



A Comprehensive Review of Radiohumeral Synovial Plicae for a Correct Clinical Interpretation in Intractable Lateral Epicondylitis

Jose Miguel Aguililla Liñan¹ · María Isabel Miguel Pérez² · Jordi Palau González³ · Ingrid Möller Parera² · Carlo Martinoli⁴

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Abstract

Purpose of Review Radiohumeral synovial plicae (RHSP) have been studied by different authors in different ways; in spite of this, the evidence is poor and the results are controversial and inconclusive even when it comes to referring to this elbow structure. The aim of this article is to review the embryologic development, anatomy and histology, pathophysiologic features, clinical manifestations, physical examination, imaging findings, and treatment of radiohumeral synovial plicae, for their correct clinical interpretation in patients with intractable lateral epicondylitis.

Recent Findings Radiohumeral synovial plicae syndrome (RHSPS) can cause intractable lateral epicondylitis and can be easily confused with other clinical conditions affecting the elbow. Many clinicians are not familiar with radiohumeral synovial plica syndrome since there are not many studies about it and previous reports do not seem to reach a consensus. Although its role in elbow injuries and epicondylitis is accepted and its surgical treatment is effective, there is no clear consensus about clinically relevant aspects.

Summary RHSP are remnants of normal embryo development of the articular synovial membrane with different anatomical locations, size and shape. Traumatism or overuse can turn RHSP into symptomatic structures at any age and can be compressed between the radial and humeral heads during movement. This compression can cause pain and other symptoms such as snapping, catching, mobility restriction, pitching, clicking, locking, blockage, popping and swelling. Radiohumeral synovial plica syndrome (RHSPS) may be an isolated condition or it can be associated with other elbow abnormalities. The findings on physical examination and imaging diagnosis are multiple and variable. Nowadays, RHSPS are quite unknown and previous reports do not seem to agree, leading to misdiagnoses as epicondylitis and making this structure the main cause of some cases of “intractable lateral epicondylitis”. The outcomes of surgical treatments are quite promising although more, higher quality research is needed. Taking this into account, this review is meant to be a starting point for new anatomical and clinical studies.

Keywords Plica · Tennis elbow · Elbow joint · Chronic pain · Meniscus

✉ Jose Miguel Aguililla Liñan
jose.aguililla@eug.es

María Isabel Miguel Pérez
mimiguel@ub.edu

Jordi Palau González
jpalau@centredelama.com

Ingrid Möller Parera
ingridmoller@ub.edu

Carlo Martinoli
carlo.martinoli@unige.it

¹ Gimbernat i Tomàs Cerdà School of Physiotherapy, Universitat Autònoma de Barcelona, Avinguda de la Generalitat 202, 204, Sant Cugat del Vallès, 08174 Barcelona, Spain

² Department of Pathology and Experimental Therapeutics, Human Anatomy and Embryology Unit, Faculty of Medicine and Health Sciences, University of Barcelona, C/ Feixa Llarga s/n, 08907 Hospitalet de Llobregat, Barcelona, Spain

³ Centre de la Mà de Barcelona, Av/ Gran Via de les Corts Catalanes 687, Pral 2^a, 08013 Barcelona, Spain

⁴ Department of Health Sciences (DISSAL), University of Genoa, Via A. Pastore 1, 16132 Genoa (GE), Italy

Abbreviation

RHSP radiohumeral synovial plicae
RHSPS radiohumeral synovial plica syndrome

Introduction

Radiohumeral synovial plicae are morphological structures, clinically controversial, that can be the cause of elbow pain and dysfunction and that can be easily confused with other elbow conditions such as lateral epicondylitis which is the most common cause of lateral elbow pain in adults [1, 2, 3•, 4–11].

Several authors have examined radiohumeral plicae and have used different terms: plica, radiohumeral plica, synovial plica, lateral synovial plica, humeroradial synovial plica, posterolateral plica, elbow plica syndrome, synovial fold of the radiohumeral joint, elbow synovial fold syndrome, synovial fringe syndrome and meniscus [1, 2, 3•, 6, 8–23]. In order to simplify this, in this article we use the term radiohumeral synovial plicae (RHSP) when referring to this structure and radiohumeral synovial plica syndrome (RHSPS) when referring to its symptomatic entity.

