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Coexistence of a Suprascapular Notch and a Bony Canal: a Rare Anatomical Variation

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In the presents study, we report a case of coexistence of a suprascapular notch and a bony canal. It occurred in a left scapula, belonging to a male individual with an age at death of approximately 45 to 50 years. The canal was formed by the base of the coracoid process anteriorly and an ossified ligament posteriorly. Because of the posterior insertion of the ossified ligament at the base of the coracoid process, we suppose that it represents an ossified superior transverse scapular ligament and exclude the possibility for formation of the canal through ossification of an anterior coracoscapular ligament.

Key words: suprascapular notch, bony canal, superior transverse scapular ligament, suprascapular nerve entrapment.

Introduction

The suprascapular notch (SSN) is a very important anatomical region of the scapula, because of its key position on the course of the suprascapular nerve (SN). Normally, the SSN serves as a passage for the SN, as the superior transverse scapular ligament (STSL) closes the upper part of the notch, converting it into a foramen. It represents a strong fibrous band extended along the superior border of the scapula, connecting the medial and lateral borders of the SSN [35]. Occasionally, another ligament may be present on the anterior side of the SSN inferior to the STSL, named anterior coracoscapular ligament (ACSL) [3]. There is a high variability in relation to the blood vessels crossing through the SSN region. The suprascapular artery (SSA) is commonly passing above the STSL, whereas the suprascapular vein (SSV) is found with a high frequency to run above [55] or below it [30, 39]. After transiting the SSN, the SN supplies motor branches to the supraspinatus and infraspinatus muscles and sensory branches to the coracoacromial and coracohumeral ligaments, subacromial bursa and acromioclavicular and glenohumeral joints [9].

There are different classifications concerning the shape of the SSN, based on scopical observations [15, 16, 41, 47] or metrical characteristics [27, 31]. In all reported classifications, there were types considered as risk factors for suprascapular nerve entrapment (SNE), such as the partial and complete ossification of STSL or the V-shaped SSN. The complete absence of the SSN was also regarded as a possible cause of SNE [28].

Based on other studies, Gosk et al. [11] noticed that the greatest risk of nerve entrapment appears in patients with a small SSN and a calcified transverse ligament. However, the coexistence of an SSN and a suprascapular foramen (SSF) is presented as a type only in the classification of Natsis et al. [27], as Type V. According to Polguj et al. [34], such coexistence narrows the space for passage of the nerve and thus increases the risk of suprascapular neuropathy.

Nevertheless, none of the classifications included the presence of a bony canal as a possible morphological variant in the SSN region. Wang et al. [54] were the first to take notice of the forming of a bony canal instead of an SSF and emphasized the very increased risk of SNE in such a case. However, there has not been reported a case of coexistence of an SSN and a bony canal, which would complicate additionally the passage of the SN through this region.

In this study, we report a case of coexistence of an SSN and a bony canal, because of the uniqueness of such a combination and the clinical importance of SNE.

Materials and Methods

The object of this study is a scapula with coexistence of an SSN and a bony canal. The sample was part from the osteological collection at the Institute of Experimental Morphology, Pathology and Anthropology with Museum, Bulgarian Academy of Sciences. The bone remains of the individual were obtained during archaeological excavations of a medieval necropolis. The age and sex of the individual were determined by standard anthropological methods [5].

The SSN and the bony canal were examined macroscopically and metrically. The measurements of the notch and posterior wall of the canal were taken in accordance with the measurements of both SSN and bony bridge described by Polguj et al. [34] for the cases with coexistence of an SSN and an SSF. In addition, two (transversal and sagittal) diameters of both superior and inferior openings of the canal were measured. All measurements were taken with a sliding caliper.

Results

The coexistence of an SSF and a bony canal was observed in a left scapula, belonging to a male individual with an age at death of approximately 45 to 50 years. The right scapula of the individual had a deep SSN, without formation of a SSF or a bony canal.

