Elbow Synovial Fold Syndrome

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OBJECTIVE. The purpose of this article is to review the embryologic development, anatomy, and histology of the synovial plicae of the elbow. The pathophysiologic features, clinical manifestations, imaging findings, and treatment of elbow synovial fold syndrome will also be reviewed.

CONCLUSION. Elbow synovial fold syndrome is an uncommon entity that is often confused with lateral epicondylitis. Knowledge of the clinical and imaging diagnosis of this entity is essential for the appropriate management of patients.

Keywords: elbow anatomy, elbow imaging, MR arthrography, MRI, synovial fold

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Synovial plicae are folds of synovial tissue, remnants of embryonic septa of the normal articular development [1–3]. Plicae have no known function and are usually asymptomatic. Plicae may cause clinical symptoms in the elbow joint, especially when they become hypertrophied or inflamed due to direct trauma, repetitive sports activities, or other pathologic elbow conditions [4, 5]. Elbow synovial fold syndrome, or posterolateral impingement [1, 3, 4, 6], can be clinically confused with epicondylitis, frequently delaying appropriate diagnosis [4, 5, 7].

In this article, we will review the embryologic development, anatomy, and histology of the synovial plicae of the elbow. The pathophysiologic features, clinical manifestations, imaging findings, and treatment of elbow synovial fold, or posterolateral impingement, syndrome will be discussed.

Normal Synovial Plicae of the Elbow

Embryonic Development

The elbow joint is formed by mesenchymal cavitation occurring in order at the radiohumeral site, the ulnohumeral region, and finally the radioulnar site, all divided by synovial septa [3]. These three cavities subsequently merge. Elbow synovial plicae, or folds, are septal remnants of this process [1, 8, 9].

Anatomy

The radiohumeral synovial fold is a consistent anatomic structure formed by capsular tissue and is located on the proximal edge of the annular ligament [7, 9, 10]. It is distinct from the annular ligament but contiguous with the radiocapitellar joint capsule, which blends with the common extensor tendon imperceptibly and forms a single enthesis at the lateral epicondyle [7]. The synovial plicae of the elbow are located at the radiohumeral joint and surround the periphery of the radial dome.

The radiohumeral synovial plica has four portions clearly differentiated by location: anterior, lateral, posterolateral, and lateral olecranon [6, 9, 10] (Figs. 1–5). There is no consensus in the literature concerning the incidence, shape, size, and anatomic location of these persistent embryonic structures in the general population. Cadaveric anatomic studies performed by Koh et al. [6] and Isogai et al. [9] identified the radiohumeral synovial fold in 100% of specimens. In 2–12% of individuals, the elbow plica surrounds the fullest extent of the radial dome and is termed a "circumferential synovial fold" [9, 10].

Prior studies have used different terms to describe the elbow synovial fold, so there is no consensus regarding a consistent term for this structure. Terms used to describe the synovial fold of the periphery of the radiohumeral compartment of the elbow include "synovial fringe" [8], "synovial plica of the radiohumeral joint" [1, 11], "lateral synovial plica" [4], and "posterolateral plica of the elbow joint" [5, 12]. A similar structure found in the posterolateral olecranon recess adjacent to the anconeus muscle is described as "posterior plica" or "lateral olecranon synovial fold" [3, 12]. We prefer to include the synovial folds of the elbow with the general term of synovial fold of the radiohumeral joint [6, 9, 10] because we believe that it best describes the nature and the location of the structure.

The most common synovial plica of the elbow, found in in 86–100% of cadaveric specimens, is the posterolateral radiohumeral synovial fold [6, 9, 10]. The anterior fold is found in 67% of cases [6]. The lateral fold is the least common, occurring in 5–20% [6, 9]. Finally, the lateral olecranon fold appears in 28–33% of individuals [3, 10, 12]. When more than two portions are present, the posterolateral component is usually larger and more deeply interposed in the radiohumeral joint than are the anterior or the lateral portions.

Anterior fold—The anterior fold is a thin part of the radiohumeral synovial fold (Figs. 1, 2A, 4, and 5A). The reported size of the anterior fold in cadaveric elbow specimens averaged 18.1 mm in length, 4.3 mm in width, and 2.3 mm in thickness [6, 9].

Lateral fold—The lateral fold is a horizontal meniscoid fold projected into the radiohumeral joint to lie between the capitellum and the outer edge of the radial dome (Figs. 1, 2A, 5A, and 5B). It is crescentic, with a free border that extends over a length of 2.5–4.0 mm between the articular surfaces. The free edge tends to be irregular or jagged and is freely mobile over the articular cartilage. The reported size of the lateral fold in cadaveric specimens averages 13.1 mm in length, 3.6 mm in width, and 1.7 mm in thickness [6, 9].

Posterolateral synovial fold—The posterolateral synovial fold is located at the angle between the lower sigmoid cavity of the ulna, transverse sulcus of the major sigmoid cavity, and radial dome (Figs. 1, 2A, 4, 5A, and 5B). It merges forward with the lateral fold and cranially with the lateral olecranon fold. The median dimensions of a posterolateral fold in cadaveric specimens are 28.5 mm in length, 5.2 mm in width, and 3.0 mm in thickness [6, 9].

Lateral olecranon synovial fold—The lateral olecranon synovial fold originates from the posterolateral fold and runs proximally along the lateral margin of the olecranon, with its rounded apex located at the peak of the lateral nonarticular portion of the trochlear notch. It is located in the posterolateral olecranon recess adjacent to the anconeus muscle (Figs. 1, 2B, 5A, and 5C). The median dimensions of a lateral olecranon fold in cadaveric specimens are 4.3 mm in length, 3.9 mm in width, and 1.9 mm in thickness.

