Acta orthop. scand. 45, 346–358, 1974

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# THE SIGNIFICANCE OF THE CORACOCLAVICULAR LIGAMENT IN EXPERIMENTAL DISLOCATION OF THE ACROMIOCLAVICULAR JOINT

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Accepted 19.ix.73

The treatment of dislocation of the acromioclavicular joint (luxatio articuli acromioclavicularis, l.a.a.) is a controversial issue. One of the reasons for this dispute is a persisting disagreement concerning the significance of the various structures influencing the stability of the joint. The present study, therefore, seeks to elucidate this subject by means of experimental clinical and radiological investigations of a post-mortem, human material.

The normal anatomical structure of the acromioclavicular joint is depicted in Figure 1. The known variations of the joint as to the form and direction of the articular surfaces and the type of any possible disc have been investigated by other authors (Urist 1946, Moseley 1959, 1969) and will not be discussed in the present study. The acromioclavicular ligament serves as a reinforcement for the joint capsule, its fibres connecting the upper edge of the clavicle with the upper edge of the acromion, some fibres being interwoven with the capsule. Some authors (Lanz & Wachsmuth 1959) have described a similar reinforcement of the lower part of the capsule, thus distinguishing between a cranial and a caudal acromioclavicular ligament; however, they also stress that this is not a constant finding. Our study is, therefore, concerned with the proximal reinforcement only. In the same way, we have not distinguished between the two parts of the coracoclavicular ligament, the trapezoid and the conoid part; for although each part has its separate function with regard to the ventral and dorsal mobility of the scapula, their clavicular function is the same, viz. to apply traction to the clavicle in a caudal direction (Urist 1946, Lanz & Wachsmuth 1959). In this study l.a.a. is defined, clinically as well as

