



Original Article

Ultrasonography of the shoulder: asymptomatic findings from working-age women in the general population

ROBERTO MERONI, PT, PhD^{1)a}, DANIELE PISCITELLI, PT, MSc^{1)a*}, SANSONE VALERIO, MD²⁾, PAOLA BORIA, MD³⁾, CECILIA PERIN, MD¹⁾, GIOVANNI DE VITO, MD¹⁾, CESARE MARIA CORNAGGIA, MD¹⁾, CESARE GIUSEPPE CERRI, MD¹⁾

¹⁾ School of Medicine and Surgery, University of Milano Bicocca: via Cadore 48, 20900 Monza (MB), Italy

²⁾ Orthopaedic Department, University of Milan, Italy

³⁾ Occupational Medicine, Private Practice, Italy

Abstract. [Purpose] The aim of this study was to estimate the prevalence of abnormal shoulder ultrasonographic findings in a sample of asymptomatic women. [Subjects and Methods] A secondary analysis of a cross-sectional study was performed. We recruited 305 women (aged 18–56 years). All the subjects had a structured interview screening for self-reported symptoms and underwent a shoulder ultrasonographic examination, in which both shoulders were examined. The radiologist was blinded to the clinical history of the participants. All detectable shoulder abnormalities were collected. [Results] Of the subjects, 228 (74.75%) were asymptomatic at both shoulders, and 456 asymptomatic shoulders were analyzed. Lack of uniformity (supraspinatus, infraspinatus, subscapularis, and biceps brachii long head) was found in 28 shoulders (6.14%), 19 (4.17%) on the dominant side and 9 (1.97%) on the non-dominant side. Tendinosis (supraspinatus, infraspinatus, subscapularis, and biceps brachii long head) was found in 19 shoulders (5.32%), 12 (2.63%) on the dominant side and 7 (1.53%) on the non-dominant side. Calcification and other abnormal findings were reported. [Conclusion] The most common abnormalities were calcifications within the rotator-cuff tendons and humeral head geodes; other degenerative findings were less common.

Key words: Shoulder, Ultrasound, Prevalence

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INTRODUCTION

Ultrasonography of the shoulder is one of the most commonly used radiological methods for the study of the rotator cuff¹⁾. It is considered to be as accurate as magnetic resonance imaging (MRI) for the diagnosis of shoulder musculoskeletal disorders in general²⁾ and for the assessment of rotator cuff tears in particular³⁾. In comparison with the various modalities currently available for diagnosing rotator cuff disorders, ultrasonography has a series of advantages, including the following: it is more widely available and far more cost-effective; it allows dynamic examination of the structures; comparison can be easily made between the affected shoulder and the contralateral side; and finally, it provides immediate feedback for the patient/clinician. The major disadvantage and limitation of the technique is operator dependence; to ensure high sensitivity and specificity in the diagnosis of rotator cuff disorders, adequate training and considerable experience of the examiner are crucial⁴⁾. Although one of the main clinical symptoms of rotator cuff disorder is the presence of pain, asymptomatic rotator cuff disorders have been detected both on MRI^{5, 6)} and ultrasonography^{7–11)}. The most common pathological findings in asymptomatic shoulder

*Corresponding author. Daniele Piscitelli (E-mail: d.piscitelli1@campus.unimib.it)

^aThese authors contributed equally to this work.

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disorders are rotator cuff tears, and the incidence of these impairments increase with age. The prevalence of asymptomatic shoulders with full-thickness tears is between 6 and 23%⁷⁻¹¹). Furthermore, abnormal rotator cable and other findings are reported to affect the surrounding structures. In a recent study conducted with adult men, various asymptomatic shoulder abnormalities were found on ultrasonography, including subacromial-subdeltoid (SAD) bursal thickening and supraspinatus tendinosis¹²). However, to our knowledge, asymptomatic shoulder abnormalities in women identified on ultrasonographic examinations of the whole shoulder have not been reported in the literature. Awareness of the possible abnormal findings that could be observed in asymptomatic shoulders is crucial for an adequate interpretation of symptoms and signs in clinical practice, which, in turn, substantially determines/greatly affects the choice of therapy in symptomatic patients.

