Clinical identifiers for early stage primary/idiopathic adhesive capsulitis: are we seeing the real picture?

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Abstract

Background: Adhesive capsulitis is often difficult to diagnose in its early stage and differentiate from other common shoulder disorders.

Objective: The aim of this study was to validate any or all of the eight clinical identifiers of early stage primary/idiopathic adhesive capsulitis established in an earlier Delphi study.

Design*:* Cross-sectional study.

Methods: Sixty-four patients diagnosed with early stage adhesive capsulitis by a physical therapist or medical practitioner were included in the study. Eight active and eight passive shoulder movements and visual analogue scale pain scores for each movement were recorded, prior to and immediately following an intraarticular injection of corticosteroid and local anaesthetic. Using the local anaesthetic as the reference standard, pain relief of ≥70% for passive external rotation was deemed a positive anaesthetic response (PAR).

Results: Sixteen (25%) participants demonstrated a PAR. Univariate logistic regression identified that of the proposed identifiers, global loss of passive range of movement (OR 0.26; p = 0.03), pain at the end of range of all measured active movements (OR 0.06; p = 0.02) and global loss of passive glenohumeral movements (OR 0.23; p = 0.02) were associated with a PAR. Following stepwise removal of the variables, pain at the end of range of all measured active movements remained the only identifier but was associated with reduced odds of a PAR.

Limitations: The lack of a recognised reference standard for diagnosing early stage adhesive capsulitis remains problematic in all related research.

Conclusions*:* None of the clinical identifiers for early stage adhesive capsulitis previously proposed by expert consensus have been validated in this study. Clinicians should be aware that commonly used clinical identifiers may not be applicable to this stage.

Introduction

Adhesive capsulitis is a diagnostic label attributed to a disorder of the glenohumeral joint capsule that has been reported to affect up to five percent of the population (Hannafin and Chiaia 2000, Hand, Clipsham et al. 2008). Primary adhesive capsulitis is due to an unknown cause as opposed to secondary which results from a known cause or extrinsic event (Chambler and Carr 2003). The condition is generally described as consisting of three stages (Chambler and Carr 2003). These have been identified as the painful stage (first), adhesive stage (second) and resolution stage (third) (Pearsall and Speer 1998). The first or painful stage, which is being considered in this study, is generally considered to last 3-9 months (Pearsall and Speer 1998).

Whilst the later stages are easily recognised often due to marked restriction of movement, the early stage of this disorder is commonly difficult to identify and correctly diagnose (Walmsley, Rivett et al. 2009). It has however been proposed that treatment in the early stage of adhesive capsulitis may decrease the overall morbidity (Hannafin and Chiaia 2000), arguably suggesting that early recognition of this disorder is desirable.

Musculoskeletal healthcare frequently relies on recognition of patient reported and physical examination findings, together with special tests and medical imaging to inform diagnosis and direct management. Determining the clinical features considered necessary to establish a diagnosis is frequently achieved through research using various types of consensus methodology (Graham, Regeher et al. 2003, Cook, Brismee et al. 2005, Cook, Brismee et al. 2006). Several studies using this approach have attempted to identify clinical characteristics of adhesive capsulitis in general (Hanchard, Goodchild et al. 2011, Zuckerman and Rokito 2011), as well as specific to the early stage (Walmsley, Rivett et al. 2009), however validation of these characteristics is lacking. As well as routine clinical assessment, musculoskeletal assessment often relies on a 'gold standard' that may include a particular diagnostic test, imaging procedure or even surgical findings with which to determine a diagnosis. As surgery is not indicated and imaging procedures in the early stage of adhesive capsulitis have yet to be systematically explored (Walmsley, Osmotherly et al. 2013) a 'gold standard' for diagnosis remains problematic in this population. Clinical tests have recently been described that may assist the diagnosis of adhesive capsulitis (Carbone, Gumina et al. 2009, Wolf and Cox 2010), however the duration of symptoms of participants in these studies was not reported resulting in

difficulty determining the stage of the disorder and whether the findings are valid for patients in the early stage.