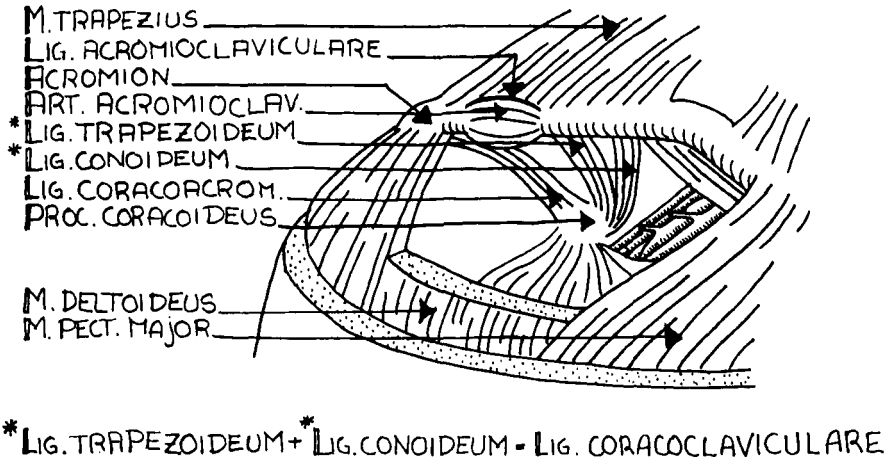


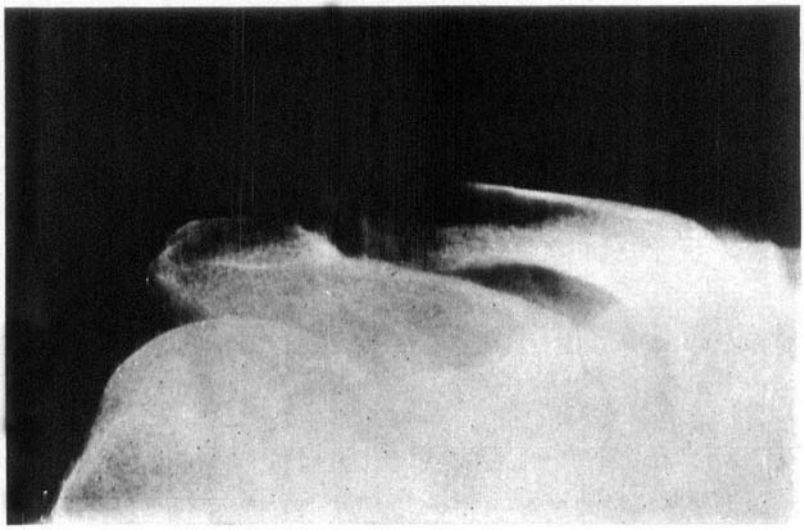

*Figure 1. The normal anatomy of the acromioclavicular joint.*

radiologically, as an injury of the joint so severe that the contact between the articular surfaces may be suspended completely, either by applying traction to the unsupported arm on the affected side, or by direct examination of the mobility of the lateral end of the clavicle.

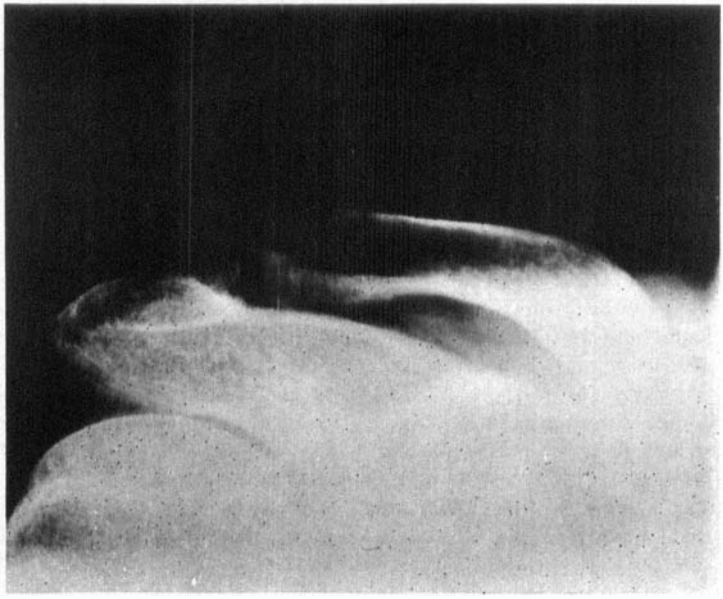
## MATERIAL AND METHOD

The experiments were carried out post-mortem in uninjured patients in the age group 62 to 80 years. Before the investigations were commenced, rigor mortis was loosened. Nine joints in all were examined. In eight of these, muscles and ligaments were divided in the following order: 1) The acromioclavicular ligament and the joint capsule immediately underneath the ligament, 2) the entire capsule of the acromioclavicular joint, 3) the insertions of the deltoid and the trapezoid muscles into the lateral 2 cm of the clavicle, and 4) the coracoclavicular ligament. This order was chosen as most authors agree that in any injury resulting in complete dislocation of the acromioclavicular joint the above structures will be affected in this order (Horn 1954, Urist 1959, 1963, Quigley 1960, Bundens & Cook 1961, Moseley 1969). Other authors (Stewart 1963, Jacobs & Wade 1966, Weitzmann 1967, Weaver & Dunn 1972) have described injuries to these muscles in cases with l.a.a., but they do not correlate these injuries with a possible injury of the coracoclavicular ligament. In the ninth case the order of the division was changed, the coracoclavicular ligament being divided before the muscle insertions were cut. Due, probably, to the lack of muscular tone the result of these divisions could not be registered directly by x-ray exposures; therefore, in three out of the eight cases and in the ninth case one kilogram traction in the cranial direction was applied to the clavicle by means of a silk suture affixed laterally to the coracoclavicular ligament.

