, 40, 46, 50, 52, 53, 54, 65, 68, 69, 70} and others doubting or denying such luxation altogether,^{4, 26, 35, 41, 44, 51, 55, 58} but conceding the possibility of a dislocation, the result of chronic arthritis^{1, 5, 12, 16, 21, 63, 64, 67} or a complication of other severe lesions (fracture, dislocation, *etc.*) of the shoulder.^{32, 40, 44, 46}

Commenting on the divergency of opinions of the cases reported, White,⁷⁰ in 1884, stated: "Although for more than 100 years cases of supposed luxation of the tendon of the long head of the biceps muscle have been reported or alluded to by surgical writers, yet they have been so poorly observed or so carelessly described, that they fail altogether to carry conviction, the one case which possesses any strong element of probability being itself open to reasonable doubt."

Meyer⁴⁸ and his associates have found over 50 cases of marked dislocation of the tendon of the long head of the biceps and many others of lesser degree in the dissection of 1,000 arms. Some of these were bilateral. I have had four clinical cases, one successfully operated on† and three under observation. In addition I have analyzed two other cases through the courtesy of Dr. Edward Bull.¹¹

Literature.—In a complete review of the literature I find no mention of an operation having been performed for the relief of this condition. It has been an alluring subject for thought and discussion, nevertheless, and has arrested the attention of some of the greatest surgeons from the time of Hippoc-

* Read before the Western Surgical Association, St. Louis, December 8, 1934.

† This was in 1926 and as far as I have been able to determine is the first uncomplicated case reported of an operation to relieve this condition.

rates, 59 of whom have recorded their opinions. Because of the length of this most interesting history, I have placed it as an appendix to this report.

Anatomic Considerations and Causes of Dislocations.—A consideration of the anatomic structures which form the intertubercular sulcus (bicipital groove), and the course of the tendon within the sulcus and the capsule, readily reveals that the direction of the tendon varies with the position of the arm

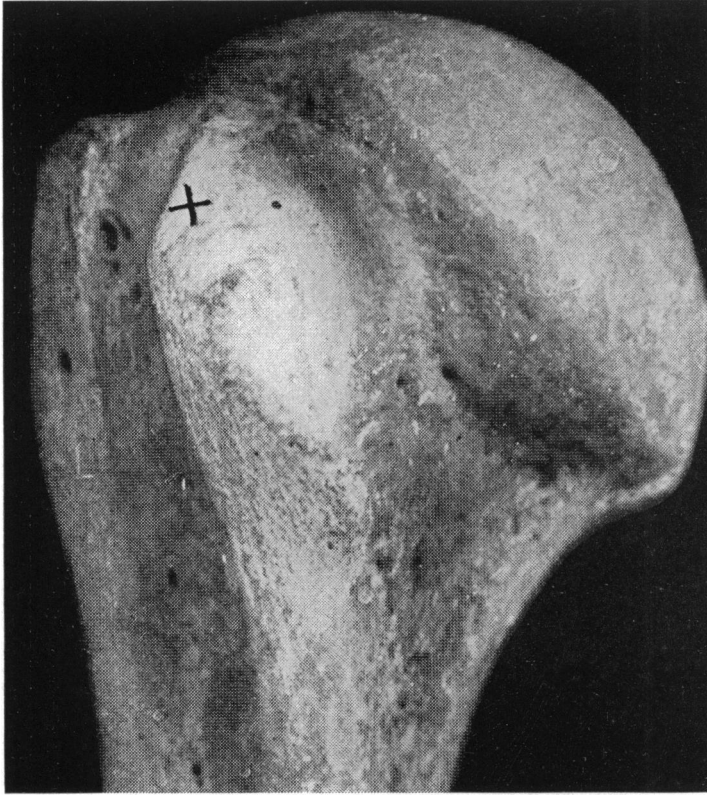


FIG. 1.—Portion of a right humerus with a supratubercular ridge marked X. This bony ridge extends obliquely forward and downward from the region of the articular cartilage to the upper and dorsal portion of the lesser tuberosity. As the surface of the distal extremity of this ridge is on a level with the surface of the latter, and since the tendon plays on it much as the tendon of the peroneus longus plays on the trochlea of the cuboid, its rôle in dislocation is plainly evident. In a study made by Cilley (unpublished) it was present in 17.5 per cent of 200 humeri. (I am indebted to Dr. A. W. Meyer, Professor of Anatomy, Stanford University, for this photograph and the explanation of it.)

(Figs. 1, 2, 3). With the arm at rest, Bera⁶ has pointed out, “the tendon is almost horizontal in its intra-articular course and has, in the groove, a vertical direction; its course follows the lines of a right angle with rounded angle at the level of the lesser tuberosity, on the slope of which it rests to be reflected and to slide at the contraction of the biceps. The angle formed by the intra-articular and extra-articular portions of the tendon varies, and according to the different attitudes and positions of rotation of the arm, the tendon is re-

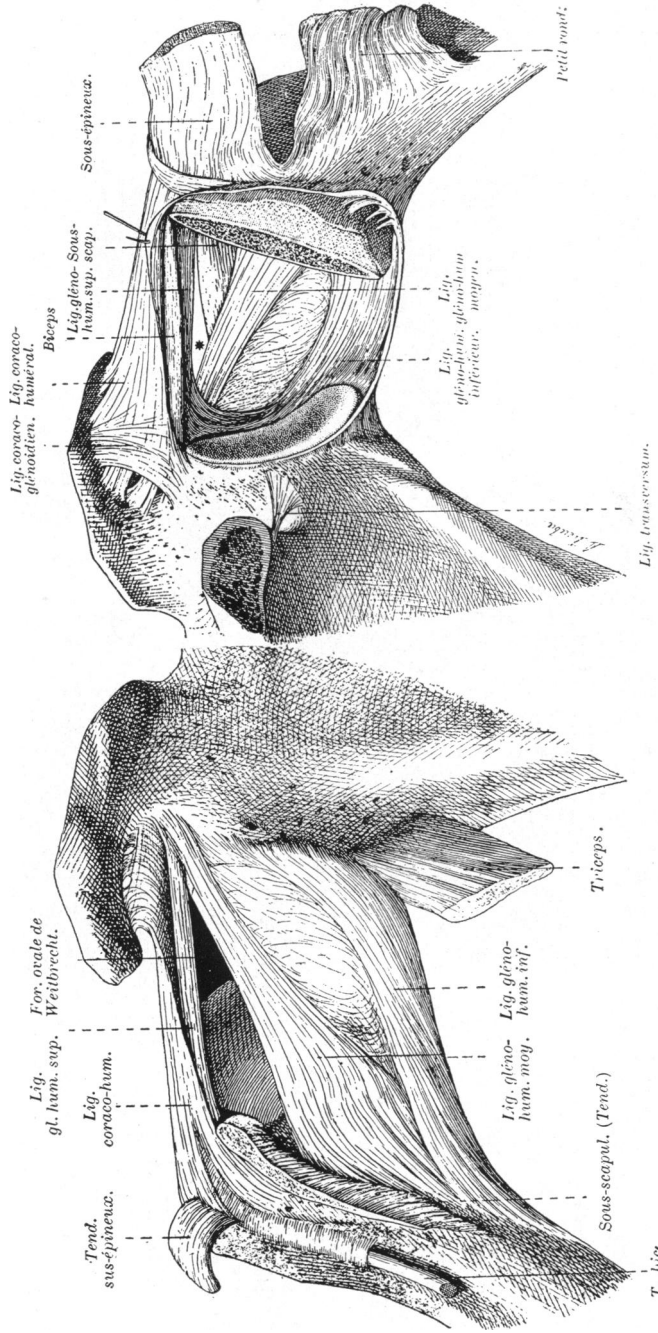


FIG. 2.—Anterior view of shoulder joint showing relationship of tendon of long head of the biceps to articular capsule. (From Poirer's and Charpy's Human Anatomy.)