Synovial plica also exist in other joints [1, 6, 8, 9, 15, 20, 21, 24], but many clinicians are not familiar with this condition [5] caused by elbow plicae since there are not many studies about it and previous reports do not seem to reach a consensus [22]. Therefore, further studies are needed.

The purpose of this article is to review the embryologic development, anatomy, and histology of RHSP of the elbow joint. The pathophysiologic features, clinical manifestations, physical examination, imaging findings, and treatment of RHSPS will also be reviewed for a correct clinical interpretation.

Normal Synovial Plica of the Radiohumeral Joint

Embryological Development

Radiohumeral synovial plicae (RHSP) are remnants of normal embryo development of the articular synovial membrane [8, 20–22]. The elbow joint is formed by mesenchymal cavitation first at the radiohumeral site, then in the ulnohumeral region and finally at the radioulnar site. These cavities fuse together forming folds (radiohumeral plicae) that persist as structures similar to synovial septa [19, 21, 23]. One of the most important studies on embryos found two synovial plicae (anterior and posterior) in each radiohumeral joint and also described a RHSP variant of circular shape [20]. Embryonic plicae seem to be of homogeneous morphology; however, homogeneity is not noted in adult specimens, which supports the hypothesis

that these three types of RHSP (anterior, posterior and circular shape) in adults develop from embryonic structures [20]. Nonetheless, the embryonic origin of the other variants is unknown.

Anatomy

From a structural point of view, RHSP are folds that project into the intermediate radiohumeral space contiguous with the capsule-ligament complex [20], found proximal to the edge of the annular ligament within the intra-articular space [12, 15, 19, 20]. They are structurally distinct from the annular ligament since they are contiguous with the radio-humeral articular capsule and subtly mingle with the common extensor tendon forming an entheses at the lateral epicondyle [12]. This structure can extend up to approximately one-third of the posterior aspect of the radial head [10, 13].

A number of partly inexact descriptions of this entity have been provided in different anatomical studies. So far, they are all based on studies done on cadavers using different dissection methods with no consistent results, which means there is no consensus in the literature regarding basic aspects concerning the anatomic location, incidence, size, shape, thickness and symmetry of RHSP in the general population [12, 13, 19–21, 25].

Regarding the anatomic location of RHSP, different criteria have been adopted and, therefore, plicae have been described according to their site [22]: anterior, lateral, posterolateral and lateral olecranean, including the circular shape variant [19, 20, 25]. The exact incidence of each individual type [22] and their inter-relations are unknown [19–21, 25, 26], although there exists agreement that RHSP are consistent anatomical structures [25].

The overall incidence of RHSP varies greatly according to authors [27]. Moore [24], Satoh et al. [14], Isogai et al. [20], Koh et al. [25] and Tsuji et al. [12] reported an incidence of 100% of plicae in the specimens studied. Other authors find a different incidence, for example, Awaya et al. [21] (80%), Duparc et al. [19] (86%). This is due to a lack of consensus on the inclusion and exclusion criteria adopted when choosing the specimens to be studied and on the definition of RHSP.

The physiological size of the different variants of RHSP has been described in just a few anatomical studies, and their results are not conclusive [19, 20, 25], which might be attributed to whether a fresh-frozen or an embalmed cadaver was used [25].

Regarding RHSP morphology, authors like Isogai et al. [20] extensively describe three basic fold patterns based on the shape of the free margin and the surface of the fold, combined with differences in texture on palpation. These different RHSP patterns are: the *villous* pattern, with clusters of rod-like folds; the *fringed* pattern, which resembles the dressed lower edge of a curtain, with a rough surface and a ruffled free

margin; and the *plicate* pattern, with a smooth surface and margin. Isogai et al. included two intermediate/mixed patterns: *villous-fringed* and *fringed-plicate*. Other authors such as Duparc et al. [19] claim that the posterior variants of RHSP are generally longer and wider than anterior variants and they can extend more laterally and are more deeply interposed in the radiohumeral joint. This illustrates the different morphologies identified by different authors in terms of RHSP size and thickness. The shapes vary considerably depending on the width and length of the fold.

