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# Ultrasonographic evaluation of the posterolateral radiohumeral plica in asymptomatic subjects and patients with osteoarthritis.

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**Abstract**

**Aims:** The aim of this study was to describe the morphological features of posterolateral radiohumeral (RH) plica in asymptomatic subjects and in patients with elbow osteoarthritis using ultrasonography (US). **Material and methods:** The control group included a total of 100 healthy elbows (51 subjects) and the study group consisted of 22 elbows (22 patients) with osteoarthritis confirmed clinically and by imaging methods. The presence, length, height, thickness, cross sectional area, shape, and echogenicity of the posterolateral RH plica were evaluated in both groups. In addition, humeral and radial cartilage thicknesses were also measured. The clinical characteristics and radiographic findings of the study group were evaluated. **Results:** The posterolateral RH plica was present in all elbows of the control group (100%) and in 15 (68%) of elbows in the study group ($p<0.05$). All sizes and cross sectional areas of the plica were statistically significantly lower in the elbows of the study group compared to the elbows of the control group ($p<0.05$ and $p<0.001$, respectively). The detected posterolateral RH plicae were triangularly shaped in both groups. The plica was hyperechoic in 95 elbows (95%) in the control group and 7 osteoarthritis elbows (46.7%) ($p<0.001$). The thicknesses of radial and humeral cartilage were also significantly higher in the control group ($p<0.001$). There were no statistically significant relationships between the radiographic scoring of the elbow osteoarthritis and US findings of the RH plica (all $p>0.05$). **Conclusions:** The posterolateral RH plica can be successfully evaluated using US. Based on these findings, it appears that osteoarthritis can result in a reduction of sizes of the RH plica and affect its morphological appearance.

**Keywords:** radiohumeral plica, ultrasonography, elbow, osteoarthritis

## Introduction

The radiohumeral (RH) plica is an embryological synovial remnant arising from the synovial membrane of the elbow joint [1,2]. This plica (fig 1) is located on the proximal border of the annular ligament and extents into the radiohumeral joint space [3]. Synovial plicae may also exist in other joints, including the knee and hip; these plicae are thin, vascularized structures and have been reported to have little clinical significance [4-6], although the plicae can sometimes be associated with pathological processes, especially when these structures become hypertrophic and inflamed (plica syndrome).

Disorders associated with the elbow plicae, which are usually associated with plica syndromes, have been less frequently described in the literature. Accordingly, there is no consensus about the shape, size, and location of the normal RH plica [3,7]. To our knowledge, no study has evaluated and imaged features in patients with elbow osteoarthritis.

The purpose of this study is to describe morphological features of posterolateral RH plica in asymptomatic subjects and in patients with elbow osteoarthritis using ultrasonography (US).

## Material and methods

The control group encompassed a total of 100 elbows in 51 subjects without complaints, history of trauma and

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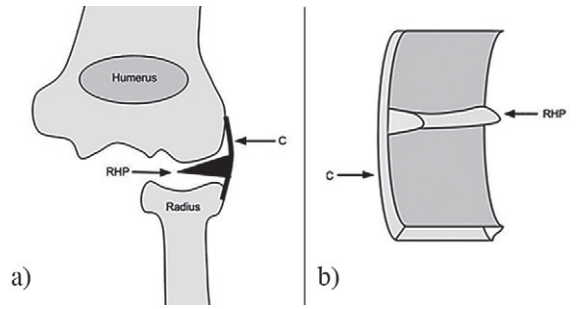


**Fig 1.** Diagrams show the RH plica. RHP: Radiohumeral plica, C: Joint capsule

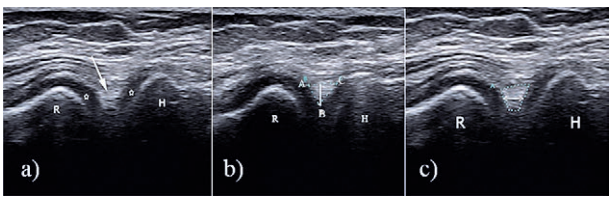


**Fig 2.** The posterolateral RH plica (arrow) is hyperechoic and triangularly shaped in an asymptomatic 37-year-old female (a). Maximal thickness (AC), radial side length (AB), humeral side length (BC), and width (white line) of the posterolateral RH plica were measured (b). The area (dashed line) and midpoint thickness (double head arrow) were also measured (c). R: radius; H: humerus; Stars: cartilage.

surgery, arthritis, or congenital abnormality associated with the elbow. The osteoarthritis group consisted of 22 elbows in 15 patients with osteoarthritis confirmed clinically and by imaging modalities, such as X ray, computed tomography, or magnetic resonance (MR) imaging. Special attention was directed to the exclusion of patients with a history of elbow surgery in the osteoarthritis group. Age and gender of all patients were recorded. All patients and healthy volunteers of our study gave full written informed consent, according to the World Medical Association Declaration of Helsinki, revised in 2013 and the internal Ethics Review Board approved the design of the study.