FIG. 3.—Posterior view of the shoulder joint showing relationship of the tendon of the long head of the biceps to the articular capsule. (From Poirer's and Charpy's Human Anatomy.)

flected on either tuberosity or against the transverse humeral ligament which forms the roof of the osteofibrous tunnel of the bicipital canal.”*

On the other hand, the head of the humerus has a rounded and polished surface. The tendon curves over it anteriorly and mesially, and at that point it broadens and flattens out. This is an anatomic and a physiologic factor for its dislocation. The tendency to dislocation is further increased by the fact that contraction of the biceps muscle puts the tendon of the long head under tension and the curvature, which the tendon has over the head of the humerus when the arm is more or less adducted, tends to straighten out, “while the head of the humerus is pushed downwards and backwards.”⁴⁷

According to Meyer,⁴⁷ “In all normal joints there are three, and there may be six, factors which favor dislocation of this tendon: (1) the normal course of the intracapsular portion of the tendon and its relation to the humeral head; (2) the much greater width of the proximal portion of the tendon; (3) the fact that the anterior wall of the sulcus which is formed by the lesser tuberosity normally acts as a trochlea for the tendon in the usual position of medial rotation; (4) a supratubercular ridge may be present; (5) the capsular attachment may be weakened by intracapsular bursae, and (6) the capsular attachment to the anatomic neck in the region proximal to the lesser tuberosity may be restricted.”

He believes that “the tendency to dislocation of this tendon, which exists in all normal shoulder joints, is opposed primarily by the attachment of the articular capsule in the region proximal to the lesser tuberosity” and by the medial ridge of the sulcus which sometimes is very steep. He does not agree with most anatomists that the transverse humeral ligament plays an important rôle in preventing this dislocation and has accumulated conclusive evidence, in his dissections, that the partial dislocation of the tendon of the long head of the biceps brachii is a surprisingly common condition. In a number of his specimens the capsule is entirely intact though it has stretched, forming a sling around the dislocating tendon so that the tendon lies partly or wholly upon the lesser tuberosity, using it as a trochlea (Figs. 4 and 5). To quote Meyer, it is interesting that “since the surface of the lesser tuberosity is normally rough, the under surface of the tendon will show evidence of wear unless protected by this capsular sling, the deeper portion of which forms a cushion for the tendon. If this wear progresses, it weakens the tendon and may ultimately destroy it to the extent that a rupture may follow.”

Another factor which undoubtedly plays an important rôle in the dislocation of the tendon was first described by Bera,⁶ who showed that a malforma-

* As Meyer⁴⁷ has said: “When the arm is in slight lateral rotation, the under surface of the tendon lies fully on the floor of the sulcus; but as lateral rotation is increased its anterior margin is forced against the anterior wall of the sulcus, especially that portion formed by the lesser tuberosity and the capsular attachment proximal to it. In medial rotation, on the other hand, the anterior wall of the sulcus and the adjacent capsular attachment become the surfaces which the tendon uses as a trochlea, while its dorsal margin is forced against the dorsal wall of the sulcus.”

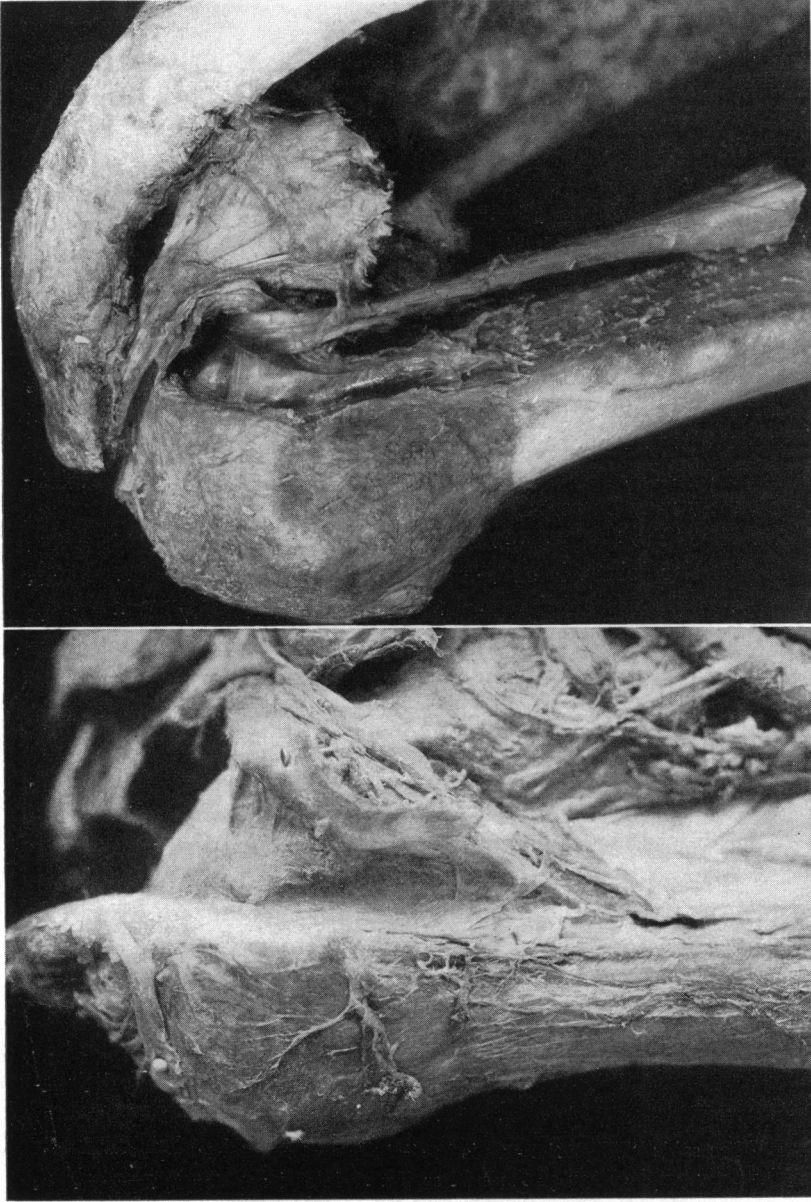


FIG. 5.—A right humeroscapular articulation with the tendon reflected anteriorly to reveal its bed. The proximal portion of the intertubercular sulcus is seen to the left of the new bed of the tendon. This tendon, which lies in a capsular sling, had passed practically over the lesser tuberosity but still occupied the sulcus distal to the intertuberosal region. (Kindness of Dr. A. W. Meyer, Professor of Anatomy, Stanford University.)