All the joints were examined radiologically, the first exposures made following

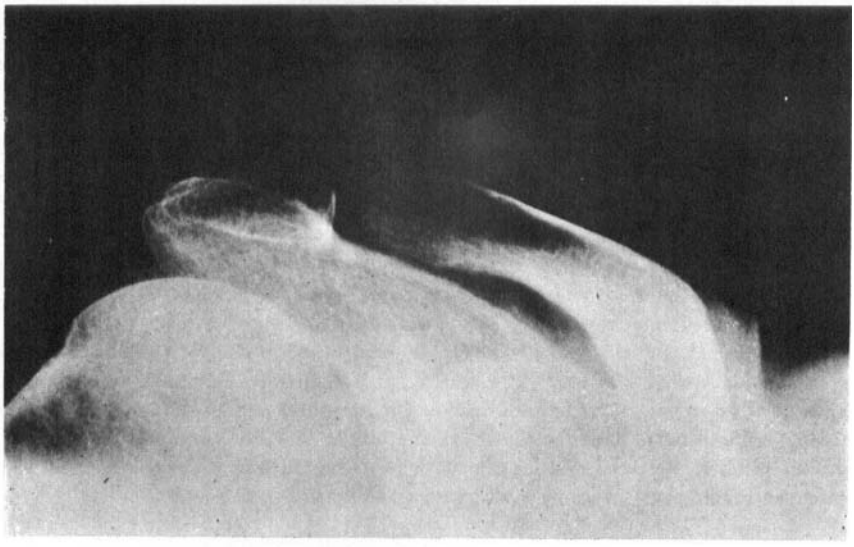


*A: The joint without traction to the arms.*

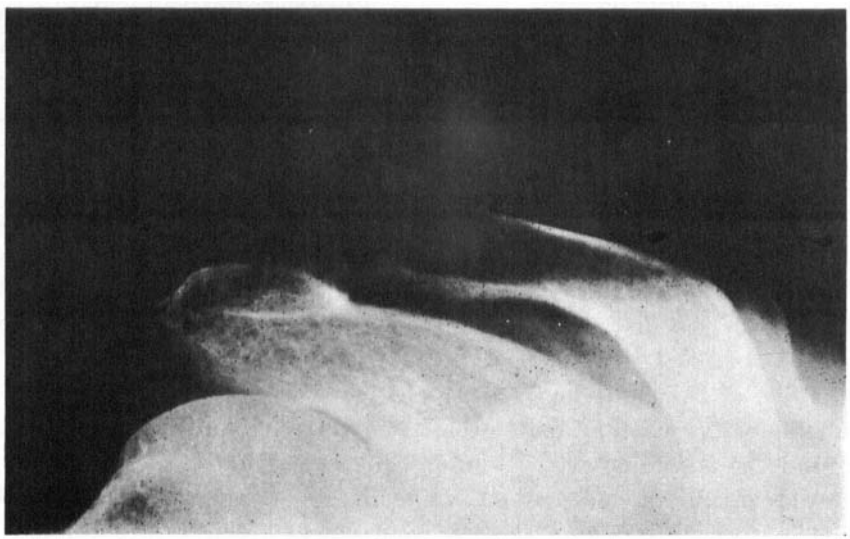


*B: The joint with traction of 10 kgf to each arm in a caudal direction.*

***Figure 2 A, B. The acromioclavicular joint after skin incision and traction of one kgf to the lateral end of the clavicle in a cranial direction.***



*A: Without traction to the arms.*



*B: With traction of 10 kgf to each arm.*

*Figure 3 A, B. The acromioclavicular joint after division of the acromioclavicular ligament.*

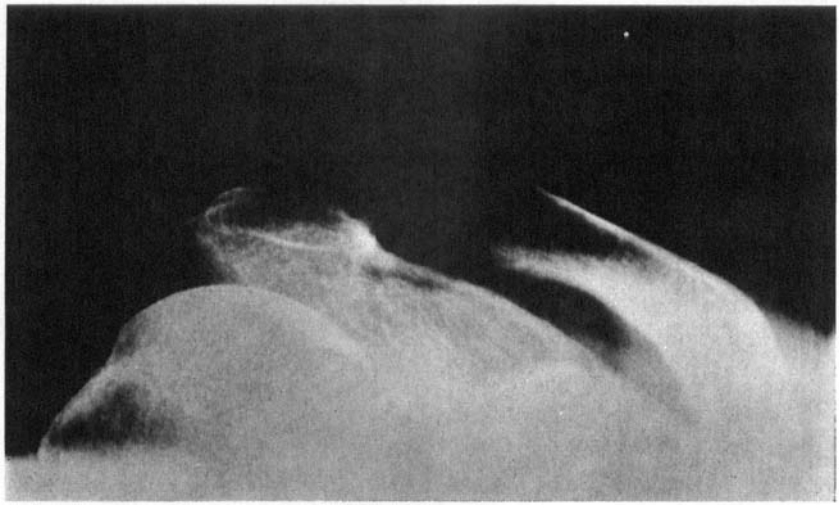
the incision of the skin and subcutis, or, when traction was applied, following the institution of traction as mentioned, exposures being taken with and without traction of 10 kgf being applied to both arms. Following the division of each new structure the procedure of repeated exposures was carried out.