Histology

Normal synovial folds appear as meniscoid (triangular) structures, composed predominantly of fibroadipose tissue (Fig. 6A), with moderate vascularization (Fig. 6B) and abundant nerve endings in the periphery, suggesting the possibility of pain associated with abnormality [7, 10]. Because the synovial fold lacks fibrocartilage, it cannot be called a meniscus [10]. The posterolateral, anterior, and lateral olecranon synovial folds are loose structures composed of a thick fibrous axis and adipose tissue (Fig. 6A). The lateral fold has a more rigid structure than the posterolateral fold, with a preponderance of dense connective tissue and a lesser fatty component.

Function

The function of the synovial elbow folds is unknown. They might act as stabilizers to prevent excessive movement [9]. The fold could occur in the joint and fill the radiohumeral space during extension of the elbow, when the fovea radialis is no longer in close contact with the capitellum. Although their role during pronation and supination may be considered protective, these folds are not directly compressed between the capitellum and the fovea radialis. It does not appear that these folds act like menisci to disperse loading forces across the joint because these stresses are mainly transmitted from the central part of the capitellum to the center of the fovea radialis and from the capitellotrochlear notch to the medial crest of the ulnar edge of the radial head [10].

Because they are richly ennervated, the elbow synovial plicae may play a role in nociception, proprioception, and coordination of movements. The elbow synovial folds might help to distribute synovial fluid within the elbow joint by way of the "windshield wiper" effect during joint motion.

Elbow Synovial Fold Syndrome

Pathophysiologic Features

The pathophysiologic features of plica syndrome are not clearly defined. Plica syndrome arises from an injury, such as a direct blow, repetitive microtrauma, and overloading (e.g., sports that require repetitive flexion-extension, such as throwing athletes and golfers), a twisting force that stretches the plica, or some other pathologic elbow condition that incites an inflammatory reaction [4]. Repetitive injury provokes inflammatory thickening of the synovial fold and chronic localized synovitis [1, 13]. As the fold thickens, it can become interposed and compressed between the articular surfaces during certain movements, producing snapping of the joint. Mechanical abrasion by the snapping plica may produce chondromalacia along the radial head and capitellum [1, 11] (Fig. 7). Some authors have suggested a possible relationship of the elbow synovial folds with the pathogenesis of epicondylitis [7].

Clinical Manifestations

Synovial fold syndrome of the elbow is more common in athletic young adults. It is more common in sports that require repetitive flexion-extension, such as tennis, golf, and other sports that involve throwing [3, 4].

The symptoms of synovial plicae in the elbow are nonspecific and require careful evaluation for proper diagnosis because the clinical findings mimic epicondylitis [5]. On examination, pain is usually located posterolaterally, not along the lateral epicondyle or extensor tendon origin. Plicae can cause lateral elbow pain even before the development of locking or catching symptoms [1, 13].

Thickened synovial folds may present clinically with snapping pain as the main complaint or elbow locking during elbow flexion and extension [1, 5, 8, 14]. The diagnosis of elbow synovial fold syndrome, or posterolateral impingement, should be considered in patients with painful snapping, particularly if they have symptoms on the lateral side of the elbow [1, 14, 15]. Description of the exact arm position for reproducing symptoms of this condition has been inconsistent in the literature. Reproduction of symptoms during flexion-extension of the pronated forearm (flexion-pronation test) should lead the examiner to consider the possibility of a pathologic synovial plica in the radiocapitellar joint [1, 8, 11]. Because a positive flexion-pronation test is found in only 25–50% of patients presenting with symptoms of clicking or catching [4, 11], it is possible that these symptoms depend on the location of the plicae and other anatomic variations. A syndrome of limited extension caused by impingement of a lateral olecranon plica in the olecranon fossa has also been described [3].

Elbow synovial fold syndrome is usually an isolated condition [4]. There are only a few cases reported in the literature of elbow synovial fold syndrome associated with other abnormalities, such as posterolateral instability, medial collateral ligament injury, lateral epicondylitis, cubital neuropathy, or loose bodies [1, 5].

Imaging Diagnosis

Ultrasound—High-resolution ultrasound is a useful tool in the evaluation of patients with lateral elbow pain and elbow snapping, allowing an accurate diagnosis of elbow synovial fold syndrome and establishing the differential diagnosis with other more common conditions of the elbow, such as lateral epicondylitis [16].

The elbow synovial folds can easily be evaluated on ultrasound because of their superficial location at the periphery of the radiohumeral compartment [16, 17]. On ultrasound, the normal synovial fold shows a hyperechoic triangular shape surrounded by a thin hypoechoic ring [6]. Pathologic synovial folds appear thickened on ultrasound, with irregular echogenicity and margins (Fig. 8). Color Doppler ultrasound enables easy identification of focal synovitis in some cases of elbow synovial fold syndrome.

Advantages of ultrasound are multiple: the ability to perform contralateral comparative studies, clinical correlation, and dynamic study [17]. The dynamic exploration in flexion and extension is a simple and reliable method to assess the snapping elbow [6]. The interaction with the patient enables location of the point of the elbow pain and snapping joint in the dynamic study.

MRI—MRI is the imaging method of choice in the evaluation of most of the pathologic processes of the elbow. MRI assures an accurate assessment of pathologic plicae of the elbow, articular cartilage, and associated injuries, helping in determining appropriate treatment planning. However, MRI is limited when there is a small quantity of fluid [4] or absence of focal synovitis. Most of the cases of elbow plica syndrome diagnosed on MRI occur in patients diagnosed with lateral epicondylitis after failure of long-term conservative treatment [16].

