Anterior Labroligamentous Structures of the Glenohumeral Joint: Correlation of MR Arthrography and Anatomic Dissection in Cadavers

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OBJECTIVE. The purpose of this study was to establish the accuracy of MR arthrography in depicting the morphology of the glenohumeral ligaments and the superior portion of the glenoid labrum.

MATERIALS AND METHODS. Findings on MR arthrography and those derived from careful dissection of gross specimens were compared in 15 cadaver shoulders, focusing on the morphology and size of the superior and middle glenohumeral ligaments and the morphology of the inferior glenohumeral ligament. The frequencies of sublabral recess and sublabral foramen seen on MR arthrography and at anatomic dissection were also compared.

RESULTS. For the superior and middle glenohumeral ligaments, moderate correlation of size was found between measurements made on MR arthrograms and at anatomic dissection, with the Spearman's rank correlation coefficient calculated as .69990 and .71133, respectively. Morphologic descriptions of the inferior glenohumeral ligament based on MR arthrography and on anatomic dissection also showed good association (Cohen's κ = .8936). Dissection revealed that the sublabral recess was present in 11 specimens. Of these, 10 recesses were identified on MR arthrograms. MR arthrography also revealed a sublabral recess that was not found at dissection. Four sublabral foramina were identified by both MR arthrography and dissection, and two were revealed only by MR arthrography.

CONCLUSION. MR arthrography is useful in the evaluation of the glenohumeral ligaments and the superior portion of the labrum. Anatomic variations of these anterior intraarticular structures can be accurately shown by MR arthrography. In addition, estimation of the size of glenohumeral ligaments can be achieved with acceptable accuracy on MR arthrograms.

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Glenohumeral ligaments have received increased attention in recent years and are thought to play an important role in stabilization of the glenohumeral joint [1, 2]. However, evaluation of the glenohumeral ligaments by conventional MR imaging is challenging, in part because the ligaments may be poorly visualized or may simulate labral lesions [3, 4]. MR arthrography of the glenohumeral joint has been proposed as a more accurate method for evaluation of intraarticular structures than CT arthrography and MR imaging [5–7]. Most of the MR arthrographic studies have used arthroscopic correlation as the gold standard. To our knowledge, no direct correlation of MR arthrographic findings with findings derived from anatomic dissection in cadavers has been accomplished. Indeed, because inconsistencies may be found between arthroscopy and dissection findings, arthroscopy may not be a perfect gold standard. Thus, we compared findings detected with MR arthrography with findings derived from careful dissection of gross specimens.

Materials and Methods

MR arthrography of the glenohumeral joint was performed in 15 shoulders (seven right shoulders and eight left shoulders) derived from 14 cadavers who were 61 to 96 years old at death. No clinical information was available for any of these cadavers. Before MR arthrography was performed, routine radiographs were obtained in each specimen to exclude those with severe arthropathy.

MR imaging was performed after fluoroscopically guided intraarticular injection of 15 ml of a solution of diluted gadopentetate dimeglumine (Magnevist; Berlex, Wayne, NJ), which was made by mixing 1 ml of the contrast medium with 250 ml of normal saline. The humerus was placed in neutral position. MR images were obtained with a 1.5-T scanner (Signa; General Electric Medical Systems, Milwaukee, WI) using a shoulder coil (General Electric Medical Systems). Fat-suppressed T1-weighted spin-echo imaging was then

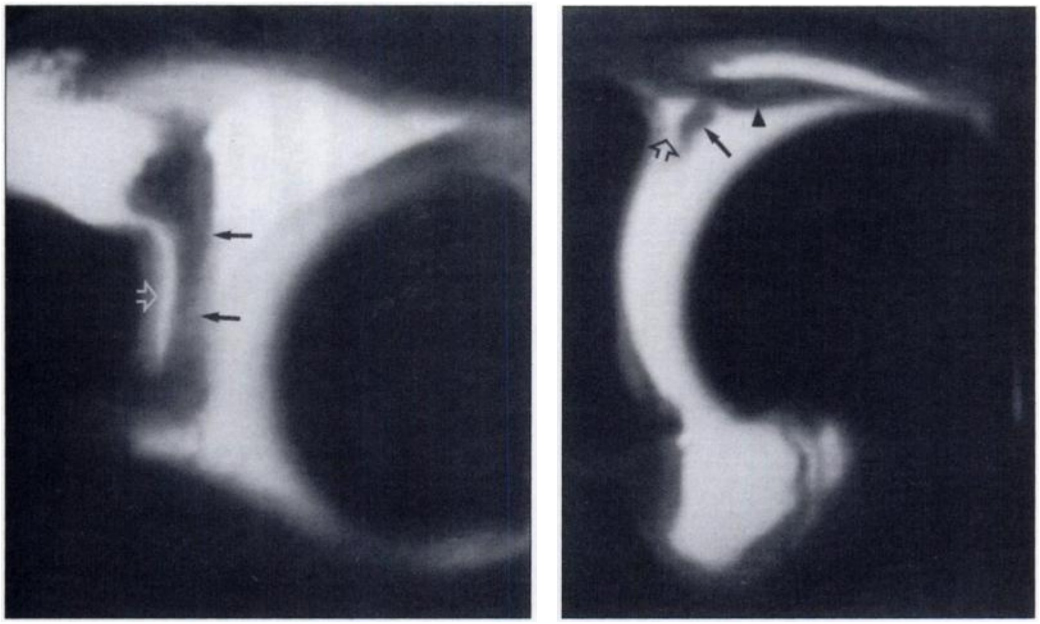

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Fig. 1.—Shoulder of female cadaver who was 76 years old at death.
A, Axial T1-weighted fat-suppressed spin-echo MR arthrogram at level of superior portion of glenoid labrum. Arrows indicate superior portion of glenoid labrum. Open arrow indicates sublabral recess.
B, Oblique coronal T1-weighted fat-suppressed spin-echo MR arthrogram at level of glenoid fossa shows sublabral recess (*open arrow*) between meniscuslike free edge of superior portion of labrum (*arrow*) and articular surface of glenoid rim. Note long head of biceps tendon (*arrowhead*).

performed in transaxial, oblique coronal (parallel to the long axis of the supraspinatus tendon), and oblique sagittal (parallel to the plane of the glenohumeral joint) planes. The technical parameters were 800/16 (TR/TE), two excitations, 12-cm field of view, 3-mm slice thickness, 0.5-mm interslice gap, 256 × 192 image matrix, and fat suppression.