US examinations were performed using a Toshiba Aplio 500 (Toshiba Medical Systems, Tokyo, Japan) scanner with a multifrequency (14–18 MHz) linear-array transducer by a radiologist with 7 years of experience. The patients were seated facing towards the operator and the lateral aspect of their elbows in flexion with the forearm pronated was examined.

The posterolateral synovial plica was defined as a hypo- to hyperechoic, relative to muscle, structure between the capitellum and the outer edge of the radial head in the RH joint. Echogenicity, homogeneity, and shape of the plicae were evaluated. The echogenicity of the plicae were recorded as hyper, iso, or hypoechogenic. The side lengths, width, maximal thickness, midpoint thickness of the plicae, and cartilage thickness of the humeral and radial surface were measured. The cross sectional area of the plicae was estimated using an area measurement tool (fig 2). The clinical data based on the referring physician's records and elbow radiographs of the study group were examined when available. The elbow radiographs were also graded using Broberg and Morrey rating system (grade 0, normal; grade 1, slight joint-space narrowing with minimum osteophyte; grade 2, moderate joint-space narrowing with moderate osteophyte; and grade 3, severe degenerative change) [8]. Based on this grading system, elbows in the study group were divided into two subgroups: subgroup I with grade 0-1, and subgroup II with grade 2-3. The presence, morphology, and dimensions of the RH plica were also evaluated for the subgroups.

All statistical analyses were performed using the SPSS version 11.0 for Windows software package (SPSS Inc., Chicago, IL, USA). Continuous data was expressed as mean±standard deviation (SD) and categorical data was expressed as numbers with related percentages (n, %). Differences in continuous data were analyzed using the Student's t test and Mann Whitney U test, while categorical data were compared using a chi-square test. A two-tailed p value of $<0.05$ was considered statistically significant.

## Results

The demographic data about the study and the control groups are detailed in table I. There was a significant difference in age between groups ($p=0.023$) but no significant gender difference was found ($p=0.401$).

The posterolateral RH plica was observed as a triangular-shaped structure in all the elbows of the control group (100%), whereas it was observed in only 15 elbows (68.2%) of the study group ($p<0.001$). The plica was hyperechoic, in 95 elbows (95%) in the control group; this was significantly different from the 7 hyperechoic plica (46.7%) observed in the study group ($p<0.001$). There was also a statistically significant difference regarding the homogenicity of the plica; 97 (97%) of the plicae in the control group were homogenous comparing with only 1 homogenous plicae (6.7%) in the study group ($p<0.001$) (table II) (fig 3, fig 4).

Table I. Demographic characteristics of the study and control groups

| | Study Group (N =15) | Control Group (N =51) |
|---|---|---|
| Gender (N) (males/females) | 10/5 | 26/25 |
| Age (years) (mean ± SD) | 52.6 ± 9.58 | 44.12 ±13.08 |

Table II. US findings of the study and control groups.

| US findings of the plica | Study Group (n = 100) | Control Group (n = 22) | p value |
|---|---|---|---|
| Presence, n (%) | 100/100 (100%) | 15/22 (68.2%) | <0.001 |
| Triangular shaped, n (%) | 100/100(100%) | 15/15 (100%) | - |
| Ecogenicity (hyperecogenic/hypoecogenic), n/n | 95/5 | 7/8 | <0.001 |
| Homogenicity (homogenous/heterogenous), n/n | 97/3 | 1/14 | <0.001 |

US: Ultrasonography

Table III. Measurements of the posterolateral radiohumeral plica and of the radiohumeral cartilage.

| Measurements | Study group (N= 15/22) (mean ± SD) | Control group (N=100) (mean ± SD) | P value |
|---|---|---|---|
| Base side, mm | 2.407 ± 0.561 | 3.445 ± 0.8567 | <0.001 |
| Proximal side, mm | 2.440 ± 0.763 | 3.284 ± 0.794 | <0.001 |
| Distal side, mm | 2.193 ± 0.590 | 3.045 ± 0.742 | <0.001 |
| Height, mm | 2.020 ± 0.832 | 2.767 ± 0.733 | 0.002 |
| Thickness, mm | 1.420 ± 0.462 | 2.127 ± 0.485 | <0.001 |
| Cross sectional area, cm² | 0.0273 ± 0.0158 | 0.0554 ± 0.0222 | <0.001 |
| Thickness of humeral cartilage, mm | 0.381 ± 0.387 | 1.234 ± 0.023 | <0.001 |
| Thickness of radial cartilage, mm | 0.527 ± 0.313 | 1.147 ± 0.237 | <0.001 |

