ORIGINAL ARTICLE

The Validity of the Lag Signs in Diagnosing Full-Thickness Tears of the Rotator Cuff: A Preliminary Investigation

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ABSTRACT. Miller CA, Forrester GA, Lewis JS. The validity of the lag signs in diagnosing full-thickness tears of the rotator cuff: a preliminary investigation. Arch Phys Med Rehabil 2008;89:1162-8.

Objective: To investigate whether the lag signs were valid tools in diagnosing full-thickness tears of the rotator cuff.

Design: A same-subject, correlation, double-blinded design was used. The results of the external rotation lag sign, drop sign, and internal rotation lag sign were compared with the criterion standard of diagnostic ultrasound to establish their accuracy.

Setting: A regional orthopedic hospital.

Participants: Consecutive subjects (N=37), 21 women and 16 men, with shoulder pain referred to a consultant orthopedic surgeon specializing in shoulder conditions were recruited for this investigation.

Interventions: Not applicable.

Main Outcome Measures: Sensitivity, specificity, and positive and negative likelihood ratios of the lag signs when using ultrasound as the reference test.

Results: The specificities of the drop sign and internal rotation lag sign were 77% and 84%, respectively, which, together with low positive likelihood ratios 3.2 (95% confidence interval [CI], 1.5–6.7) and 6.2 (95% CI, 1.9–12.0), indicate that a positive result was poor at recognizing the presence of full-thickness tears. The drop sign had a sensitivity of 73% with a negative likelihood ratio of .34 (95% CI, 0.2–0.8), suggesting that a negative test was fair at ruling out the presence of full-thickness tears. The sensitivity of the internal rotation lag sign (100%) supported by the negative likelihood ratio of 0 (95% CI, 0.0–2.5) suggests that a negative test will effectively rule out the presence of full-thickness tears of the subscapularis. A positive external rotation lag sign is the clinical test most likely to indicate that full-thickness tears of the supraspinatus and infraspinatus are present (specificity, 94%). However, the external rotation lag sign did demonstrate a low sensitivity score of 46% and negative likelihood ratio of .57 (95% CI, 0.4–0.9), which means that a negative test will not rule out the presence of full-thickness tears.

Conclusions: The findings of this investigation suggest that a clinical diagnosis of a full-thickness tear of the rotator cuff cannot be conclusively reached using one or more of the lag signs.

Key Words: Rehabilitation; Rotator cuff; Shoulder pain.

THE TENDONS OF THE supraspinatus, infraspinatus, teres minor, and subscapularis muscles fuse to form the rotator cuff tendon, which covers the humeral head and functions to produce movement, stability, and sensorimotor control at the glenohumeral joint.[1-4] Disorders of the periarticular soft tissues of the shoulder, including those involving the rotator cuff tendons, are common.[5] The spectrum of orthopedic pathologies involving the rotator cuff tendons is extensive and includes tendinitis, tendinosis, partial-thickness tears, and full-thickness tears. Shoulder pain in the presence of full-thickness tears has the potential to limit shoulder and upper-limb function severely.[6] The incidence of full-thickness tears increases with age,[7-9] and up to 50% of people over the age of 60 years will have full-thickness tears of the rotator cuff.[8]

Despite the high prevalence rate, the exact etiology of a rotator cuff tear is much disputed in the literature. Neer[10,11] stated that 95% of rotator cuff pathology occurred as a result of irritation by the acromion onto the rotator cuff leading to microtrauma and an inflammatory repair process in the tendon (tendinitis). In the presence of continuing acromial irritation, the rotator cuff tissue would eventually tear, passing from microtears to partial-thickness tears and culminating in full-thickness tears. However, histologic research in this area has produced equivocal findings regarding the presence of inflammatory cells.[12,13] Fukuda et al[12] reported no infiltrations of neutrophils, lymphocytes, or plasma cells in rotator cuff tendon biopsies from patients (n=12) undergoing surgery for rotator cuff pathology. In a more recent study, Matthews et al[13] found that large tears were associated with a decrease in blood vessels, leukocytes, and fibroblasts. In addition, increased tendinosis and edema were observed. The absence of inflammatory cells and the amount of degenerative changes observed in larger tears suggest that healing may not occur. This has significant implications for the diagnosis and treatment of this subgroup of patients with rotator cuff pathology. Therefore, although many causes of shoulder pain will respond to conservative treatment, when full-thickness tears of the rotator cuff develop, more aggressive management such as surgery may need to be considered.[14] Consequently, because the management of shoulder pain differs markedly in the presence of full-thickness tears of the rotator cuff, accurate diagnosis is clinically important to guide further decision-making toward the most appropriate and effective form of management for these patients.

A number of clinical tests have been recommended to assess the presence of full-thickness rotator cuff tears.[14-18] However, there is uncertainty about the value of diagnostic tests in the

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Presented to the International Conference on Movement Dysfunction, September 25, 2005, Edinburgh, United Kingdom.

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit upon the authors or upon any organization with which the authors are associated.

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0003-9993/08/8906-00542$34.00/0
doi:10.1016/j.apmr.2007.10.046

assessment of rotator cuff pathology because many of the recommended tests lack acceptable levels of sensitivity and specificity to assess clinically the status of the rotator cuff with confidence.[19] Hertel et al[18] have recommended 3 clinical tests to assess the integrity of the rotator cuff: the external rotation lag sign, the internal rotation lag sign, and the drop sign. These tests are collectively referred to as the *lag signs*.

