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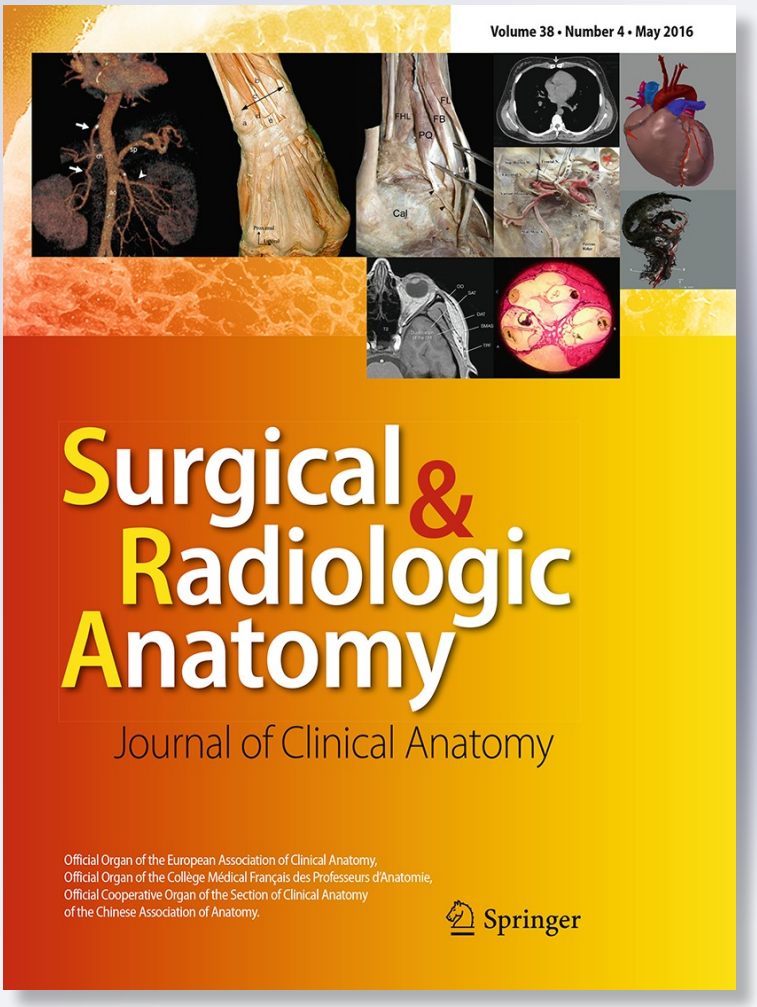

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ANATOMIC VARIATIONS

Anatomical evidence for a uniquely positioned suprascapular foramen

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Abstract The suprascapular foramen is a rare but not exceptional variation of the suprascapular notch. The suprascapular notch and suprascapular foramen could lead to pain and muscles atrophy because of nerve compression. In this study, we present a suprascapular foramen which does not correspond to a nerve's trajectory but rather corresponds to a specific bone formation that increases the surface area for muscle attachment. As a consequence, its presence cannot be taken as an indication for neurolysis, contrary to ossification of the foramen in its normal anatomical position. Moreover, this unique foramen is distinguishable from a classical suprascapular foramen on radiographs and, especially, on CT scan images.

Keywords Suprascapular foramen · Scapula · Neurolysis · Ossification

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Introduction

The superior border of the scapula typically has a recess where it joins the coracoid process, named the suprascapular notch [8, 10]. The latter is sometimes replaced by a bone opening called the suprascapular foramen (i.e. [2, 11, 15]). The suprascapular notch and suprascapular foramen are of interest both in paleoanthropology and medicine. They can contribute to suprascapular nerve compression, which leads to pain and, eventually, to supraspinatus and infraspinatus muscle atrophy [8, 10, 12] (Fig. 1a, b). The suprascapular notch is present in more than 50 % of adult scapulas (Fig. 1c, d) [17], but its shape varies [2, 5, 10, 16]. It tends to narrow with age, likely due to ossification of the superior transverse scapular ligament (STSL) (Fig. 1e) [5–7, 16]. When this ligament is completely ossified, the notch becomes a foramen (*foramen scapula osseum*) [2, 12, 15, 16]. This foramen occurs equally in both genders and both sides of the body [17] contra [11]. It is an aging-related phenomenon, as confirmed by its absence in children [13, 15]. It is present in 4–8 % of scapulas, but has been found in 14–30 % of individuals in some studies where age was not specified [10, 14, 17]. Furthermore, the STSL can have two more or less individual bands; ossification of these bands can lead to the formation of a rare double suprascapular foramen [1, 2].

