THE SPECTRUM OF RADIOGRAPHIC AND SONOGRAPHIC FINDINGS IN PATIENTS WITH SHOULDER PAIN AT THE DEPARTMENT OF DIAGNOSTIC IMAGING AND RADIATION MEDICINE, UNIVERSITY OF NAIROBI

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ABSTRACT

Background: Shoulder pain is a common complaint. Prevalence estimates vary from 6.9% to 26% in the general population. The most frequent cause of shoulder pain is rotator cuff disease. Shoulder radiography is the primary imaging modality in shoulder pain but is limited in the evaluation of the soft tissues. MRI is the chief modality used in the evaluation of shoulder soft tissues both locally and elsewhere but is limited by cost and availability. Shoulder ultrasonography is a cost effective modality for evaluating the soft tissues but is underutilized locally. No data is available in our local population regarding spectrum of findings in shoulder radiographs and ultrasound.

Objective: This study was designed to determine the spectrum of shoulder radiographic and sonographic findings in patients with shoulder pain.

Setting: Department of Diagnostic Imaging and Radiation Medicine, University of Nairobi. It is located within the old wing of Kenyatta National Hospital.

Design: This was a cross sectional descriptive study.

Subjects: A total of 72 patients with shoulder pain who were referred for shoulder radiographs.

Method: The study was conducted over a period of four months between the months of January 2016 to April 2016. Seventy two consecutive patients with shoulder pain referred for shoulder radiographs had a complementary shoulder ultrasound scan done and findings of both examinations recorded in the data collection form. Statistical analysis of the findings was then done using SPSS version 20 IBM. No surgery findings were available to correlate with the imaging findings.

Results:. Radiographs identified abnormalities in 36 (50%) patients' majority of which were degenerative changes. Ultrasound identified abnormalities in 57 (79%) patients with the bulk of lesions seen within the rotator cuff. There was statistically significant association between presence of greater tuberosity degenerative changes and rotator cuff tears ($p<0.001$).

Conclusion: The combination of shoulder radiography and ultrasound significantly increased the diagnostic yield by evaluating both osseous and soft tissue components. These findings aim to increase the awareness and utility of shoulder ultrasound locally.

INTRODUCTION

Shoulder pain is a common complaint. Prevalence in the general population varies widely from 6.9-20.9% (1) while studies in the primary care setting show a lower prevalence of 2.36% (2). No local data is available on the prevalence of shoulder pain.

The shoulder is a complex region with osseous, articular and soft tissue components. Accurately localizing the source of pain presents a diagnostic challenge clinically due to overlap of the clinical signs. Imaging therefore plays a major role in management of the patient with shoulder pain by identifying the abnormalities and increasing the diagnostic confidence (3).

Rotator cuff disease is the most common cause of shoulder pain. Ostor *et al* (4) in a study of patients with shoulder pain in primary care found rotator cuff tendinopathy in 85% and impingement in 74% of the study population. Majority (77%) had multiple lesions. Locally a 2009 study on the pattern of shoulder MRI findings in patients with shoulder pain in Nairobi found rotator cuff lesions in 54% and subacromial bursitis in 12% of the patients seen (5).

Radiography is the initial imaging modality in the evaluation of patients with shoulder pain (6). It is useful in trauma and assessment of bone lesions but limited in visualization of the soft tissues. Shoulder ultrasound has been shown to have a similar accuracy to MRI in the diagnosis of either full or partial thickness rotator cuff tears (7). This is noteworthy especially in our local set up where availability and costs of MRI make it inaccessible to majority of the population therefore delaying decision making in patients with suspected rotator cuff disease.

Recognizing the lack of clear cost effective guidelines in imaging of shoulder pain the Society of Radiologists in Ultrasound consensus conference came up with several imaging pathways for shoulder pain

depending on the clinical scenario (8). It recommended ultrasound as the first modality in suspected cuff disease in patients younger than 40 years and with no history of trauma. Recently Sheehan *et al's* (9) study showed that a combination of shoulder radiographs and ultrasound is adequate in diagnosis of most shoulder lesions especially at primary care level.

Locally shoulder ultrasound remains underutilized despite strong evidence demonstrating its accuracy in evaluating both rotator cuff and non rotator cuff structures. Shoulder radiography as the main imaging modality is limited in the evaluation of soft tissues. This results in 'normal' radiographs in symptomatic patients majority of whom cannot afford MRI for further evaluation. This delays the definitive diagnosis and further management. Shoulder ultrasound offers a cheaper, accurate and more accessible option in the examination of patients with shoulder pain resulting in faster diagnosis and decision making. This study aimed at providing baseline data on shoulder sonography and increasing the utility of this modality locally.

MATERIALS AND METHODS

This was a cross sectional descriptive study carried out at the Department of Diagnostic Imaging and Radiation Medicine, University of Nairobi. It is located within the old wing of Kenyatta National Hospital and provides general radiography, fluoroscopy and ultrasound services. The research proposal was submitted to Kenyatta National Hospital/University of Nairobi research and ethics committee for review and approval prior to commencement of the study (reference KNH-ERC/A/10).