In relation to bilateralism, Duparc et al. examined the two elbows of 14 cadavers and observed that the fold was bilateral in 12 of these cadavers (85.7%). They only found a single case in which RHSP was absent in both elbows (7.1%) and a single case of unilateral RHSP (7.1%). When considering symmetry, only two out of these 14 cadavers (14.3%) showed a symmetrical RHSP appearance in both limbs [19]. Previously, Isogai et al. reported that no laterality of the macroscopic pattern was evident but one side tended to show a similar pattern to the other, except in a few subjects with highly developed folds in one elbow. In these subjects, the opposite elbow had poorly developed folds with different patterns; however, none of the pairs had totally different patterns [20].

Histology

From a histological point of view, RHSP are generally described as a structure mainly made up of fibroadipose tissue with moderate vascularization and plenty of nerve endings in their periphery [12, 19, 21]. No distinct histological differences exist between male and female cadavers, but there are differences in terms of the shape of each RHSP variant [22]. According to Isogai et al., *villous*, *villous-fringed*, *fringed*, and *fringed-plicate* patterns presented hypertrophy of the synovial covering, well-developed capillary networks, fat-rich tissue, and randomly arranged thin fibres. In contrast, according to the same authors, RHSP with *plicate* and *fringed-plicate* patterns contained bundles of thick fibres running in and out along the axis of the fold and intermingling with those of the annular ligament. Hyalinization of the fibre bundles was often observed. Finally, this type of RHSP showed unique histological characteristics: covering of the monolayer of squamous cells or absence of the synovial covering; hyalinization, often containing round and paired cells such as chondrocytes; and absence of fatty tissue and very poor vascularization [20].

Although some authors consider RHSP as a meniscus [5, 28], there is still a debate about whether RHSP are or are not a meniscus-like structure. In their histological study, Duparc et al. did not find fibrochondroid tissue in any of the RHSP. Therefore, taking this into account and also the presence of a synovial layer on the two sides of the fold, these authors conclude that this anatomical structure cannot be called a meniscus [19]. Antuna and O'Driscoll [2] observed a thickened

hardened synovial fold containing small regions of chondroid metaplasia or degenerative fibrocartilage and a plica usually has no fibrocartilage. Other authors however state that the meniscus is not a real meniscus but a thickened synovial fold, which, without a histological analysis, was sometimes called meniscus or meniscus-like tissue. Akagi and Nakamura [1], Fabié et al. [29], Huang et al. [30], and Kang and Kim [5], based on histological findings, state that there may exist a meniscal structure in the radiohumeral joint that can cause elbow pain and dysfunction. Although some authors conclude that RHSP are a developmental anomaly since the origin of menisci is unclear [28, 30] the findings in Isogai et al.'s histological study [20] could account for this anomaly.

Function

The function of RHSP has not been specifically examined. Isogai et al. think that these folds might act as stabilizers to prevent excessive movement [20], whereas Antuna and O'Driscoll [2] argue that RHSP can help in proprioception and perform a similar function to that of the meniscus in the knee. For Duparc et al., the latter is not possible because these folds do not seem to disperse loading forces across the joint because these stresses are mainly transmitted from the central part of the capitellum to the centre of the fovea radialis and from the capitulo-trochlear notch to the medial crest of the ulnar edge of the radial head [19]. Therefore, the function of RHSP remains unknown.

Symptomatic Plicae of the Radiohumeral Joint

Pathophysiological Features

The pathophysiological features of radiohumeral synovial plicae syndrome (RHSPS) have not been clearly defined either. The most accepted hypothesis is that this dysfunction is a consequence of a direct blow [2, 4, 8, 11, 23] or of repetitive microtraumas [1, 2, 5, 7, 11].

The embryonic folds examined by Isogai et al. seem to have a more homogeneous morphology than those in adult specimens, which seems to suggest that the alterations in morphology are related to movements of the radial head through ageing, whereas the different morphology of RHSP among subjects may reflect different joint movements in elderly subjects, such as differences in size and localization of the articular contact area [20]. Back in 1929, Trethowan and Ogilvie believed that the elbow synovium could be compressed during movement between the head of the radius and the humerus and this could cause inflammation and pain [2, 4], which has been checked and confirmed in live participants by numerous authors [2, 4, 8, 11].