Subsequently, the 15 shoulders were dissected by several different orthopedic surgeons under the additional supervision of one experienced orthopedic surgeon, using a posterior approach that was designed to avoid damage to the glenoid labrum and anterior intraarticular structures. The superior, middle, and inferior glenohumeral ligaments were inspected, and the glenolabral junction was probed to detect the presence of a sublabral recess or sublabral foramen. The sublabral recess was defined as a recess located between the central edge of the superior portion of the labrum and glenoid cartilage (Fig. 1), and the sublabral foramen was defined as a complete separation located between the anterosuperior portion of the labrum and the underlying glenoid rim (Fig. 2A). Both have been described previously as normal variants [8–10].

The configuration of the superior glenohumeral ligament was categorized as foldlike or cordlike. A foldlike structure was defined as a ligament that appeared as a fold of the superior joint capsule, whereas a cordlike structure was defined as a ligament that was suspended intracapsularly with attachment to the capsule only at both ends. The sizes of the superior and glenohumeral ligaments on MR arthrography and their sizes on anatomic dissection were compared. The superior glenohumeral ligament was defined as large when the width was equal to or greater than that of the bi-

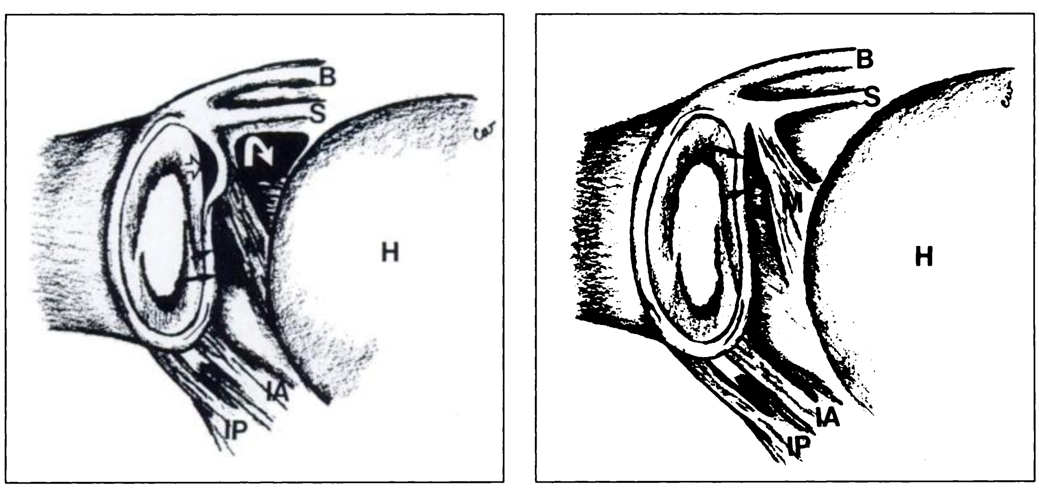

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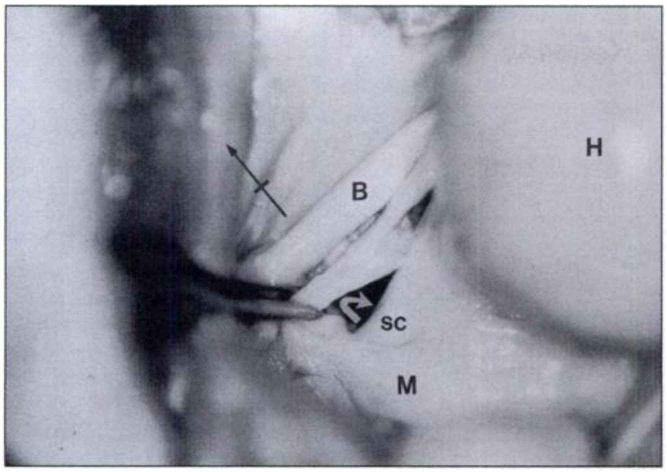
Fig. 2.—Schematic posteroanterior views of anterior structures of glenohumeral joint.
A, Superior glenohumeral ligament (S) arises in glenoid labrum just anterior to insertion of long heads of biceps tendon (B). Middle glenohumeral ligament (M) shows most variation in size of all glenohumeral ligaments. It arises most frequently from labrum immediately below superior glenohumeral ligament or from anterior aspect of glenoid neck. Sublabral foramen (*open arrow*) is normal separation of anterosuperior portion of labrum from glenoid rim. Note also foramen of Weitbrecht (*curved arrow*) and foramen of Rouvière (*long solid arrow*), which are two possible openings to subscapular recess and are located above and below middle glenohumeral ligament, respectively. Short solid arrow indicates subscapularis muscle. IA = anterior band of inferior glenohumeral ligament, IP = posterior band of inferior glenohumeral ligament, H = humeral head.
B, Middle glenohumeral ligament (M) may also conjoin with superior glenohumeral ligament (S). Note that middle glenohumeral ligament is located posterior to subscapularis muscle (*short arrow*). Anterior and posterior bands of inferior glenohumeral ligament (IA and IP) are attached to and contribute to formation of anterior and posterior portions of labrum. Long arrow indicates foramen of Rouvière. H = humeral head, S = superior glenohumeral ligament, B = biceps tendon.



