

## **A comparative study of the identification of rotator cuff calcifications: X-ray versus ultrasound**

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### **Abstract**

A deposit of calcium in the rotator cuff tendons, also known as calcifying tendinopathy, is a common condition. Calcifications are often associated with significant pain and restriction of shoulder movement. The hypothesis of this retrospective, descriptive study is that ultrasound is more sensitive to detect calcifications in the rotator cuff than x-rays. The study was done on the records of 60 patients aged between 30 and 72 years of age. The records were selected using a convenient sample from the archives of the Radiology Department of a private hospital. Calcifications were detected with x-rays in the rotator cuff of 10 patients in 7 of these patients the calcification was located in the supraspinatus tendon. With ultrasound calcifications were detected in 9 patients; in 6 of these patients the calcification was located in the supraspinatus tendon and in 3 patients in the infraspinatus tendon. This study indicated that calcifications in the rotator cuff were more often seen on x-ray examination than on ultrasound, though the difference was marginal.

**Keywords:** Calcifications, rotator cuff, x-ray, ultrasound, calcifying tendinopathy.

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### **Introduction**

The deposits of calcium in rotator cuff tendons are a common condition, also known as calcifying tendinopathy (Faure & Daculsi, 1983; Rowe, 1985). The calcifications are often associated with significant pain and restriction of shoulder movement. To date, a comparative study on the identification of rotator cuff calcifications between x-ray and ultrasound (US) has not been conducted in South Africa. X-rays are mainly used in the diagnosis of pathology of bony structures, but are known to result in a significant amount of ionizing radiation for the patient.

US is a non-invasive, sensitive and a cost effective method of evaluating the rotator cuff (Weiner & Seitz, 1993). The ability to examine a joint through its range of motion in real time is unique to US. It has the further advantage of the absence of ionizing radiation and superb soft tissue detail.

Some studies have shown that certain calcifications of the rotator cuff are detectable on US examination, but not on x-ray (Farin & Jaroma, 1995). Early diagnosis of rotator cuff calcifications is important, as it facilitates better management of patient's symptoms, and improvement in quality of life.

High resolution US allows the examiner to focus on the area of maximal discomfort and take dynamic multiplane images in different arm positions (Jacobson, 1999). US can obtain images in longitudinal, transverse and coronal planes (Jacobson et al, 2004). Disadvantages of US are the long learning curve; it is an operator-dependent imaging modality, with poor technique standardization. Even slight alterations of the probe or the position of the patient can change the appearance of a tendon (O'Connor, Rankine & Gibbon, 2005). Due to the operator dependence, variation in the reported accuracy has been documented (Rogers, 2000). US of the shoulder is limited in obese patients and in patients with restricted range of movement. Although US cannot demonstrate calcifications deep to the acromion, it is still a very useful and widely available technique to assess a painful shoulder (Rogers, 2000). The strength of US lies in its extreme sensitivity in the identification of calcium deposits, its dynamic nature, its ability to guide interventional procedures, and its versatility to produce reliable images in the presence of postoperative metallic hardware and pacemakers, or claustrophobic patients (Papatheodorou, Ellinas & Takis, 2004). Three types of calcifications can be identified with an US examination:

1. Type 1 appears as hyperechoic focus with well-defined acoustic shadowing, resembling gallstones.
2. Type 2 presents with hyperechoic focus with faint shadowing.
3. Type 3 may present as hyperechoic focus with absent shadow, or as an undefined isoechoic or hyperechoic structure with mobile internal echoes, reflecting a semi-liquid content (Bianchi & Martinoli, 2007)

The aetiology of formation of calcifications is unclear, but a few theories exist. According to studies, tissue hypoxia (insufficient amount of oxygen) creates a critical zone in the rotator cuff. This zone becomes vulnerable to calcification. The initial necrosis in this area is then succeeded by calcification (Mosley, 1969; Bianchi & Martinoli, 2007).

Recent studies show that osteopontin is considered to be a potent regulator of calcium deposits. Osteopontin is one of the major non-collagenous bone-matrix proteins. It is associated with mineralization and bone formation (Denhardt & Guo, 1993). Osteopontin plays a role in the calcium deposit in calcific tendinopathy and may also contribute to resorption of the calcium deposits (Takeuchi, Sugamoto & Nakase, 2001).

In x-rays, the calcifications are visualized as a characteristic shadow (Holt & Keats, 1993). Axial views are often needed to diagnose involvement of the subscapularis

and infraspinatus tendons. Faint milky calcifications with a fuzzy periphery on plain radiographs are usually liquid (Figure 1).