A set of clinical identifiers considered necessary and sufficient by a group of experts to diagnose early stage adhesive capsulitis (Walmsley, Rivett et al. 2009) (Table 1) has been proposed as a framework with which to begin the process of addressing this diagnostic dilemma. The identifiers established in that study by our research group included both patient reported and physical examination findings, and interestingly clustered into two discrete dimensions of pain and movement.

Table 1 Clinical identifiers achieving consensus (Walmsley, Rivett et al. 2009)

Criterion
There is a strong component of night pain
There is a marked increase in pain with rapid or unguarded movements
It is uncomfortable to lie on the affected shoulder
The patient reports the pain is easily aggravated by movement
The onset is generally in people greater than 35 years of age
On examination there is pain at the end of range in all directions
On examination there is global loss of active and passive range of movement
There is global loss of passive glenohumeral joint movement

As pain is reportedly a significant feature of the early stage (Hannafin and Chiaia 2000), it was therefore not surprising that several dimensions in pain were reported to achieve consensus. Night pain, a marked increase of pain with rapid or unguarded movements, discomfort lying on the affected shoulder and pain easily aggravated by movement, were all identified as required to achieve diagnosis. These descriptors were suggested to reflect the inflammatory nature of the disorder in the early stage (Hand, Athanasou et al. 2007). Although often unquantified, recognition of the later stages of adhesive capsulitis through marked movement restriction, in particular external rotation, has been previously reported (Bulgen, Binder et al.

1984). Conversely there is a lack of description of movement dysfunction in the early stage of the disorder. Physical examination findings achieving consensus in our Delphi study (Walmsley, Rivett et al. 2009) similarly lacked quantification, but it was suggested global loss of both active and passive ranges of movement, together with pain at the end of range in all directions were necessary characteristics. Although the clinical identifiers proposed for early stage adhesive capsulitis by expert consensus (Walmsley, Rivett et al. 2009) were suggested as a starting point for future validation studies, it was recognised that they could not at this time be regarded as a gold standard or provide a certain differential diagnosis, but could rather potentially be used to assist in clinical decision-making.

The aim of this study was therefore to validate any or all of the eight clinical identifiers previously proposed for the early stage of adhesive capsulitis (Walmsley, Rivett et al. 2009).

Materials and methods

The Human Research Ethics Committee of The University of Newcastle granted ethical approval for this study. All participants signed an informed consent form prior to entering the study.

Participants

Participants were recruited from a private upper limb physical therapy clinic in Newcastle, Australia over a three year period between May 2010 and April 2013. Patients clinically diagnosed with adhesive capsulitis by various health care practitioners including orthopaedic surgeons, shoulder physicians, general practitioners and physiotherapists were invited to

participate in the study. To be considered for inclusion, potential participants were required to have been referred for an intraarticular glenohumeral joint corticosteroid and local anaesthetic injection using radiological guidance to confirm correct placement of the needle, as part of routine clinical care. Consistent with the reported duration of the early stage of adhesive capsulitis (Pearsall and Speer 1998), potential participants were excluded from the study if they had a symptom duration of greater than nine months. As primary/idiopathic adhesive capsulitis was being investigated, individuals with a history of previous major trauma or surgery on the affected shoulder were also excluded. Reported minor trauma was not an exclusion criterion. Potential participants were required to have had a recent unremarkable X-ray examination in order to eliminate glenohumeral osteoarthritis, calcific deposits or other potentially confounding diagnoses. They were also required to have had a recent ultrasound examination that excluded a full-thickness rotator cuff tear. Potential participants who had undergone an intraarticular corticosteroid injection into the glenohumeral joint in the preceding six weeks, had a history of inflammatory arthropathies or of cervical spine pathology that may refer into the shoulder joint, were also excluded from the study. As the contralateral shoulder was being used to determine percentage loss of range of movement, the presence of pain or restriction of movement in that shoulder was a further exclusion criterion.