The dislocation gradually appearing in the joints examined was evaluated clinically by direct examination of the mobility of the clavicle and, hence, by the reciprocal position of the two articular surfaces, as well as by measurements obtainable from the x-ray exposures. The increasing dislocation was caused, partly, by a displacement in a lateral direction and a rotation of the scapula resulting in a lateral and slightly caudal displacement of the acromion, partly, by an increasing, proximal displacement of the lateral part of the clavicle, the diastasis between the articular surfaces thus increasing while at the same time the angle between these surfaces changed. In order to simplify the results we chose to express the extent of the dislocation by the vertical distance, in millimetres, between two horizontal planes passing through the lower edges of the acromial and the clavicular articular surfaces, respectively, thus disregarding the horizontal diastasis. In each case the vertical distance between the upper edge of the coracoid process and the lower clavicular surface was measured, and also expressed in millimetres.

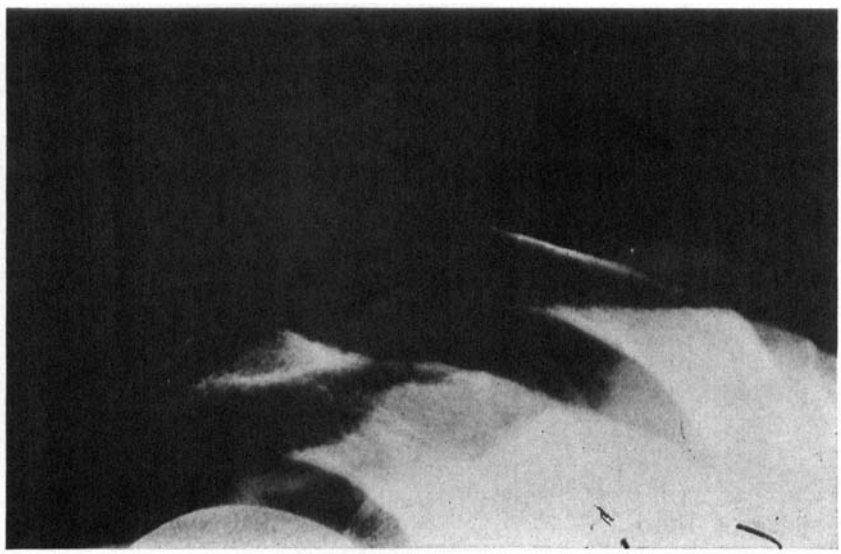
## RESULTS

In eight joints the division of the acromioclavicular ligament resulted in a clinically increased mobility of the joint. When the joint capsule had been completely divided, the lateral part of the clavicle could be moved so far cranially as to bring the lower edge of the articular surface of the clavicle on a level with the upper edge of the acromion—the joint thus being dislocated. When the muscular insertions had been cut also, the dislocation became more evident, the lower clavicular edge being displaced from 0.5–1 cm above the upper acromial edge. Division of the coracoclavicular ligament increased the extent of the dislocation, the distance between the acromion and the clavicle now being from 1.5–2.5 cm.