The SSN was shallow and its vertical diameter was only 3 mm. The transversal diameter in the upper part of the notch was 6 mm. The superior opening of the bony canal was situated below and laterally to the notch, near the root of the coracoid process. It was oval-shaped with a transversal diameter of 8.5 mm and a sagittal one of 4 mm. The canal was directed downward and laterally, following the course of the SN toward the spinoglenoid notch (**Fig. 1**). The size of the inferior opening was smaller than the superior one with a transversal diameter of 5.5 mm and a sagittal one of 3.5 mm. The canal was formed by the base of the coracoid process anteriorly and by an ossified ligament posteriorly. According to the measurements of the ossified ligament, it was 10.5 mm long, with a proximal width of 15 mm, a middle width of 12.5 mm and a distal one of 16 mm.

Fig. 1. Left scapula showing coexistence of a suprascapular notch and a bony canal: a) Anterior view; b) Posterior view

From the lower end of the canal began a sulcus, leading to a nutrient foramen, which was at a distance of 3 mm from the superior border of the base of the scapular spine.

Discussion

The size and shape of the SSN are supposed to be predisposing factors for compression of the SN. The earliest symptom of SNE is a deep pain around the suprascapular region and shoulder [19]. The pain is often aggravated by lifting the arm above the shoulder level. Moreover, the shoulder pain may radiate medially and upward, involving the neck area, or medially and downward to the infrascapular region. Atrophy of supra- and infraspinatus muscles is frequently present, along with weakness of external rotation of the shoulder [52]. The ossification of the STSL is the most common cause of SNE. The formation of an SSF by ossification of the STSL is reported by many authors with a varying frequency from 1.5% to 30.76% in the different population groups [2, 4, 8, 17, 23, 25, 27, 31, 36, 41, 45, 46, 47, 48, 49, 53, 54]. According to Tubbs et al. [51] and Polguj et al. [38], the presence of an ossified STSL was more common in males and in the right scapulae. However, some studies reported a higher frequency in females [36, 49]. As a whole, Albino et al. [2] did not found any relation between the type of the SSN and sex of the individuals. Concerning the more common occurrence of the ossified STSL on the right side, Tubbs et al. [51] supposed that it may be due to a predilection for right-sided handedness in most people.

The coexistence of a SSN and a SSF is another interesting type of the SSN, which is more rarely observed, with a frequency often below 1%. Polguj et al. [34] supposed that the frequency of this anatomical variation depend on the population like to the frequency of completely ossified STSL. Hrdlicka [14] was first to describe such a case among a sample of 2792 dried scapulae (0.036%). Later, Natsis et al. [27] found 3 cases with coexistence of a SSN and a SSF among 432 German scapulae (0.7%). Such coexistence was reported by Sinkeet et al. [46] in one out of 138 Kenyan scapulae (0.72%). Polguj et al. [34] investigated 616 scapulae of Polish patients by CT and found this rare anatomical variation in 2 left scapulae (0.33%) as well as in a right dried one, and assumed that the ossification of a single bundle ACSL is the most probable hypothesis for the formation of a bony bridge above the SSF. According to the studies conducted on Indian scapulae, the frequency of coexistence of a SSN and a SSF varied from 0.56%

to 1.33% [25, 44, 47]. Saritha [44] also described this anatomical variation with the complete ossification of the ACSL. However, there are studies in which this type of morphology of the SSN was not observed at all [1, 54]. It is supposed that the presence of an SSF along with an SSN increases the risk of SNE, because of the additionally reduced size of the SSF, i.e. the space available for passage of the SN. According to Polguj et al. [35], the presence of a bony bridge passing through the middle part of the SSN decreases this space by about 36.5-38.6%.