The study population comprised patients referred for shoulder radiographs by the primary physician because of shoulder pain. The shoulder ultrasound examination was done at no extra cost to the patients. Consecutive patients above the age of 18 years who gave informed consent were included in the study. Patients with trauma were excluded from the study. Radiography was done using an AGFA CR-X Computed Radiography machine. Standard AP view in neutral position and scapular Y views were obtained. Additional views like the abduction view were done guided by the initial findings.

Ultrasounds were done by the principal investigator using a General Electric LOGIC S7 Expert ultrasound scanner with a 7.5– 12 MHZ linear transducer. The scanning protocol was based on the European Society of Musculoskeletal Radiology musculoskeletal ultrasound technical guidelines for the shoulder (10). Systematic scanning of the anterior, lateral and posterior aspects of the shoulder was done with the patient seated on the examination couch. Each tendon was evaluated in its short and long axes in the positions described below;

(i) *Long head of biceps tendon*: The arm was placed in internal rotation with the elbow flexed 90^0 and palm facing up. It was evaluated from its intraarticular part to the myotendinous junction.
(ii) *Subscapularis tendon*: The arm was rotated externally with the elbow fixed on the iliac crest to show the subscapularis tendon and its insertion to the lesser tuberosity.
(iii) *Supraspinatus tendon:* The arm was placed posteriorly with the palm of the hand at the region of the back pocket and the elbow flexed and directed posteriorly.
(iv) *Infraspinatus and teres minor tendons*: The arm was placed in internal rotation with the palm placed on the contralateral shoulder. The transducer was placed over the posterior aspect of the glenohumeral joint.
(v) *Acromioclavicular joint*: The probe was placed in the coronal plane and swept anteroposteriorly to examine the joint.

All the radiographs and ultrasound images were analysed by the principal investigator and the supervisors who are consultant radiologists with bias in musculoskeletal imaging.

There was no reference gold standard for the imaging findings as it was not feasible to obtain surgery findings within the duration of the study. In addition studies have shown a similar accuracy between ultrasound and MRI hence the use of ultrasound as a standalone modality.

A questionnaire was used for data collection. The patient's biodata and imaging findings for both modalities were recorded by the principal investigator. Data was recorded in the data collection form and analyzed using Statistical Package for Social Scientists (SPSS Version 20 IBM).

RESULTS

Participants' characteristics: A total of 72 patients with shoulder pain were imaged at the University of Nairobi, radiology unit. The mean age of the patients was 47.3 years (SD ± 16.2) with an age range between

18 and 79 years. The most common age groups were 60 years and above with 19 (26.4%) patients and 50-59 years with 16 (22.2%) patients as shown in Figure 1. There were 28 males presenting with shoulder pain giving a male-to-female ratio of approximately 2: 3 as shown in Figure 2.

Figure 1
Age characteristics

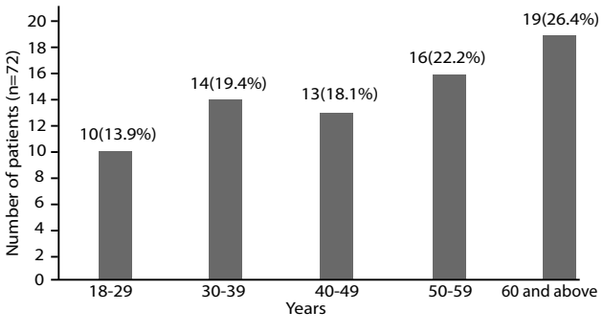
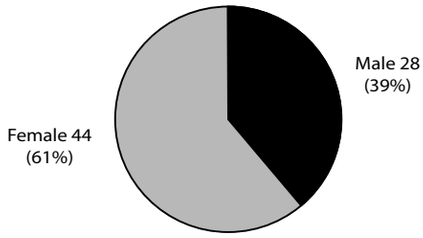
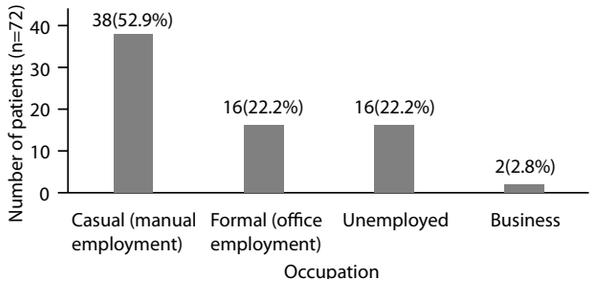


Figure 2
Gender distribution



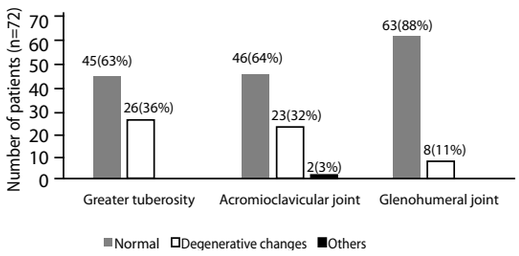
Occupation: Thirty eight (52.8%) patients with shoulder pain were engaged in manual employment (Figure 3). There were 16 (22.2%) formally employed persons and 16 (22.2%) patients reported that they were unemployed.