Procedure

Immediately prior to the injection each participant attended the clinic to complete routine assessment including measurement of active and passive ranges of movement and pain at the end of ranges of movement. Additional questions were asked to determine the presence of the

eight clinical identifiers being validated. To provide baseline measurements of shoulder pain and disability, the Shoulder Pain and Disability Index (SPADI) (Roach, Budiman-Mak et al. 1991, Staples, Forbes et al. 2010) was administered. This instrument is a validated questionnaire measuring shoulder pain and impairment and has a high level of internal consistency and good test-retest reliability (Heald, Riddle et al. 1997). General health status was measured using the Short Form 36 (SF-36) (Brazier, Harper et al. 1992). This instrument is easy to administer, has been demonstrated to be reliable and valid (Brazier, Harper et al. 1992) and has been previously used to describe study samples with adhesive capsulitis (Carette, Moffet et al. 2003, Jacobs, Smith et al. 2009). On completion of the assessment, participants attended a radiology practice to undergo the intraarticular glenohumeral corticosteroid and local anaesthetic injection under radiological guidance. Within one hour of administration of the injection the participant returned for re-assessment including measurement of active and passive ranges of movement and pain at the end of ranges of movement. Following the measurement of range of movement and recording of post-injection pain levels the participant continued with routine clinical management.

Shoulder movement measurement

A comprehensive series of active and passive shoulder ranges of movement were evaluated. Seated upright in a chair to limit trunk extension, measurement of the following ranges of movement were performed based on the method described by Green et al (1998): total shoulder flexion (TSF), glenohumeral flexion (GHF), total shoulder abduction (TSA), glenohumeral abduction (GHA). The starting position for each of these movements was with the palm facing

medially to ensure consistent rotation. The elbow was extended and the inclinometer placed along the shaft of the humerus (Green, Buchbinder et al. 1998). As GHF and GHA were being measured, a device was constructed to limit movement of the acromion so as to provide consistent scapular stabilization (Figure 1).