Normal synovial folds appear as hypointense bands surrounded by synovial fluid [3, 12]. They are best assessed on fluid-sensitive sequences. On MRI, a pathologic plica is characterized by thickening, abnormal signal intensity, and irregular margins. There is significant overlap in the size between symptomatic and asymptomatic plicae. A cutoff value of 3 mm for thickened elbow folds has been suggested in the literature [3, 12]. Thickened synovial folds (> 3 mm) are most frequently symptomatic. Furthermore, although nodular or irregular appearance is associated more often with symptomatic plicae, these changes are not specific and can be seen in both symptomatic and asymptomatic patients [4, 18].

MRI can be used to evaluate important secondary signs of elbow synovial fold syndrome, such as the existence of focal posterolateral synovitis and chondromalacia in the anterolateral aspect of the radial head or, less frequently, on the capitellum [1, 11]. Chondromalacia is secondary to chronic mechanical snapping of the synovial folds over the surface [1, 11].

MRI after IV administration of gadolinium improves the detection of focal synovitis [19]. The presence of focal synovitis in the posterolateral elbow is an important secondary sign of elbow synovial fold syndrome but may not be present in some cases, especially in patients with chronic symptoms.

CT arthrography or MR arthrography—Some symptomatic plicae could be missed on nonarthrographic MRI in patients without joint fluid [4]. Intraarticular contrast administration with CT or MR arthrography highlights joint surfaces and distends the capsule, thereby providing excellent visualization of plicae [15]. Thickening and morphologic changes of the plicae and associated chondral lesions of the radial head and capitellum are identified more accurately on CT or MR arthrography than on MRI [4, 20] (Figs. 9 and 10).

MR arthrography of the elbow may also help in the evaluation of undersurface collateral ligament tears, chondral injuries, osteochondritis dissecans, and intraarticular loose bodies in patients without a joint effusion [17, 20]. CT arthrography is, in general, slightly better than MR arthrography for showing morphologic abnormalities of the articular cartilage, but both techniques are useful for showing articular cartilage defects in the elbow. Patients in whom MRI is contraindicated may benefit from CT arthrography [17].

Summary of imaging approaches—Ultrasound is a highly useful tool in the initial evaluation of patients with lateral elbow pain or snapping elbow. In patients with elbow synovial fold syndrome, ultrasound can frequently help identify pathologic plicae and suggest the differential diagnosis, with other causes of lateral elbow pain most prevalent, such as lateral epicondylitis. In patients reporting articular snapping, dynamic ultrasound can identify the plica snapping and differentiate it from other entities causing snapping elbow, such as joint bodies.

MRI is the most requested imaging method by orthopedists in cases of lateral elbow pain, especially in patients without response to conservative treatment. MRI gives an overall assessment of the elbow, identifying in most cases the elbow synovial fold syndrome and enabling determination of a differential diagnosis with other causes of lateral elbow pain and accurately ruling out associated injuries, such as ligament injuries. MR arthrography is the most reliable method in the accurate preoperative evaluation of elbow synovial fold syndrome in patients without a joint effusion.

Differential Diagnosis

Pathologic elbow synovial folds can cause lateral elbow pain even without joint locking or catching during the initial phase of the syndrome [1, 13]. The differential diagnosis for causes of lateral elbow pain includes lateral epicondylitis, compression of the posterior interosseous nerve, and intraarticular abnormality [10, 16]. The main differential diagnosis for elbow synovial fold syndrome is lateral epicondylitis (tennis elbow) [5, 11] (Fig. 11). Plica syndrome should also be considered in patients who have undergone unsuccessful treatment for lateral epicondylitis.

When a patient complains of painful locking or snapping of the elbow, several entities must be ruled out. Loose bodies, instability, a torn or incompetent annular ligament [21] (Fig. 12), and snapping of the medial head of the triceps over the epicondyle are the most common causes of this problem [1, 15, 18].

Treatment

Nonsurgical treatment, including rest from all strenuous physical activities, physiotherapy, and nonsteroidal antiinflammatory agents, is preferable initially. Failure of conservative therapy leaves arthroscopic excision of the pathologic plica as the treatment of choice. Arthroscopic intervention should not be delayed by prolonged conservative treatment because subsequent erosion of the articular cartilage can be prevented by early resection [1, 11]. Arthroscopic resection of the plica and associated focal fibrosis or synovitis and repair of chondral defects lead to excellent outcomes [1, 4, 5, 8, 11].

Conclusion

Elbow synovial fold syndrome or posterolateral impingement is a clinical entity characterized by pain and mechanical symptoms in the joint. This entity is frequently under- or misdiagnosed. Familiarity with this entity may prevent misdiagnosis in patients with lateral elbow pain or snapping elbow. MRI and CT or MR arthrography are useful tools in the diagnosis of elbow synovial fold syndrome for exclusion of other causes of lateral elbow pain and snapping. Early diagnosis and treatment of elbow synovial fold syndrome are crucial to avoid mechanical degeneration of the articular cartilage.