Figure 3
Occupation of patients



Radiographic findings: Thirty six (50%) radiographs were normal. The most common positive radiographic findings were degenerative changes in the greater tuberosity (36.1%), acromioclavicular joint (32%) and subacromial spurs (21.1%). One patient had ACJ subluxation while another had a fracture dislocation of the ACJ. Most radiographs of the study population had normal glenohumeral joints 63 (87.5%) (Figure 4).

Figure 4
Degenerative changes on radiographs

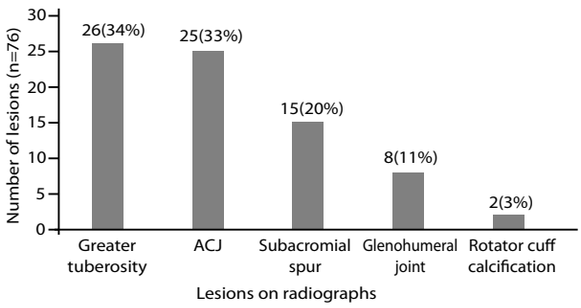


Acromial spurs and rotator cuff calcification: Subacromial spurs and inferior ACJ osteophytes were each visualized in 21.1% (15/72) of patients while 2.8% (2/72) patients had rotator cuff calcification (Table 1).

Table 1
Radiographic findings of spurring and rotator cuff calcification

Radiographic finding	Yes	No
Sub acromial spurring	15(21.1)	56(78.9)
Inferior AC joint spurring	15(21.1)	56(78.9)
Rotator cuff calcification	2(2.8)	69(97.2)

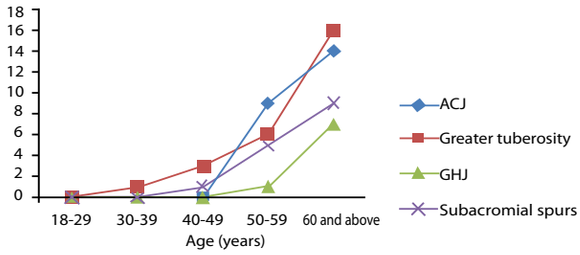
Figure 5
Overall distribution of lesions on radiographs



A total of 76 lesions were picked on radiographs indicative of multiple lesions in some of the patients.

Age distribution of radiographic findings: Degenerative changes of the acromioclavicular joint, greater tuberosity, glenohumeral joint and subacromial spurs were seen with increasing age starting at around 40 years (Figure 6).

Figure 6
Age distribution of radiographic degenerative findings



Chi square analysis showed a significant association between increasing age and degenerative changes.

Acromion type: Radiographic findings of the acromion type were reported in only 29 (40.3%) cases. Of these 17 (59%) had Type 2 and 12 (41%) had Type 1 acromion. No type 3 acromion was observed.

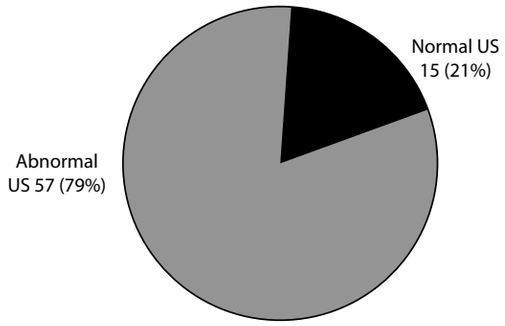
Table 2
Acromion types

Acromion type	Frequency (n)	(%)
Type 1	12	41
Type 2	17	59
Type 3	0	0
Total	29	100

Acromiohumeral distance: The mean acromiohumeral distance was 9.1mm (SD ± 2.8mm) in the 60 patients with an estimate for this interval and ranged from 1 to 12mm. There were 6 (10%) patients with acromiohumeral distances < 7mm.

Ultrasound findings: Ultrasound shoulder pathology was identified in 79% (57/72) of the study participants as shown in Figure 7. A total of 174 shoulder lesions were demonstrated**.**