FIG. 4.—This shows how clearly the yielding of the capsular attachment in the region of the lesser tuberosity permits the long head to be dislocated anteriorly, far downward, and explains the relaxation of the tendon often spoken of as the elongation of the tendon. (Kindness of Dr. A. W. Meyer, Professor of Anatomy, Stanford University.)

tion or a localized osteitis reduces the volume of the lesser tuberosity and favors the luxation of this tendon. He also believed that this tendon can be dislocated by a violent muscular contraction, particularly in the presence of preexisting arthritis. When this tendon slips over the lesser tuberosity the tension of the muscle is immediately lessened and we have what is known as the typical relaxed tendon, producing the classical bicipital syndrome.

Arthritis, however, is not always a preexisting factor in dislocation, as proved by Meyer. In a remarkable specimen revealing a bilateral dislocation of the tendon, that of the right arm was much farther luxated than the left, it having passed completely over the lesser tuberosity, while the tendon of the left arm had luxated only to the top of the tuberosity. Consistent with the condition found in other specimens of dislocated tendons of the long head of the biceps, there was not the slightest evidence of arthritis.

Types of Dislocation.—Bera⁶ also pointed out that, while the tendon may and does “dislocate forward, it may also dislocate posteriorly, completely or partially. The complete dislocation involves the opening of the bicipital groove and the local detachment of the articular capsule. The violence capable of producing this disorder will more likely produce the rupture of the tendon or the dislocation of the shoulder. But these cases of posterior dislocation are not related to the bicipital syndrome.” According to the onset, the dislocation may be acute, gradual, or recurrent. The acute and recurrent types are rapidly disabling, for the period of their duration, while the gradual type may not be disabling at all except for a more or less vague discomfort in the shoulder which often is interpreted by the patient and the physician, as being rheumatic in origin.

Mechanism of Production.—The mechanism of production of the acute and recurrent types of luxation is brought about by external rotation and abduction of the arm over 90 degrees, in which position the tendon is reflected more, over and against the attachment of the articular capsule in the region of the lesser tuberosity. According to Borchers,⁸ the production of the osteophytic outgrowths in and around the bicipital groove, the result of arthritis, may be such that the groove will be filled and thus the tendon becomes mechanically dislodged. Gurlt³³ reports one such case of dislodged tendon. Meyer⁴⁸ discussed the various factors which favor a dislocation of the tendon and came to the conclusion that it may be the result of occupation.

Symptoms.—Symptoms of a dislocated tendon are variable and depend on the onset and type. In most cases they are similar to those of a ruptured biceps tendon.²⁹ The onset is usually acute. There is pain in the region of the bicipital groove, which may radiate down the muscle. This pain is increased on external rotation and overhead extension. There is also weakness of the arm. The pain and the weakness may be so marked that the function of the limb is very much impaired.

If the dislocation has been complete, the tendon of the long head of the biceps has, according to Bera⁶ “a direction more inclined than usual in regards

to the axis of the body," and "with the arms horizontally, in cross-like fashion, the direction of the external bundle of the biceps ends in front and not over the glenoid cavity." This sign may be visible, of course, only in thin, muscular persons.

An apparent elongation of the long tendon may be seen, evidenced by a slight flabbiness of the muscular belly which may be lowered.

Palpation of the tendon outside the groove, or of the empty groove, is pathognomonic, although these signs cannot be elicited in many cases because of the overlying structures. A change in direction may be more easily detected. If the onset has been gradual or if the tendon has slipped forward slightly, the symptoms and signs are not very striking. There may be a vague soreness in and about the groove, which is increased by movements of external rotation and overhead extension.

Diagnosis.—A diagnosis is not always made easily, especially if one does not bear this entity in mind during the examination of a shoulder. The symptoms may not be very pronounced at first and many of the objective signs may be obscured by the tenosynovitis and the generalized soreness which result from the production of such a lesion. The history is very valuable. In any disability of the shoulder, brought about by a sudden movement or by movements of external rotation and overhead extension, continued over a long period of time, the possibility of the production of a dislocation of the tendon of the long head of the biceps should always be considered.

In case of a dislocation, if the onset is acute, there is marked weakness of the arm and pain, more marked on movements of external rotation and overhead extension.

On inspection, if the subject is thin and has a well-developed musculature, one may detect the changed direction of the tendon of the long head of the biceps which, with arms raised horizontally, appears to run anteriorly and more mesial than normal.

The apparent elongation of the tendon with lowering of the belly may be present but difficult to recognize because of the reflex spasm of the muscle, especially if the injury is recent or the dislocation not very severe. Palpation will confirm what inspection has revealed and often is the only means of arriving at a diagnosis.

Diagnostic Test.—We have found the following test very useful in verifying the diagnosis of dislocation of the tendon. If there is a recurrent dislocation of the tendon (Cases II and IV), one can at times reproduce the dislocation by having the patient bring his extended arms to overhead extension and marked external rotation holding, if possible, an equal weight in each hand, such as five-pound dumbbells (Fig. 6). The observer places himself either behind or in front of the patient and puts his fingers on the long head of the biceps. The patient is then instructed to lower his outstretched arms to the side in the coronal plane. When the arms reach an angle of from 110 to 90 degrees, a definite snap may be audible in the top of the injured shoulder and a sharp pain is elicited both in the shoulder and in the region of the

bicipital groove. This snap is also felt by the fingers held over the belly of the biceps and the tendon of the long head. It gives the impression of a taut violin string that snaps as it slips into a groove of the bridge. Occasionally the vibrations produced by the snap may be visible in the long head of the biceps. This snap is not produced if the arm is lowered in internal rotation, or if the belly of the biceps, or the tendon of the long head is held and pushed firmly posteriorly, even though the arm is in external rotation. Since developing this test, I have found it present in my last three cases.