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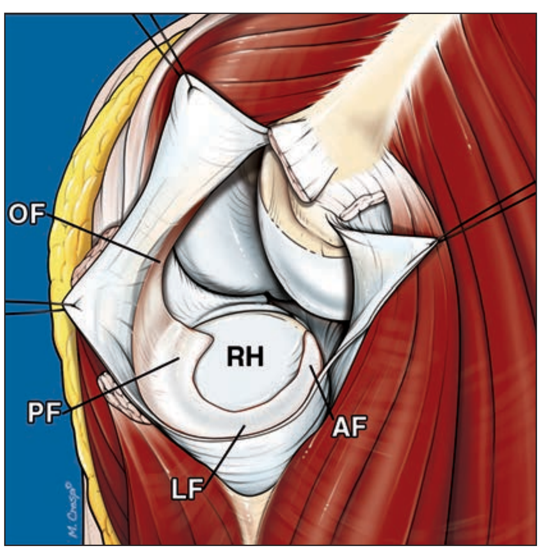
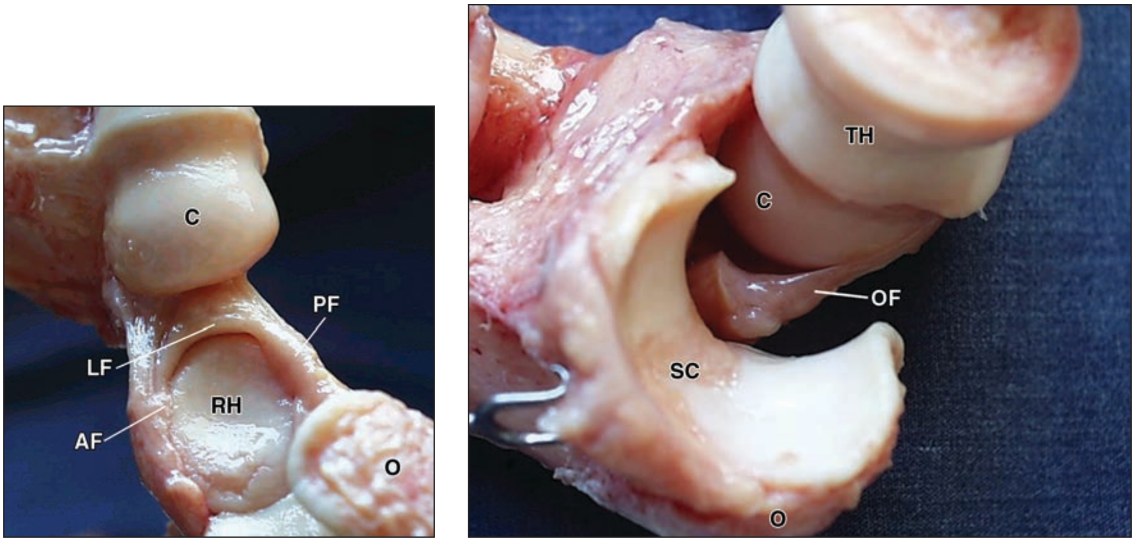
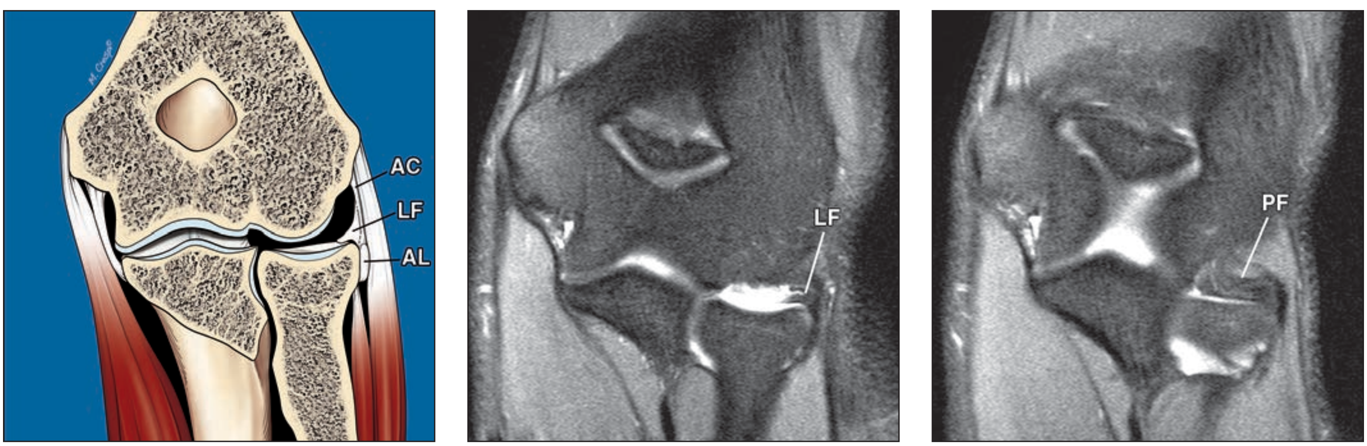


Fig. 1—Anatomy of radiohumeral synovial fold. Diagram of elbow joint laterally opened shows normal appearance of elbow synovial plicae (circular-type fold). AF = anterior fold, LF = lateral fold, PF = posterolateral fold, OF = lateral olecranon fold, RH = radial head.



A B

Fig. 2—Anatomy of radiohumeral synovial fold.
A and **B,** Cadaveric dissection images show normal radiohumeral synovial fold (circular-type fold) (**A**) and normal lateral olecranon synovial fold (**B**). AF = anterior fold, LF = lateral fold, PF = posterolateral fold, OF = lateral olecranon fold, RH = radial head, O = olecranon, C = capitellum, SC = sigmoid cavity, TH = trochlea of humerus.



A B C

Fig. 3—Anatomy of synovial folds.
A, Frontal diagram of radiohumeral joint shows normal ‘‘pseudomeniscoid’’ appearance of lateral radiohumeral fold, located between capitellum and edge of fovea radialis, fixed to capsule above superior edge of annular ligament. AC = articular capsule, LF = lateral fold.
B and **C,** Coronal proton density fat-suppressed MR images in 22-year-old man show normal jagged appearance of lateral (**B**) and posterolateral (**C**) folds. LF = lateral fold, PF = posterolateral fold.