Figure 7
Normal vs abnormal ultrasound

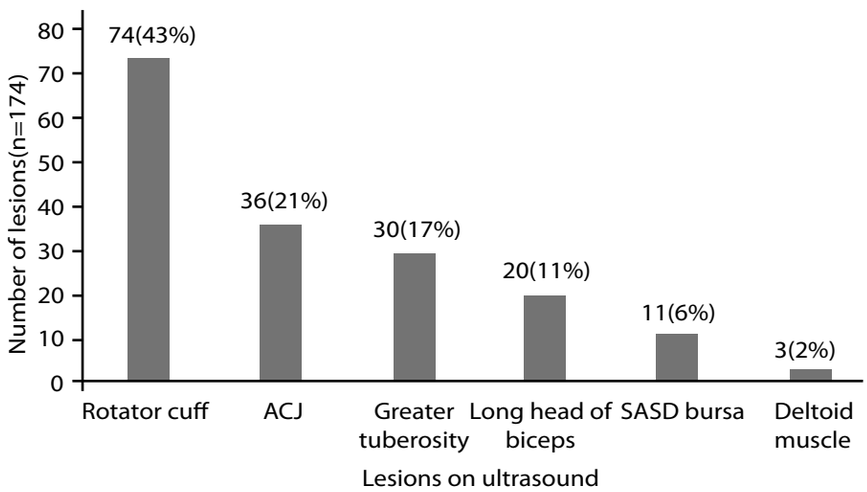


Rotator cuff findings: Rotator cuff pathology was the most common pathology contributing to 42% of lesions (Figure 8). Supraspinatus pathology was present in 60% of the study participants (Table 3) and accounted for 58% of rotator cuff pathology (Figure 9).Tears comprised 84% of supraspinatus lesions with partial tears forming 61% of tears (Table 3). In all cases where subscapularis and infraspinatus pathology was present, there was coexistent supraspinatus involvement. No isolated subscapularis or infraspinatus lesion was seen. No teres minor tendon abnormality was seen in the study population. One patient had calcification within the supraspinatus tendon.

Table 3
Shoulder ultrasound: Rotator cuff findings

	Normal	Tendinitis	Calcification	Partial tear	Full tear	Tendinitis & partial tear	Tendinitis & full tear
Subscapularis	54(75)	11(15.3)	-	1(1.4)	-	6(8.3)	-
Supraspinatus	29(40.3)	6(8.3)	1(1.4)	3(4.2)	11(15.3)	19(26.4)	3(4.2)
Infraspinatus	59(81.9)	12(16.7)	-	1(1.4)	-	-	-
Teres minor	72(100)	-	-	-	-	-	-

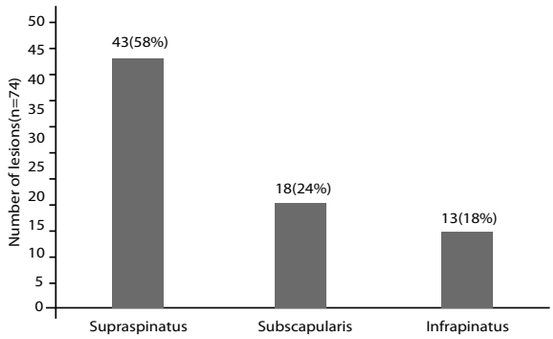
Figure 8
Lesions on ultrasound



A total of 174 lesions were identified on sonography.

Figure 9

Rotator cuff lesions



Shoulder ultrasound: non rotator cuff findings: These are presented in Table 4. The most prevalent findings were degenerative changes of the acromioclavicular joint and greater tuberosity seen in 47.2% and 41.7% of the study participants respectively. Long head of biceps abnormalities were seen in 28%. Ultrasound picked up more degenerative lesions in the ACJ (n=34) compared to radiography (n=23) and greater tuberosity (30 versus 26).

Table 4

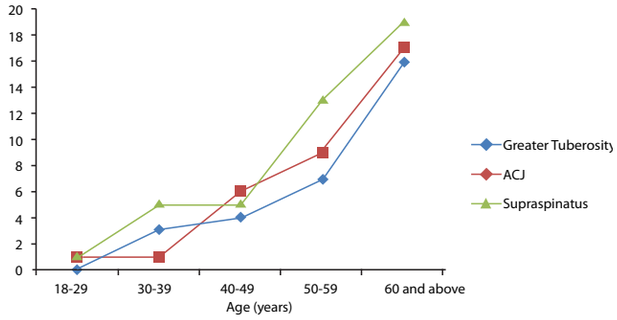
Non rotator cuff ultrasound findings

	Frequency	(%)
Long head of biceps tendon		
Normal	52	72.2
Effusion	10	13.9
Tendinosis	5	6.9
Effusion and tendinosis	4	5.6
Effusion, tendinosis and subluxation/dislocation	1	1.4
Acromioclavicular joint		
Normal	36	50
Degenerative changes	34	47.2
Others	2	2.8
Subacromial subdeltoid bursa		
Normal	61	84.7
Effusion	10	13.9
Thickening	1	1.4
Greater tuberosity irregularity		
Present	30	41.7
Absent	42	58.3
Deltoid muscle and subcutaneous tissues		
Normal	69	95.8
Mass/cyst	1	1.4
Others	2	2.8

Age distribution of shoulder lesions at ultrasound: The prevalence of rotator cuff pathology increased with age. No normal supraspinatus tendon was seen in patients above 60 years. Degenerative changes of the ACJ and greater tuberosity similarly increased with age (Figure 10).

Figure 10

Age distribution of lesions at ultrasound



Associations

1. *Association between greater tuberosity irregularity on radiographs and supraspinatus tears (partial thickness + full thickness tears):* The presence of degenerative changes of the greater tuberosity on radiographs was significantly associated with occurrence of either full or partial supraspinatus tears ($p < 0.001$). Twenty three (89%) of patients with greater tuberosity irregularity had a tear compared to 3(11.5%) having degenerative changes but no tears. (Table 5).

