Abstract

Background:

Cadaveric studies have reported suprascapular notch shape variations, however few have investigated the association between suprascapular notch variation and age or gender. The aim of this study was to investigate suprascapular notch shape variations using three-dimensional computed tomography (3DCT) and to determine if there was any association with age or gender.

Methods:

Three-dimensional CT images of 762 shoulders in 762 patients were analyzed in this study. Participants comprised 404 men and 358 women, with an average age of 58.2 ± 19.1 years. Suprascapular notch shape variations were classified into six types based on Rengachary's classification.

Results:

Of the total study population, 11.4% were classified as type I, 23.5% as type II, 30.1% as type III, 14.8% as type IV, 15.9% as type V, and 4.3% as type VI. The average age was 56.5 ± 20.5 years for type I, 57.0 ± 19.5 years for type II, 55.5 ± 20.0 years for type III, 56.4 ± 18.5 years for type IV, 65.5 ± 14.4 years for type V, and 68.0 ± 13.4 years for type VI. Statistically significant age differences were found between types I-IV and V and between types I-IV and VI, as well as between the non-ossification group (types I-IV) and the ossification group (types V and VI). There were no statistical differences of the male to female ratio among each type, and also between the non-ossification group and the ossification group.

Conclusions:

Our results suggest that transverse scapular ligament ossification is associated with aging; whereas the difference among type I, II, III, and IV was considered to be an individual variation. Three-dimensional CT provides useful information for arthroscopic resection of the transverse scapular ligament, when the wide variety of suprascapular notch shape variations is considered.

Level of Evidence: Level IV

Introduction

The suprascapular notch is located at the superior border of the scapula and medial to the base of the coracoid process, with the transverse scapular ligament traversing the notch superiorly. The suprascapular nerve runs under the transverse scapular ligament while the suprascapular artery runs over it. It is sometimes necessary to surgically resect the transverse scapular ligament in cases of suprascapular nerve entrapment at the suprascapular notch. It is very important to evaluate the shape of the suprascapular notch prior to surgery to allow for proper surgical approach to the notch.

Suprascapular notch shape variations and transverse scapular ligament ossifications have been reported in the literature [1-12]. Most of the previous reports were based on studies using cadavers [1-8, 10-12]. There was one report using three-dimensional computed tomography (3DCT) [9], however, age-related shape variation was not analyzed in this study.

The current study aims to investigate suprascapular notch shape variations in the Japanese population using 3DCT and to evaluate the association between shape variations for both gender and age.

Materials and Methods

This study was approved by the institutional review board, was performed following the declaration of Helsinki principles and informed consent was attained from all participants.

Three-dimensional computed tomography images of 762 shoulders from 762 patients were included in this study. All patients underwent 3DCT of the shoulder because of shoulder symptoms or trauma. CT scan and 3D reconstruction were performed on a four-slice CT scanner ECLOS-4S (Hitachi Medical Co., Tokyo, Japan) with a slice thickness of 1.25 mm. Cases in which injuries were found at the suprascapular notch were excluded. Four hundred and four of the 762 patients were male and 358 were female, giving a male-to-female ratio of 1.13. The mean age was 58.2 ± 19.1 years (range, 10 – 92 years) for all subjects ; 52.6 ± 19.4 years for males and 64.6 ± 16.5 for females, revealing a significant difference in age between the male and female participants($p < 0.01$). Suprascapular notch variations were classified into six types based on Rengachary's classification [1]; Type I: Wide depression, Type II: Wide blunted V shape, Type III: Symmetric U shape, Type IV: Very small V shape, Type V: Partially ossified suprascapular ligament, and Type VI: Completely ossified suprascapular ligament (Fig. 1). Shape distribution was evaluated using this classification, and age and gender were identified for each type. The average age and gender ratio were also compared between a group without ossification (types I–IV) and a group with ossification (type V, VI). The differences among each group were statistically analyzed using the Kruskal-Wallis test and using the Steel-Dwass post-hoc test. The difference between the ossification and the non-ossification group was analyzed using the Chi-square test. The level of significance was set at a P value of < 0.05 for comparisons.

Results

All cases were classified into one the six types of Rengachary's classification. Eighty-seven shoulders (11.4%) were classified as type I, 179 shoulders (23.5%) as type II, 229 (30.1%) as type III, 113 (14.8%) as type IV, 121 (15.9%) as type V, and 33 (4.3%) as type VI. (Table 1) The average age was 56.5 ± 20.5 years in the type I group, 57.0 ± 19.5 years in type II, 55.5 ± 20.0 years in type III, 56.4 ± 18.5 years in type IV, 65.5 ± 14.4 years in type V, and 68.0 ± 13.4 years in the type VI group. Differences were statistically significant between types I, II, III, IV and V, and between types I, II, III, IV and VI, respectively (Table 2).

The mean age of the non-ossification group was 56.2 ± 19.6 years, while that of the ossification group was 66.0 ± 14.2 years. The average age was statistically higher ($p < 0.01$) in the ossification group.