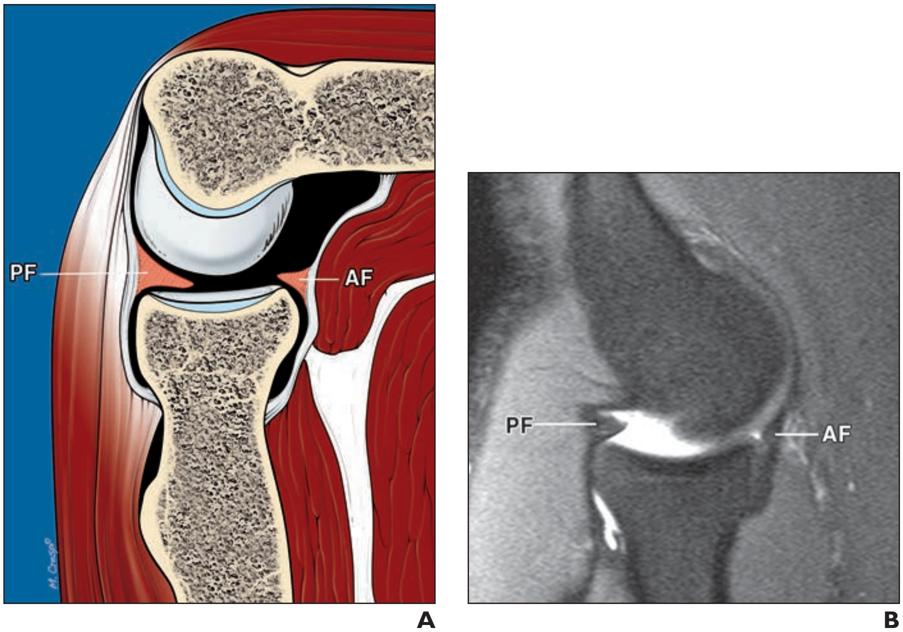


Fig. 4—Anatomy of synovial folds.
A, Sagittal diagram illustrates normal appearance of posterolateral fold (PF) and anterior fold (AF). Posterolateral fold is most common and usually thickest synovial elbow fold.
B, Sagittal proton density fat-suppressed MR image in 22-year-old man shows normal appearance of posterolateral and anterior folds. AF = anterior fold, PF = posterolateral fold.

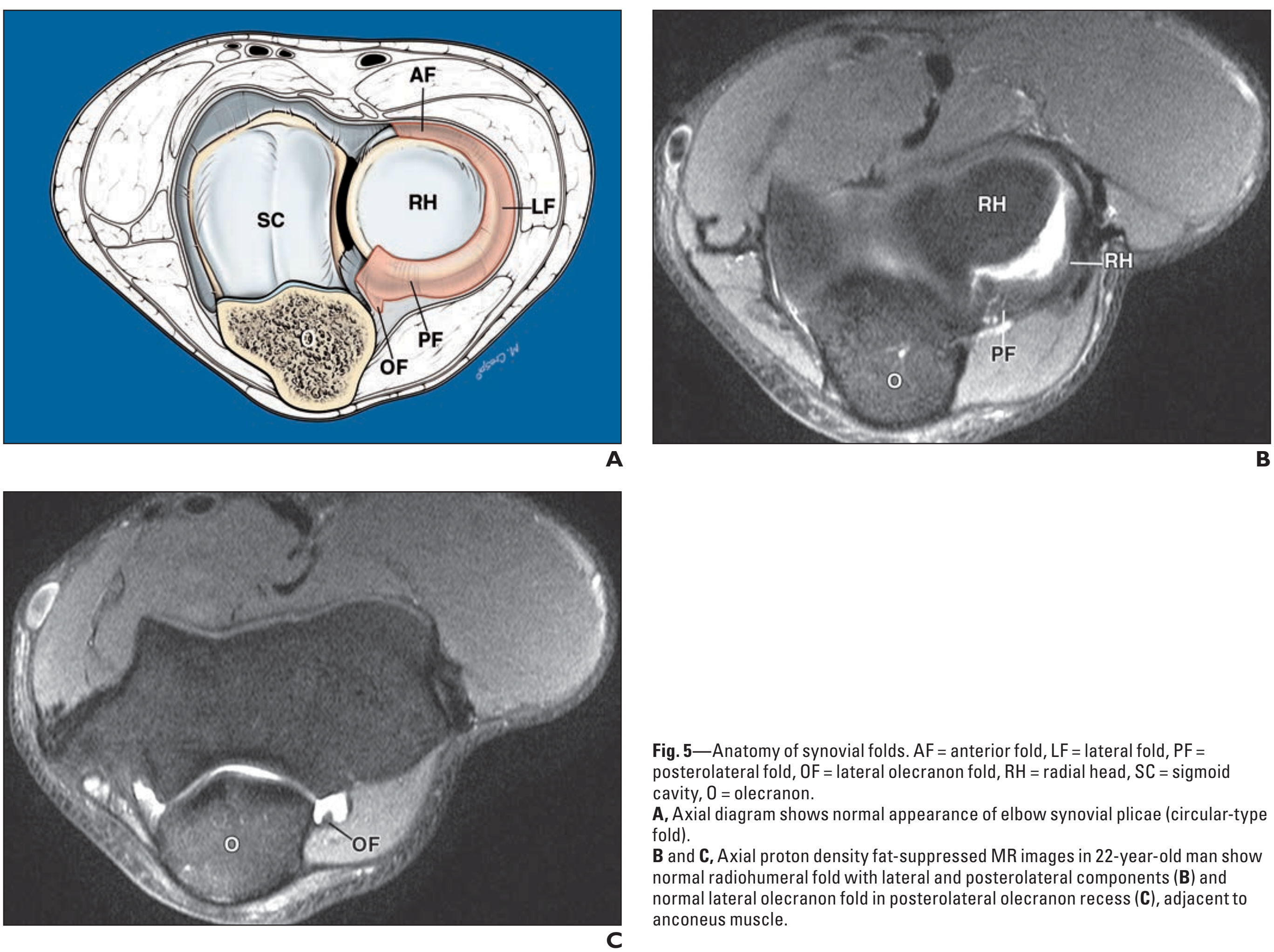


Fig. 5—Anatomy of synovial folds. AF = anterior fold, LF = lateral fold, PF = posterolateral fold, OF = lateral olecranon fold, RH = radial head, SC = sigmoid cavity, O = olecranon.
A, Axial diagram shows normal appearance of elbow synovial plicae (circular-type fold).
B and **C,** Axial proton density fat-suppressed MR images in 22-year-old man show normal radiohumeral fold with lateral and posterolateral components (**B**) and normal lateral olecranon fold in posterolateral olecranon recess (**C**), adjacent to anconeus muscle.