The aim of this study was to estimate the prevalence of shoulder ultrasonographic abnormal findings in a sample of asymptomatic women. Our analysis included not only abnormalities of the rotator cuff but also abnormalities that affect the surrounding structures.

SUBJECTS AND METHODS

This was a secondary analysis of previously published data¹³⁻¹⁵). From November 2011 to March 2012, 305 female customers of a supermarket chain in northern Italy were recruited to participate in this study. A consecutive sampling technique was used to enroll the participants. All the subjects were aged between 19 and 56 years. The exclusion criteria were a previous shoulder trauma or surgery, evident or previously diagnosed major pathologies, and the presence of other musculoskeletal, neurological, or psychiatric impairments. Furthermore, subjects who performed repetitive movements of the upper arm or carried heavy loads for professional reasons were also excluded. To reduce a subject selection bias, a prepaid gift card was given, as free ultrasonographic and orthopedic examinations could have been a selective factor for subjects with preexisting impairments. The subjects responded to a questionnaire based on the criteria of the Nordic Musculoskeletal Questionnaire to investigate shoulder symptoms¹⁶). The questionnaire was administered by an orthopedic specialist to ensure that each subject fully understood the questions. Respondents were asked if they had had any musculoskeletal disorders in the last 12 months that had prevented normal activity and if they had had shoulder pain at least once a month in the past year or during at least seven consecutive days in the past year, or if they felt continuous pain. A negative response was considered as an “asymptomatic shoulder”; otherwise, a positive response was considered as “symptomatic shoulder.” Demographic characteristics, anthropometric data, and arm dominance of each subject were recorded by the orthopedic specialist. All the subjects underwent a shoulder ultrasonographic examination, in which both shoulders were examined. The radiologist was blinded to the clinical history of the participants, and the subjects were instructed not to mention either arm dominance or the possible presence of shoulder symptoms during the ultrasonographic examination. All scans were performed by a radiologist with more than 20 years of experience in sonography of the musculoskeletal apparatus, by using a 15-MHz linear-array high-frequency transducer (Logiq E9 with a 15 MHz linear probe, GE Healthcare, Milwaukee, USA), according to the following technical guidelines of the Ultrasound Subcommittee of the European Society of Musculoskeletal Radiology (ESSR)¹⁷). The following structures were examined: rotator cuff (supraspinatus, infraspinatus/teres minor, and subscapularis), long head of the biceps tendon, SAD bursa, humeral head, and acromioclavicular joint. Tendon lesions, tendon calcifications, bursitis, capsulitis, and all other morphological and degenerative abnormalities such as arthritic alterations of the surrounding structures were registered^{18, 19}). All abnormalities were studied according to the international accepted definitions and scored according to a dichotomous assessment. Calcifications were assessed for the presence of acoustic shadowing^{20, 21}) and further divided into 3 groups (granular, milk, or linear calcifications), and were then further classed according to diameter size as follows: calcifications between 5 and 12 mm, and calcifications >12 mm in diameter. Descriptive statistics were used to describe the study sample, mean, standard deviation (SD), and the range for continuous variables. Frequency distributions were used to describe categorical variables. The prevalence was reported as the frequency of abnormalities among the shoulders. The statistical analysis was performed by using the SPSS v.21 software. Ethical principles were followed in accordance with the Declaration of Helsinki, and all subjects gave their informed consent. Institutional review board approval was gained for this study.

RESULTS

The whole cohort was comprised of 305 women (mean age, 38.5 ± 9.5 years; range, 19–56 years) with a mean body mass index (BMI) of 23.2 ± 4.2 kg/m² (range, 14.5–41.9 kg/m²).

Of the subjects, 228 (74.75%; age: mean ± SD, 36.7 ± 9.3 years; range, 19–56 years; BMI: mean ± SD, 22.8 ± 4 kg/m²; range, 14.5–41.9 kg/m²) asymptomatic subjects at both shoulders. We excluded 77 subjects (24.25%) who presented at least one symptomatic shoulder (age: mean ± SD, 43.8 ± 7.9 years; range 25–55 years; BMI: mean ± SD, 24.4 ± 4.5 kg/m²; range, 16.5–35.7 kg/m²). Detailed findings are reported in [Tables 1 and 2](#). Consequently, 456 asymptomatic shoulders were reported in the study. Of the subjects, 213 (93.4%) had dominant right shoulders and 15 (6.6%) had dominant left shoulders.