A diagnosis of a dislocated tendon can be made if one considers the mechanism of production of the injury and is careful in accounting for the various signs and symptoms. If the dislocation is not complete and recurring (Case III), the snap may not be detected so plainly. Then one has to rely upon the patient's subjective symptoms which are more severe when the arm is in external rotation and less so when it is in internal rotation or when the

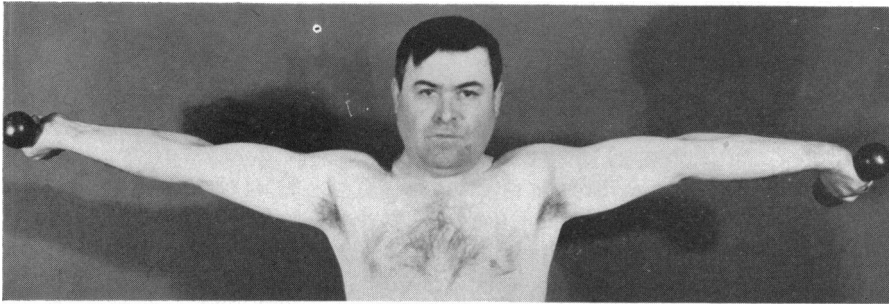


FIG. 6.—(Case II.) Diagnostic test. See text for details.

tendon is pulled outward and posteriorly so that it does not reflect itself on the anterior structures of the groove and on the lesser tuberosity. In Case III, we verified this point, checking also with the other signs of Hueter⁴⁰ and Yergason⁷¹ which are both definitely positive as long as the tendon, brought into contraction, is not held back and outward. If one exerts outward pressure on the belly or, better still, on the tendon as high as possible under the anterior border of the deltoid muscle, these signs, even though they do not become entirely negative, elicit less pain.

Whether the tendon dislocates or ruptures and takes up a new and necessarily lower attachment in or along the edge of the intertubercular sulcus, the belly or muscle loses some of its tone and undergoes more or less atrophy. This explains why, at operation, although the tendon is of normal size and consistency, the muscle is flabby and can be lifted up much more freely than the short head (Case I).

Differential Diagnosis.—In the differential diagnosis of dislocation of the tendon of the long head of the biceps one must remember that the subjective and objective symptoms are often not very clear. A painstaking examination and repeated observations are frequently necessary before a definite diagnosis is reached. This results from the fact that in the shoulder, and espe-

cially in the region of the bicipital groove, there are so many important structures, one overlapping the other and most of them very deeply situated.

Subdeltoid Bursitis.—As mentioned before,²⁹ in subdeltoid bursitis the pain and tenderness are localized in the region of the bursa and are increased by passive or active external rotation and abduction. None of the important symptoms of the bicipital syndrome are present.

Soto-Hall and Haldeman⁶⁶ emphasized the fact that the injection of novocain into the subdeltoid bursa is a very valuable means of differentiating an injury of the subdeltoid bursa from a tear of the supraspinatus tendon. I have found this to be a useful procedure.

Rupture of the Supraspinatus Tendon.—A lesion of this tendon should not be mistaken for a dislocation of the long head of the biceps. For a complete study of the supraspinatus tendon the reader is referred to Codman's excellent book.¹⁵

The dislocation may be anterior or posterior, but only the former is identified with the bicipital syndrome. The principal signs, of course, are the changed direction of the tendon, palpation of the empty groove or of the tendon outside of it if possible, and the tendon having a more anterior and mesial position. If the dislocation is complete, it may be confused with a rupture of the high type or with an elongation. A detailed history of the onset of the disability and of its mechanism may be helpful, as a luxation has always a forced abduction and external rotation as one of its main factors. In a case of dislocation, the tendon is still under tension, more so than in a rupture, and the muscle therefore is not so flabby. Impairment of function is greater in a dislocation, especially on movements of rotation and slight abduction, and also on those of flexion of the forearm. In a rupture, the movements of flexion are much more impaired than those of abduction and rotation. A rupture of the low type has signs and symptoms distinctly different and it eliminates immediately the diagnosis of dislocation, elongation, or a high rupture of the tendon.²⁹ If the dislocation is not complete, the diagnosis may be made by the change in the symptoms, that is the lessening of objective and subjective findings when the tendon is held firmly and pushed backward and externally, either by means of the belly or, better, by direct pressure on the tendon under the anterior margin of the deltoid. The high type of rupture may be confused with the true elongation of the tendon, but the latter is rather a rare condition. An apparent elongation is caused, therefore, by a dislocation or a high type of rupture. Thus, by elimination, one can attain a fairly accurate differential diagnosis.^{6, 29}

Elongation of the Tendon.—A considerable number of cases of elongation of the long head of the biceps tendon have been reported; most of them, however, were undoubtedly apparent rather than real. A true type of elongation is, according to Bera,⁶ the result of numerous ruptures of single fibers in the thickness of the tendon. An apparent elongation is the result of a dislocated tendon or of a rupture of the high type with subsequent lower attachments, or of the low type with the formation of scar tissue between the two

ends of the tendon and subsequent atrophy of the muscular belly. The true type of elongation may become a complete rupture when the tendon, after repeated ruptures of the fibers, gives way completely. Cases of true elongation are very rare, but such an elongation of the upper tendon was reported by Bera,⁶ and Holcomb³⁸ had a case, in which operation revealed that the lower tendon "had slipped down through the muscle very much as the center of a roller bandage is pulled out of the bandage."

Treatment.—If the tendon is dislocated and the patient is seen early, an attempt should be made to reduce the dislocation by the following procedure, which I have used on several occasions. The extremity, with the elbow bent and the forearm supinated in order to relax the tendon, is abducted passively and gently in the coronal plane to 90 degrees or more and simultaneously rotated internally. Sometimes it may be necessary to grasp the belly of the biceps as high as possible, near the deltoid muscle, pull it backward and hold it as the arm is lowered in the same plane, to help the replacement of the tendon and also to prevent a possible, although rare, immediate redislocation. Anesthesia may be required to overcome the reflex spasm of the structures in the shoulder.

If the patient is seen some time after the dislocation occurred the treatment really depends on the subjective symptoms and especially on the disturbances of function. If they are not very severe, it may not be necessary to intervene surgically, as the tendon and the structures around the intertubercular sulcus will have adapted themselves to the new condition. If the patient is engaged in heavy work which requires constant use of his biceps, the best procedure is to operate early as there is every reason to believe that, if he is having trouble a fairly long time after the accident, his condition will not improve, but will probably get worse.

The surgical repair varies according to the operative findings. If the structures around the groove are such that their repair will give assurance of a good result, this should be done, and, if necessary, the groove should be deepened. An easier procedure, and one probably more satisfactory, is to repair the tear in the structures around the groove, after severing the tendon of the long head as high in the joint as possible, and then to suture this tendon to the coracoid process and to the tendon of the short head (Fig. 7) as described previously.^{27, 28} This has invariably given a satisfactory result.

Prognosis.—The outlook depends both on the severity of the injury and on whether there are other concurrent lesions of the shoulder girdle. In the latter case the lesion of the tendon is of secondary importance, though when present it should be recognized early and treated as soon as the other injuries have received attention. In case the dislocation is isolated, spontaneous reduction may occur under a sudden movement which returns the tendon to its normal position. In this case soreness may persist for several days. If the reduction is not accomplished soon, newly formed adhesions may fix the tendon to the humerus or the tendon may be reflected in a capsular sling and work through this newly acquired position, as shown by Meyer.^{47, 48, 49} In

such a case there may be discomfort and functional disturbance of varying extent, according to the degree of relaxation of the biceps and to the subsequent shortening of the muscle if any, especially to the pulling and tugging on the stretched capsule where it forms the capsular sling.