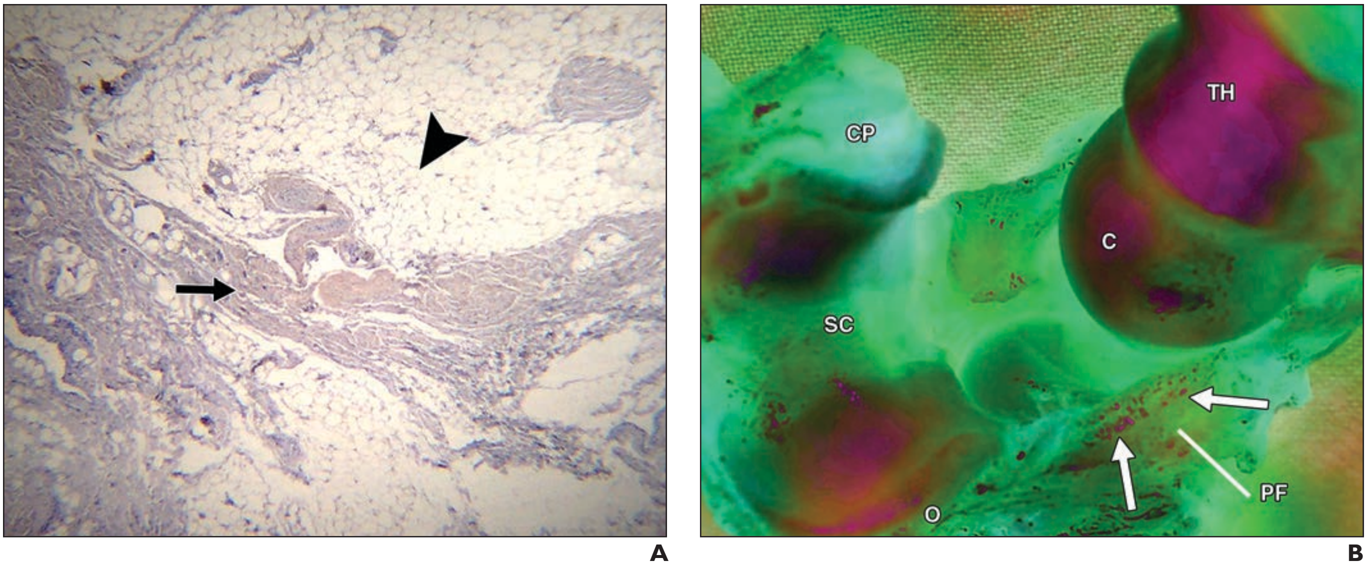


Fig. 6—Histology of elbow synovial fold.
A, Photomicrograph of posterolateral synovial fold in 58-year-old man shows loose structure with thick fibrous axis (*arrow*) and predominance of adipose tissue (*arrowhead*), without fibrocartilage.
B, Photomicrograph shows normal vascularization of posterolateral synovial fold (*arrows*) in 58-year-old man. PF = posterolateral fold, O = olecranon, C = capitellum, TH = trochlea of humerus, CP = coronoid process.

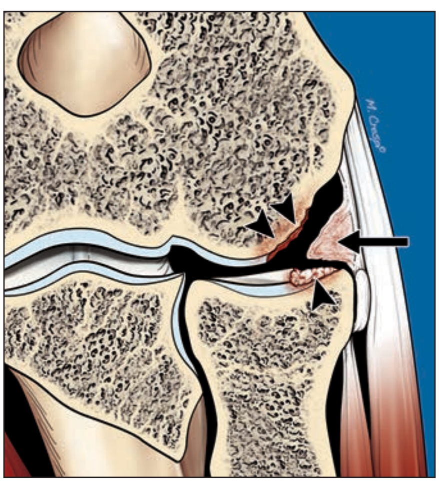


Fig. 7—Diagram shows typical features of elbow synovial fold syndrome, including thickened and inflamed plica (*arrow*) and chondral fraying of radial head and capitellum (*arrowheads*).

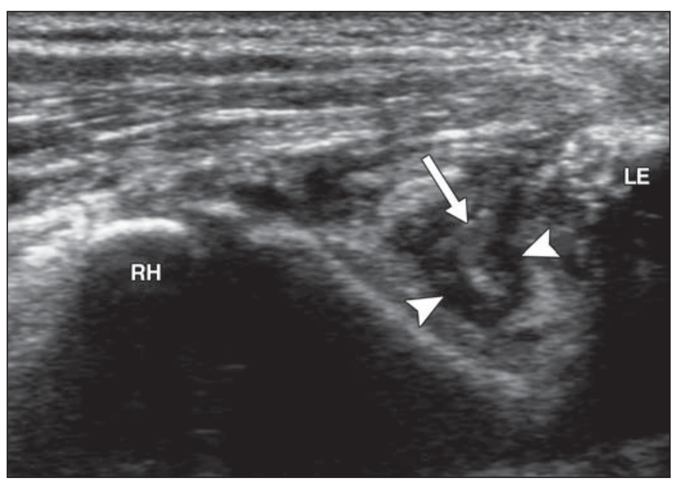


Fig. 8—32-year-old male tennis player with posterolateral elbow pain without snapping. Longitudinal ultrasound image obtained at posterolateral aspect of elbow reveals thickened posterolateral fold (*arrow*) with focal surrounding synovitis (*arrowheads*). RH = radial head, LE = lateral epicondyle.