Unlike the above cited studies, Wang et al. [54] observed the presence of a bony canal instead of just an SSF. They found it in 4 scapulae (1.36%), as the canal length ranged from 5.89 mm to 17.86 mm. Vyas et al. [53] also reported such a canal in 4 cases (1.33%) with a length varying from 11.83 to 14.03 mm. Taking into account the lengths of the ossified ligament measured in the described case, the length of the canal is similar to the reported long ones. According to the summed bilateral distribution of the bony canal findings [53, 54], a higher frequency came out for the right side. However, the left scapula was involved in our case.

According to Wang et al. [54] and Vyas et al. [53], the bony canal was most probably formed by the complete ossification of a wide and flat STSL. Although the attachment of the ossified ligament in our case was a bit lower on the medial border of the SSN, because of the posterior insertion of the ossified ligament at the base of the coracoid process, we also suppose that it represents an ossified STSL and exclude the possibility of formation of the canal through ossification of an ACSL. There are different studies reporting cases with bifid STSL [4, 32, 48], trifid STSL [33, 48], bifid ACSL [37], as well as classifying the types of STSL [4, 35] and ACSL [29, 37]. However, the coexistence of an SSN and a bony canal, and more precisely the formation of such a long bony canal, as in the reported case, could not be explained with any of these classifications. Classifying the types of STSL, Polguj et al. [35] obtained 15.1 mm and 13.1 mm as biggest proximal and distal width in specimens with fan-shaped ligaments and lower maximum values in these with band-shaped ones. Such high values show the presence of rather wide STSL, but obviously it is more typical of fan-shape type, which is hard to be related to our case. Besides, the proximal and distal widths of a bifid STSL with superior and inferior bands, reported by Polguj et al. [32], are comparatively smaller. In the case with trifid STSL, described by Polguj et al. [33], taking into account the summed proximal widths of the three bands comes out a quite wide ligament on the medial border of SSN, where the three bands attached separately, while the common distal part of the ligament is quite narrower. Thus, the ossified ligament in our case could not be compared to such an ossified trifid STSL. In addition, it should be considered the relation of the STSL with the fasciae of both supraspinatus and omohyoid muscles as well as with the adjacent conoid part of the coracoclavicular ligament, which might blend with it [22, 26]. Thus, these structures could also be supposed to have played a part in the canal formation.

There may be different causes for ossification of the STSL. Morrigl et al. [26] proved that both entheses of STSL are strongly fibrocartilaginous as well as the remainder of the ligament has a moderately fibrocartilaginous matrix and suggested that the frequency with which the STSL ossifies is related to its fibrocartilaginous character. According to Millela [24], age has a great impact on the expression of entheseal changes, which are probably related to such causes as the response of bone to continuous microtraumatic stress in connection with daily biomechanical stimuli, ontogenetic processes of the musculoskeletal system, and degenerative processes associated with aging. Yonemoto [56] asserted that entheseal changes are influenced by the age to a certain degree, depending on specific physical activities associated with the individual occupation. The mean age of the sample with a completely ossified STSL, reported by Polguj et al. [38], was over 60 years. However, Zehetgruber et al. [57] announced a mean age of 37 years for individuals with SNE, caused by ligament compression, but it was not related to the ossification of the ligament. The observation of the other bones in the reported case showed a presence of osteophytes on the thoracic vertebral bodies as well as a fusion of manubrium and sternal body, which are considered age-related changes. Thus, it could be supposed that the ossification of STSL in given cases could be prompted by the age advance. However, Rogers et al. [43] noted that enthesophyte formation was associated with age, but above all enthesophytes could be considered as skeletal responses to stress. These authors also noticed that some people are more prone to form new bone in response to stress than others. Here, it should be mentioned that there is a hypothesis presuming that the ossification of STSL could be genetically predetermined. It was brought forward by Cohen et al. [7], who described a calcification of the STSL in two members of a family (father and son) with concomitant symptoms of SNE.