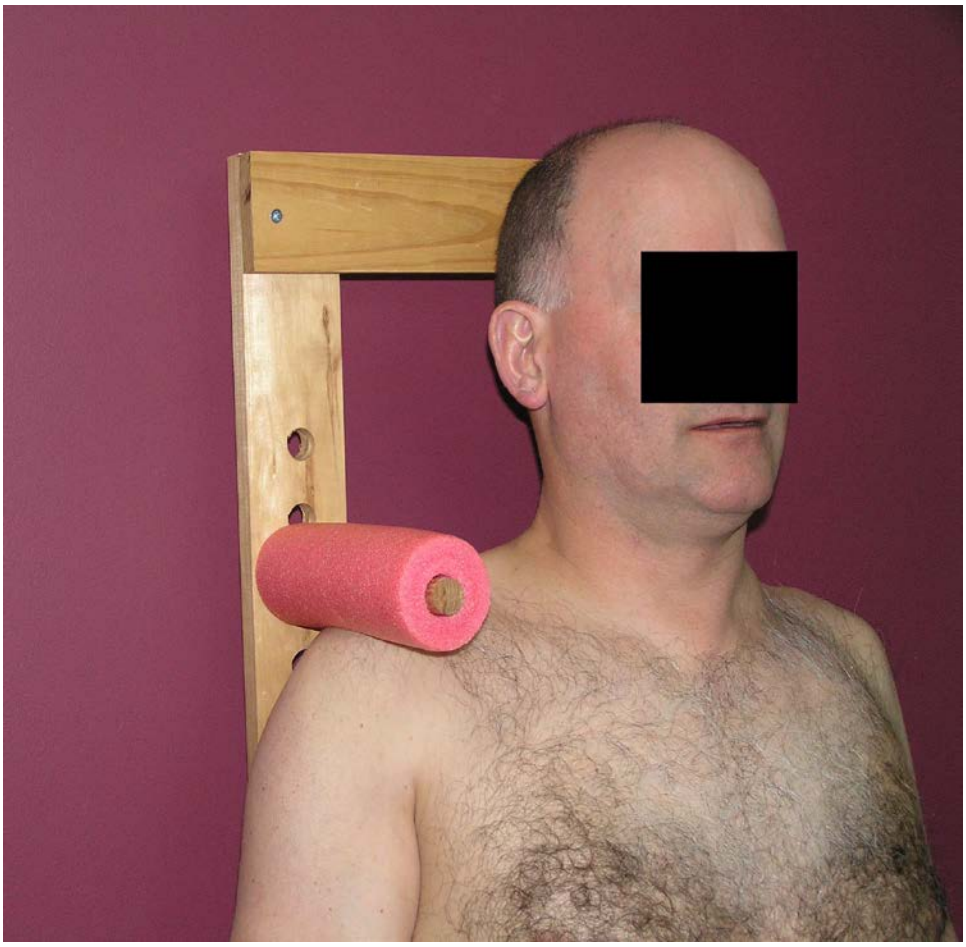

Figure 1 Device to stabilise the scapula for measurement of glenohumeral joint movement.

Each of the following movements was performed in the supine lying position based on previously described methods (Clarke, Willis et al. 1974, Bower 1982, Green, Buchbinder et al.

1998): external rotation in neutral abduction (ERN), external rotation in 90 degrees abduction (ERA), internal rotation in 90 degrees abduction (IRA) . A towel was placed under the shaft of the humerus to ensure it was parallel to the plinth, the elbow flexed to 90 degrees and the inclinometer was placed on the dorsal surface of the participant's forearm. For ERA and IRA the arm was abducted to 90 degrees or if this was not possible it was taken to the limit of movement. Internal rotation in abduction was measured based on a method previously described whereby the end range was determined as the point at which the posterolateral acromion was visualised to rise off the plinth (Awan, Smith et al. 2002). In addition, hand behind back (HBB) was measured in standing using the distance between the spinous process of T1 and the spinal level reached by the radial styloid process with the arm taken behind the back (Ginn, Cohen et al. 2006).

All movements, with the exception of HBB were measured in degrees using a Baseline digital inclinometer (Fabrication Enterprises Incorporated, Irvington, NY, USA). Prior to each measurement the digital inclinometer was reset to zero after placement on the participant to ensure consistency. Digital inclinometery has been demonstrated to have a measurement error of ±1° (Downer and Sauers 2005). HBB was measured with a tape measure and recorded in millimetres. The order of measurement was standardised (TSF, GHF, TSA, GHA, ERN, ERA, IRA, HBB) and all active movements were performed prior to any passive movements.

The instruction to participants for all active movements was to move the arm as far as possible until they were no longer able to tolerate the movement due to pain or they were unable to move the arm any further. For passive movements, the researcher performed each of the

movements to the point of resistance or when the participant reported the pain was intolerable. To determine percentage loss of active and passive ranges of movement, contralateral shoulder range of movement was also measured prior to the injection of corticosteroid and local anaesthetic in an identical manner to the affected shoulder. In the absence of any documented deficit, a loss of range of movement of 10% or greater with respect to the contralateral shoulder was determined to constitute loss of movement. Such a loss exceeds the measurement error of shoulder range of movement of less than 7% previously reported (Clarke, Willis et al. 1974) as well as that reported for the commonly used universal goniometer (5-7 degrees) (MacDermid, Chesworth et al. 1999) thus affording some translation of the findings to the clinical setting.

Calculation of post injection pain intensity

In the absence of a 'gold standard' for the diagnosis of early stage adhesive capsulitis, the response to the local anaesthetic (administered concurrently with the corticosteroid injection) was used as the reference test standard. Local anaesthetic injection has been previously proposed as a method of determining diagnosis (Sheridan and Hannafin 2006, Neviaser and Hannafin 2010). To determine the anaesthetic response, each participant was required to record their level of pain at the end of active and passive ranges of movement on a 100 mm visual analogue scale (VAS) with 0 mm = 'no pain' and 100 mm = 'worst pain imaginable'. The percentage change in pain intensity from before to after the injection was calculated for each active and passive movement. Pain relief of ≥ 70% for ERN was considered a positive anaesthetic response (PAR). External rotation in neutral abduction was chosen as it is generally recognised as the most frequently affected movement in adhesive capsulitis (Hanchard,

Goodchild et al. 2011). The required ≥ 70% of pain relief obtained was chosen as it is considered clinically relevant and has been used in previous research (Strobel, Pfirrmann et al. 2003).