Table 5

Association between greater tuberosity irregularity on radiographs and supraspinatus tears

	Supraspinatus tear(partial+full thickness)			P value
Greater tuberosity irregularity	Yes	No		
Normal	13(28.9)	32(71.1)	1.00(Ref)	
Degenerative changes	23(88.5)	3(11.5)	18.87 (4.82-73.89)	<0.001
		95% CI		
Sensitivity	63.9%	46.2%	79.2%	
Specificity	91.4%	76.9%	98.2%	
PPV	88.5%	69.8%	97.6%	
NPV	71.1%	55.7%	83.6%	

2. Association between greater tuberosity irregularity on ultrasound and supraspinatus tears (partial thickness + full thickness): The presence of degenerative changes of the greater tuberosity on sonography was also significantly associated with occurrence of either full or partial supraspinatus tears ($p < 0.001$) as shown in Table 6. Sonography picked 3 more degenerative changes at the greater tuberosity than radiograph. Twenty seven (90%) of patients with degenerative changes of the greater tuberosity had supraspinatus tears compared to 3 (10%) patients with no tears who also had degenerative changes. Degenerative changes had a sensitivity of 75% and specificity of 92% for supraspinatus tears.

Table 6

AAssociation between greater tuberosity irregularity on ultrasound and supraspinatus tears

	Supraspinatus tear(partial+full thickness)			
	Yes	No	OR (95% CI)	P value
Greater tuberosity irregularity				
Present	27(90.0)	3(10.0)	1.00(Ref)	
Absent	9(21.4)	33(78.6)	0.03(0.01-0.12)	<0.001
			95% CI	
Sensitivity	75%	58%	88%	
Specificity	92%	78%	98%	
PPV	90%	74%	98%	
NPV	79%	63%	90%	

3. Association between acromiohumeral interval of less than 7mm and full thickness supraspinatus tears: Acromiohumeral interval less than 7mm was significantly associated with occurrence of full thickness supraspinatus tears ($p < 0.001$). All six patients with an interval less than 7mm had a full thickness tear. Eight patients with full thickness supraspinatus tear had an interval greater than 7mm. An acromiohumeral interval of 7mm had a sensitivity 43%, specificity 100%, PPV 100% and NPV 85% for full thickness supraspinatus tear (Table 7).

Table 7

Association between acromiohumeral interval of less than 7mm and full thickness supraspinatus tears

	Supraspinatus full tear		
Acromiohumeral interval	Yes	No	P value
< 7 mm	6(100.0)	0(0.0)	
7 mm and above	8(14.8)	46(85.2)	<0.001
			95% CI
Sensitivity	43%	18%	71%
Specificity	100%	92%	100%
PPV	100%	54%	100%
NPV	85%	73%	93%

4. Association between subacromial spurring and supraspinatus tears: Significant association was also seen between subacromial spurs and supraspinatus tears (p=0.017). Twelve (80%) of the patients with a subacromial spur had a supraspinatus tear as shown in Table 8.

Table 8

Association between subacromial spurring and supraspinatus tears

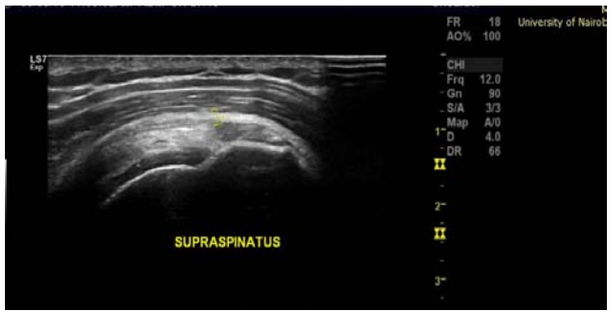
	Supraspinatus tear			
Subacromial spurring	Yes	No	OR (95% CI)	P value
Yes	12(80.0)	3(20.0)	1.00(Ref)	
No	24(42.9)	32(57.1)	0.19(0.05-0.74)	0.017
		95% CI		
Sensitivity	33%	19%	51%	
Specificity	91%	77%	98%	
PPV	80%	52%	96%	
NPV	57%	43%	70%	

Illustrative cases

1. 59 year old male with left shoulder pain.

a. A normal AP radiograph of the patient's left shoulder

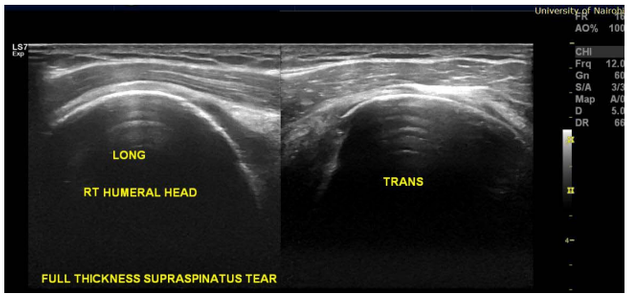
b. Full thickness supraspinatus tear demonstrated on ultrasound



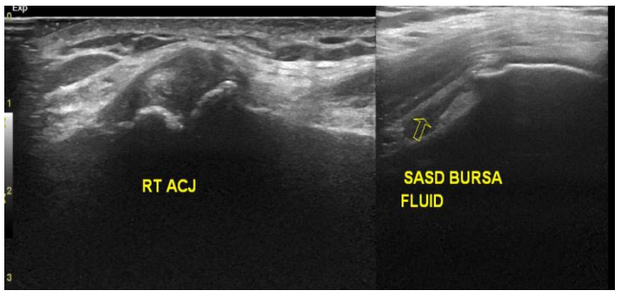
2. 69 year old male with chronic right shoulder pain. AP radiograph (a) shows markedly reduced acromiohumeral interval, subacromial and glenohumeral degenerative changes. The ultrasound shows a complete supraspinatus tear (b), ACJ degenerative changes and fluid in the subdeltoid bursa (c).

a.

b.