From a structural perspective, pathological RHSP are characterized by an erythematous [8], hypertrophic [4, 6, 8, 11, 23], fibrotic [4, 23] and thickened [6, 8, 11, 23] structure associated with synovitis [2, 4, 6].

On the other hand, several studies demonstrate that RHSPs can often be associated with alterations of the radial head [1, 2, 4, 6, 14, 17] and capitellum [1, 2, 6, 7]. It is postulated that the mechanical abrasion by a snapping plica may produce chondromalacia along the radial head and capitellum [22], but it has not been clearly demonstrated whether there is a direct significant correlation between both of them.

Clinical Manifestations

RHSPs may be confused with lateral epicondylitis [2, 3•, 4–6, 9, 13, 24], but it must also be included in the differential diagnosis of other clinical entities that present with anterolateral and/or posterolateral elbow pain [1, 4–8, 10, 12, 24], snapping [1, 2, 3•, 5, 9–11, 13], catching [1, 3•, 4, 13], mobility restriction [3•, 4, 6, 13, 18, 29], pitching [29], clicking [4–6], locking/blockage [4, 11], popping [11, 13] and/or swelling [6]. RHSPs can be an isolated condition or it can be associated with other elbow abnormalities [9, 17, 31].

RHSPs can occur at any age [1, 2, 3•, 4–6, 9–11, 13, 24, 30] including paediatric age [6–8, 10, 18, 27, 29], but there are no significant differences between men and women [1, 2, •, 4–6, 8–11, 13, 15, 16, 18, 27–30]. The appearance of symptoms in the dominant or contralateral arm [3•, 7, 8, 10, 11, 18, 24, 27, 28, 30] and occupation [2, 3•, 8, 10, 11, 13] are not specified in all the published case reports, which make outcomes inconclusive.

From a pathophysiological perspective, RHSPs sufferers do not present significant differences in relation to the incidence of previous traumas or in comparison with those with repetitive microtraumas [1, 2, 4, 5, 7, 8, 11, 13, 18, 27, 29, 30].

Physical Examination

Our current knowledge of the signs of RHSPs is quite limited. The findings on physical examination are inconsistent [17] and there is no consensus regarding the diagnosis [13, 32].

The findings on examination are multiple and variable [32]. They can include any of the following: limited range of motion [3•, 4, 6, 13, 18, 28, 32]; blockage [4, 8]; pain during maximum range of motion and while making movements with overpressure (quite prevalent in extension and extension with supination) [4, 10, 13, 24, 32]; tenderness around the radial head [4] and lateral epicondyle [23], in the posterolateral anconeus soft spot [6], and over the capitellum [29] and the radio-humeral joint line [13, 32]; and even palpation of some mass in the region of the radial head during active movements [1]. Resisted wrist extension can cause pain [6]. Both active

and passive elbow movements can cause pain [1, 3•, 4, 5, 10, 13, 18, 24, 27, 29] and other symptoms [1, 3•, 4–6, 11, 13, 29], among them snapping [1, 2, 3•, 5, 9–11, 13], although this is not always constant [2, 3•, 4, 6, 8, 10, 11, 13, 18]. Authors such as Clarke [4] (who first described catching due to RHSPs), Akagi and Nakamura [1], Antuna and O'Driscoll [2], Steinert et al. [11] and Cerezal et al. [22] stress the importance of having a differential diagnosis with other pathologies that also present this sign.

Antuna and O'Driscoll proposed the flexion-pronation test by reproducing snapping with passive flexion of the pronated elbow [2]. However, other authors like Kim et al. criticized the test arguing that it was positive in only 25% of their patients [6]. Many authors have demonstrated that this test should not be an essential diagnostic tool in the diagnosis of RHSPs [2, 6, 13]. Recently, Park et al. have presented the “posterolateral radiocapitellar plica test”, with a sensitivity and specificity of 83.3% and 87.5%, respectively. However, the small number of patients and the retrospective study are a limitation [32].