Statistical analysis

Descriptive statistics were used to summarise the characteristics of the participants and presence of the eight clinical identifiers. The participant characteristics together with the eight identifiers were analysed against anaesthetic response using univariate logistic regression. As the clinical identifier describing pain at the end of range in all directions was non specific about whether this was active or passive range of movement, both dimensions were included in the analysis. Further, although only global loss of passive glenohumeral joint movement was proposed as a clinical identifier, for completeness active range of movement was also included in the model. The criterion that described glenohumeral joint movements comprised the movements of GHF, GHA, ERN, ERA and IRA. All factors with a p-value of 0.20 or less were included in a multiple logistic regression model. Outcomes were expressed as odds ratios with 95% confidence intervals. A p-value of < 0.05 was considered to be statistically significant. Data were analysed using Stata 12.0 statistical software (Stata Corporation, Texas, USA).

Results

The flow of participants through the study is shown in Figure 2.

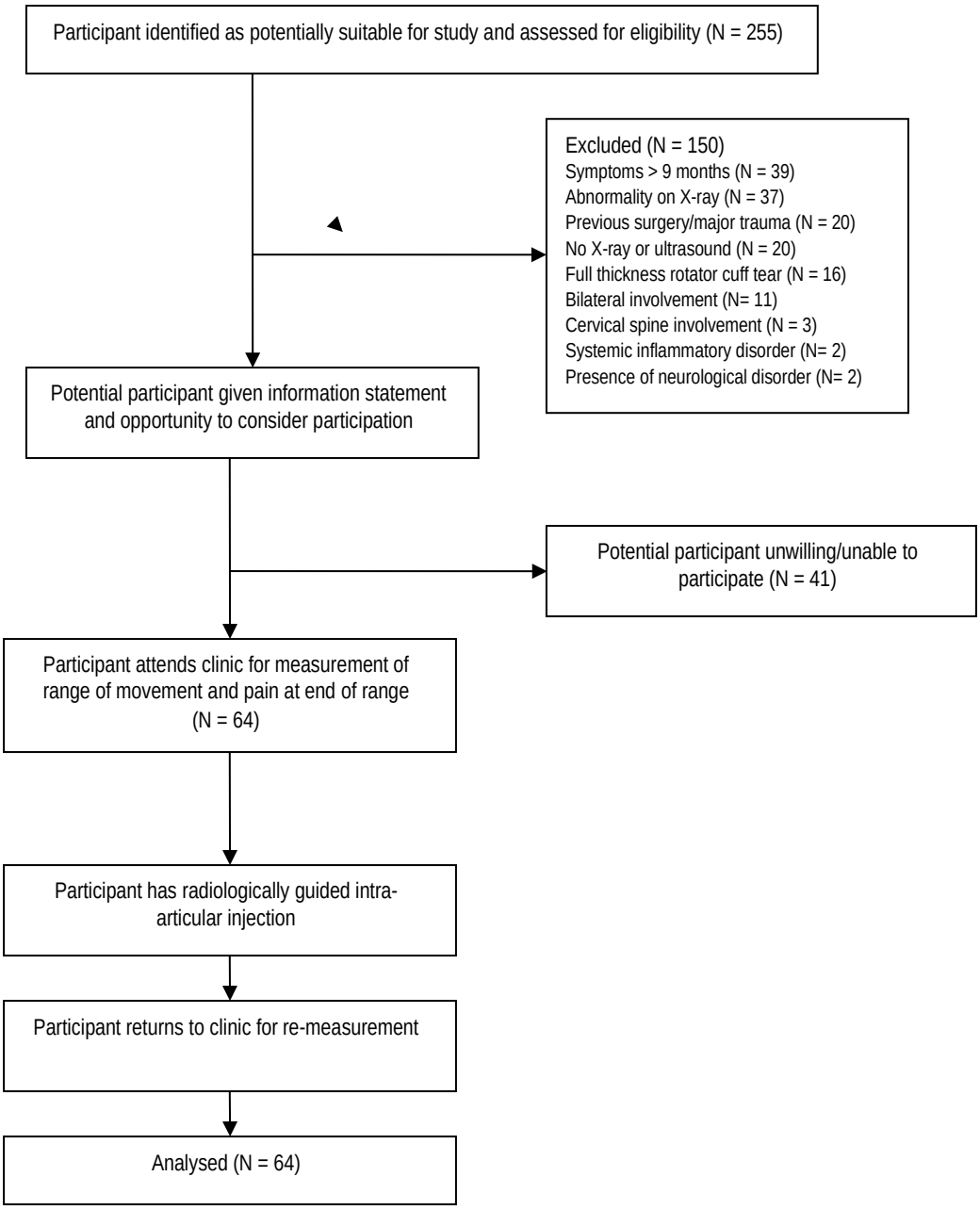

Figure 2 Design and flow of participants through the study

In total, 255 patients were assessed for inclusion in the study and 191 were excluded for either not meeting the inclusion or exclusion criteria (N = 150), or being unwilling or unable to

participate (N = 41). Sixty-four participants were included in the study and participant demographic characteristics are reported in Table 2.

Table 2 Characteristics of the study participants (N=64)

Variable	
Age (yrs), mean (SD)	55.1 (6.5)
Female (%)	33 (51.6)
Duration of symptoms (months), mean (SD)	5.4 (1.9)
Affected shoulder dominant	28 (43.8)
History of minor trauma (%)	23 (35.9)
History of diabetes (%)	6 (9.4)
History of Dupytren's disease (%)	8 (12.5)
SPADI (mean, SD)	49.2 (1.9)
SF-36 (PCS) (mean, SD)	41.2 (6.8)
SF-36 (MCS) (mean, SD)	50.9 (10.6)

Legend: SPADI = Shoulder Pain and Disability Index, SF-36 = Short Form 36, PCS = physical component summary, MCS = mental component summary