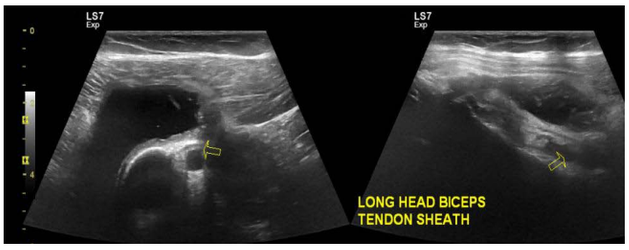
c.



3. 69 year old female with chronic right shoulder pain, unable to abduct the arm.

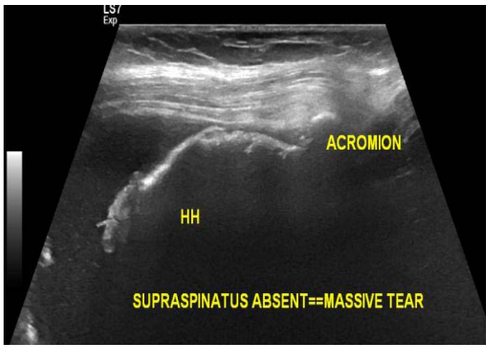
AP radiograph shows reduced acromiohumeral interval and subacromial degenerative changes

b.



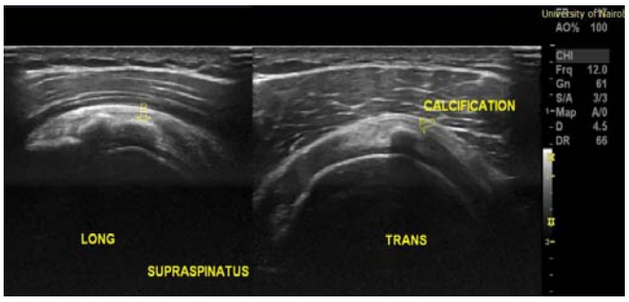
Ultrasound demonstrates a large subacromial subdeltoid effusion as well as effusion in the long head of biceps tendon sheath (b) with a massive supraspinatus tear (c).

c .



4. 35 year male. Supraspinatus calcification on radiograph (a) and ultrasound (b)

b.



None of these patients had surgery during the duration of the study to determine the correlation of the radiographic/ultrasound findings with operative findings.

DISCUSSION

Shoulder pain is a common cause of musculoskeletal pain and is most frequently due to rotator cuff disease (4). Comprehensive evaluation of the shoulder therefore needs assessment of the rotator cuff. Locally, shoulder ultrasonography is underutilized despite being an accurate, cheaper and more available modality. Currently MRI is the main imaging modality used in evaluating soft tissues of the shoulder but its accessibility is limited by cost and availability. This study is the first report on the spectrum of findings in both shoulder radiographs and ultrasound locally.

Our study showed increasing prevalence of shoulder pain with age as well as higher prevalence in females which is corroborated in other studies. Linsell *et al* (2) showed increasing prevalence of shoulder pain with age and a higher prevalence in females. Thirty eight (52.9%) of the patients were engaged in manual employment which is a known risk factor for shoulder pain (11).

Radiographic findings: Half of the radiographs were normal and degenerative changes were predominant in the rest. One patient had a healing fracture dislocation of the ACJ which had been missed in previous radiographs. That patient had persistent shoulder pain. In Cadogan *et al's* study (12) 64% of radiographs were normal and the most common abnormalities were in the ACJ (17%) and rotator cuff calcification (13%). Both studies show a high percentage of normal radiographs despite the patients being symptomatic. A major difference is seen in the prevalence of rotator cuff calcification which is 3% in the present study and 13% in Cadogan's series. A likely explanation for this could be intrinsic race or environmental differences between the study populations. Another local study on the spectrum of shoulder MRI pathology did not report any rotator cuff calcification (5).

Subacromial spurring was present in 21% (15/72) of patients all of whom were above 40 years. Eighty percent of those with subacromial spurs had a rotator cuff tear. This compares favorably with other studies. In Cone's *et al* (13) study 26% (26/103) had subacromial spurs and of those with a spur and who subsequently had an arthrogram 63% had rotator cuff tears.

Hardy *et a*l (14) reported subacromial spurring in 68% and greater tuberosity degenerative changes in 66% of the study population. Notably that study comprised specifically of patients with clinical subacromial impingement and this could explain the high occurrence of radiographic features of impingement in the series.

This study demonstrates increasing prevalence of degenerative changes with age and Chi square analysis showed a significant association between increasing age and degenerative changes. Bonsell *et al* (15) documented this association as well. The interpretation of this finding is that some of these changes are normal age related phenomena and their contribution to patient's symptoms should be placed in the clinical context.