Case study

During a comparative study of the lateral portion of the hominoid scapula [18], approximately thirty human scapulas from the anthropology collection of the *Musée de l'Homme* in Paris were examined in detail. One of these specimens, No. 35046 from the Olivier collection, had a

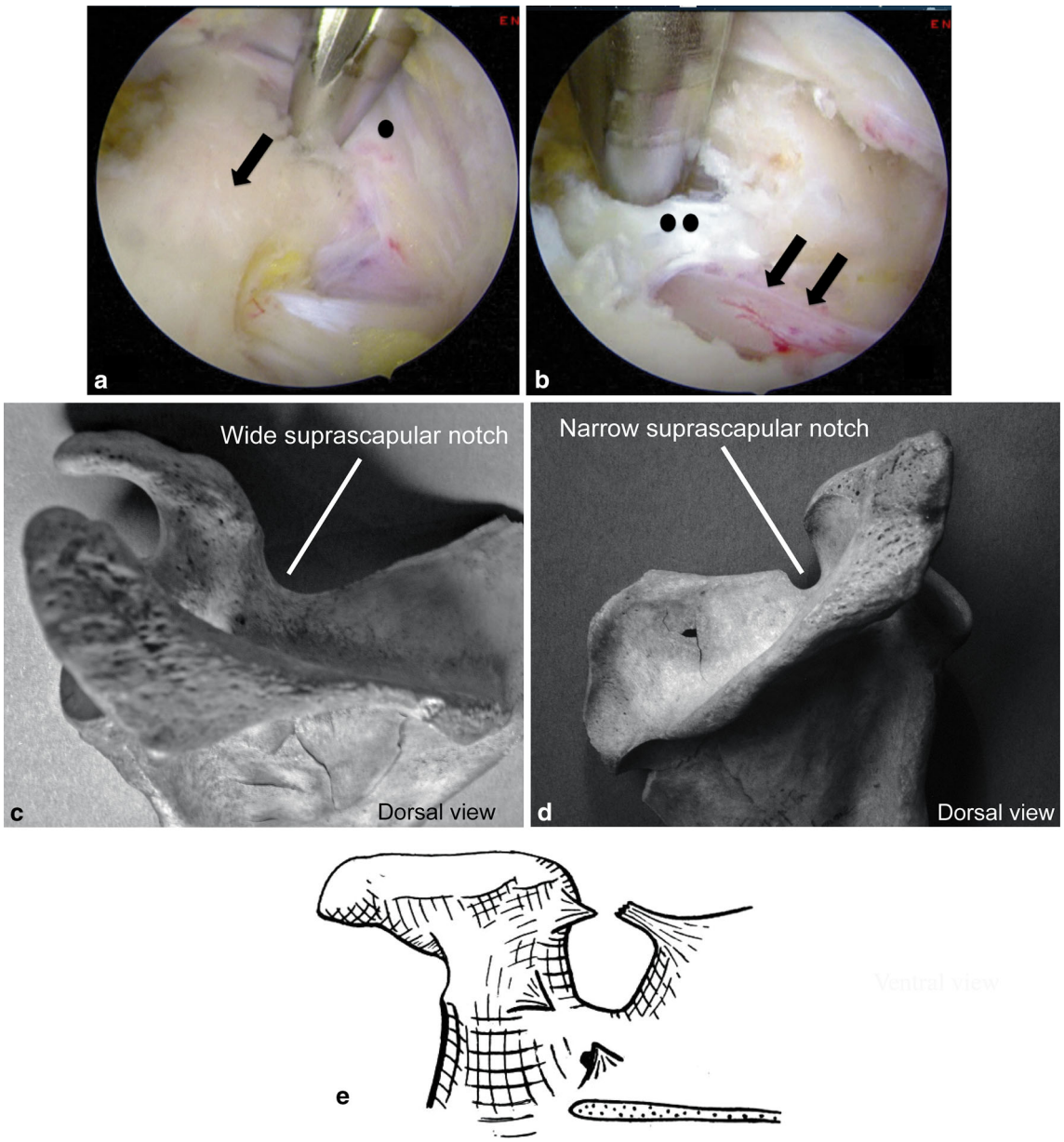

Fig. 1 **a**, **b** Arthroscopic treatment of a classical suprascapular foramen of a right shoulder. The osseous bridge (**a**) is removed (**b**) (*single arrow*) freeing the suprascapular nerve (*double arrow*). Note that the anatomy is respected with the suprascapular artery passing over the bridge (*single dot*) and the transverse scapular ligament lying underneath and still present after bone removal (*double dot*). **c**, **d** Variations in shape of the scapula's superior border where a notch is either wide (**c**) or narrow (**d**) (after [17]). **e** Diagram of partial STSL ossification (after [16])