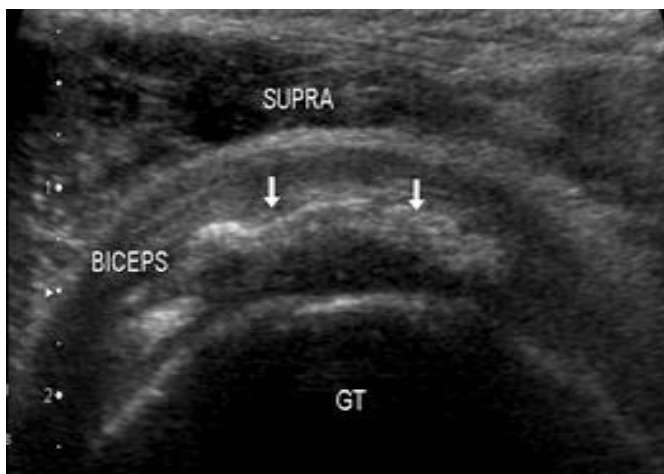


Figure 1: Faint milky calcification

Dense calcifications (depicted as opaque on plain radiographs) are often very hard (Figure 2). Two to five per cent of calcifications are incidental radiographic findings in asymptomatic patients (Simon, 1975).

In most cases, the calcifications are located 1 to 2 cm from the insertion of the supraspinatus tendon on the greater tuberosity, but can also be present in the other tendons of the rotator cuff.

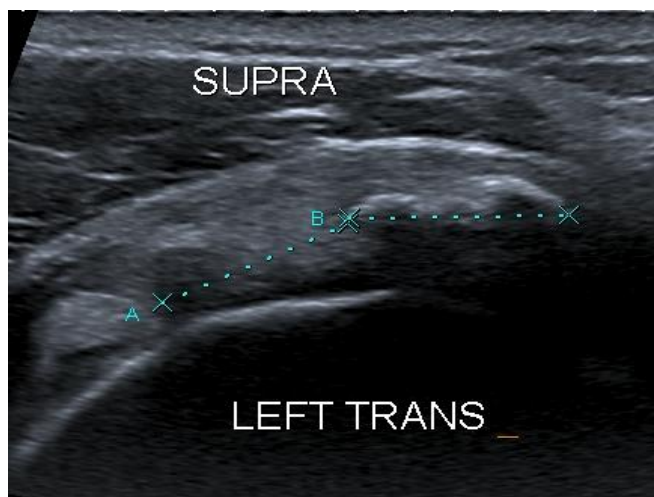


Figure 2: Dense calcification

All calcifications larger than 1,5cm in diameter become symptomatic at some stage.

Resorption of the calcifications may occur at any time; therefore the symptoms are not always related to the size of the calcification (Lippman, 1961). Fifty per cent of the patients with calcific tendinopathy have acute or chronic pain that causes restriction of movement and negatively affects their daily life activities. (Bosworth, 1941; McKendry et al., 1982).

The hypothesis of this retrospective, descriptive study is that ultrasound is more sensitive to detect calcifications in the rotator cuff than x-rays.

## **Methods and Material**

A retrospective, descriptive study design was used; the records of 60 patients were selected, using a convenient sample from the Radiology Department of the N17 Private Hospital, Gauteng, South Africa. The convenient sample consisted of the records of 60 patients who had US and x-ray examinations done on the same shoulder, by the same operator, of these every second patient was selected randomly. The patients were aged between 30 and 70 years.

Each patient had 2 tests (measurements): X-ray and US (Paired sample observation). The x-ray and the US images of the calcifications were compared. The reports of only one US operator were used to avoid potential differences in interpretation.

In collaboration with the Department of Statistics of the University of Pretoria, data were analysed using the Statistical Package for the Social Sciences (SPSS), Version 17.0. The Chi Square test was used to establish the association between the method used and the detection of the calcifications. The Z-test was applied to check the significance of the percentages of visualization on x-ray to those of the visualization of the calcifications on US. Differences are only reported when considered statistically significant at  $p$ -values  $\leq 0.05$ .

The study was approved by the Research Proposal and Ethics Committee of the University of Pretoria, South Africa.

## **Results**

All 60 patients ( $n=60$ ) had x-rays and US examination on the same day. Antero-posterior and lateral view x-rays were taken of the shoulder. The patients had an US examination on the same shoulder after the x-ray. A linear probe with a frequency of 12, 5 MHz was used during the US examination. To decrease intra-tester variability the same operator performed all the examinations. Out of 60 patients, calcifications were detected with x-ray in 10 patients and with US in 9 patients (Table 1).

Table 1: X-ray calcification vs. US calcification

X-ray Calcification vs. US Calcification			
	No	Yes	Total
No	48.00	2.00	50.00
	42.50	7.50	
	80.00	3.33	83.33
	96.00	4.00	
	94.12	22.22	
Yes	3.00	7.00	10.00
	8.50	1.50	
	5.00	11.67	16.67
	30.00	70.00	
	5.88	77.78	
	51.00	9.00	60.00
Total	85	15	100

US examination showed calcifications in 9 of the 60 patients, in 6 of these patients, calcifications were seen in the supraspinatus and 3 in the infraspinatus (Figure 3).