The male to female ratio was 1.07 (45:42) in type I, 1.16 (96:83) in type II, 1.08 (119:110) in type III, 1.56 (69:44) in type IV, 1.02 (61:60) in type V, and 0.73 (14:19) in type VI. There was no statistically significant difference in each group. The male to female ratio was 1.18 (329:279) in the non-ossification group and 0.94 (75:79) in the ossification group; the difference was not statistically significant.

Discussion

Suprascapular nerve entrapment at the suprascapular notch was first reported in 1959 [13, 14], and open resection of the transverse scapular ligament to alleviate suprascapular nerve palsy was reported in the 1970s [15-17]. Arthroscopic transverse scapular ligament resection for suprascapular nerve palsy has been reported since 2006 [18-26]. Arthroscopic release of the transverse scapular ligament is a useful procedure to release the suprascapular nerve since the transverse scapular ligament is located deep under the trapezius and supraspinatus muscles. Ossification of the transverse scapular ligament was first reported in 1979, and it is known that there are some variations of the suprascapular notch shape including ligament ossification [1-12]. It is generally difficult to obtain the correct orientation during arthroscopic release of the suprascapular nerve when the transverse scapular ligament is ossified, and it is necessary to resect the ossified ligament using a punch or a Kerrison punch [25, 27, 28]. Therefore, advance knowledge of the suprascapular notch shape or type using preoperative 3DCT is useful to perform adequate and safe arthroscopic resection of the transverse scapular ligament.

A correlation between ossification of the transverse ligament and aging was previously suggested [2], but the relationship was not clear because most previous studies were performed using dry cadavers with no mention of age [1, 2, 6, 7, 8, 10, 11], and other studies showing average participant age did not analyze the association between ossification and age [3, 4, 9, 12]. It is very important to identify the notch shape variation in a broad age range, which reflects the actual age distribution of suprascapular nerve palsy patients. Therefore, we have performed the current study using 3DCT data in a wide age group. Our study did include young patients, and found that the average age of types V and VI scapular notches were statistically higher than the average age for the other scapular notch types. Based on these findings, transverse scapular ligament ossification was suspected to be associated with aging. However, among the shoulders categorized as type VI, one patient was aged 21 years of age, while twenty other participants in this group were over fifty years of age. Congenital ossification of the ligament may exist. There was no significant difference in the average age of participants with type I, II, III, and IV suprascapular notches in the current study. This result suggests that the shape difference for type I, II, III, and IV shoulders is related to individual variation.

There has been one report of the male to female ratio of transverse scapular ligament ossification. Polguj *et al.* reported that complete ossification of the transverse scapular ligament was more frequent in females in their cadaveric study [10]. The ratio between males and females in the present study showed a trend toward more females than males exhibiting transverse scapular ligament ossification, in agreement with the previous report; however, this difference was not statistically significant. Other studies of ligament ossification revealed a male to female ratio of 1.96 (1388:709) [29], and 1.45

(42:29) [30] for ossification of the posterior longitudinal ligament (OPLL) in the cervical spine. In addition, more males than females exhibited OPLL of the cervical spine in contrast to the gender ratios described for the transverse scapular ligament. However, no apparent causes were reported for the gender difference in OPLL, and the cause of differences in transverse scapular ligament ossification was also unclear.

Rengachary *et al.* [1], Urgüden *et al.* [6], Dunkelgrun *et al.* [5], Albino *et al.* [12], and Sangam *et al.* [11] all previously published reports on the shape of the suprascapular notch from cadaveric studies (Table 3). Our results showed a different distribution compared with previous reports, probably because the age distribution was different, as mentioned before, and the race of the participants was also different.

There were some limitations in this study. The participants were a biased population, as they were not normal volunteers but were patients with some shoulder symptoms or trauma. In addition, the existence of suprascapular nerve palsy in these subjects was not investigated. Since the correlation between suprascapular notch shape and suprascapular nerve palsy is unclear, the notch shapes of patients with paralysis of the suprascapular nerve should be investigated in a future study.

Conclusions

We investigated the variations in suprascapular notch shape using 3DCT with Rengachary's Classification. Ossification of the transverse scapular ligament existed in 20% of the subjects and was associated with aging.

Rengachary's type I, II, III, and IV were considered to represent individual variation. Preoperative 3DCT examination is useful to perform the arthroscopic resection of the transverse scapular ligament safely and adequately when the wide variety of suprascapular notch shape variations is considered.