distinctive suprascapular foramen. It belonged to an elderly woman (no additional information) who had both a scapular notch and a suprascapular foramen (Fig. 2). This foramen was shaped like an elliptical bone tunnel about 10 mm high, slightly less than 5 mm wide and about 10 mm long. It was angled medial-to-lateral, passed through the base of the coracoid process, and joined the ventral and dorsal sides of the scapula (Fig. 2). This scapula was completely normal in all other aspects and had no distinctive morphological or pathological features.

Discussion

The foramen described here is completely different from the traditional suprascapular foramen. The latter is typically an opening at the superior border of the scapula formed by ossification across the suprascapular notch (Fig. 1a, b) and does not form a bone tunnel [2, 16]. This distinctive suprascapular foramen has been reported by only two other authors [1, 3], who gave no further description or explanation.

Fig. 2 Scapula no. 35046 with its distinctive suprascapular foramen and the supraspinatus notch above it. *Scale* 2 cm

Our observations of scapula no. 35046 led us to speculate about the foramen's origin, as it does not seem to result from closure of the suprascapular notch. The latter is present with a depth and a morphology corresponding to that of a normal notch. As a consequence, the specific morphology of the scapula no. 35046 foramen cannot be attributed solely to age-related STSL ossification. It may be evidence of bone formation at the superior border of the scapula, analogous to the one known to occur in two types of South American primates, spider monkeys (*Ateles* sp.) and woolly monkeys (*Lagothrix* sp.) [4]. This foramen increases the surface area for scapular muscle attachment [4, 15]. The distinctive shape of the suprascapular foramen in scapula no. 35046 may also be the result of a specific bone formation that increases the attachment area for certain muscles such as the omohyoid muscle and especially the supraspinatus muscle. In this case, instead of guiding a nerve's trajectory, it transmits mechanical loads—either pure bone loads related to the base of the coracoid process or tensile musculotendinous loads related to extension of the muscle attachment sites.

An embryological explanation for this foramen could also been proposed. It could be the remaining space between two ossification nuclei (sometimes it may have an aspect of "fracture" line in children with a difficulty for assessing the good diagnosis in trauma conditions). Two pillars can be seen in the constitution of the vertical portion of the coracoid process, one lateral, related to the superior glenoid bone growth area, one medial related to the scapular part. In this latter case, the foramen is not linked neither to any age-related ligament ossification nor transmitting mechanical loads.

Scapula no. 35046 provides evidence that not all suprascapular foramen are alike. In other words, all suprascapular foramens are not homologous and hence comparative studies within human populations and with other groups of primates, particularly the great apes, must be performed carefully and meticulously. In a study of the suprascapular notch in primates, particularly the great apes, Patte [9] described different foramens, some of which resulted from STSL ossification and others that resembled scapula no. 35046. In other words, there are two types of suprascapular foramen in humans and great apes: those corresponding to complete STSL ossification and more rarely, those resulting from specific bone formation that increases the surface area for muscle attachment and/or resulting of a peculiar growth history.

Conclusion

Although rare in humans, the distinction between these two types of foramens must be made because of the risk of confusion during the analysis of CT slices performed prior to suprascapular nerve neurolysis. The foramen described here does not correspond to a nerve's trajectory. As a consequence, its presence cannot be taken as an indication for neurolysis, contrary to ossification of the foramen in its normal anatomical position. This observation is all the more important in that this unique foramen is distinguishable from a classical suprascapular foramen on radiographs and, especially, on CT scan images [1]. This conclusion leads us also to think about double suprascapular foramens. Most of them result from an ossification of a double STSL and increased greatly nerve compression risk [2, 11]. However, before any neurolysis, it is required to verify if the two foramens are from the same origin (i.e. ossification of a double STSL) or not. In the former, it is necessary to suppress the two bony bridges while in the latter, only the superior foramen must be open to avoid weakening of the scapula.

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Compliance with ethical standards

Conflict of interest The authors declare they have no conflicts of interest concerning this article.

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