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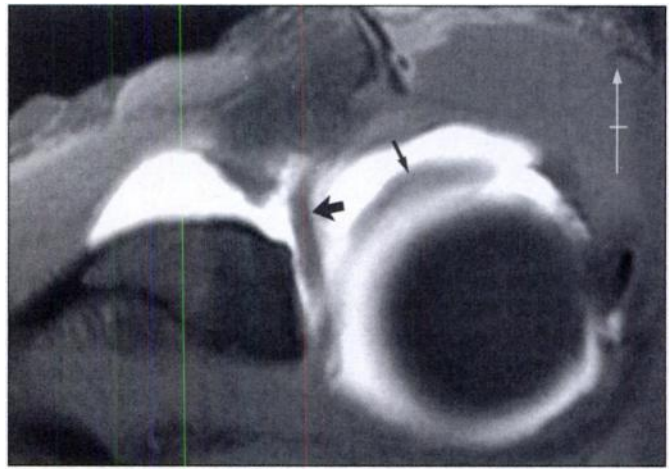

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Fig. 3.—Shoulder of female cadaver who was 84 years old at death.
A, Photograph shows posteroanterior view of anterosuperior joint structures. In about one half (8/15) of shoulders, superior glenohumeral ligament appears as cordlike structure (seen here held in forceps). B = biceps tendon, H = humeral head, SC = subscapularis tendon, M = middle glenohumeral ligament. Curved arrow indicates foramen of Weitbrecht. Direction of crossed long arrow indicates orientation of figure, with arrow pointing to superior side of joint.
B, Axial T1-weighted fat-suppressed spin-echo MR arthrogram. Large arrow indicates superior glenohumeral ligament; small arrow indicates biceps tendon. Direction of crossed long arrow indicates orientation of figure, with arrowhead pointing to anterior aspect of joint.

ceps tendon, medium in size when its width was less than that of the biceps tendon but greater than half of it, and small when its width was less than half the width of the biceps tendon. The middle glenohumeral ligament was defined as large, medium, or small when its width was greater than or equal to 10 mm, between 5 and 10 mm, or less than 5 mm, respectively. The measurements on MR images were based on the axial plane of the glenohumeral joint, whereas the measurements on dissection were determined by direct observation of the width of the ligaments.

The inferior glenohumeral ligament consists of three components: the anterior and posterior bands and the axillary pouch. Of the three components, the anterior band is considered most important to anterior stability of the glenohumeral joint [11]. Because dissection was performed using a posterior approach, the posterior band of the inferior glenohumeral ligament in some specimens was destroyed during the procedure; therefore, only the anterior band was analyzed. The configuration of the anterior band of the inferior glenohumeral ligament was described as bandlike (similar width from the glenoid end to the humeral end, width greater than thickness), cordlike (similar width from the glenoid end to the humeral end, width similar to thickness), or fanlike (gradually increased width from the glenoid end to the humeral end). The characterizations were based on observations derived from MR arthrograms and gross inspections.

All the MR images were analyzed by two radiologists who interpreted the images together and gave an impression on a consensual basis, without knowing the results of the anatomic dissection in advance. The observations derived from the gross inspection of the dissections were also made by consensus with the observers unaware of the MR findings. The observations regarding the superior, middle, and inferior glenohumeral ligaments and the superior portion of the labrum obtained from MR arthrograms and the observations derived from the anatomic dissections were then compared. Spearman's rank correlation coefficient was used for the sizes of the superior and middle glenohumeral ligaments, and Cohen's kappa was used to measure agreement with regard to the appearance of the inferior glenohumeral ligament as observed by the two methods.

Results

MR imaging of the superior, middle, and inferior glenohumeral ligaments was best achieved on the axial and oblique sagittal planes. Oblique coronal images were useful for showing the inferior glenohumeral ligament if it was prominent. The superior glenohumeral ligament was identified in all 15 specimens by MR arthrography, but it could not be seen in one specimen on anatomic dissection because it had been destroyed during the procedure. The inferior glenohumeral ligaments were identified in all 15 specimens by both MR arthrography and anatomic dissection. The middle glenohumeral ligament was identified in 14 specimens by both methods. In one case, the middle glenohumeral ligament and inferior glenohumeral ligament merged into a single prominent structure. The relationship of the anterior labroligamentous structures of the glenohumeral joint with some of the normal variants is seen in Figure 2.

In seven of 15 cases the superior glenohumeral ligament was foldlike, and in eight of 15 specimens it was cordlike (Figs. 3 and 4A). The middle glenohumeral ligament showed great variation in configuration and size. Superiorly, it generally appeared as a discrete intraarticular band that was freely separable from the anterior joint capsule (Figs. 5A, 5C, 6A, and 6B). The middle glenohumeral ligament then became part of the capsule as it descended to the humeral attachment. The free intraarticular part occasionally was very short (2/15) or even absent (2/15), leaving the middle glenohumeral ligament only as a focal thickening (Fig. 7) or folding (Fig. 4A) of the anterior joint capsule. This ligament was absent in one specimen.

The inferior glenohumeral ligament usually arose from a broad-based attachment (1–2 cm) to the anterior portion of the labrum (Fig. 8). In one specimen with a prominent inferior glenohumeral ligament, the ligament was found to originate from the whole anterior portion of the labrum at the 1-o'clock position, with its base spanning more than 4 cm. In contrast, the origins of the superior and middle glenohumeral ligaments usually were narrower and spanned less than 1 cm.