The prevalence of the eight clinical identifiers is presented in Table 3. All of the participants were aged over 35 years. Global loss of active and passive ranges of movement were the least prevalent of the eight criteria (65% and 67% respectively).

Table 3 Prevalence of the eight clinical identifiers (N = 64)

Criterion	Number of participants (%)
There is a strong component of night pain	62 (96.9)
There is a marked increase in pain with rapid or unguarded movements	57 (89.1)
It is uncomfortable to lie on the affected shoulder	61 (95.3)
The patient reports the pain is easily aggravated by movement	55 (85.9)
The onset is generally in people greater than 35 years of age	64 (100)
On examination there is pain at the end of range in all directions	Active 59 (92.2) Passive 60 (93.8)
On examination there is global loss of active and passive range of movement	Active 42 (65.6) Passive 43 (67.2)
There is global loss of passive glenohumeral joint movement	47 (73.4)

Sixteen (25%) participants demonstrated a PAR. The relationship between the demographic characteristics and the proposed eight clinical identifiers of the participants with a positive PAR is reported in Table 4.

Table 4 Relationship between participant characteristics and the eight clinical identifiers and PAR (N = 64).

Variable	Univariate association		Multivariate association	
	Odds ratio (95% CI)	p value	Odds ratio (95% CI)	p value
Age	1.08 (0.98, 1. 18)	0.12		
Gender	0.92 (0.16, 0.78)	0.89		
History of minor trauma	1.09 (0.34, 3.53)	0.88		
History of diabetes[1]				
History of Dupytren's disease	1.98 (0.42, 9.44)	0.39		
SPADI	0.38 (0.02,8.09)	0.54		
SF-36 (PCS)	1.02 (0.93, 1.11)	0.69		
Sf-36 (MCS)	1.02 (0.96, 1.08)	0.46		
Presence of night pain	0.32 (0.02, 5.42)	0.43		
Pain with rapid movement	2.14 (0.24, 19.30)	0.50		
Uncomfortable lying on affected shoulder[1]				
Pain easily aggravated by movement	0.62 (0.14, 2.83)	0.54		
Global loss of active movement	0.41 (0.13, 1.31)	0.13		
Global loss of passive movement	0.26 (0.08,0.85)	0.03*		
Pain at the end of range of active movements	0.06 (0.01, 0.62)	0.02*	0.06 (0.01, 0.62)	0.02*
Pain at the end of range of passive movements[1]				
Global loss of active glenohumeral movements	0.43 (0.13, 1.40)	0.16		
Global loss of passive glenohumeral movements	0.23 (0.07, 0.78)	0.02*		