Hertel[18] compared the clinical response of the lag signs with intraoperative surgical findings. One hundred consecutive patients were examined, revealing a 53% prevalence rate of full-thickness tears of the rotator cuff. Using the operative findings as a criterion standard to compare the clinical results, Hertel[18] reported that the drop sign had a sensitivity of 44.4% and a specificity of 98.3%. The corresponding positive and negative likelihood ratios were 26.1 and 0.6. The comparable values for the external rotation lag sign were 68.3% and 100%, and 34.8 and 0.3, respectively; and for the internal rotation lag sign, 62% and 100%, and 31 and 0.4, respectively. The high specificity suggests that these tests can effectively rule out the presence of a full-thickness tear in subjects but are unlikely to rule in conclusively the presence of full-thickness tears. One limitation of this study was the bias of the sample. Because arthroscopy was used as the reference test, the population had symptoms severe enough to warrant surgery. This population may not generalize well to other clinical scenarios in which symptoms are lesser and the prevalence rate of a full-thickness tear is much lower.

Although arthroscopy is considered the criterion standard, there are methodologic issues that may confound the results of research using this procedure as a reference test. One includes the lack of blinding, because surgeons involved in these investigations are likely to be aware of the clinical and imaging results, which has the potential to influence the intraoperative findings. Second, because of ethical concerns, it is not appropriate to examine asymptomatic shoulders. In addition, Mohtadi et al[20] demonstrated that diagnostic arthroscopy is susceptible to subjective interpretation. In this study,[20] 2 experienced surgeons were required to interpret arthroscopic video footage. Diagnostic agreement of supraspinatus pathology (no pathology, inflammation, partial-thickness bursal-side tear, partial-thickness joint-side tear, full-thickness tears) was reached in only 58.5% of 50 cases, with a κ value of .47, suggesting that agreement between the observers was only moderate. However, perfect agreement was reached in the diagnosis of full-thickness tears, which supports the argument that arthroscopy is the criterion standard for the identification of structural full-thickness tears.

Diagnostic ultrasound is commonly used in the diagnosis of partial-thickness and full-thickness rotator cuff tears. One advantage of this modality over arthroscopy is that it allows (ethically and financially) a side-to-side comparison in both symptomatic and asymptomatic shoulders. A synthesis of the research literature suggests that the accuracy of detecting full-thickness tears is greater than that of detecting partial-thickness tears.[19] A sensitivity of 91% and specificity of 86% for the pooled results of partial-thickness and full-thickness rotator cuff tears in a retrospective analysis of ultrasound results compared with arthroscopic findings in 44 subjects undergoing revision surgery were reported by Prickett et al.[21]

Teefey et al[22] reported that ultrasound correctly identified 45 (98%) of 46 full-thickness tears and 13 (68%) of 19 partial-thickness tears when tested against arthroscopic findings. When compared with all surgical findings (open and arthroscopic), a correct diagnosis was made using ultrasound in 37 (88%) of 42 full-thickness tears and 20 (70%) of 37 partial-thickness tears, and 16 (80%) of 20 healthy tendons.[23] Iannotti et al[23] also reported that there was no significant difference between ultrasound and magnetic resonance imaging (MRI) in the detection of full-thickness tears. The results suggest that both MRI and ultrasound are acceptable modalities for the diagnosis of full-thickness rotator cuff tears when referenced against arthroscopy, although both are less accurate in the diagnosis of partial-thickness tears.

These findings suggest that diagnostic ultrasound is a possible alternative reference standard to determine the diagnostic accuracy of the lag signs. In addition, more complete blinding is possible using diagnostic ultrasound as the reference test to compare clinical findings because it is possible to design a study in which the radiologist's and clinician's findings are blinded from each other. Furthermore, ultrasound allows a side-to-side comparison. For ethical and pragmatic reasons, these factors are usually not included in intraoperative comparison studies.

The aim of this investigation was to determine the accuracy of the lag signs for the diagnosis of full-thickness tears of the rotator cuff in comparison with diagnostic ultrasound. The clinical and imaging findings remained blinded until the final analysis, which involved determining the sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratios of the lag signs.

METHODS

Study Design

A same-subject, correlational, double-blinded design was used in this study. Ethics approval was obtained from Coventry University and South Birmingham Ethics Committee before commencing the study. Subjects were informed of their rights, including the right to withdraw from the investigation at any stage without providing an explanation.

Study Sample

Thirty-seven subjects with shoulder pain referred to a consultant orthopedic surgeon specializing in shoulder conditions were recruited for this investigation.

The inclusion criteria were shoulder pain (pain in the C5-6 dermatome), full passive movement of the involved shoulder, and age over 18 years. Exclusion criteria were previous surgery to the symptomatic upper limb and any symptoms of neurologic origin.

Investigators

The clinical investigator was a specialist physiotherapist with 5 years of experience in outpatient musculoskeletal practice and a special interest in shoulder pathology. To ensure test quality, the clinical tests were practiced on 5 separate occasions with an orthopedic surgeon with a special interest in shoulders on a separate group of subjects (n=10).

The consultant radiologist had worked in a musculoskeletal setting for over 10 years and in the previous 3 years had specialized in diagnostic ultrasound of the shoulder.

The ultrasonographer and clinical investigator were blinded to each other's results and to the opinion of the consultant orthopedic surgeon.

Procedure

Data for this investigation were collected over a period of approximately 6 months. Potential participants who met the inclusion criteria and did not fulfill the exclusion criteria were invited to consider participation in the investigation. Those who agreed completed informed consent documentation before