The measurements of the superior and middle glenohumeral ligaments are summarized in Tables 1 and 2. For both ligaments, moderate correlation was found between the sizes as measured by MR arthrography and as measured on anatomic dissection, with the Spearman's rank correlation coefficient calculated as .69990 and .71133, respectively. Morphologic descriptions of the inferior glenohumeral ligament based on MR arthrography and on anatomic dissection also showed good agreement (κ = .8936). Most of the anterior bands of the inferior glenohumeral ligament were either bandlike (47%) or fanlike (40%), with the

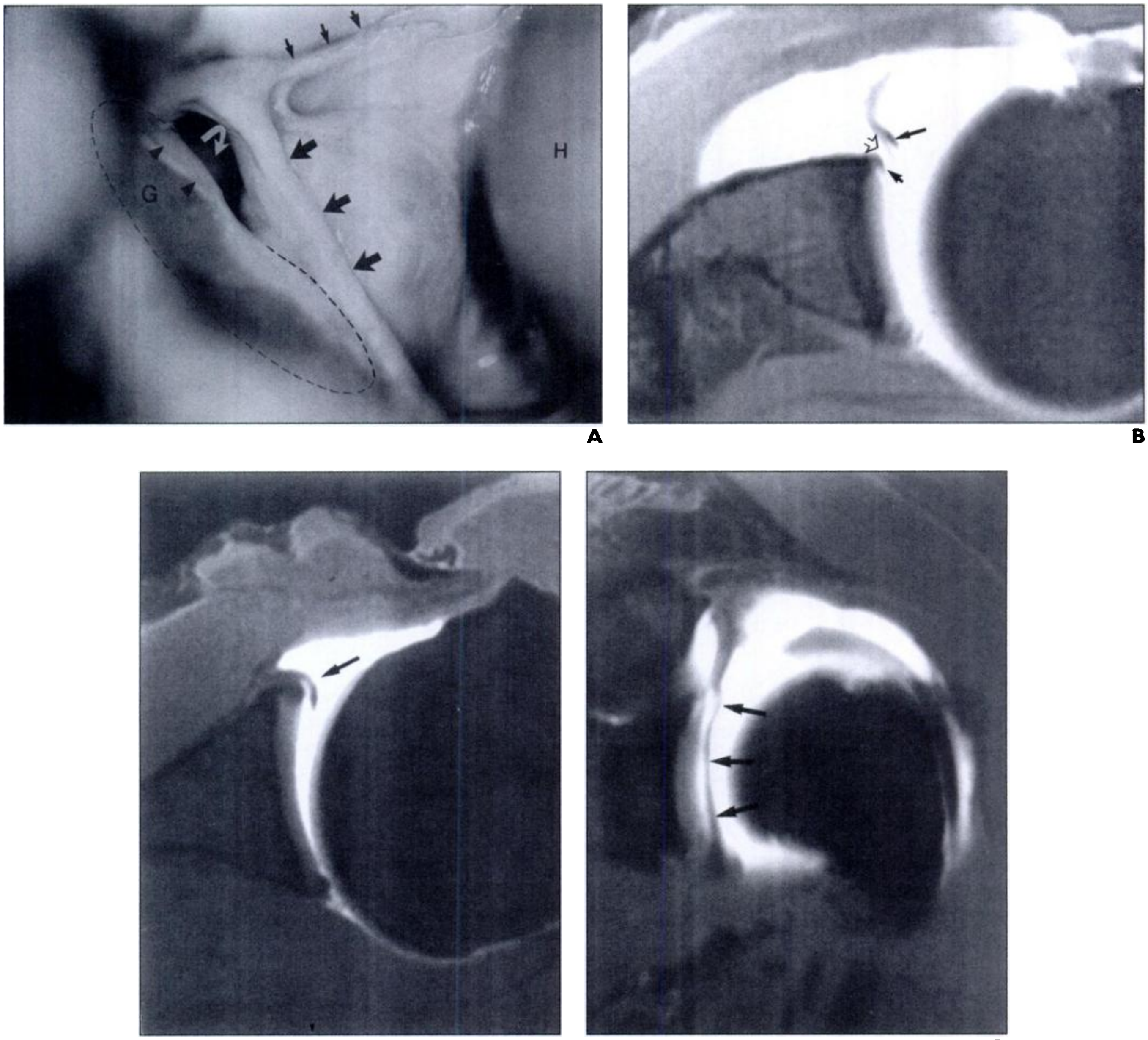

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Fig. 4.—Shoulder of male cadaver who was 76 years old at death.
A, Photograph shows posteroanterior view of anterior joint structure. In this specimen, anterosuperior portion of labrum (*arrowheads*) was hypoplastic. Middle glenohumeral ligament (*large arrows*) originated normally from junction of superior glenohumeral ligament and anterosuperior portion of glenoid labrum, but its medial border reattached to junction of anterior joint capsule and anterior aspect of labrum as it descended to humeral insertion, thereby forming foramen of Rouvière (*curved arrow*) between middle glenohumeral ligament and anterosuperior portion of labrum. H = humeral head, G = glenoid fossa. Interrupted line indicates margin of glenoid fossa. Also noted is foldlike superior glenohumeral ligament (*small arrows*).
B, Axial T1-weighted fat-suppressed spin-echo MR arthrogram at level of superior portion of glenoid fossa. Foramen (*open arrow*) resembled sublabral foramen on casual inspection, but its location between glenoid labrum (*short arrow*) and middle glenohumeral ligament (*long arrow*) is clearly different from that of sublabral foramen.
C, Axial T1-weighted fat-suppressed spin-echo MR arthrogram at level of midportion of glenoid cavity. Arrow indicates middle glenohumeral ligament.
D, Oblique coronal T1-weighted fat-suppressed spin-echo MR arthrogram at level of anterior portion of glenoid fossa. Lateral border of middle glenohumeral ligament (*arrows*) is folded and located between humeral head and glenoid fossa.

cordlike pattern being the least common (13%) (Table 3, Figs. 5 and 8).

