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Incidence of teres minor muscle atrophy in young and middle-aged populations

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A R T I C L E I N F O

Keywords:
Shoulder
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Teres minor atrophy
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Level of evidence: Level IV; Case Series; Descriptive Epidemiology Study

Background: Teres minor atrophy can be seen in shoulders both with and without a rotator cuff tear, even among the young population. The purpose of this study was to retrospectively investigate the incidence of teres minor atrophy in young and middle-aged patients with or without a rotator cuff tear.
Methods: Patient records were reviewed to identify 10-39-year-old patients (Group Y) and 60-69-year-old patients (Group O) who underwent MRI because of shoulder disorders. The exclusion criteria were as follows: (1) prior surgeries, (2) neurological disorders in the cervical spines or shoulder girdle, (3) global atrophy of all four cuff muscles without a rotator cuff tear, (4) acute trauma, and (5) poor image quality due to artifacts. An experienced shoulder surgeon evaluated teres minor atrophy on T1-weighted oblique sagittal images. Statistical analysis was performed using the chi-square test for comparison of Groups Y and O.
Results: Group Y consisted of 528 shoulders in 520 patients, including 406 males and 114 females with a mean age of 26 years. Group O consisted of 884 shoulders in 837 patients, including 394 males and 443 females with a mean age of 65 years. Rotator cuff tears were seen in 33 shoulders (6.3 %) in Group Y, and 411 shoulders (46.5%) in Group O. Teres minor atrophy was more present in Group O (59 shoulders [6.7%]) than Group Y (11 shoulders [2.1%], $P < .001$). Among shoulders with teres minor atrophy, the incidence of intact cuff tended to be higher in Group Y than O (7 shoulders [64%] and 21 shoulders [36%], $P = .08$). However, the ratio of the intact cuff to the number of patients in each group was not significantly different (Group Y, 7 of 528 [1.3%]; Group O, 21 of 884 [2.3%]). Teres minor muscle atrophy tended to be more common in athletes than nonathletes in Group Y, although the difference was not significant ($P = .057$).
Conclusion: The incidence of teres minor atrophy was significantly higher in middle-aged patients than young patients. Middle-aged patients with teres minor atrophy were more associated with rotator cuff tears. The common cause of teres minor atrophy may be rotator cuff tears. Teres minor atrophy in young patients might be associated with sports-related factors such as infraspinatus hypertrophy or axillary nerve injury.

Teres minor is one of the shoulder external rotators and plays an important role in maintaining active external rotation in patients with a massive rotator cuff tear, including the infraspinatus tendon. Quality of the teres minor muscle can affect the clinical outcomes of reverse shoulder arthroplasty.[1,13] Rotator cuff tears with teres minor atrophy can lead to loss of active external rotation with or without loss of active elevation.[2]

Teres minor atrophy has been occasionally reported in shoulders without a rotator cuff tear.[7,12,14] A previous report indicated that isolated teres minor atrophy was associated with quadrilateral space syndrome,[9] but another article has suggested that clinical findings of isolated teres minor atrophy were possibly different

Institutional review board approval was received prior to initiating this study (the IRB/ERC of Funabashi Orthopedic Hospital #2020004).
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than those of quadrilateral space syndrome.[15] Thus, the causes of isolated teres minor atrophy remain controversial.

Previous studies have investigated the incidence of teres minor atrophy in middle-aged or elderly populations. We have noticed through our clinical experiences that teres minor atrophy was sometimes seen in young patients, even without a rotator cuff tear. No studies have elucidated the incidence of teres minor atrophy and its relation to rotator cuff tears in a young population.

The purpose of this study was to retrospectively investigate the incidence of teres minor atrophy in young and middle-aged patients with or without a rotator cuff tear. We hypothesized that teres minor atrophy would exist at a higher rate in middle-aged patients than young patients and would not be associated with rotator cuff tears in young patients.

