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MEASUREMENT OF SUPRASPINATUS TENDON STRAIN RATIO WITH SONOELASTOGRAPHY: AN EXPLORATORY STUDY

by

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Abstract

Purpose
The aim of this study was to measure the strain ratio of supraspinatus tendon, and assess the accuracy of sonoelastography when compared with grey-scale ultrasound in the diagnosis of supraspinatus tendinopathy in patients with shoulder pain. The findings were compared with those obtained at clinical diagnosis and strain ratio.

Materials and Methods
The study was undertaken in three phases. In phase 1, 284 asymptomatic supraspinatus tendons of healthy volunteers were assessed by grey-scale ultrasound and sonoelastography to obtain baseline results which included strain ratio.
In phase 2, 204 consecutive patients clinically diagnosed with supraspinatus tendinopathy, results of sonoelastography (index test) were compared with grey-scale ultrasound and clinical diagnosis (reference test). Strain ratio is proposed as a new reference standard and was used to test the accuracy of diagnosis. Supraspinatus tendons abnormalities detectable by grey-scale ultrasound were defined as swelling, hypoechoic or hyperechoic intratendinous lesions, while supraspinatus pathological alterations detectable by sonoelastography were defined as intratendinous tissue softening shown as experimentally proven colour changes and strain ratio values below cut-off value of 4.0 ($p \leq 0.0001$).
In phase 3, intra-observer and inter-observer variability evaluation was done to assess the supraspinatus tendons of healthy volunteers.

Results
The overall mean strain ratio value in healthy supraspinatus tendons was 5.6 ($\pm$ 1.24 *SD*). In healthy supraspinatus tendons, 9.9% showed evidence of softening suggesting subclinical tendinopathy which was not evident on grey-scale ultrasound. The correlation (*kappa*) between sonoelastography and grey-scale ultrasound in healthy volunteers was 0.42 showing moderate agreement ($p < 0.001$).
In patients with tendinopathy, the mean strain ratio value was smaller and measured 3.59 ($\pm$ 5.16 *SD*) with a significant statistical difference ($p = 0.001$).
When clinical diagnosis was used as the reference standard, sonoelastography showed better accuracy than grey-scale ultrasound (65% vs 59%; 95% CI: 59 - 70%), sensitivity (75% vs 65%; 95% CI: 60 - 86%) and specificity (63% vs 57%; 95% CI: 59 - 66%) ($p < 0.001$).
When strain ratio was used as the reference standard, sonoelastography also showed better accuracy than grey-scale ultrasound (92% vs 68%; 95% CI: 88 - 94%), sensitivity (98% vs 73%; 95% CI: 92 - 100%) and specificity (88% vs 67%; 95% CI: 85 - 90%) ($p < 0.001$).
There was a statistically good agreement in the symptomatic group between sonoelastography and strain ratio ($k = 0.84$; $p < 0.0005$). The *kappa* measure of agreement between grey-scale ultrasound and sonoelastography was fair with a value of $k = 0.35$ ($p < 0.0005$). There was significant statistical difference in the mean score for the asymptomatic and symptomatic groups ($p = 0.001$).
The *kappa* values for the intra-observer agreement showed very good level of agreement within each observer. Comparison of the inter-rater agreements between the two groups showed good and reproducible *kappa* values of 0.715 (Group 1) and 0.750 (Group 2).

Conclusion
Sonoelastography has been shown to be a valuable imaging modality in the detection of intratendinous tendinopathy. It improved the accuracy, sensitivity and specificity of detection of tendinopathy when compared with grey-scale ultrasound. Strain ratio colour grading is proposed as new reference standard for supraspinatus tendinopathy.