An acute dislocation requires immediate reduction because of the intensity of symptoms and the duration of disability, if reduction is not accomplished. A dislocation which has developed gradually may not produce many symptoms nor be very disabling.

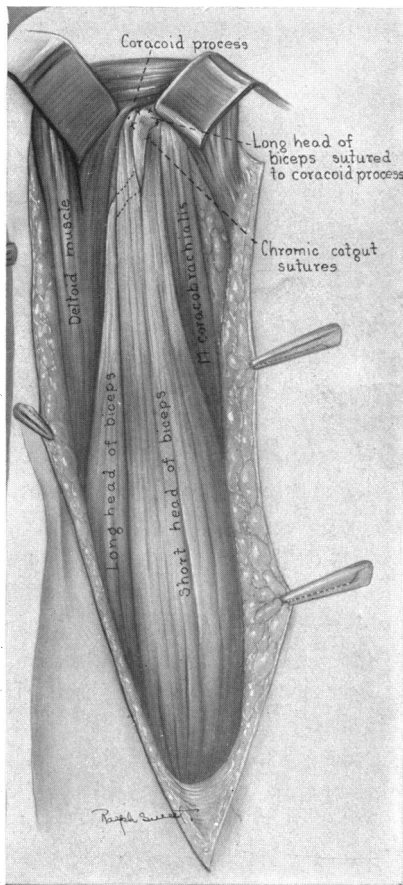


FIG. 7.—The tendon of the long head of the biceps inserted through the tendon of the short head to which it is sutured, as well as to the coracoid process.

Medicolegal Aspect.—The medicolegal aspect depends, of course, on many factors, especially on the amount of disability which may arise as a result of a dislocation of the tendon and on the time of onset of the disability. There is no question as to industrial liability in the acute type. Its onset and mode of production are very clear. There is question, however, in a luxation which has been produced gradually, as in the case of workers who use their arms in external rotation and abduction, such as painters, carpenters, decorators, miners, fruit pickers, *etc.* Usually many of their symptoms are attributed to arthritis or sprains for a while until they, with a slight effort, stretch the capsule a little more and therefore cause immediate disability. Each individual case, therefore, should be studied carefully, especially if the onset is not sudden. In all fairness to the employee one must not forget that there is, at times, an occupational factor in these cases and that, since the soft tissues in various shoulders give way differently and to a varying degree, the symptoms change from case to case and from time to time in the same patient according to the amount of reaction

produced by the injury and often by an examination. In fact, symptoms may appear or disappear on two successive examinations. It is very important and highly essential to the contending parties that the surgeon, who accepts the care of these cases or whose opinion is sought, obtain a complete history of the accident, a clear idea of the mechanism of production of the injury and an understanding of the underlying causes in order that he may be able to render a just opinion.

APPENDIX

Literature.—Hippocrates³⁷ was the first to give any information about musculotendinous displacement in luxations. In 1724 William Cowper¹⁷ reported a dislocation in which both tendons of the biceps were rigid, interfering with extension of the elbow and in which, after manipulation, function was restored. Pouteau,⁵⁷ in 1760, doubted that tendons could be displaced. Bromfield,¹⁰ in 1773, wrote on the technic of reduction,* Knox,⁴² in 1827, was the first to notice a morbid condition of this tendon; Stanley,⁶⁷ in 1828, reported one case, found at autopsy, in which the tendon was dislocated from its groove and resting over the greater tuberosity. Monteggia,⁵⁰ in 1829, reported a recurring subluxation which could be reduced by placing the outstretched hand and arm over the shoulder of another person; John Gregory Smith,⁶³ in 1835, found at autopsy among other lesions of the biceps two instances of dislocated tendons in the two shoulder joints of the same subject; Adams,¹ in 1835, considered that chronic arthritis was the underlying factor of dislocation as evidenced in the case of J. G. Smith. He also believed that, in Soden's case, the dislocation was the result of arthritis rather than of trauma. John Soden,⁶⁵ in 1841, reported two cases one of which has been the subject of much discussion; Partridge,⁵⁴ in 1841, discussing Soden's case, considered it traumatic; Cooper,¹⁶ in 1842, wrote a treatise on the subject; Hancock,³⁶ in 1844, gave a good clinical description of this subject; Smee,⁶² in 1848, also wrote on it; Callaway,¹² in 1849, wrote a dissertation on the subject and cited a specimen (No. 55) kept in St. Bartholomew's Hospital as an example of dislocation. He discussed the difficulty of a differential diagnosis between rupture and dislocation; Parrish,⁵³ also in 1849, reported one case; Erichsen,²⁰ in 1850, wrote on the subject; Postgate⁵⁶ reported one case in 1851; Fergusson,²² in 1853, said he had no doubt that the bicipital tendon could be displaced in dislocations as he had seen this more than once in the dissecting room; Robert W. Smith,⁶⁴ in 1853, reviewed several cases recorded in the literature as instances of partial luxation of the humerus upward with dislocation of the bicipital tendon (those of Gregory Smith, Fergusson, Smee and Hilton) and concluded that they were not of traumatic origin but the result of arthritis; Schiff⁵⁹ wrote on the subject in 1855; Hamilton³⁴ reported one case and Malgaigne⁴⁴ discussed the subject and especially Soden's case. He denied a traumatic luxation of the tendon unless it occurred as a complication of fracture or luxation of the shoulder; Sebergondi,⁶⁰ in 1856, reported one case; Mercer,⁴⁶ in 1859, reported one case of dislocation of the shoulder with luxation of the tendon; Hueter,⁴⁰ in 1864, gave a very clear explanation of some of the signs and symptoms in lesions of this tendon; Jarjavay,⁴¹ in 1867, discussing several cases, thought that the signs reported were not the result of a dislocation of the tendon, but in the light of his studies, were caused by a subacromial bursitis. He further stated that a simple luxation of the tendon had never been demonstrated and, in his opinion, did not exist. Fleury,²⁴ in 1868, reported a case traumatic in origin, while Von Pitha⁵⁵ agreed with Jarjavay⁴¹ and questioned the diagnosis in several of the cases reported which was "founded on symptoms referred to the neighborhood of the bicipital groove and on the associated disturbance of function." He also said that "no one had ever felt a luxated tendon on the greater tuberosity or been able to replace it." Ashurst,⁵ in 1871, wrote that Canton believed the

* ". . . the cubit being bent the muscle is relaxed and while an assistant holding the lower extremity of the os brachii, moves the head thereof, sometime inward, sometime outward in the acetabulum scapulae; the operator with his fingers will easily replace it and the patient presently becomes perfectly easy."