Dissection revealed that the sublabral recess was present in 11 of the 15 specimens. Of these, 10 recesses were identified on MR arthrograms (Fig. 1). MR arthrography also revealed a definite sublabral recess that was not observed on dissection. With regard to the sublabral foramen, slightly greater discrepancy existed between findings derived by MR arthrography and findings on anatomic dissection. Four sublabral foramina were identified by both MR arthrography and dissection, and two were revealed only by MR arthrography. The sublabral foramen was not found in any specimen that did not also have a sublabral recess (Fig. 9).

Discussion

The glenohumeral ligaments are thought to be the major passive stabilizers of the glenohumeral joint [11]. The superior glenohumeral

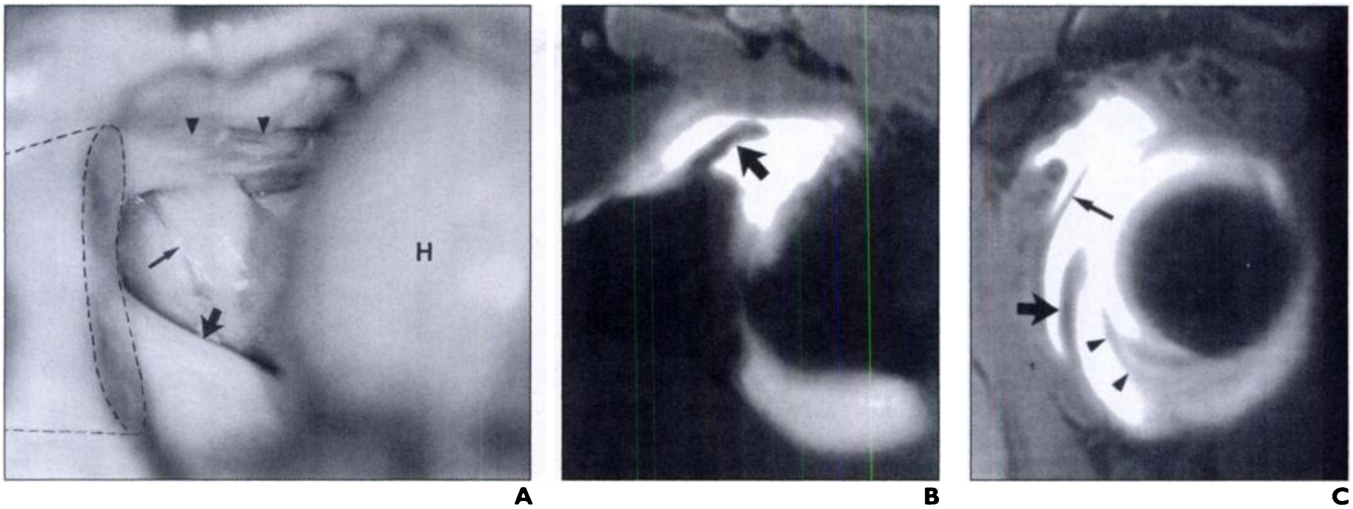


Fig. 5.—Shoulder of female cadaver who was 72 years old at death.
A, Photograph shows posteroanterior view of anterior joint structures, including bandlike inferior glenohumeral ligament (*large arrow*) and middle glenohumeral ligament (*small arrow*). Arrowheads indicate superior glenohumeral ligament. Interrupted line indicates margin of glenoid process. H = humeral head.
B, Axial T1-weighted fat-suppressed spin-echo MR arthrogram. Arrow indicates inferior glenohumeral ligament.
C, Oblique sagittal T1-weighted fat-suppressed spin-echo MR arthrogram shows that inferior glenohumeral ligament (*large arrow*) appears as broad band; middle glenohumeral ligament appears as thin band (*small arrow*). Arrowheads indicate inferior glenoid labrum.

ligament is a fairly constant structure. It arises in the glenoid labrum just anterior to the insertion of the long head of the biceps tendon and inserts just superior to the lesser tuberosity in the region of bicipital groove. This ligament is found in 90–97% of dissected cadavers. In our series, it was seen in all 15 specimens. On MR arthrograms, the superior glenohumeral ligament is best depicted in the axial and oblique sagittal planes.

The middle glenohumeral ligament shows the most variation in size of all the glenohumeral ligaments and is reported to be absent in as many as 30% of shoulders [12]. In our series, it was absent in only one of 15 cases. It arises most frequently from the labrum immediately below the superior glenohumeral ligament (Figs. 2A and 9A) or from the neck of the glenoid fossa. It can also conjoin with the superior glenohumeral ligament (Figs. 2B, 4A, and 5A). This ligament inserts into the anterior aspect of the humerus just medial to the lesser tuberosity. Because it is oriented obliquely from a mediosuperior to a lateroinferior position, this ligament is also best depicted on oblique sagittal MR arthrographic images, and axial images show the transectional dimension of the middle glenohumeral ligament clearly. Although this ligament is oriented in an oblique coronal plane, the oblique coronal images did not allow visualization of the entire length of the ligament, mostly because of the partial volume effect with the anterior joint capsule. In our series, the oblique coronal images clearly showed the middle glenohumeral ligament in only two cases: In the first, a very thick ligament was present, and in the second, a rotated middle glenohumeral ligament was trapped between the glenoid rim and the humeral head (Figs. 4C and 4D).