Materials and methods

Patient selection

This study was conducted at a single orthopedic clinic, which specializes in shoulder and elbow surgery. The institutional review board of our hospital approved this study. Patient records were retrospectively reviewed to identify younger and older patients who underwent plain shoulder MRI at our clinic because of shoulder disorders. We defined younger patients from 10 to 39 years old as Group Y, and older patients from 60 to 69 years old as Group O. Power analysis was conducted by use of an α value of 0.05 and an effect size of 0.8 and suggested that 1283 shoulders would be needed to achieve a power of 0.8. Younger and older patients were collected to exceed the suggested number. As a result, Groups Y and O included patients that underwent MRI between April 2016 and October 2019 and between April 2018 and October 2019, respectively. The inclusion criterion was shoulders that underwent plain shoulder MRI at our clinic. The exclusion criteria were as follows: (1) prior surgeries, (2) neurological disorders in the cervical spines or shoulder girdle such as cervical myelopathy, thoracic outlet syndrome, or quadrilateral space syndrome, (3) global atrophy of all four cuff muscles without a massive rotator cuff tear (> stage 1 in Goutallier staging), (4) acute trauma within 3 months, and (5) poor image quality due to artifacts. For Group Y patients, sports activity was investigated, and those who participated in sports more than three times a week were defined as athletes.

Magnetic resonance imaging

All patients underwent MRI using a 1.5-T system (Intera; Philips, Amsterdam, the Netherlands). Patients were positioned with the shoulder at the side in the neutral rotation. T2-weighted images were obtained in axial, oblique coronal (parallel to the long axis of the supraspinatus tendon), and oblique sagittal (perpendicular to the long axis of the supraspinatus tendon) planes with a 3.5-mm slice thickness and a 1-mm slice gap. The scan parameters for T2 coronal images were as follows: repetition time (TR), 5000 msec; echo time (TE), 100 msec; field of view (FOV), 160 mm; and matrix 512 × 800. For T2 sagittal images, the parameters were TR, 4147 msec; TE, 100 msec; FOV, 160 mm; and matrix, 384 × 720. For T2 axial images, the parameters were TR, 4000 msec; TE, 100 msec; FOV, 160 mm; and matrix, 400 × 720. In addition, T1-weighted oblique sagittal images (TR, 400 msec; TE, 10.5 msec; FOV, 160 mm; and matrix 400 × 720) were obtained to assess the atrophy of the rotator cuff muscles. Rotator cuff tears were assessed with T2-weighted images, and the tear size of the supraspinatus/infraspinatus was determined as the mediolateral width on T2-weighted oblique coronal images according to DeOrio and Cofield classification[4]: small, ≤1 cm; medium, 1 to 3 cm; large, 3 to 5 cm; massive, >5 cm.

Figure 1 Evaluation of teres minor atrophy. Teres minor atrophy (◯) was evaluated on the Y-view of T1-weighted oblique sagittal MRI (right shoulder).

Evaluation of the teres minor muscle

The teres minor muscle was assessed on the Y-view images (Fig. 1).[6] Teres minor atrophy was graded with T1-weighted oblique sagittal images according to the reported grading of cuff muscle atrophy[11]: grade I, no atrophy; grade II, mild atrophy with more muscle than fat; grade III, moderate atrophy with equal amounts of fat and muscle; grade IV, severe atrophy with more fat than muscle. In cases where discriminating the teres minor from the infraspinatus was difficult, the muscle was subsequently followed from the lateral to medial images to distinguish the two muscles. We defined grades II, III, and IV as teres minor atrophy.

All images were assessed by a single experienced shoulder surgeon (Y.T.) who was blinded to patients' data. Although the intraobserver and interobserver variabilities of the grading for the infraspinatus have been reported as 0.90 and 0.93, respectively,[11] no studies have evaluated the variabilities for the teres minor muscle. To investigate intraobserver and interobserver variability of Matsuki's muscle atrophy grading system, we used images from 50 randomly selected patients. For intraobserver variability, a single surgeon (Y.T.) evaluated the images twice at 1-week intervals. For intraobserver and interobserver variabilities, two surgeons (Y.T. and I.K.) independently evaluated the images.

Assessment

Patients' factors were compared between Groups Y and O: sex, age at MRI, the incidence of teres minor atrophy, the incidence of rotator cuff tear. In shoulders with a rotator cuff tear, the incidence of teres minor atrophy was also investigated between Groups Y and O. Additionally, we evaluated the rate of rotator cuff tear cases in teres minor atrophy between Groups Y and O, patients' cuff tear sizes between with and without teres minor atrophy in Groups

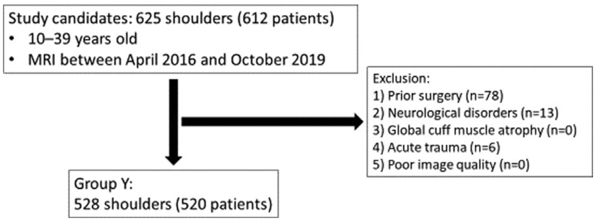

Figure 2 Flow chart for patient selection of Group Y.