dislocation to result from the existence of chronic rheumatic arthritis; Hood,³⁹ in 1871, wrote, "displacement of a tendon is certainly of more frequent occurrence than is usually supposed"; Adams,² in 1873, said that the luxation of the tendon was the result of arthritis and not of trauma; Green,³⁰ in 1877, reported a case, the result of a fall, which was reduced by a second fall; Agnew,³ in 1878, wrote that the only unequivocal case he had seen was that of White;⁷⁰ Callender¹³ mentioned one of recurring dislocation in which the tendon could not be retained in place because of fibrous tissue filling the groove and cited specimens in the London museums showing displacement of the bicipital tendon; Gerster²⁶ wrote that no luxation had been found, in the living subject, in its uncomplicated form and doubted its existence as such; in his opinion, when concomitant to injuries, it was a secondary pathologic phenomenon. Hamilton,³⁴ in 1880, cited one case of luxation; Andrews⁴ a year later doubted that this tendon could dislocate, while Nancrede⁵¹ was of the opinion that the so called luxation of the long head of the biceps was the result of chronic subdeltoid bursitis; Gross,³¹ in 1882, conceded that the obscure nature of the lesion allowed it to be overlooked or mistaken for fracture, sprain or dislocation of the shoulder; Mady^{1,43} also in 1882, wrote on the subject in general; Treves,⁶⁸ in 1883, recognized a traumatic dislocation of this tendon; von Volkmann⁶⁹ in the same year said that uncomplicated luxation of the tendon had not been found at autopsy. However, he mentioned a case recorded by Cloquet in which the patient could dislocate his biceps tendon at will. J. William White,⁷⁰ in 1884, reviewed the literature and discussed a case in which he believed there was a traumatic luxation of the tendon. Eastland,¹⁹ in 1886, reported one case; Senf,⁶¹ in 1892, wrote on the subject; Guermontprez and Ahmed Michel,³² in 1896, reported one case concurrent with a dislocation of the shoulder; Marsh,⁴⁵ in 1896, Parkhill⁵² in the following year and Robinson,⁵⁸ in 1902, wrote on the subject, each reporting one case; four years later Berne⁷ reported two cases; Bossuet,⁹ in 1907, reported two; Fievez,²³ in 1910, reported a case of elongation, and in the same year, Bera⁶ wrote a classical thesis on the subject. Borchers, in 1914, writing on lesions of this tendon, mentioned that it could become displaced mechanically by osteophytic outgrowths of arthritic origin which fill the groove. Gurlt,³³ in 1927, found one case of tendon dislodged by the filling of the groove.

CASE REPORTS

Case I.—A. N., male, aged 49 years, was seen first on September 22, 1925. He had hurt his right shoulder the day before, when he was standing in a crouched position, pulling a heavy steel bar which he had just driven into a board with a sledge hammer. He gave a quick pull and instantly heard a snap in the anterior portion of the top of his right shoulder followed immediately by a smarting sensation rather than severe pain. He continued working, but was unable to pull, as such effort produced pain in his shoulder. The next morning he had difficulty in raising his arm because of soreness in the upper part of his arm and his shoulder.

Examination.—September 23, 1925, no ecchymosis or tumefaction was visible. By abducting and externally rotating the arm a definite snap was felt and heard in the shoulder where the long head of the biceps emerges from the joint. This phenomenon was attributed to a recurring dislocation of the tendon of the long head of the biceps which, on rotation of the humeral head, came out of its groove and over the lesser tuberosity and then snapped back into the groove.

After a few weeks' treatment, consisting of rest and heat, the patient's symptoms subsided and he resumed his usual work, but he soon returned again complaining that his arm had grown weak and that the following movements hurt him: (1) lifting with the

arm extended; (2) putting the arm back to get into his right hip pocket; (3) rotating the arm with it extended in front; (4) pulling the arm back from forward extension. He located the pain exactly in the middle of the anterior portion of the shoulder, where the tendon of the long head of the biceps emerges from the joint.

On December 26, 1935, with arms abducted and extended, the normal convexity of the long head of the biceps was absent entirely and was seen to be flattened. The bone could be palpated between the deltoid and the belly of the biceps. On flexing the forearm only the belly of the short head was seen to contract and there were 6 cm. between the muscular belly and deltoid fold, as compared to $1\frac{1}{4}$ cm. on the uninjured side (Fig. 8).

Diagnosis.—Dislocation of the long head of the right biceps.

Operation.—January 2, 1926, under general anesthesia, a linear incision was made over the long head of the biceps muscle. The muscular portion of the long head was smaller than normal, but there was no tear in it. The tendinous portion was normal. However, the long head was elongated and could be lifted like an overstretched rubber band, as compared with the short head which had its normal contractile power. In the light of these findings it seemed best to shorten the tendon by plication, thus reducing its length about 1.5 cm. The arm was then immobilized in acute flexion in a Velpeau bandage to relieve all strain and to restore its contractility.

Result.—The patient regained complete use of his arm, and seven weeks after the operation returned to his usual work as a carpenter (Fig. 9). The muscle regained its normal size, and he was discharged as cured. Nine years later on examination I found that his arm was still normal in every respect. Even though the patient obtained such a perfect result, in a similar case I believe I should sever the tendon as high up as possible and suture it to the coracoid process and to the tendon of the short head.

Case II.—A. D., male, aged 40 years, was seen first on October 8, 1931, complaining of pain and weakness in the right shoulder and arm. On the previous day while trying to loosen some poles with a crowbar, and pulling, he suddenly felt two consecutive sharp snaps in his right shoulder and in the middle internal aspect of the right arm, as well as a dull pain in his right shoulder. He rested an hour and exercised his arm, with the hope that the pain would subside, following which he went back to his regular work of washing carpets and worked the remainder of the day, although his right shoulder pained. The pain increased gradually until the next morning he could hardly raise his elbow.

Examination.—He localized the pain by putting his finger along the tendon of the long head of the biceps which was tender to pressure, especially over the bicipital groove. Yergason's sign²⁷ was positive. After many painstaking examinations the diagnostic test spoken of in this paper was worked out and perfected. Roentgenologic examination was negative.

Diagnosis.—Dislocation of the tendon of the long head of the right biceps.

Treatment.—Rest with the shoulder in an abduction splint and diathermy afforded him some relief.

Result.—Operation was advised, but he preferred instead a settlement from the insurance company. He was examined recently and while the general soreness about his shoulder has improved, he still has pain when he raises his arm above his head and rotates it externally. The snap, as described in the test outlined in this paper, is still present.