Imaging Diagnosis

Throughout the years, different diagnostic tools have been used to diagnose RHSPs such as X-rays [22] (in spite of the lack of important findings in RHSPs sufferers) [1, 2, 5–8, 11, 18, 27–30], arthrographies [5, 6, 18], pneumoarthrograms [1, 5], MRI [5–7, 13, 27, 28], MR arthrogram [5, 8, 11, 18, 29, 30] and ultrasounds [3•]. Other diagnostic tools would include arthrotomies [5, 18, 28], lateral epicondyle injections [10, 18] and arthroscopies [2, 4, 6, 9, 11, 13]. The last one has proven to be the most reliable tool for the diagnosis of RHSPs [32].

The most commonly used tool are MRs, in which RHSP appear as hypointense bands surrounded by synovial fluid. A few studies have aimed to analyse the predictive value of this tool to diagnose RHSPs [13, 17, 23, 26]. Unfortunately, there is currently no concrete cut-off value for determining abnormal thickness or length that indicates a diagnosis of RHSPs [13].

Ultrasound scans have demonstrated that RHSP in asymptomatic patients can be assessed in a reliable way; the advantage is that this is a non-invasive procedure that involves little or no risk for these patients [15, 22, 25]. In ultrasound images, the morphology of RHSP is described as a triangular structure surrounded by hypoechoic borders between the capitellum and the radial head and isoechoic with muscles shown as a consistent structure, distinct from other periarticular structures [15, 25]. There is no correlation between the real size of RHSP and the mean size in ultrasound images according to Koh et al. [25]. However, to date, only one research paper in English language have been published in which ultrasounds have been used (together with other clinical examination measures) for the assessment and diagnosis of RHSPs [3•], with no characteristic data for this clinical entity using ultrasound scans.

Further studies are needed to define their common morphological characteristics and their correlation with the patient's symptoms.

Treatment

There are no randomized control trials on the conservative treatment of RHSPS. The studies published are about orthopaedic surgery, which is carried out when the conservative treatment has failed [1, 2, 3•, 5–11, 13, 18, 28–30]. A conservative treatment may include rest [9], pain medication [11], non-narcotic analgesics [1], anti-inflammatory medication [6], non-steroidal anti-inflammatory drugs [9, 13], supervised physiotherapy [6, 9, 11, 13], ultrasounds [9], bracing [9], activity modification [6, 11, 13, 29], strengthening exercises [29] and/or radiohumeral joint (intra-articular) corticosteroid injections [4, 6, 17] for several months. The duration of symptoms in these patients tends to go from 3 weeks to 36 months [1, 2, 3•, 4–10, 13, 27–30].

The decision to proceed with surgery must be based on the patient's clinical symptoms and physical examination findings [3•, 13], but their reliability is poor [13, 17]. Consequently, a surgical treatment for RHSPS is often advised when the patient is diagnosed with intractable lateral epicondylitis [2, 4–6, 10].

The results of a resection performed via posterior [18] or posterolateral [27] approach, an arthrotomy [5, 8, 11, 18, 28] and arthroscopic radiohumeral synovial plica resection surgery [1, 2, 3•, 4–11] in patients with RHSPS are promising [3•, 32]. A randomized prospective trial is needed in order to validate the effect of these procedures, the exact reason why some patients complain of residual symptoms [13], their possible adverse effects in the long run [13, 32] and the comparison of these procedures and more conservative treatments in the short and long run.

Conclusion

Radiohumeral synovial plicae (RHSP) have been studied by different authors in different ways; in spite of this, the evidence is poor and the results are controversial and inconclusive even when it comes to referring to this elbow structure. RHSP are remnants of normal embryo development of the articular synovial membrane with different anatomical locations, size and shape, whose incidence is unknown, although there are no differences in terms of incidence between sexes or age. From a histological perspective, there are differences according to the shape of RHSP. Their exact size, thickness, symmetry and function are unclear. Higher-quality research is needed.

Compliance with Ethical Standards

Competing Interests Jose Miguel Aguililla, Maria Isabel Miguel, Jordi Palau, Ingrid Möller, and Carlo Martinoli declare that they have no competing interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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