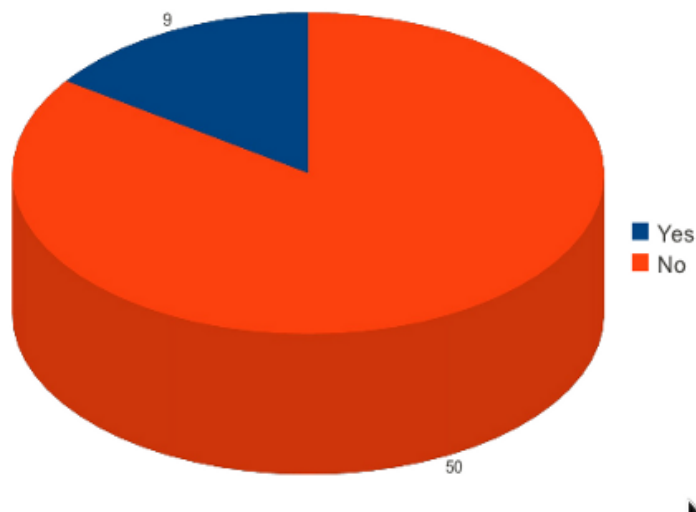


Figure 3: Ultrasound calcifications

X-ray detected calcifications in the rotator cuff of 10 of the 60 patients, in 7 of these patients, the calcifications were seen in the supraspinatus (Figure 4).

Sensitivity is calculated by considering the results as a symptom (Yes = positive, No = negative). In a screening test, sensitivity is the probability that the symptom is present, given that the person has a disease, whereas specificity is the probability that the symptom is not present, given that the person does not have a disease. In this study, sensitivity and specificity are relative, not absolute (Table 2).

Table 2: Specificity and Sensitivity of US and X-ray

Variable	Ultrasound	X-ray
Specificity	7 / 9 – 77.78%	7 / 10 – 70%
Sensitivity	48/51 – 94.12%	48/50 - 96%

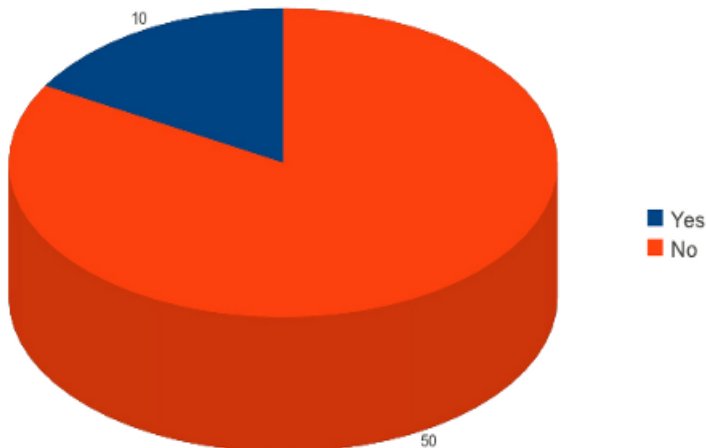


Figure 4: X-ray calcifications

## Discussion

The hypothesis of this retrospective study that ultrasound will be more sensitive to detect calcifications in the rotator cuff than x-rays was not confirmed. Of the 60 patients calcifications were observed in 10 patients with x-ray and in 9 patients with US.

The disadvantage of x-ray irradiation and the fact that the direction of the beam might often be inaccurate could be the reason why x-rays miss detecting some calcifications. The calcific deposits demonstrated on plain x-ray films are characterized by their localization (i.e. tendon affected) and size. The advantage of x-ray is that it can localize rather small calcific deposits and calcifications located under the acromion.

The disadvantage of US is its operator-dependency, where even a slight change in the probe position and patient's position may change the tendon appearance. The interpretation of the images may be complicated by the presence of anatomic variants and the high prevalence of asymptomatic pathology predominantly in the elderly. The quality of the examination is affected by the weight of the patient and in patients with a restricted range of movement. US cannot detect subacromial calcifications. The advantages of US lie in its safety, extreme sensitivity in the identification of calcium deposits, its multiplane dynamic possibilities and ability to guide interventional procedures. US is very reliable in predicting the consistency of the

rotator cuff calcifications, which is helpful in selecting the appropriate treatment. Despite noted limitations US remains a widely accepted imaging modality in the evaluation of painful shoulders and in experienced hands appears to be more sensitive than ordinary x-rays.

This study has several weaknesses; being retrospective it was not a well-designed scientific trial, results may have been influenced by the small sample group: a larger population sample may have yielded different results. Clinical history was not documented; no inclusion or exclusion criteria were noted. Calcifications were not measured, types were not described, other pathology i.e. tears and subacromialsubdeltoid bursitis was not documented, the age related occurrences of the calcifications were not included.

The diagnostic imaging modalities, x-ray and ultrasound of the shoulder are widely used in clinical practice. They are both valuable diagnostic tools and when used together, contribute to greater diagnostic accuracy.

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