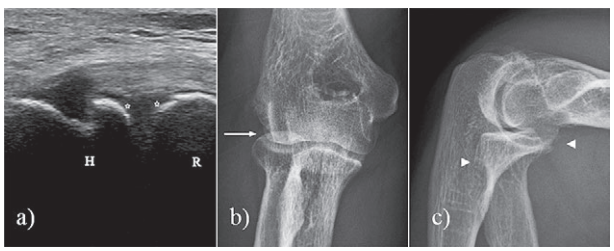


**Fig 3.** The posterolateral RH plica was not detected in a 60-year-old female patient with elbow ostheoarthitis. There is also a reduction in cartilage thicknesses of the radius and humerus. R: radius; H: humerus; Stars: cartilage. On radiographs, joint space narrowing (arrow) and osteophyte formation (arrowhead) are seen (grade II osteoarthritis) (b, c)

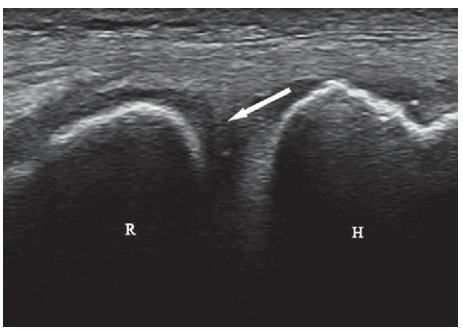


**Fig 4.** Small, hypoechogenic posterolateral RH plica (arrow) in a 61-year-old male patient with elbow osteoarthritis.

All mean edge sizes, height, and mean cross sectional area and thickness of the posterolateral RH plica were significantly lower in osteoarthritis elbows comparing to the control group (all $p<0.05$). The mean thicknesses of the radial and humeral cartilage were also significantly greater in control group ($p<0.001$) (table III). The 90$^{th}$ percentile for the maximal thickness, midpoint thickness, and area of the posterolateral RH plica were 4.6 mm, 2.9 mm, and 9.9 mm² in the control group, respectively.

The data on symptoms of the study group were retrieved from the hospital database in 20 (90.9%) patients. The patients' symptoms are summarized in Table IV. The elbow radiographs of 20 (90.9%) patients were available in our database: 7 (31.8%) elbows were in subgroup I and 13 (59.1%) elbows in subgroup II. Six (85.7%) elbows had the posterolateral RH plica in subgroup I, seven (53.8%) elbows in subgroup II. Nonetheless, there was no statistically significant relationship between the subgroups and the presence, morphological features and dimensions of the RH plica (all $p>0.05$).

Table IV. Clinical characteristics of the study group.

| Symptoms | N=20 |
|---|---|
| Pain and limited ROM, n (%) | 12 (60%) |
| Pain, n (%) | 7 (35%) |
| Swelling, n (%) | 1 (5%) |

ROM: Range of Motion

## Discussion

The RH plica is a synovial fold that is located peripherally to the humeroradial joint and protrudes into joint space [3]. The plica is considered a remaining part of the initial intraarticular septum, covering a larger part the radial head during the fetal period [9]. Although there is no consensus as to anatomical identification, the RH plica is usually separated into four parts, including the anterior,

lateral, posterolateral, and lateral olecranon [3,7]. These parts are rarely found together in the elbow. The posterolateral fold is longer and wider than the other sections and is often more seen deeply inserted in the radiohumeral joint. The most common synovial plica of the elbow is the posterolateral radiohumeral synovial fold, which is found in 86 to 100% of the asymptomatic population, while the lateral olecranon synovial fold is found in 30% of the population [3,10,11]. Some studies have reported that the plica could be of a circular type in 2-15% of the population [10,11].