The inferior glenohumeral ligament is the largest and most important of the glenohumeral ligaments. It consists of an anterior band, a posterior band, and an axillary recess of the capsule between these bands. The anterior and posterior bands are attached to and contribute to the formation of the anterior and posterior portions of the labrum. The ligament inserts in a collarlike fashion into the inferior aspect of the humeral neck. It is lax in adduction and becomes tighter with increasing abduction of the humerus. On MR arthrography, this ligament is usually well visualized in oblique sagittal and axial images and sometimes in oblique coronal images as well.

In our series, the estimation of the size of the glenohumeral ligaments on MR arthrography correlated only moderately well with the measurement derived from anatomic dissection. This result may be attributed to several factors. First, the elasticity of the tissue made our measurements less precise, as the measurement data differed slightly with different degrees of stretching of the tissue. Another factor was slight differences in orientation of the ligaments on MR arthrography and anatomic dissection, which influenced measurements. On MR arthrograms, measurements were based on the axial plane of the glenohumeral joint, whereas on dissection, measurements were determined by the observed width of the ligaments. Theoretically, the middle glenohumeral ligament width evaluated on MR arthrograms should be slightly greater than that obtained on dissection because with MR arthrography the ligament is oblique in orientation.

Nomenclature regarding the normal variations of the superior part of the labrum is not consistent in the literature. The terms "sublabral recess" and "sublabral foramen" are sometimes used interchangeably. In our study, these two terms were applied to different findings. The sublabral foramen was defined as representing the normal separation of the anterosuperior portion of the labrum from the glenoid rim [9, 10] (Fig. 2A). The sublabral recess is a term used to describe the space formed between the meniscuslike free edge of the labrum and the articular surface of the glenoid rim (Fig. 1). It is usually located beneath the superior portion of the labrum, extending both anteriorly and posteriorly. A labrum associated with a sublabral recess has been designated a "type A" labrum in the arthroscopic literature; in contrast, a type B labrum is well attached both centrally and peripherally [8]. These two variations probably are closely related because we have never seen a sublabral foramen without the presence of a sublabral recess. However, the reverse is not true; the presence of a sublabral recess does not necessarily indicate the coexistence of a sublabral foramen.

On the basis of arthroscopy, the sublabral foramen is reported to be present in approximately 11% of all shoulders [8, 13]. This variation was seen more commonly in our series (6/15 cases by MR arthrography, 4/15 cases by

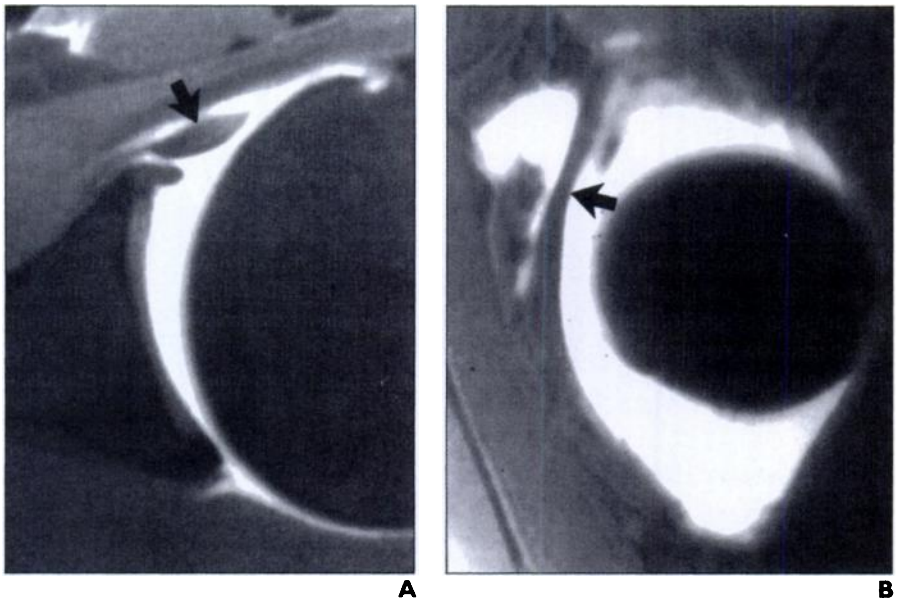


Fig. 6.—Shoulder of male cadaver who was 80 years old at death.

A, Axial T1-weighted fat-suppressed spin-echo MR arthrogram.

B, Oblique sagittal T1-weighted fat-suppressed spin-echo MR arthrogram shows prominent thick middle glenohumeral ligament (*arrow*), which was identified as intraarticular structure separate from anterior joint capsule.

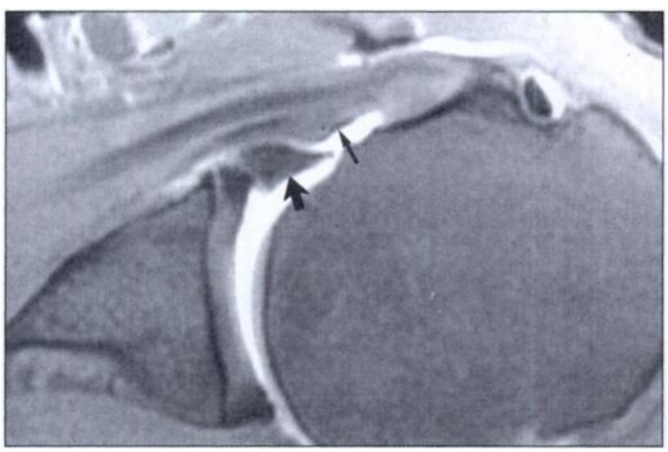


Fig. 7.—Shoulder of male cadaver who was 69 years old at death. Axial T1-weighted fat-suppressed spin-echo MR arthrogram shows another variation of middle glenohumeral ligament and inferior glenohumeral ligament. Middle glenohumeral ligament (*small arrow*) is seen as focal thickening of anterior capsule that is inseparable from capsule. Anterior portion of inferior glenohumeral ligament (*large arrow*) is thick band.