In five of the eight joints these changes could not be demonstrated radiologically; when all the muscles and ligaments, as mentioned above, around the acromioclavicular joint had been divided, x-ray exposures showed an unchanged contact between the articular surfaces of the clavicle and acromion, persisting even when traction was applied to both arms. Countertraction was, therefore, as described above, applied to the clavicle in three cases, which afforded the following results, uniform for the three joints: Radiological control exposures after traction had been applied showed a normal mobility of the joints (Figure 2 A, B). Division of the acromioclavicular ligament resulted in increased mobility, the x-ray exposure of the joint when no traction



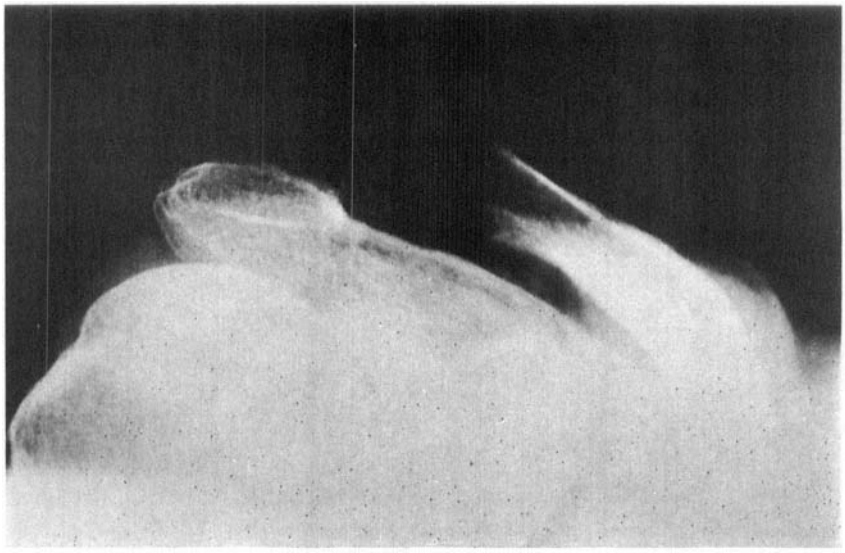
*A: Without traction.*



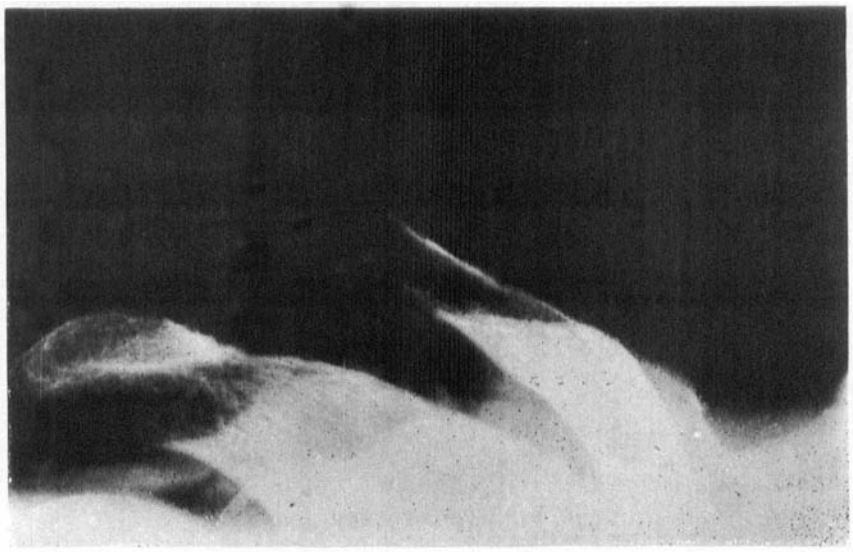
*B: With traction to each arm.*

*Figure 4 A, B. The acromioclavicular joint after total division of the joint capsule.*

was applied showing an increased diastasis, while on application of traction the lower clavicular edge was seen to be displaced a further 2–5 mm above the lower acromial edge (Figure 3 A, B). A division of the entire joint capsule led to dislocation when traction was applied,