Lack of uniformity (supraspinatus, infraspinatus, subscapularis, and biceps brachii long head) was found in 28 shoulders (6.14%), 19 (4.17%) on the dominant side and 9 (1.97%) on the non-dominant side. Tendinosis (supraspinatus, infraspinatus, subscapularis, and biceps brachii long head) was found in 19 shoulders (5.32%), 12 (2.63%) on the dominant side and 7 (1.53%) on the non-dominant side.

Table 1. Ultrasound findings for the rotator cuff tendons

Findings	Supraspinatus		Infraspinatus - Teres Minor		Subscapularis	
	Dom N=228	Non-Dom N=228	Dom N=228	Non-Dom N=228	Dom N=228	Non-Dom N=228
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Lack uniformity	8 (3.5)	3 (1.3)	8 (3.5)	5 (2.2)	2 (0.9)	1 (0.4)
Tendinosis	6 (2.6)	3 (1.3)	5 (2.2)	3 (1.3)	1 (0.4)	1 (0.4)
Partial-thickness tear	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Full-thickness tear	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Calcification TOT	15 (6.6)	10 (4.4)	18 (7.9)	8 (3.5)	10 (4.4)	9 (3.9)
Calcification >5 mm <12 mm	15 (6.6)	8 (3.5)	13 (5.7)	5 (2.2)	10 (4.4)	8 (3.5)
Calcification >12 mm	0 (0)	2 (0.9)	5 (2.2)	3 (1.3)	0 (0)	1 (0.4)
Calcification characteristics						
Granular calcification	0 (0)	5 (2.2)	6 (2.6)	3 (1.3)	1 (0.4)	1 (0.4)
Milk calcification	0 (0)	0 (0)	2 (0.9)	1 (0.4)	0 (0)	0 (0)
Linear calcification	15 (6.6)	5 (2.2)	10 (4.4)	4 (1.8)	9 (3.9)	8 (3.5)

Dom: dominant; Non-Dom: non-dominant

Rotator Cuff: Lack of uniformity of the asymptomatic rotator cuff (supraspinatus, infraspinatus, and subscapularis) was found in 27 shoulders (5.92%), 18 (3.95%) on the dominant side and 9 (1.97%) on the non-dominant side. Total rotator cuff calcifications were found in 70 shoulders (15.35%), 43 (9.43%) on the dominant side and 27 (5.92%) on the non-dominant side. No rotator cuff partial- or full-thickness tear was found in any of the participants. Supraspinatus: The thickness was 4.1 ± 0.6 mm (range, 2.9–7.1 mm) on the dominant side and 4.1 ± 0.5 mm (range, 2.8–7.0 mm) on the non-dominant shoulder. Asymptomatic supraspinatus lack of uniformity was observed in 11 shoulders (2.4%), and tendinosis was found in 9 shoulders (1.97%). Supraspinatus calcification was found in 25 shoulders (5.48%), 15 (60%) on the dominant side and 10 (40%) on the non-dominant side. All the calcifications of the dominant side (n=15, 60%) were linear. Granular calcifications were absent on this side. On the other side, the classification type was granular in 5 (20%) and linear in another 5 (20%). Milk calcifications were absent on both sides. The calcifications between 5 and 12 mm were found in 23 (92%) and 15 dominant shoulders (69%), respectively. Calcifications of >12 mm were found in 2 (8%) non-dominant shoulders. Infraspinatus: The mean thickness was 3.8 ± 0.5 mm (range, 2.8–6.2 mm) on the dominant side. On the non-dominant side, the mean was 3.8 ± 0.5 mm (range, 2.7–6.2 mm). Nonuniformity was observed in 13 shoulders (2.85%), 8 (1.75%) on the dominant side. Tendinosis was detected in 13 shoulders (2.85%). Total calcifications were found in 26 shoulders (5.7%). Eighteen (69.23%) of the total infraspinatus calcifications were on the dominant side. The features of the calcification were as follows: granular calcifications on 9 dominant sides (34.62%) and 3 (11.54%) on the non-dominant sides. Of the 14 (53.85%) linear calcifications found, 10 (38.46%) were found on the dominant side. Milk calcifications were found on 3 shoulders (11.54%), 2 (7.69%) on the dominant side. Calcifications between 5 and 12 mm were found in 18 shoulders (69.23%), 13 (50%) on the dominant side and 5 (19.23%) on the non-dominant side. Calcifications of >12 mm were found in 8 shoulders (30.77%), 5 (19.23%) on the dominant shoulders and 3 (11.54%) on the other shoulder. Subscapularis: The mean thickness was 4.0 ± 0.5 mm (range, 2.9–7.4 mm) on the dominant side. On the non-dominant side, the mean \pm SD was 3.8 ± 0.5 (range, 2.9–6.7 mm). Asymptomatic nonuniformity was found in 3 shoulders (0.66%), 2 (0.44%) on the dominant side. Tendinosis was found in one subject in both shoulders. Calcifications were detected on 19 shoulders, 10 (52.63%) on to dominant side. Granular calcifications were found in 2 shoulders (10.53%), one on each side. Linear calcifications were found in 17 shoulders (89.47%), 9 (47.37%) on the dominant side. Milk calcifications were absent. The calcifications between 5 and 12 mm were found in 18 shoulders (94.74%), 10 (52.63%) on the dominant side. Only one (5.26%) calcification was >12 mm. Biceps brachii long head: Asymptomatic lack of uniformity was observed in 1 shoulder (0.4%), on the dominant side. No biceps brachii long head tendinosis, partial-thickness tear, spilling, subluxation, or dislocation was found in any shoulders. Bursal surface: Asymptomatic abnormalities were found only in 1 shoulder (0.22%). The lesions were bursal surface distention