Case III.—J. T., male, aged 43 years, was first seen on May 3, 1933, complaining of weakness, stiffness and a continuous dull aching in his right shoulder, more severe on movement, which prevented his raising his right arm above the level of the shoulder. On January 11, 1933, while he was pushing a hand truck, weighing about 538 pounds, over an incline, his foot slipped on the wet sidewalk and he fell forward. He struck his right shoulder on the handle of the truck. For the rest of the day (two hours) he did light work. In spite of the use of hot compresses, the aching in his shoulder was so severe that he could not sleep. Two days after the injury he consulted a physician, who first had roentgenograms taken of his shoulder and then strapped his arm to the

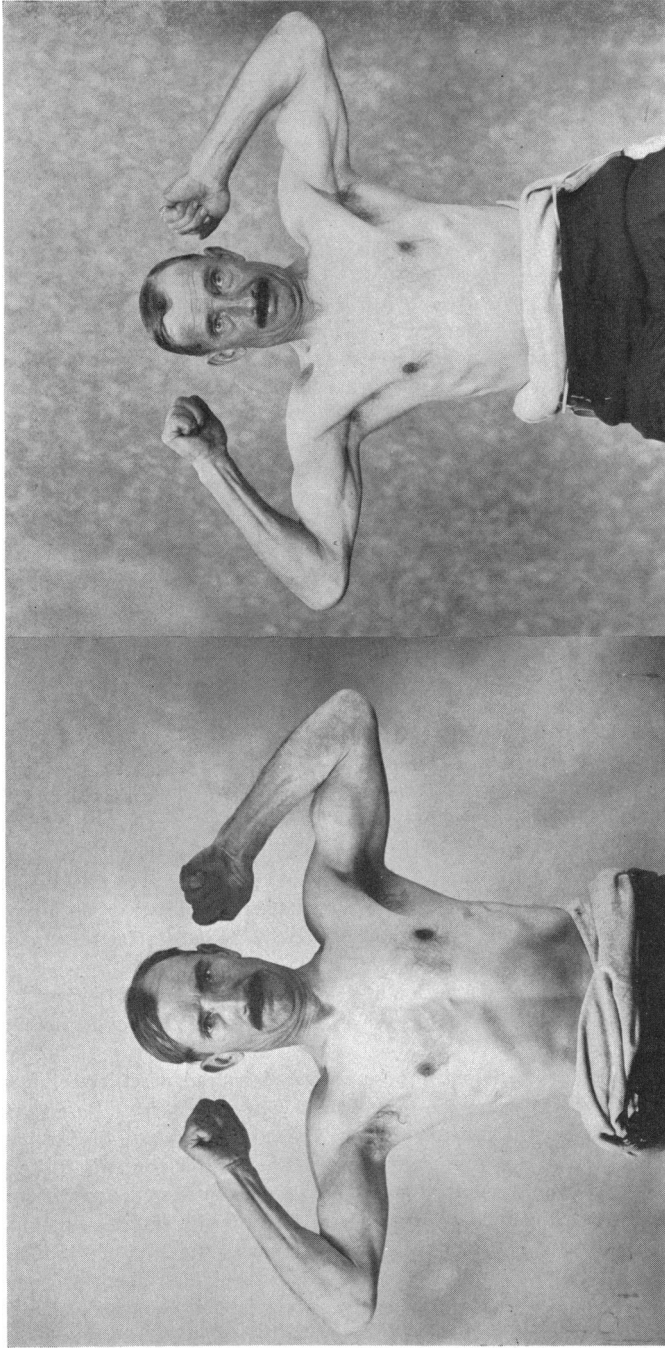


FIG. 8.—Case I. (Before operation.) Dislocation and elongation of the tendon of the long head of the right biceps. Note diminution in size, as well as the widening of space between the biceps and deltoid muscles.

FIG. 9.—Case I. (Few weeks after operation.) Note how the muscle of the long head of the right biceps has increased in size, and how the contour of the arm is more nearly normal.

side of his chest. Since the strapping did not relieve the pain, it was removed in two days and he was given radiant heat and diathermy for a few weeks, without relief.

Examination.—General physical examination was essentially negative except for moderate pyorrhea, chronic tonsillitis and very mild chronic sinusitis and chronic prostatitis.

Right arm and shoulder.—There was a definite flattening of the right deltoid region, especially when the elbow was at the level of the shoulder. A marked depression, 10x11 cm., was evident in the substance of the deltoid muscle just below the acromion process. This area, corresponding to the level of the subdeltoid bursa, was tender to pressure, and it was at this point that he felt most of the pain on movement. There was a slight atrophy of the muscles of the scapulohumeral region. Movements were limited about 20 degrees. It was difficult to ascertain the range of motion of his right shoulder because of the pain whenever he moved the arm. On palpation he complained of tenderness in the region of the subdeltoid bursa and at the level of the intertubercular sulcus, and there was a point of tenderness which rotated with the rotation of the arm and which did not disappear when the arm was abducted. There was no definite change in the scapulohumeral rhythm nor a definite jog on abducting or adducting the arm after it had been extended overhead. At that time, examination of the long head of the biceps and of its tendon was clinically negative.

Roentgenologic examination of the right shoulder.—Outward rotation showed a small area of calcification above the greater tuberosity of the humerus, probably the result of an old hematoma.

Impression.—(1) Severe contusion of right shoulder with (2) probable partial tear of the tendon of the right supraspinatus muscle and of muscular fibers of the right deltoid muscle; (3) subdeltoid bursitis; (4) chronic tonsillitis, slight pyorrhea, and low grade sinusitis.

Treatment.—He was treated conservatively with rest of the shoulder in an abduction splint, physiotherapy, and injections of iron cacodylate intravenously which, on several occasions, I have found to be very efficacious in relieving the pain of subdeltoid bursitis.

Discussion.—The patient was kept under observation for many months, during which time he was treated conservatively and several foci of infection were given attention. The condition and the range of motion of his shoulder gradually improved. When most of the pain had subsided, his clinical picture gradually became clearer and, after painstaking and continual observation of his symptoms and signs, it became evident that he had a *partial dislocation of the long head of the biceps*. On November 6, 1933, Hueter's sign and Yergason's sign²⁷ were positive. The diagnostic test mentioned previously did not elicit a very definite snap, but there was more severe pain when all these three signs were tested without holding back the muscle belly or the tendon of the biceps, pushing it outward and posteriorly, or when the arm was lowered in internal rotation. This maneuver evidently held back into the groove the tendon of the long head so it reflected itself over the slope of the lesser tuberosity and not over the sling formed by the tearing of the capsule which occurred at the time of his injury when he had abducted his right arm violently and brought it in overhead extension and external rotation. He had, therefore, put indirectly a great strain on the attachment of the articular capsule in the region proximal to the lesser tuberosity which forms the roof of the osteofibrous tunnel of the bicipital groove.

Progress.—After a year and a half of conservative treatment, his range of motion was almost normal and the weakness and pain in his arm were greatly relieved. He was discharged as being able to resume work.

Case IV.—R. G. H., male, aged 50 years, dentist, was seen first on December 9, 1933, complaining of neuritis in his left shoulder and arm. About seven years before, he began to have a dull ache in his left shoulder which radiated down his arm and which he attributed to muscular strain. This condition had become worse slowly and progressively until, at the time when I first saw him, he was even disturbed at night. In fact, he

had to sleep on his back with his left arm abducted to 90 degrees, the elbow flexed at a right angle and the hand at the level of the head. Recently he had not been able to bring his arm above a horizontal plane unless he twisted his forearm, first supinating and abducting it, then pronating it while he gradually lifted it with the other hand. The pain ceased after he abducted his arm to about 80 degrees. He also had pain radiating down the biceps when he leaned back against a chair.