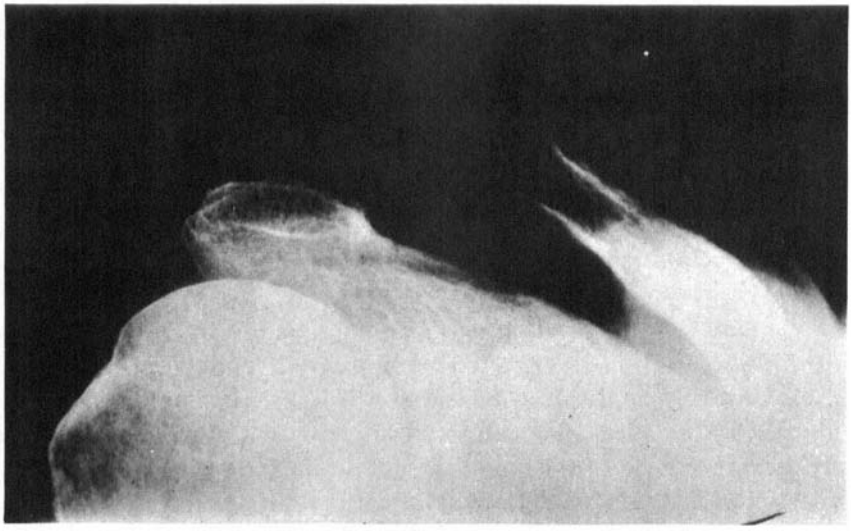


*A: Without traction.*

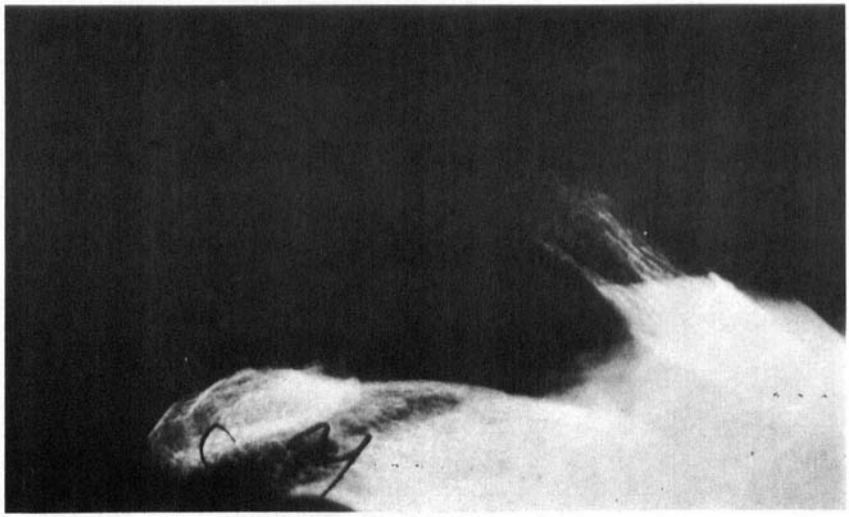


*B: With traction to each arm.*

*Figure 5 A, B. The acromioclavicular joint after division of the joint capsule together with the muscular insertions on the lateral 2 cm of the clavicle.*



*A: Without traction.*



*B: With traction to each arm.*

*Figure 6 A, B. The acromioclavicular joint after division of the joint capsule together with the muscular insertions and the coracoclavicular ligament.*

the lower clavicular edge being on a level with the upper acromial edge (Figure 4 A, B). When no traction was applied, the cutting of the insertions of the muscles from the clavicle resulted in subluxation in one case, and in dislocation in two cases while, when traction was applied, dislocation occurred in all cases, the distance between the lower edges of the acromion and the clavicle being at least 12 mm (Figure 5 A, B). When the coracoclavicular ligament was divided, dislocation was registered radiologically whether or not traction was applied (Figure 6 A, B).

In one case counter-traction was also applied, but the order in which the different divisions were made was altered. Following division of the joint capsule application of traction to the joint showed a clinical as well as radiological dislocation, similar to that found in the previously examined cases. Division of the coracoclavicular ligament without any lesion of the muscles left the clinical mobility and the radiological picture of the joint practically unchanged (Figure 7 A, B). Only after division of the muscular insertions, as mentioned above, did the more distinct dislocation become apparent, whether or not traction was applied (Figure 7 C).