The poor yield of shoulder radiographs in patients below forty years was highlighted in the Society of Radiologists in Ultrasound multidisciplinary consensus statement in 2011. After evaluating the evidence on various shoulder imaging modalities based on factors such as accuracy and cost effectiveness it recommended ultrasound as the first line modality in evaluation of suspected rotator cuff disease in patients younger than 40 years (8).

Acromion type: Only 29 (40.3%) of the study participants had their acromion type determined chiefly because the scapular Y view is not routinely done therefore a number of radiographs in this view were technically inadequate for accurate depiction of the acromion type. Of the 29 radiographs 12 (41%) had a type 1 flat acromion and 17 (59%) had a type 2 curved acromion. No type 3 hooked acromion was seen. However because of the small number not much statistical inference can be made from this observation.

Acromiohumeral interval: The mean acromiohumeral interval was 9.1mm. In Saupe's series the mean interval was 8.7mm. The cut off for abnormal acromiohumeral interval is 7mm (16). In our study an acromiohumeral interval less than 7mm was significantly associated with occurrence of full thickness supraspinatus tears ($p < 0.001$). All (6/6) patients with an interval less than 7mm had a full thickness tear. Eight patients with full thickness supraspinatus tear had an interval greater than 7mm. In Saupe's study 90% (19/21) of patients with an interval of less than 7mm had a full thickness tear. This compares well with our study.

Both studies showed the presence of a normal acromiohumeral interval in a significant number of full thickness cuff tears implying the possible role of other factors like the size of tear, chronicity and muscle atrophy. Goutallier *et al* (17) showed that a chronic full thickness infraspinatus tear is a requisite for an acromiohumeral interval less than 6mm.

Sonographic findings: Rotator cuff pathology accounted for 42% of lesions with supraspinatus pathology present in 60% of the study participants. Notably no normal supraspinatus tendon was detected in patients above 60 years of age. These findings have been corroborated in other studies. In Cadogan's series rotator cuff pathology accounted for 50% of lesions (12) while supraspinatus component was most affected accounting for 85% of overall rotator cuff lesions. Locally, Mugambi (5) demonstrated similar

distribution of shoulder lesions on MRI in Nairobi with rotator cuff pathology constituting 54% of the lesions.

A major difference noted between the studies is the high prevalence of rotator cuff calcification in Cadogan's series accounting for 39% of supraspinatus abnormalities. This could possibly be explained by race or environmental differences between the study populations. In this series one case of rotator cuff calcification identified on radiographs could not be confidently re-demonstrated on ultrasound because of associated irregularity of the humeral anatomical neck and greater tuberosity suggestive of a fracture.

Non rotator cuff findings: The commonest lesions identified were in the ACJ (47.2%), long head of biceps tendon (27.8%) and subacromial subdeltoid bursa (15.3%). One case each of a subcutaneous lipoma, supraclavicular cellulitis and intradeltoid haematoma in a patient with coagulopathy were detected.

Cadogan *et al* (12) showed SASD pathology in 31% and long head of biceps tendon abnormalities in 17% of the study participants. Their study did not evaluate the ACJ and greater tuberosity changes on ultrasound.

Girish *et al* (18) in a study of asymptomatic shoulders in men aged 40-70 years found SASD thickening in 78% of study participants and ACJ degenerative changes in 65%. A significant finding in that study was that abnormalities were present in 96% of the subjects (18). This highlights the importance of correlating imaging with clinical findings.

The presence of degenerative changes of the greater tuberosity in radiographs and ultrasound was significantly associated with occurrence of supraspinatus tears ($p < 0.001$). At sonography the degenerative changes had a sensitivity of 75% and specificity of 92% for supraspinatus tears. Wohlwend *et al* (19) showed a sensitivity of 90% and specificity of 89%. Even after adjusting for age, the association was significant.

Combined diagnostic yield: The combination of shoulder radiography and ultrasound significantly increased the diagnostic yield by assessing both osseous and soft tissues. A recently published study by Sheehan *et al* (9) has demonstrated that the combination of radiography and ultrasound is adequate in diagnosing majority of shoulder lesions at a much cheaper cost to the health care system. This is critical in our set up where shoulder ultrasound is underutilized and MRI remains out of reach for the majority.

Study limitation

The main limitation in this study was the absence of surgery findings to correlate with the imaging findings. It was not feasible to obtain surgery findings within the duration of the study. Additionally studies have shown a similar accuracy between ultrasound and MRI hence the use of ultrasound as a standalone modality.

CONCLUSIONS

1. Degenerative changes seen in both radiographs and ultrasound increase with age while the diagnostic yield of non traumatic shoulder radiographs is low in patients below 40 years of age.
2. Rotator cuff disease constitutes the bulk of pathology at ultrasound. There is significant association between greater tuberosity degenerative changes with rotator cuff tears ($p<0.001$) and an acromiohumeral interval less than 7mm and full thickness supraspinatus tears ($p<0.001$). Their presence on radiographs can be used to predict the presence of tears.
3. Combination of shoulder radiograph and ultrasound increases the diagnostic yield by evaluating both osseous and soft tissue structures.