Examination.—A creaking sound could be heard in both shoulders on the abduction of both arms. There was pain on pressure at the lower end of the left bicipital groove. Hueter's and Yergason's signs were negative. He could abduct his left arm to 75 or 80 degrees without pain, then he halted because pain was elicited in the shoulder. To obtain overhead extension, he lifted his left arm in medial rotation with elbow slightly flexed until he reached about 45 degrees abduction. Then he had to rotate the arm externally, after which with a jerk and twinge of pain he was able to accomplish overhead extension.

Abduction and elevation of the left arm were not so painful when the biceps muscle was held and pushed outward, as if to hold the tendon back in the groove.

Progress.—Operation was declined. His condition remained almost stationary and about a year after he was seen last, he had to give up his work on account of pain in the shoulder.

Case V.—V. M., male, aged 52 years, on March 24, 1933, fell, striking on his right shoulder. He tried to check his fall with hand and wrist against the ground by strongly rotating the right arm externally. The instant he struck the ground he felt a snapping sensation "like a string breaking." Inasmuch as he felt as if the shoulder were out of joint, other workmen pulled downward on the arm with counter pressure in the axilla, and the shoulder seemed to snap back into place. He felt better after this but on account of soreness in his shoulder and arm, was unable to work. He saw a physician and was advised to keep his arm at his side. He first began to use his arm in about two weeks. Finally he felt well enough to work four days during the first week of June, but a return of pain stopped him. He worked three days during the last week of June. He suffered no pain with his arm across his chest, but attempts to use the arm caused pain at the top of the shoulder; a fairly regular snapping was heard and felt deep in the upper front part of the joint and over the front of the humerus at or just below the insertion of the pectoralis major muscle. His condition did not improve. The patient gave a history of never having had arthritis, lumbago, neuritis or sciatica.

Examination.—July 22, 1933, the right shoulder snapped audibly when abducted and rotated. This snapping, I thought, was caused by the tendon of the long head of the biceps which seemed to be displaced forward, lying just in front of the tip of the coracoid, and which snapped back and forth at the level of the tip of the coracoid on abduction and particularly rotary movements in from 60 to 80 degrees abduction. He felt pain over the tip of the coracoid when the snapping occurred, and this area was distinctly tender. There was a slight tenderness also over the region of the subdeltoid bursa. There was very little atrophy. Normal range of movement was present.

Roentgenologic Examination.—Roentgenograms (stereoscopic, internally rotated and single, externally rotated) taken July 22, 1933, showed a small calcified mass in the region of the subdeltoid bursa. There was also a curved narrow line of increasing density in the region of the bicipital groove which was interpreted as calcification where the periosteum had been torn when the tendon of the long head of the biceps was forced from its groove. On the inferior surface of the clavicle a well-developed bony prominence appeared where the coracoclavicular ligaments attach, but the normal relations of clavicle and scapula excluded injury as a cause, and the pattern of the bone seemed normal and did not suggest an arthritic etiology.

Impression.—A forced active movement of external rotation and supination against resistance has caused the tendon of the long head of the biceps to tear loose from its groove. It now lies just anterior to the coracoid process and certain movements cause it

to snap back and forth at the level of the tip of the coracoid, causing pain and chronic irritation.

Operation.—August 5, 1933, a six-inch incision was made along the anterior margin of the deltoid muscle. The deltoid was separated from the pectoralis major by sharp dissection and retracted laterally and upward. The tendon of the long head of the biceps was felt lying medial to its normal location in the bicipital groove. The transverse humeral ligament was found detached from the lesser tuberosity of the humerus for a distance of 1 to 1½ inches. It was cut to expose the bicipital groove. The biceps tendon lay outside the groove at this point, having slipped across the denuded lesser tuberosity. The point of the lesser tuberosity was sharp and prominent, and movements of the arm caused the tendon to snap over it. This was evidently the chief cause of the painful snapping at examination. The nature and extent of the damage made repair of the transverse humeral ligament impossible. Repair by fascia lata would have required bone work at the subscapularis insertion, which would have been painful for some time, with slow convalescence.

The cut biceps tendon was freed of areolar tissue and split, each half being looped through the bone tunnel and sutured to the outer half in the groove. The transverse humeral ligament and periosteum were closed over and sutured to the tendon in the bicipital groove, with interrupted No. 0 chromic catgut. The deltoid was replaced and lightly sutured with No. 00 plain catgut. The skin was closed with interrupted black silk without drainage. A starch bandage and yuca board were applied with the elbow flexed and the arm held in the Velpeau position. Convalescence was uneventful. He returned to light work much improved on November 28, 1933, and since has resumed his regular heavy work.

Case VI.*—J. T., male, aged 49 years. On December 22, 1933, a piece of equipment, weighing 200 or 300 pounds, toppled two or three feet and struck the front of his left shoulder, his arm being forced into external rotation in a position of 60 degrees abduction. The weight pinned him against the flat surface on the wall behind. As his shoulder was painful he did little work for the rest of the day. A swelling the size of a walnut appeared on the front of the shoulder, but gradually subsided. He complained of pain over the front of the shoulder and a cracking sensation on raising the arm from the side. Any use of the arm caused soreness which lasted for some time. At first he had pain in the shoulder at night, but it became less. He could do straight lifting with arms dependent without pain, so long as he did not abduct. He had no previous injuries, arthritis, lumbago or neuritis, and his general health was good.

Examination.—Examination of the left shoulder on January 23, 1934, revealed a clicking and grating on motion. The biceps tendon clicked. The biceps (long head) did not contract firmly unless he made a special effort. There was some crepitation and pain in the shoulder on abduction of the arm. Range was not restricted. There was tenderness and a click on rotation in the region of the bicipital groove, especially with the biceps taut. Roentgenologic examination was negative.

Impression.—The tendon of the long head of the biceps slips out of the groove. Thickened soft parts crepitate and pinch slightly in passing under the acromion.

Operation.—January 26, 1934, the tendon of the long head of the biceps was exposed. It had torn the transverse humeral ligament and lay about one inch anteriorly to its normal position. The groove which it normally occupied was so filled with lacerated soft tissue and granulations that the tendon could not be replaced in its normal position. The tendon itself was frayed along one margin.

The shoulder joint was opened and the tendon cut free from its attachment to the scapula. The tendon was denuded of areolar tissue and split longitudinally. The bicipital groove was denuded of soft parts and a small tunnel was made through the bone. Through this tunnel one-half of the split tendon was looped, and brought back and sutured to the

* I am indebted to Dr. Edward C. Bull for the report of both Cases V and VI.

other half. The reflexed periosteum and soft parts were sutured over the transplanted tendon. The incision in the shoulder joint was sutured and the deltoid muscle was brought back to its normal position and likewise sutured.

Progress.—His shoulder improved very definitely, and his arm was freer and stronger, but as he continued to have pain on abduction and external rotation, it was decided to do an exploratory operation.

Operation.—February 2, 1935, it was found that the greater tuberosity was striking the acromion as it moved beneath this bone in the act of abduction.

Progress.—Since the second operation he has been even more relieved and is still improving.

I wish to express my appreciation to my associate, Dr. Piero Albi, for his splendid assistance in the preparation of this paper, for reviewing much of the foreign literature and for compiling the complete bibliography.

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