In the four cases in which counter-traction was applied to the joint radiological measurements revealed a primary distance of 6–11 mm between the coracoid process and the clavicle. In all cases of dislocation

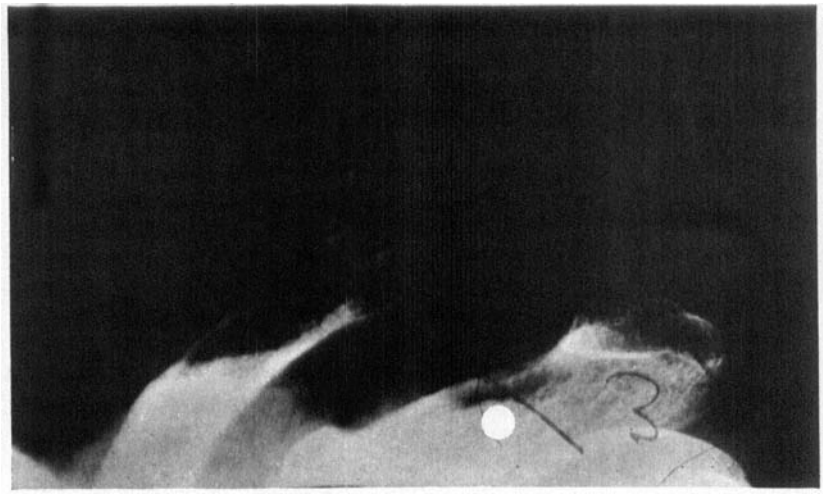


*Figure 7 A. The acromioclavicular joint after total division of the joint capsule and the acromioclavicular ligament.*

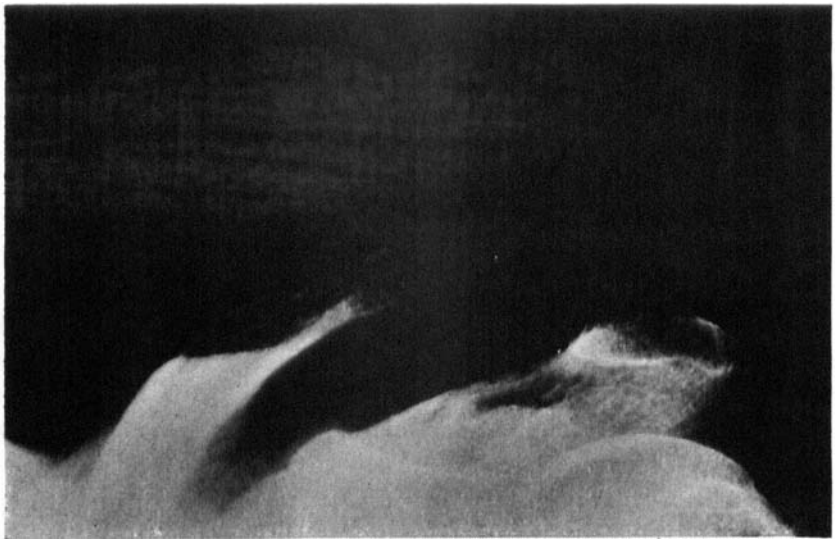


*Figure 7 B. Division of the joint capsule together with the coracoclavicular ligament —with muscular insertions left intact.*