References

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Figure captions

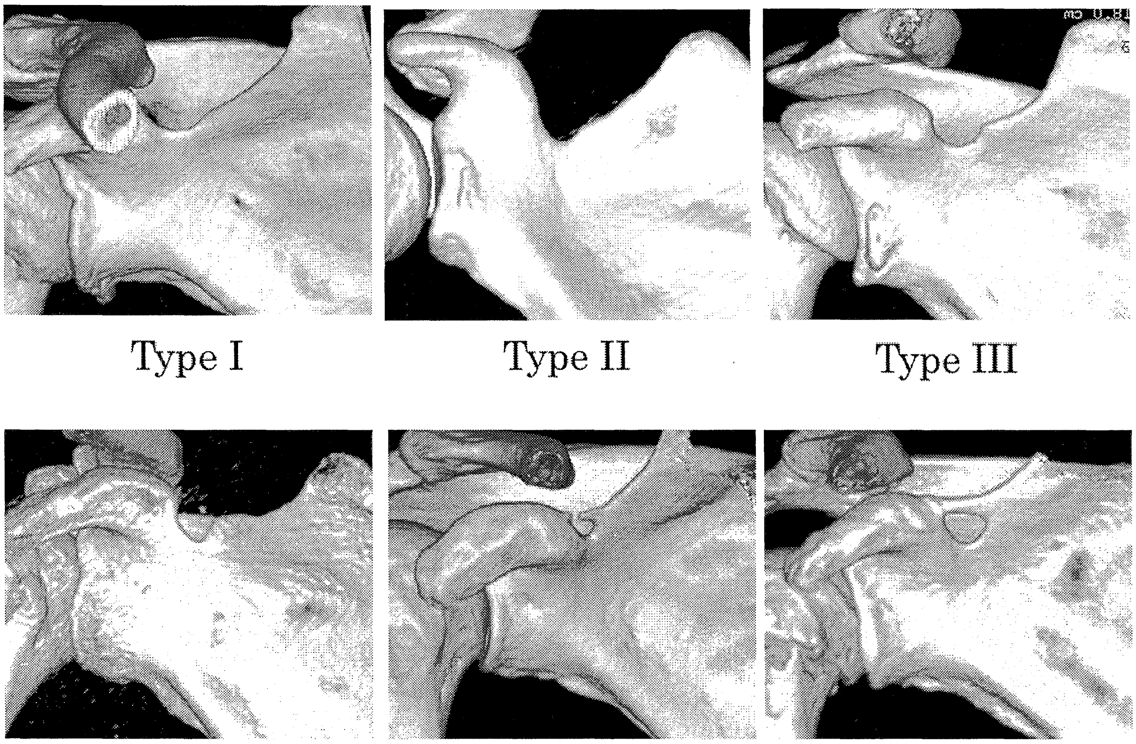
Fig. 1; Rengachary's classification; Type I: Wide depression, Type II: Wide blunted V shape, Type III: Symmetric U shape, Type IV: Very small V shape, Type V: Partially ossified suprascapular ligament, and Type VI: Completely ossified suprascapular ligament.

Table 1; Data of cases in Rengachary's classification.

Table 2; Ages in each type.

Table 3; Shape distribution compared with other studies. [1, 5, 6, 11, 12]

Fig.1



Type I Type II Type III

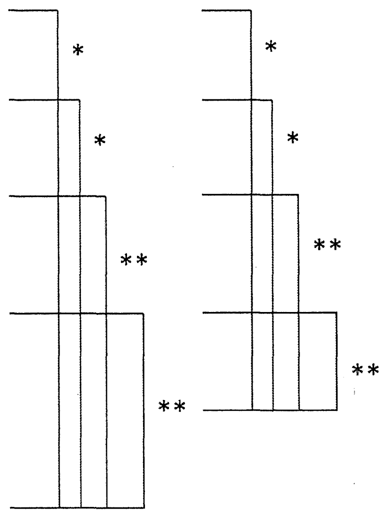
Type IV Type V Type VI

Table 1

Rengachary' s classification	I	II	III	IV	V	VI
Number (shoulders)	87	179	229	113	121	33
(Male: Female)	(45:42)	(96:83)	(119:110)	(69:44)	(61:60)	(14:19)
Ratio between male and female	1.07	1.16	1.08	1.56	1.02	0.73
The average ages (y.o)	56.5	57.0	55.5	56.4	65.5	68.0

Table 2

	Age (avg. ±SD)
Type I	56.5±20.5
Type II	57.0±19.5
Type III	55.5±20.0
Type IV	56.4±18.5
Type V	65.5±14.4
Type VI	68.0±13.4



*P<0.05 ; Type I vs Type V, VI, Type II vs Type V ,VI
**P<0.01 ; Type III vs Type V, VI, Type IV vs Type V, VI

Table 3

Type	I	II	III	IV	V	VI	The average ages
Rengachary (%)	8	31	48	3	6	4	Unknown
Urguden (%)	6	24	40	13	11	6	Unknown
Dunkelgrun (%)	8	33	31	6	18	5	58 (18-90)
Albino (%)	12.4	19.8	22.8	31.1	10.2	3.6	Unknown
Sangam (%)	21.15	8.65	59.61	2.88	5.76	1.92	Unknown
This study (%)	11.4	23.5	30.1	14.8	15.9	4.3	58.2 (10-92)