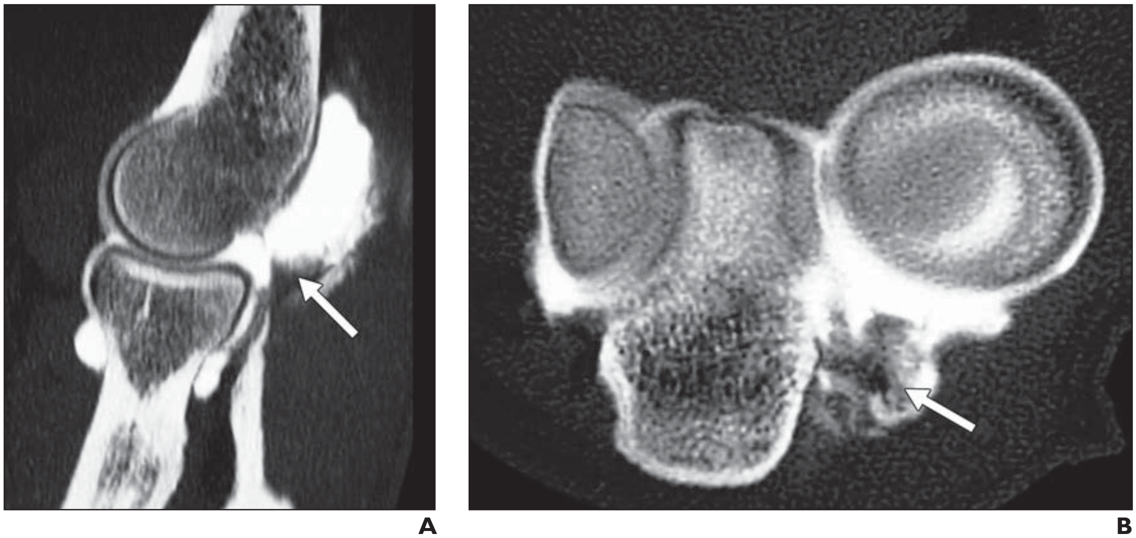


Fig. 9—24-year-old male tennis player with lateral elbow snapping pain.
A and **B,** Sagittal (**A**) and axial (**B**) CT arthrography images show irregular thickening of posterolateral synovial fold and focal surrounding fibrosis (*arrow*). Articular cartilage appears normal.

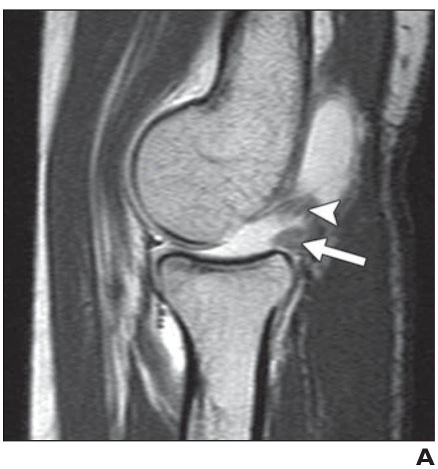
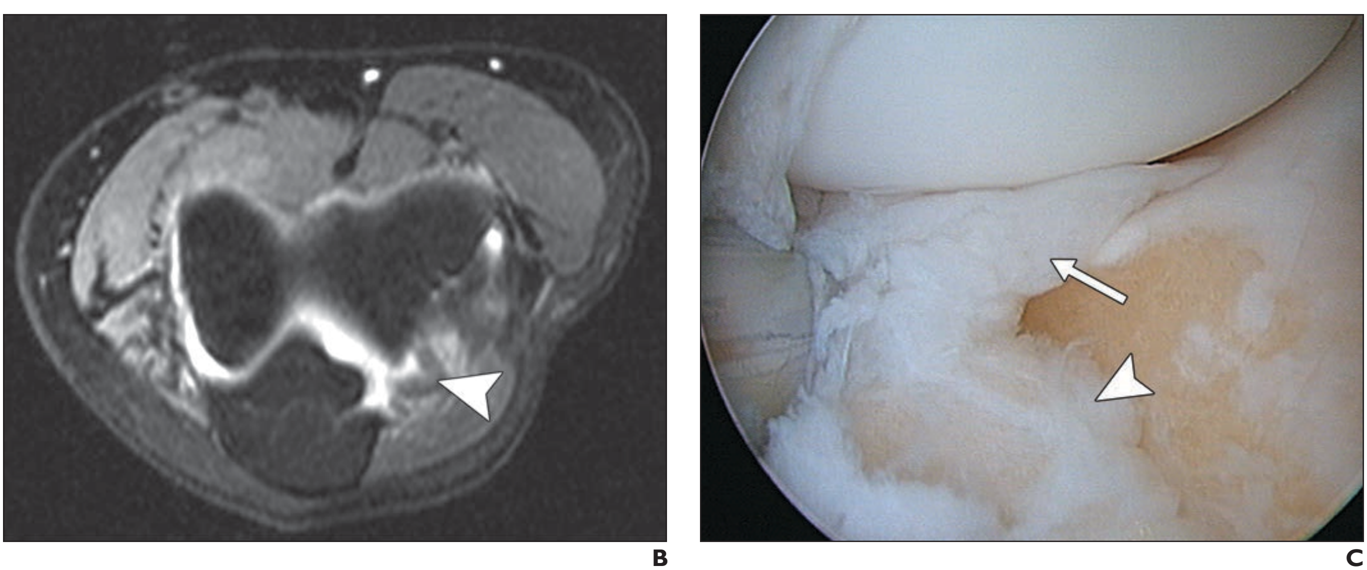
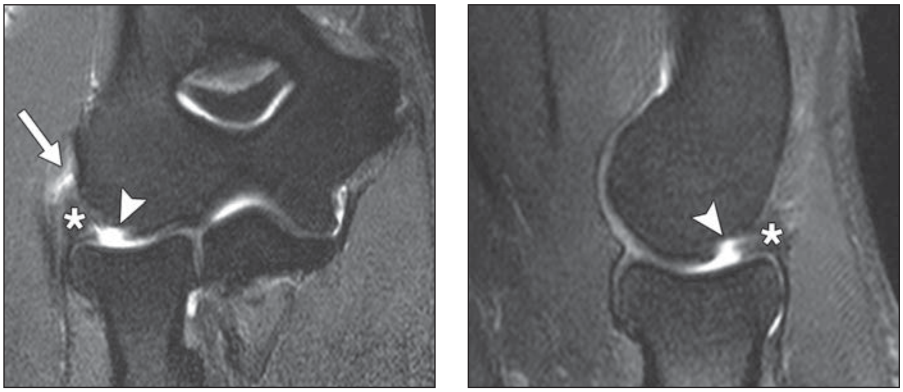