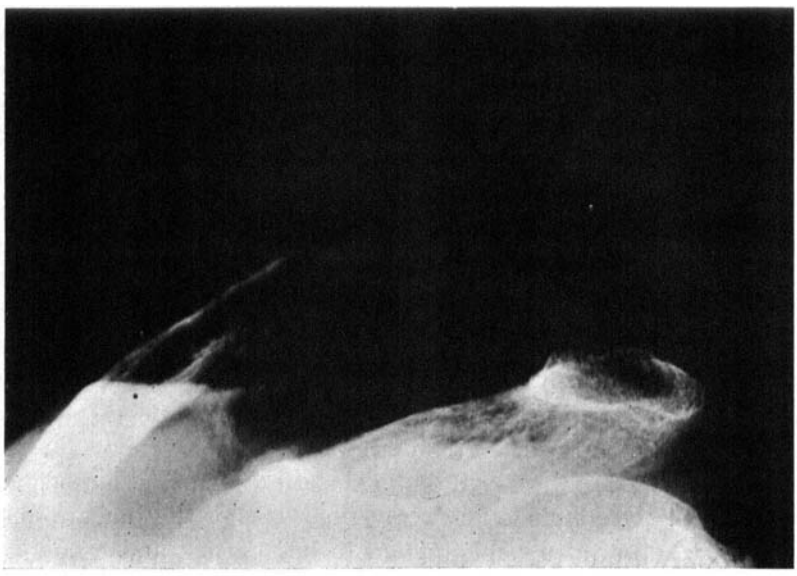


*Figure 7 C. Division of the joint capsule together with the coracoclavicular ligament and the muscular insertions.*

*All pictures are with traction of 10 kgf to each arm.*

with an intact coracoclavicular ligament, this distance increased, the maximum increase being 7 mm. Division of the coracoclavicular ligament led to an increase of a further 6 to 20 mm, except in the case in which the muscles remained intact—the increase amounting to only one mm. Only on division of the muscles did this distance increase by a further 6 mm.

## DISCUSSION AND CONCLUSION

Ever since the first experimental investigations of the pathological anatomy of the acromioclavicular joint (Cadenat 1917) the significance of the coracoclavicular ligament for the stability of the joint has been a subject of discussion. On the basis of post-mortem experiments in five joints not controlled radiologically Urist (1946) concluded that dislocation could take place without the presence of injury to this ligament, and operative investigations in patients with dislocation have corroborated this (Horn 1954). Even so, other authors (Watson-Jones 1956, Brosgol 1961, Stewart 1963 and Riedeberger et al. 1970) have later maintained that rupture of the ligament is a prerequisite for dislocation, as a radiological demonstration of an increase in the distance between the clavicle and the coracoid process has been made in all cases with dislocation.

In our opinion our clinical investigations corroborate Urist's findings, and our radiological results are in complete accordance with the same: A dislocation of the acromioclavicular joint may be present, clinically as well as radiologically, without any injury of the coracoclavicular ligament being present. The length of this ligament allows for a displacement of the lateral end of the clavicle in a proximal direction resulting in a radiological increase in the distance between the clavicle and the coracoid process. An increase in this distance up to 7 mm is thus a useless indication, seen from a diagnostic point of view, as far as the question of a rupture of the ligament is concerned.

In our experience the diagnosis, dislocation of the acromioclavicular joint, should be established by x-ray exposures of the joint in question and with traction of 10 kgf applied to both arms, and a comparison with the opposite, uninjured joint should be made—the reciprocal position of the articular surfaces being the determining factor. Any possible injury of the coracoclavicular ligament can only be definitely demonstrated by surgical intervention, but its presence is considered probable, when the dislocation results in an increase in the distance

between the coracoid process and the clavicle of at least 13 mm, and the distance between the lower edges of the clavicle and the acromion exceeds 20 mm. Complete instability of the joint may be found without any rupture of this ligament, and reconstructive procedures involving the ligament only thus appear irrelevant and rather unsuccessful in the treatment of acromioclavicular dislocations.

The results of post-mortem experiments can hardly be applied directly to the conditions of the living organism, the muscles surrounding the joint apparently having special significance for the stability of the joint; even so, we consider our experimental procedure a realistic imitation of the forces influencing the acromioclavicular joint.

## SUMMARY

The results of post-mortem investigations of the acromioclavicular joint are presented. They concern experiments involving division of the structures around nine joints, the mobility of which has been examined clinically and radiologically. It is demonstrated, clinically as well as radiologically, that acromioclavicular dislocation may occur without injury of the coracoclavicular ligament.

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