RECOMMENDATIONS

1. Increase the awareness to clinicians about the utility of shoulder ultrasound as a cost effective modality in the evaluation of shoulder pain.
2. Shoulder radiographs and ultrasound should be considered as first line modalities in the evaluation of shoulder pain in line with the Society of Radiologists in Ultrasound consensus statement.
3. Clear shoulder radiography protocol should be implemented. The scapular Y view proved a challenge to the radiographers due to lack of practice.

REFERENCES

1. Luime, J.J., Koes, B.W., Hendriksen, I.J.M., Burdoff, A., Verhagen, A.P., Miedema, H.S., *et al*. Prevalence and incidence of shoulder pain in the general population; a systematic review. *Scand J Rheumatol.* 2004; **33**:73-81.
2. Linsell, L., Dawson, J., Zondervan, K., Rose, P., Randall, T., Fitzpatrick, R., *et al*. Prevalence and incidence of adults consulting for shoulder conditions in UK primary care; patterns of diagnosis and referral. *Rheumatology*. 2006; **45**:215- 221.
3. Dinnes, J., Loveman, E., McIntyre, L. and Waugh, N. The effectiveness of diagnostic tests in assessment of shoulder pain due to soft tissue disorders. *Health Tech. Assessment.* 2003; **7**(29):
4. Ostor, A.J., Richards, C.A., Prevost, A.T., Speed, C.A. and Hazleman, B.L. Diagnosis and relation to general health of shoulder disorder presenting to primary care. *Rheumatology.* 2005; **44**: 800-805.

5. Mugambi L. The pattern of MRI findings in patients with shoulder pain at three imaging centres in Nairobi. University of Nairobi 2009. http://erepository.uonbi.ac.ke/
6. Stiles, R.G. and Michael, T.O. Imaging of the shoulder. *Radiology*. 1993; **188**: 603-613.
7. De Jesus, J.O., Parker, L., Frangos, A.J. and Nazarian, N.L. Accuracy of MRI, MR Arthrography and ultrasound in diagnosis of rotator cuff tears: a meta-analysis. *AJR Am J Roentgenol.* 2009; **192**:1701-1707.
8. Nazarian, N.L., Jacobson, J.A., Benson, C.B., Bancroft, L.W., Bedi, A., McShane, J.M., *et al.* Imaging algorithms for evaluating suspected rotator cuff disease: Society of Radiologists in Ultrasound consensus conference statement. *Radiology.* 2013; **267**:589-595.
9. Sheehan, S.E., Coburn, J.A. and Singh, H. Reducing unnecessary shoulder MRI examinations within a capitated healthcare system: a potential role for shoulder ultrasound. *J Am Coll Radiol* 2016. Article in press. *http://dx.doi.org/10.1016/j.jacr.2016.03.015*
10. Beggs, I. Musculoskeletal ultrasound technical guidelines – Shoulder. European Society of Musculoskeletal Radiology.
11. Windt, D.A., Thomas, E., Pope, D.P., Winter, A.F., Macfalane, G.J., Bouter, L.M., *et al*. Occupational risk factors for shoulder pain; a systematic review. *Occup Environ Med*. 2000; **57**:433-442.
12. Cadogan, A., Laslett, M., Hing, W.A., McNair, P.J. and Coates, M.H A prospective study of shoulder pain in primary care; prevalence of imaged pathology and response to guided diagnostic blocks. *BMC Musculoskeletal disorders*. 2011; **12**:119.
13. Cone, R., Resnick, D. and Danzig, L. Shoulder impingement syndrome: Radiographic evaluation. *Radiology.* 1984; **150**: 29-33.
14. Hardy, D.C., Vogler, J.B. and White, R.H. The shoulder impingement syndrome: prevalence of radiographic findings and correlation with response to therapy. *AJR.* 1986; **147**: 557-561.
15. Bonsell, S., Pearsall, A.W., Heitman, R.J., Helms, C.A., Major, N.M. and Speer, K.P. The relationship of age, gender and degenerative changes observed on radiographs of the shoulder in asymptomatic individuals. *J Bone Joint Surg (Br)*. 2000; **82-B**: 1135-1139.
16. Saupe, N., Pfirmann, C.W., Schmid, M.R., Jost, B., Werner, C.M. and Zanetti, M. Association between rotator cuff abnormalities and reduced acromiohumeral interval. *AJR*. 2006; **187**: 376-382.
17. Goutallier, D., Guillox, P.L., Postel, J.M., Radier, C., Bernageau, J. and Zilber, S . Acromiohumeral distance less than 6 millimetres: its meaning in full thickness rotator cuff tear. *Orthop Traumatol Surg Res.* 2011; **97**: 246-251.
18. Girish, G., Lobo, L.G., Jacobson, J.A., Morag, Y., Miller, B. and Jamadar, D.A. Ultrasound of the shoulder: asymptomatic findings in men. *AJR.* 2011; **197**:W713-W719.
19. Wohlwend, J.R., Holsbeek, M., Craig, J., Shirazi, K., Habra, G., Jacobsen, G., *et al.* The association between irregular greater tuberosities and rotator cuff tears: A sonographic study. *AJR.* 1998; **171**: 229-233.