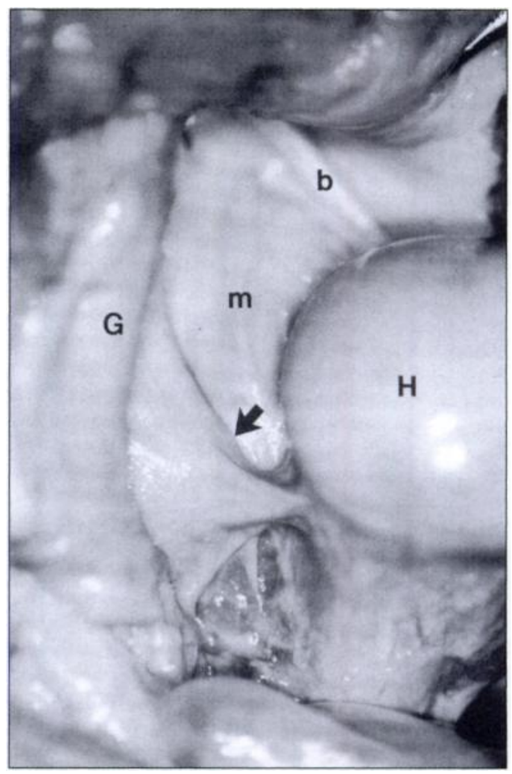


Fig. 8.—Shoulder of female cadaver who was 82 years old at death. Photograph of inferior portion of anterior joint capsule shows fan-shaped anterior band of inferior glenohumeral ligament (*arrow*). H = humeral head, G = glenoid portion of scapula. Long head of biceps tendon (b) and middle glenohumeral ligament (m) are not in focus but are still visible.

dissection), probably related to the elderly population that was studied. The prevalence of the sublabral recess was also high in our series (11/15 by dissection), probably for the same reason. In 1949, DePalma et al. [14] reported findings from 108 cadaver shoulder joints that indicated that nonattachment of the superior portion of the labrum to the glenoid rim was seen in only 17% of cadavers who died during the second decade of life, in more than 50% of subjects who died after the age of 20 years, and in more than 95% of subjects who died in the seventh and eighth decades of life. These investigators suggested that it was an age-dependent degenerative phenomenon, and they

TABLE 1 Correlation of Superior Glenohumeral Ligament Size Revealed by MR Arthrography and Dissection

MR Arthrography	Anatomic Dissection			
	Large	Medium	Small	Subtotal
Large	2	1	0	3
Medium	0	5	2	7
Small	0	1	3	4
Subtotal	2	7	5	14

Note.—Superior glenohumeral ligament was not identified in one specimen because it was destroyed during dissection.

TABLE 2 Correlation of Middle Glenohumeral Size Revealed by MR Arthrography and Anatomic Dissection

MR Arthrography	Anatomic Dissection				
	Large	Medium	Small	Absent	Subtotal
Large	4	1	0	0	5
Medium	2	5	1	0	8
Small	0	0	0	1	1
Absent	0	0	0	1	1
Subtotal	6	6	1	2	15

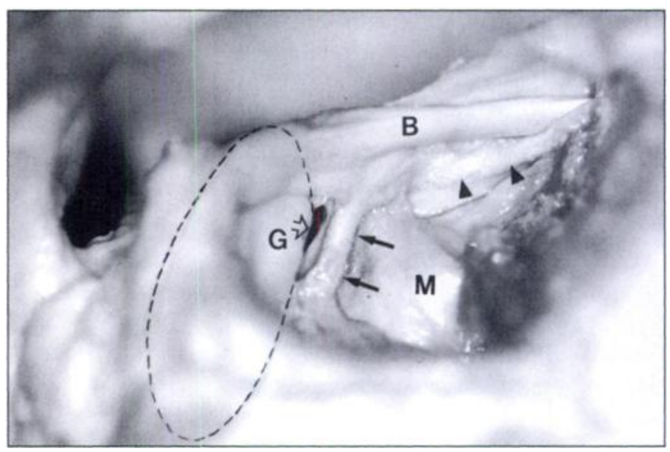
hypothesized further that the pull by the glenohumeral ligament and biceps tendon played a major role in the formation of this variation.

We failed to identify the sublabral foramen on dissection in two specimens in which it was apparent on MR arthrography. In both cases, the foramen was very small. The discrepancy between MR arthrography and anatomic dissection may be related to two factors: either the foramen was too small to probe, resulting in a false-negative on anatomic dissection, or the relatively higher signal intensity of hyaline cartilage was mistaken for contrast medium on the MR arthrograms, resulting in a false-positive MR arthrographic study.

Another important variation of the anterosuperior portion of the glenoid labrum is the Buford complex, which is characterized by focal absence of the anterosuperior glenoid labrum and an associated cordlike middle glenohumeral ligament that originates directly from the superior portion of the labrum at the base

TABLE 3 Correlation of Inferior Glenohumeral Ligament Morphology Revealed by MR Arthrography and Dissection

MR Arthrography	Anatomic Dissection			
	Bandlike	Fanlike	Cordlike	Subtotal
Bandlike	6	0	0	6
Fanlike	0	6	0	6
Cordlike	1	0	2	3
Subtotal	7	6	2	15