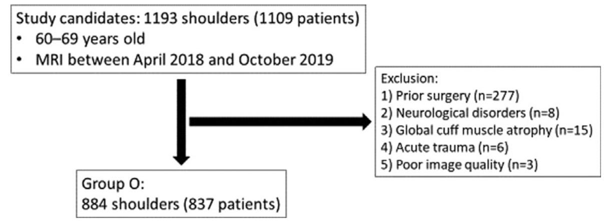

Figure 3 Flow chart for patient selection of Group O.

Y and O and the characteristics of patients with teres minor atrophy in Group Y.

Statistical analysis

Statistical analysis was performed using the chi-square test for comparison of the two groups. The level of significance was set at $P < .05$. The kappa coefficient was used to assess intraobserver and interobserver variabilities of the grading for the teres minor muscle atrophy. The strength of correlation was categorized according to Landis and Koch[8]: a kappa value of .00-.20, slight; .21-.40, fair; .41-.60, moderate; .61-.80, substantial; .81-1.00, almost perfect. All analyses were performed with SPSS software (IBM, Armonk, NY, USA).

Results

Shoulder MRI was performed in 612 patients (625 shoulders) at the age of 10-39 years between April 2016 and October 2019. Ninety-seven shoulders were excluded from the study: prior surgeries, 78 shoulders; neurological disorders, 13 shoulders; acute trauma, 6 shoulders (Fig. 2). Thus, Group Y included 528 shoulders in 520 patients (406 men and 114 women) with a mean age of 26 years (range, 11-39 years) at the time of MRI (Table I).

Shoulder MRI was performed in 1109 patients (1193 shoulders) at the age of 60-69 years between April 2018 and October 2019. Three hundred nine shoulders were excluded from the study: prior surgeries, 277 shoulders; neurological disorders, 8 shoulders; global atrophy of all four cuff muscles, 15 shoulders; acute trauma, 6 shoulders; poor image quality due to artifacts, 3 shoulders (Fig. 3). Thus, Group O included 884 shoulders in 837 patients (394 men and 443 women) with a mean age of 65 years (range, 60-69 years) at the time of MRI (Table I).

The intraobserver variability of the grading for the teres minor muscle atrophy was .83, which was considered as an almost perfect agreement. The interobserver variabilities for the two examiners were .68 and .73, respectively, both of which were considered as substantial agreement.

Teres minor atrophy was present in 11 shoulders (2.1%) in Group Y, and 59 shoulders (6.7%) in Group O, and the difference in the incidence was statistically significant (Table I, $P < .001$). Rotator cuff tears were found in 33 shoulders (6.3 %) in Group Y and 411 shoulders (46.5%) in Group O (Table I, $P < .001$).

Table I
Demographic data.

Demographic datax	Group Y	Group O	*P* value
Number of shoulders	528	884	
Sex (male/female)	411/109	394/443	<.001
Age at MRI	26 ± 8 (10-39)	65 ± 3 (60-69)	<.001
Teres minor atrophy	11 (2.1%)	59 (6.7%)	<.001
Rotator cuff tear	33 (6.3%)	411 (46.5%)	<.001
Large & massive tear	3	86	

Among shoulders with teres minor atrophy, the incidence of intact cuff tended to be higher in Group Y than O (Tables II and 7shoulders [64%] in Group Y and 21 shoulders [36%] in the Group O, $P = .08$). However, the ratio of the intact cuff to the number of patients in each group was not significantly different between the groups (group Y, 7 of 528 [1.3%]; Group O, 21 of 884 [2.3%], $P = .17$). In Group Y, no shoulders with teres minor atrophy were associated with large or massive rotator cuff tears. Fifteen (39.5%) out of 38 shoulders with a rotator cuff tear had a large or massive tear in Group O shoulders with teres minor atrophy, while 71 (19.0%) of 373 shoulders with a rotator cuff tear that were not associated with teres minor atrophy had a large or massive tear. The difference in the incidence of large and massive tears in Group O shoulders with a rotator cuff tear was statistically significant ($P < .001$).

In Group Y, 8 out of 235 athletes had teres minor atrophy, while only 3 of 293 nonathletes showed teres minor atrophy. Teres minor muscle atrophy tended to be more common in athletes than non-athletes, although the difference was not significant (Table III, $P = .057$).