Legend: SPADI = Shoulder Pain and Disability Index, SF-36 = Short Form 36, PCS = physical component summary, MCS = mental component summary; * p< 0.05; [1] omitted due to collineraity

Variable	Univariate association	Multivariate association

Univariate logistic regression identified that none of the patient demographic characteristics were associated with a PAR. Of the eight proposed clinical identifiers, pain at the end of range of all measured active movements (OR 0.06; p = 0.02), global loss of passive range of all measured movements (OR 0.26; p = 0.03), and global loss of passive glenohumeral movements (OR 0.23; p = 0.02) were associated with a PAR. Following stepwise removal of the variables, pain at the end of range of all measured active movements remained the only identifier but was associated with a reduced odds of a positive response (OR 0.06; p = 0.018).

Discussion

This is the first study that has attempted to validate a set of clinical identifiers for the early stage of primary/idiopathic adhesive capsulitis. It is unique in that it has used clinical identifiers previously established by expert consensus (Walmsley, Rivett et al. 2009) and only investigated patients with symptoms for less than nine months. Whilst the identifiers established by this consensus method have also been frequently recognised in the literature (Nash and Hazleman 1989, Lin, Jarmain et al. 2004, Mitchell, Adebajo et al. 2005), none were validated in this study. Interestingly of the eight clinical identifiers, pain at the end of all active ranges of movement has emerged as the least likely to indicate a diagnosis of early stage adhesive capsulitis. These results may suggest expert opinion and possibly clinical practice may not be recognising the appropriate clinical identifiers of patients in the early stage of this disorder. This study highlights the difficulty in quantitatively determining an exclusive set of criteria for the early stage of adhesive capsulitis.

Using the effect of intraarticular local anaesthetic injection as the diagnostic reference standard and associated pain relief of ≥ 70% in external rotation, 25% of participants in this study were determined to have early stage adhesive capsulitis. This was less than may have been anticipated but possibly in keeping with the proposal that this disorder is over diagnosed and the true incidence is much lower than generally reported (Bunker 2009). A further consideration is that every patient with a painful shoulder and apparent limitation of motion may not necessarily indicate a diagnosis of early stage adhesive capsulitis (Neviaser and Neviaser 1987). It is likely that the clinicians assessing the patients in the current study used similar clinical identifiers as the experts in the Delphi study (Walmsley, Rivett et al. 2009) given the specialist nature of the practice from which the participants were recruited. It is therefore not surprising that the prevalence of the identifiers in the participants was generally high, as demonstrated in Table 2. Our results suggest that using these criteria may not actually be appropriate to identify the early stage of this disorder. The differences of opinion and lack of understanding of adhesive capsulitis in its early stage, as well as the general appreciation of the specific diagnostic criteria which distinguish it at this stage from other shoulder disorders have been previously reported (Bell, Coghlan et al. 2003). Further, there is no consensus as to the exact range of motion restriction required for a patient to qualify for a diagnosis of early stage adhesive capsulitis (Brue, Valentin et al. 2007). Although consensus exists regarding the presence of three phases of the disorder, controversy still arises regarding the diagnostic criteria that distinguishes these stages (Dudkiewicz, Oran et al. 2004). The findings of this study are consistent with this confused picture.