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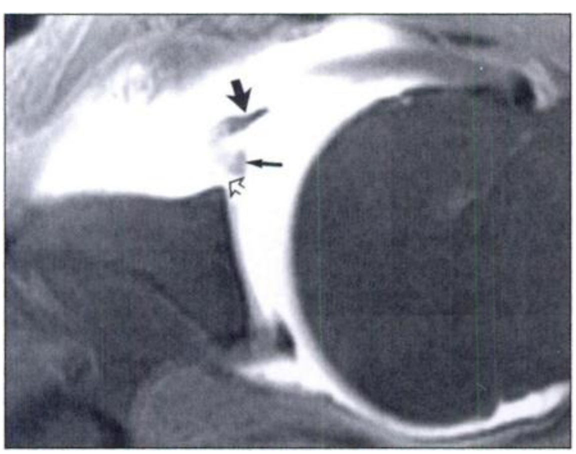

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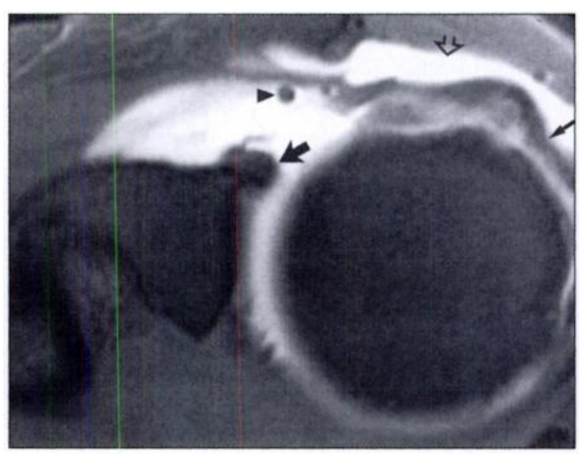

C

Fig. 9.—Shoulder of male cadaver who was 68 years old at death.
A, Photograph of posteroanterior view of anterosuperior joint structure. Separation of anterosuperior portion of labrum (*arrows*) and glenoid cartilage (G) is identified, indicating sublabral foramen (*open arrow*). Arrowheads indicate superior glenohumeral ligament. Interrupted line indicates margin of the glenoid fossa. Humeral head was removed for better visualization of anterior structures. M = middle glenohumeral ligament, B = biceps tendon.
B, Axial T1-weighted fat-suppressed spin-echo MR arthrogram at level of superior portion of glenoid fossa. Sublabral foramen (*open arrow*) was seen between anterosuperior portion of labrum (*small arrow*) and glenoid fossa. Large arrow indicates middle glenohumeral ligament.
C, Firmly attached anterosuperior portion of labrum (*large arrow*) for comparison. Also noted is contrast medium in subdeltoid bursa (*open arrow*) and thinning and irregularity of supraspinatus tendon (*small arrow*), indicating full-thickness rotator cuff tear. Arrowhead indicates gas bubble.

of the biceps tendon [13]. This anomaly, which may be present in 2–5% of persons, may simulate labral tear or detachment. Furthermore, in the axial MR imaging plane, this anomaly may also simulate the sublabral foramen at the level of the superior portion of the glenoid fossa. On MR imaging, a major difference between these two normal variations is that with a sublabral foramen, the cordlike structure reattaches to the anterior portion of the glenoid rim no more inferior than the 3-o'clock position and represents a portion of the labrum. In the Buford complex, the cordlike structure that represents the thickened middle glenohumeral ligament leaves the anterior glenoid rim at the level of the mid and inferior glenoid fossa. No Buford complex was found in our series.

Six different patterns of communication between the glenohumeral space and the subscapular recess have been described by DePalma [15]. In his series, the two most common patterns were type I—one opening between the superior glenohumeral ligament and the middle glenohumeral ligament (30.2%)—and type III—two openings, one above and one below the middle glenohumeral ligament (40.6%). The least common type was type II—one opening below the middle glenohumeral ligament (2.04%). The opening above the middle glenohumeral ligament is referred to as the foramen of Weitbrecht (Fig. 3A) and the one below as the foramen of Rouvière [16] (Fig. 4). In our series, the type II variant defined by DePalma was also uncommon and was observed in only one specimen. On the axial MR arthrographic images in this case, a small foramen of Rouvière was found that closely resembled the sublabral foramen. In this specimen, the anterosuperior portion of the labrum was hypoplastic. The middle glenohumeral ligament originated normally from the junction of the superior glenohumeral ligament and the anterosuperior portion of the glenoid labrum, but the medial border of the middle glenohumeral ligament soon reattached to the junction of the anterior joint capsule and the anterior aspect of the labrum as it descended to its humeral insertion, thereby forming a foramen between the middle glenohumeral ligament and the anterosuperior portion of the labrum. On MR arthrography, the medial border closely resembled the sublabral foramen on casual inspection, but its location between the glenoid labrum and the middle glenohumeral ligament was clearly different from that of a sublabral foramen, which is located between the labrum and the hyaline cartilage of the glenoid cavity. Also apparent in this case was an abnormal orientation of the lateral border of the middle glenohumeral ligament, which was rotated and inserted or trapped between the humeral head and the glenoid rim. The clinical significance of this trapping of the middle glenohumeral ligament was unclear. We also noted that the hyaline cartilage of the humeral head and glenoid fossa was intact (Fig. 4).

This study is limited by several factors. The small number of specimens renders the statistics less significant. The old age of the cadavers at death obviously resulted in a greater frequency of sublabral recess and foramen, which are generally believed to be age-related normal variations. Lack of clinical information about the cadavers was an additional limitation of this study. Histologic data regarding the differentiation of the sublabral recess and foramen from superior labrum anteroposterior lesions were not obtained in this study.

In conclusion, we believe MR arthrography is useful in evaluation of the glenohumeral ligaments and the superior portion of the labrum. Anatomic variations of these anterior intraarticular structures can be accurately shown by MR arthrography. Estimation of the sizes of the glenohumeral ligaments also can be achieved with acceptable accuracy.

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