Table 2. Ultrasound findings of the structures surrounding the shoulder

Findings	Shoulder side	
	Dom N=228	Non-Dom N=228
	N (%)	N (%)
Articular spilling	0 (0)	0 (0)
SAD bursal surface		
Distention	0 (0)	1 (0.4)
Synovial hypertrophy	0 (0)	1 (0.4)
Humeral head		
Geodes	18 (7.9)	10 (4.4)
Hill-Sachs	3 (1.3)	1 (0.4)
Normal acromial edge	228 (100)	228 (100)
Bone spur	0 (0)	0 (0)
Subacromial impingement	0 (0)	0 (0)
Acromioclavicular		
Abnormal	2 (0.9)	2 (0.9)
Osteoarthritis	2 (0.9)	2 (0.9)
Cysts	0 (0)	0 (0)
Diastasis	2 (0.9)	0 (0)

Dom: dominant; Non-Dom: non-dominant

and synovial hypertrophy on the same non-dominant shoulder of one subject. Humeral head: The most common asymptomatic abnormalities were represented by geodes found in 28 shoulders (6.14%), 18 (64.29%) on the dominant side and 10 (35.71%) on the other side. Hill-Sachs lesion was found in 4 shoulders (0.88%), 3 (75%) on the dominant side. Acromioclavicular joint: Asymptomatic abnormalities were found in 4 shoulders (0.88%), two on each side. Two subjects presented both osteoarthritis on the dominant and non-dominant sides. The same subjects presented diastasis on the dominant side. No acromioclavicular cysts were found. No articular spilling, no bone spur, and no subacromial impingement were noted in any of the participants.