On the other hand, the variations in thickness and length of STSL as well as its tendency to ossify suggest that the ligament responds to changes in mechanical load [26]. Although the STSL is connecting two areas of the same bone and has no direct attachment to any joint, the nearby fascia of the supraspinatus, origin of the omohyoid muscle as well as attachment of the conoid ligament could concentrate significant stress at the STSL entheses during twisting movements and force acting on them [22]. Therefore, the ossification of STSL could be provoked by vigorous and repeating overhead upper limb movements and thus to cause SN compression. Suprascapular nerve neuropathy frequently affects individuals who have been involved in violent overhead activities [1] and is common in athletes who overuse the shoulder region [53]. The repetitive overhead motions and forceful rotational movements performed during sports activities such as volleyball, baseball, tennis, and weightlifting may cause traction upon the nerve at SSN [10, 20, 42, 58]. The regular carrying of heavy objects on the shoulder also might lead to SNE [17]. Thus, it is hypothesized that repetitive overhead motions contribute to ossification of the ligament [51]. According to Kopell and Thompson [21], the movement of abduction or horizontal adduction of the shoulder results in compression of the nerve against the STSL. Rengachary et al. [41] described the etiopathogenesis of SNE with so-called "sling effect". According to it, the SN makes only minimal transitional movements during upper limb motions, but at maximal rotation, the nerve could be pressed against the sharp bony margin of the SSF. In this way, a repeated kinking may cause nerve irritation and induce microtrauma, which to result in neuropathy.

Besides, the ossification of STSL could be a result from a microtrauma of the ligament, caused by exertion of blood pressure from the SSA in cases when it passes below the STSL along with SN and the size of the SSF is significantly reduced [38]. The SSA normally runs above the STSL, but there were reported cases with its course under the ligament [12, 39, 40, 50, 55]. It could be assumed that the presence of the notch above the canal in the described case reduced additionally the area for passing of the SN, and in case that SSA and SN passed together through the formed bony canal, the STSL might have been at serious risk of trauma. The observed groove running from the inferior opening of the bony canal to the spinoglenoid notch ended in a nutrient foramen above the scapular spine. Since the SSA gives nutrient branches, supplying the clavicle and scapula [13], there is a possibility that a nutrient artery or vein might have passed along with the SN through the bony canal. However, there is only one reported case of an accessory SSA, accompanying the SN under the STSL, while SSA was passing above the ligament [6]. So in case of passing through the canal, the SSA is more likely to have given rise to a nutrient branch immediately after going out of it. On the other hand, the SSV is more frequently observed to pass below the STSL than the SSA [12, 30, 39]. Furthermore, Podgórski et al. [30] described the presence of suprascapular notch veins, crossing the SSN, as a separate structure from the SSV. All this goes to show that the SN is very likely to have passed through the bony canal along with any of the above-mentioned blood vessels. The reported diameter of SN ranged from 2 mm to 3.3 mm [3, 30, 39, 51]. According to Podgórski et al. [30], the diameters of the SSA and SSV were 2.3 mm and 3.4 mm, respectively and the diameter of the suprascapular notch veins varied from 0.5 mm to 3 mm. The measurements of the superior and inferior openings in our case showed a narrowing of the space within the canal. Thus, bearing in mind the reported size of the SN and blood vessels and the dimensions in the smaller lower end of the canal, the passage of the nerve along with some of the vessels might have led to its compression as well as caused exertion of blood pressure on the STSL.

Nevertheless, the real cause for ossification of the STSL in our case cannot be pointed out, i.e. if it was prompted by certain activities of the individual, age advance or the unusual morphology of the ossified ligament. However, it is very likely that this rare anatomical variation caused SNE.

The coexistence of a SSN and a bony canal is very interesting, because it has not been reported or taken into consideration by other researchers. The presence of such a case would be of significance for clinicians and surgeons dealing with suprascapular neuropathy. Furthermore, the knowledge of the morphological variations in the suprascapular region can be helpful for a better understanding the way of living and health problems of the people, living in the past. A specific morphology of the SSN could be an indicator of SNE and a supposition that the individual might have suffered from the concomitant symptoms for this pathological condition.

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