Discussion

In this study, we investigated the incidence of teres minor atrophy, and the rate of teres minor atrophy was statistically higher in Group O (6.7%) than Group Y (2.1%). Among shoulders with teres minor atrophy, the incidence of intact cuff tended to be higher in Group Y than O; however, the ratio of the intact cuff to the number of patients in each group was not significantly different between the groups. In Group Y, no shoulders with teres minor atrophy were associated with large or massive rotator cuff tears. The ratio of large and massive tears to whole rotator cuff tears was significantly higher in shoulders with teres minor atrophy than those without atrophy in Group O.

Table II
Relationship between teres minor atrophy and rotator cuff tear.

	Group Y (n = 528)		Group O (n = 884)	
	Atrophy	No atrophy	Atrophy	No atrophy
Rotator cuff tear	4	29	38	373
(Large & massive)	(0)	(3)	(15*)	(71*)
Intact cuff	7	488	21	452

*The ratio of large and massive tears to whole rotator cuff tears was significantly higher in shoulders with teres minor atrophy than those without atrophy in the Group O ($P < .001$).

Table III
Relationship between teres minor atrophy and sports participation in group Y.

	Athletes	Nonathletes	*P* value
Teres minor atrophy	8	3	.057
No teres minor atrophy	227	290	

Table IV
Previous reports on teres minor atrophy.

Author, year	Modality	Subjects (mean age)	Teres minor atrophy	Rotator cuff tears
Sofka, 2004[14]	MRI	2563 (no data)	61 (2.4%)	47 (77%)
Melis, 2011[12]	CT, MRI	1572 (57)	53 (3.4%)	53 (100%)
Kang, 2019[7]	MRI	1264 (no data)	78 (6.2%)	67 (86%)
This study	MRI	Group Y 528 (26)	11 (2.1%)	4 (36%)
		Group O 884 (65)	59 (6.7%)	38 (64%)

Previous studies[7,12,14] have reported that the incidence of teres minor atrophy ranged from 2.4 to 6.2% (Table IV). The incidences in this study were similar with these reports. All previous studies indicated that teres minor atrophy was associated with rotator cuff tears with high incidences. Group O in this study also showed that the incidence of rotator cuff tears in shoulders with teres minor atrophy was 64%, and large or massive rotator cuff tears accounted for 15 of 38 tears. Thus, the common cause of teres minor atrophy may be rotator cuff tears, especially large or massive tears. Superior translation of the humeral head caused by large or massive rotator cuff tears might cause a stretch of the nerve branches to the teres minor muscle.[10,15] Additionally, large or massive tears, including the teres minor, also might cause its atrophy.

On the other hand, Group Y had the high incidence (64%) of intact rotator cuff, and no shoulders were associated with large or massive rotator cuff tears. Group O also included shoulders with teres minor atrophy that were not accompanied by rotator cuff tears, and the rate of such shoulders to the number of subjects (2.3%) was not significantly different than that in Group Y (1.3%). These findings suggest that teres minor atrophy might develop in the young population at a certain rate by some causes other than rotator cuff tears and be maintained thereafter.

The causes of teres minor atrophy other than rotator cuff tears remain unclear, but there seems to be a few possible causes. Chafik et al[3] have reported that a stout fascial sling could be a source of compression force on the nerve to the teres minor muscle. Friend et al[5] have also reported traction injury and a fascial sling around the teres minor nerve as possible causes of axillary nerve injury. In this study, teres minor atrophy tended to be more common in athletes than nonathletes in Group Y, although the difference was not significant. Infraspinatus muscle hypertrophy by training or nerve injury during sports activities might be associated with teres minor atrophy in the young population. Congenital atrophy may be another possible explanation, but there has been no English literature on this pathology.

Limitations

This study had several limitations. First, this study was only based on MRI findings, and the relationship between radiographic and clinical findings was not assessed. Second, the subjects were symptomatic patients and did not include healthy subjects. Findings might be different in healthy subjects. Third, the proportion of sexes was different between the groups. Sex might have some influence on teres minor atrophy. Last, teres minor atrophy was semi-quantitatively assessed. Since the intrarater and inter-rater agreement were optimal, the influence may be minimal. Despite these limitations, we believe that this study provides important information on the incidence of teres minor atrophy.

Conclusion

The incidence of teres minor atrophy was significantly higher in middle-aged patients than young patients. Middle-aged patients with teres minor atrophy were more associated with rotator cuff tears. The common cause of teres minor atrophy may be rotator cuff tears. Teres minor atrophy in young patients might be associated with sports-related factors such as infraspinatus hypertrophy or axillary nerve injury.

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