DISCUSSION

This secondary analysis was performed to describe the presence of US-detected abnormalities in healthy women. Most shoulders were free from abnormalities. Several previous studies reported that rotator cuff tears were found more often in older subjects. These studies aimed to describe the presence of major lesions such as tears; moreover, the sample size and thus the number of asymptomatic shoulders inspected ranged between 50 and 212^{7, 9, 12, 20}. Our findings, with 456 asymptomatic shoulders inspected, support this observation. In addition to the available literature, this study provides a detailed examination that aimed to spot not only major lesions but also small structural abnormalities. The major abnormalities found in the present study were calcifications of the rotator cuff (70 shoulders, 15.35%), especially in the supraspinatus, followed by humeral head geodes (28 shoulders, 6.14%) and lack of uniformity of the rotator cuffs (27 shoulders, 5.92%). Recently, Girish et al.¹² reported the results of their work conducted with a similar methodology. In their study with healthy men, the authors reported a 96% prevalence of shoulder abnormalities. In our work concerning asymptomatic rotator cuff abnormalities, no partial- or full-thickness tears were found in any participant, which seems to apparently contradict the 9.8% of tears reported by Girish et al.¹² and especially the results reported by Reilly et al.²² In a review of cadaveric and radiological studies indicated that the total prevalence of ultrasonographic asymptomatic rotator cuff tears was 38.9%. However, a major difference between our sample and the one from the study of Girish et al. is the mean age (56 years for the subjects in the study by Girish et al.). The mean age of our sample was younger than that in the previous reported study. Tears are reported to increase with age, so a difference in prevalence is expected¹⁰. The validity of our findings is supported by the substantial concordance with the absence of tears reported in previous published data⁷ collected from samples with a mean age similar to the one reported in our study. In particular, a previous study conducted by Minagawa et al.²³ reported the prevalence of tear in each decade; tears were absent in subjects whose ages ranged from 20 to 40 years. We described tendinosis within incidental asymptomatic abnormal findings. Among the supraspinatus, subscapularis, and infraspinatus tendons, the most affected was the supraspinatus tendon; this result is compatible with those of other studies⁷. As reported for tears, the prevalence of tendinosis is higher in elderly people and could be considered as an age-related abnormality⁶. The presence of calcifications (15.35% of the shoulders) within the examined structures was identified more frequently at the supraspinatus tendon than at the infraspinatus and subscapularis tendons. Calcifications were more frequent on the dominant side among all the tendon structures examined and similar findings were reported in previous studies with smaller samples^{7, 24}. Concerning the long head of the biceps brachii tendon, we registered lack of uniformity in only one shoulder; a similar finding was reported by Girish et al.¹². This abnormality seems to have a small representation in asymptomatic women. Furthermore, younger and middle-aged subjects do not show this abnormality in accordance with previous studies⁷.

Only one subject presented an asymptomatic bursal surface abnormality, in contrast to the results of the study by Girish et al.¹², which reported a higher prevalence. Our prevalence was in line with the studies conducted with comparable sample age groups⁷. The second most common asymptomatic abnormality was represented by geodes of the humeral head. We reported four Hill-Sachs lesions. In similar studies conducted in elderly subjects, osteophytes and erosions of the glenohumeral joint were reported with a higher prevalence than that observed in this study^{6, 7}. Osteoarthritis of the acromioclavicular joint was found only in 2 participants (0.88%); these subjects presented asymptomatic abnormalities on both shoulders, which were not unusual because the local impairments showed an age-related progression⁶. The dynamic ultrasonographic assessment for the evaluation of impingement did not reveal any abnormalities in our sample, close to the data obtained by Iagnocco et al.⁷.

The shoulder is a complex anatomic area with articular and periarticular structures; therefore, the knowledge of possible asymptomatic abnormalities is crucial for understanding shoulder pain and dysfunction. The presence of ultrasonography-detected abnormalities such as calcifications or lack of uniformity within the rotator-cuff tendons cannot explain alone the clinical symptoms reported by the patient. Similar findings (i.e., positive imaging findings alone cannot explain symptoms) have been reported for the lumbar spine; in fact, subjects without low back pain may have abnormal radiography or MRI findings^{25, 26}. For low back pain, the use of imaging alone to explain the patient symptoms or establish whether an imaging finding is important for the patient condition without a clinical assessment has proven to be inappropriate²⁷. Supported by the results of the present study, we believe that a similar consideration can be given for the shoulder complex. We acknowledge several possible limitations of our study. Historical self-report information may be affected by recall bias when elicited from respondents. However, we excluded in our analysis the subjects who presented at least one symptomatic shoulder because impairment on one shoulder could be a risk factor for the contralateral side²⁸. Finally, the original work was an observational cross-sectional study¹³⁻¹⁵; therefore, the sample was assessed at one time point, so no surgical confirmation or clinical follow-up for the abnormalities was found. We could not determine whether the shoulders we examined will remain asymptomatic and how long the abnormality was present.

Conflict of interest

The authors have no conflict of interest to report.

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