Fig. 10—20-year-old female hockey player with posterolateral painful snapping elbow.
A and **B,** Sagittal T1-weighted (**A**) and axial T1–weighted fat-suppressed (**B**) MR arthrography images reveal thickened posterolateral fold (*arrow*, **A**) and irregular band of fibrosis (*arrowhead*).
C, Arthroscopic image of radiocapitellar joint shows impingement of joint caused by thickened hypertrophic fold (*arrow*) and irregular focal fibrosis (*arrowhead*). Arthroscopic débridement allows complete recovery of symptoms.



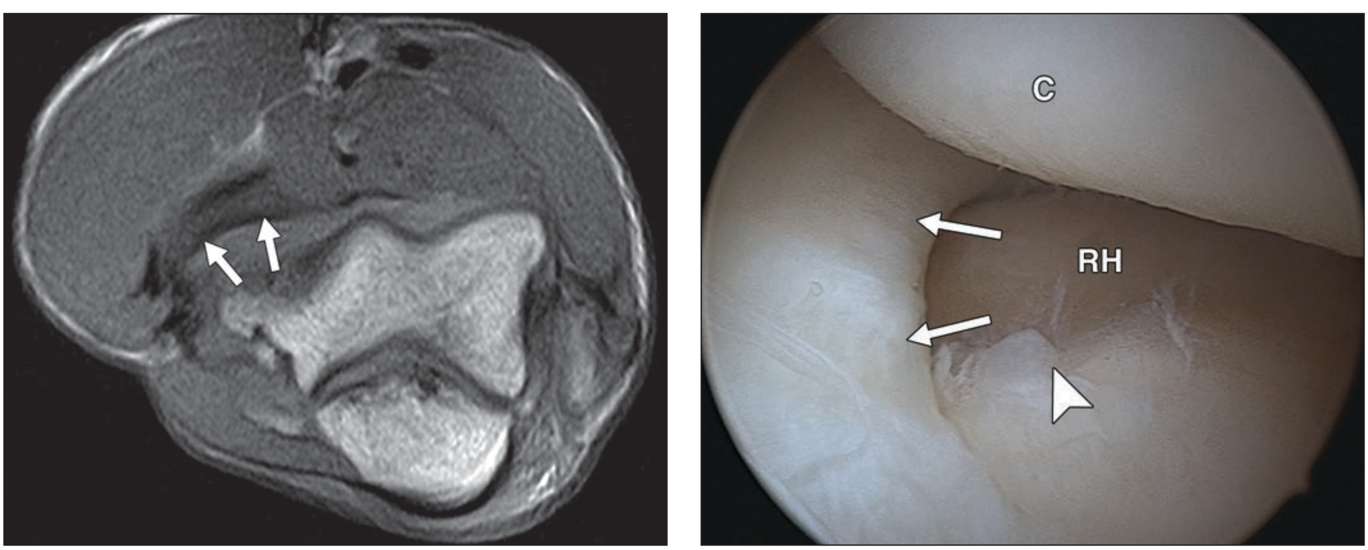


A B

Fig. 11—38-year-old man with lateral elbow pain.
A and **B,** Coronal (**A**) and sagittal proton density fat-suppressed (**B**) MR images show tendinosis and partial tear of common extensor tendon (*arrow*, **A**), presence of pseudodefect of capitellum (*arrowhead*), and normal posterolateral synovial fold (*asterisk*). These anatomic variants should not be confused with pathologic fold with chondromalacia of capitellum.

A

Fig. 12—32-year-old man with posterolateral rotatory instability and lateral elbow snapping pain.
A and **B,** Sagittal proton density fat-suppressed (**A**) and axial T1-weighted (**B**) MR images show intraarticular luxation of anterior aspect of annular ligament (*arrows*) and humeral condyle chondromalacia with subchondral marrow edema (*arrowhead*, **A**). This entity can easily be misdiagnosed as anterior fold thickening.
C, Arthroscopic image of radiocapitellar joint shows intraarticular subluxation of anterior aspect of annular ligament (*arrows*) and chondromalacia of anterolateral aspect of radial head (*arrrowhead,* not detected at MRI). C = capitellum, RH = radial head.



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