We evaluated the posterolateral RH plica because it can be seen more easily by US than other parts of the plica due to its dimensions. In addition, the posterolateral RH plica has been more frequently approached in radiologic and orthopedic literature due to its involvement in the plica syndrome, which results in lateral elbow pain [6,7,12-15]. Lateral elbow pain may also result from lateral epicondylitis, which refers to as tendinopathy in the origin of common extensor tendons. US findings of lateral epicondylitis are well described in the literature and include tendon thickening, focal hypoechogenicity, tendon tear, intratendinous calcification, and neighboring bone irregularity [16]. On the other hand, plica syndrome usually results from an injury, such as a direct blow or repetitive microtrauma, and is characterized by an inflammatory reaction with a thickening of the synovial fold and chronic localized synovitis. The thickened fold can result in the compression of the folds between the articular surfaces during the movements of the joint and causes symptoms [2,6]. It is important to know the normal size and morhpology of the posterolateral RH plica as these features can change in the plica syndrome; however, the RH plica is usually evaluated by MR imaging [6,7,13,14]. Nevertheless, US is also a diagnostic method with a high resolution of the soft tissues that was developed using new transmitter technology; it is also an easier and cheaper method. The RH plica is a superficial structure that may be easily evaluated using US. To our knowledge, this is the first study that evaluated the morphology of the posterolateral RH plica in asymptomatic subjects and in patients with osteoarthritis using US.

Cadaveric and anatomical studies have reported high rates of visualization of the posterolateral RH plica, including Duparc et al [10] with 86% and Isogai et al [11] with 100%. These studies have reported that degenerative changes, inflammation, injury, and aging are closely related to the morphology of the plica. Isogai et al [11] reported that RH plicae morphologies in adults were different compared to embryonic plicae, and that the plicae were much more homogenous and larger in embryos. In addition, they showed that the RH plica was circular in shape in 15% of the embryonic elbows evaluated. Koh et al [15] investigated the RH plicae of the elbow in forty-nine fresh cadavers using US after administration of intraarticular saline and reported higher visualization rates at posterior aspects of the radiohumeral joint (94% of the specimens). Husarik et al [14] reported the prevalence of the posterolateral plica as 98% using MR imaging. In our study, the posterolateral RH plica was visualized in all patients in the control group but only in 68.2% patients from the osteoarthritis group. These results may explain the lower rates of the posterolateral RH plica in some studies, as degenerative processes could affect the plicae visualization and structure.

In both groups, we found that the detected plicae were triangular in shape. Koh et al [15] also reported that RH plicae were triangularly shaped using US. In the present study, the posterolateral RH plicae were homogenous and hyperechoic in the control group but heterogenous and hypoechoic in patients with osteoarthritis.

Morphological measurements of the posterior RH plica are described in the studies of Duparc et al [10], Isogai et al [11], Husarik et al [14], and Koh et al [15]. These studies reported varied results: Duparc et al [10] and Isogai et al [11] reported thickness of 1.7 mm, while Koh et al [15] reported thickness of 3.3 mm, and Husarik et al [14] found that the maximal thickness of the posterolateral RH plica was 1.9 mm. In our study, the mean maximal thickness was found to be 3.4 mm in the control group. Similarities in findings between Koh et al [15] and our study may be due to the use of US as a tool for assessment. Luzuriaga et al [17] reported that patients with plica syndrome had an increased RH plica thickness and cross sectional area greater than 2.6 mm and 20 mm² using MR imaging, respectively. We found that the 90$^{th}$ percentile for maximal thickness was 4.6 mm, midpoint thickness was 2.9 mm, and area was 9.9 mm² in the control group. Evaluation of the normal dimensions of the RH plica may be helpful in assessing patients with elbow plica syndrome using US.

In our study, the mean cross-sectional area of the posterolateral RH plica was 5.5 mm² in the control group and 2.7 mm² in the ostheoarthitis group. All sizes and cross sectional areas of the posterolateral RH plica were reduced in patients with osteoarthritis. There was also a decrease in cartilage thicknesses of the radius and humerus in patients with osteoarthritis due to degeneration. The reduction in dimensions and areas of the posterolateral RH plicae may be due to the mechanical changes or to the involvement of synovial tissue in osteoarthritis. We found that the posterolateral RH plica tended to be lost in the grade 2-3 elbow osteoarthritis. Nonetheless, we did not find any significant relationship between the radiographic osteoarthritis degree and the presence, sono-

graphic features, and dimensions of the RH plica. Further studies with larger patients groups are required to assess whether the morphological features of the RH plica are associated with osteoarthritis degree

There were several limitations in this study. The sample size of the study group was small, as primary osteoarthritis of the elbow is a rare condition and affects fewer than 2% percent of the population [18]. Arthroscopic or histopathological confirmation was also not performed, although it is not necessary in clinical practice. The anisotropy artifact might have affected US assessments. Finally, all of the examinations were performed by a single radiologist, which represents a significant limitation in validity.

## Conclusions

This study demonstrated that posterolateral RH plica may be successfully evaluated using US. The knowledge of normal structural features of the posterolateral RH plica using US can be applied when evaluating patients with RH plica syndrome. Osteoarthritis may reduce the size of RH plica and affect its morphological appearance.

**Conflicts of interests**: none

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