Recent understanding of the pathology of adhesive capsulitis has suggested that the behaviour of the symptoms throughout the stages of the disorder may be explained by the underlying pathological process of initial inflammation followed by subsequent contracture (Hand, Athanasou et al. 2007). In particular, inflammation of the anterior glenohumeral joint capsule (Ozaki, Nakagawa et al. 1989, Wiley 1991) has been implicated in early adhesive capsulitis. It may therefore be reasonable to expect pain or restriction of movement to not be global in the early stage of adhesive capsulitis, given this reported pathology (Hand, Athanasou et al. 2007). Despite this, consensus studies on diagnostic criteria or clinical identifiers previously reported (with the exception of the Delphi study (Walmsley, Rivett et al. 2009), notably omit consideration of the stages described when proposing diagnostic criteria (Hanchard, Goodchild et al. 2011, Zuckerman and Rokito 2011). Further, the degree and directions of restriction required to constitute adhesive capsulitis have not been previously identified as necessary to determine appropriate diagnosis (Shaffer, Tibone et al. 1992). As each of the eight measured active and passive movements stresses various aspects of the glenohumeral joint capsule, this may provide an explanation for none of the clinical identifiers involving physical assessment being validated. This may suggest that a 'one size fits all' approach has been taken to diagnosis and, as the later stages reportedly present with global restriction of movement and end-range pain (Siegel, Cohen et al. 1999, Mitchell, Adebajo et al. 2005), this is likely to be similarly assumed in the early stage of the disorder. Potentially, it is the global rather than specific nature of these clinical identifiers that resulted in reduced odds of a PAR. The suggestion that limitation of external rotation may be the most recognisable feature (Hanchard, Goodchild et al. 2011) may warrant specific further exploration in a similar population.

The early stage of adhesive capsulitis has been reported to be frequently confused with impingement syndrome, with differentiation between the two disorders often difficult (Lubiecki and Carr 2007, Manske and Prohaska 2008). Compounding the confusion between these two disorders, impingement tests used clinically have been reported to lack specificity (Hanchard, Goodchild et al. 2012). As well as recognition of groups of physical examination findings, the use of local anaesthetic as a diagnostic tool in shoulder disorders has been previously reported (Cadogan, Laslett et al. 2011). The confusion between early stage adhesive capsulitis and impingement syndrome may be better addressed with use of local anaesthetic into the subacromial space (Neer 1983) to facilitate the diagnosis of adhesive capsulitis by exclusion.

The aim of musculoskeletal healthcare is to provide effective management of patients presenting with various disorders. However, the lack of strong evidence for treatment success of shoulder disorders reported in systematic reviews (Buchbinder, Green et al. 2006) has been suggested to be a result of the lack of uniformity of the use of diagnostic labels or that the criteria used in determining diagnostic sub-groups are not related to treatment success (Schellingerhout, Verhagen et al. 2008). Establishing diagnostic criteria or clinical identifiers for various shoulder disorders allows identification of a homogeneous subgroup of patients with which to evaluate treatment outcomes and make comparisons across trials more meaningful (Walmsley, Rivett et al. 2009). However, in the shoulder the validity of various shoulder examination procedures has recently been challenged (Hegedus, Goode et al. 2007) with the lack of diagnostic accuracy possibly explained by the lack of anatomical validity of most shoulder tests (Green, Shanley et al. 2008). Various authors (Schellingerhout, Verhagen et al.

2008) have proposed that alternate methods should be used to classify patients with shoulder disorders. The shoulder symptom modification procedure (SSMP) approach proposed recently to address rotator cuff tendinopathy/subacromial impingement syndrome (Lewis 2009) may be worthy of further exploration in the group of patients with presumed early adhesive capsulitis.

There are a number of limitations that require consideration in this study. Firstly the lack of an agreed reference standard for early stage adhesive capsulitis makes any validation investigation problematic. The selection of intraarticular local anaesthetic was however based on its previously reported diagnostic utility as a method of determining the source of patient symptoms (Sheridan and Hannafin 2006, Neviaser and Hannafin 2010). Whilst an alternative reference standard may be to follow-up patients in the long term to confirm the diagnosis of adhesive capsulitis, (as the characteristic loss of motion becomes evident), this was not feasible in the present study because participants were being concurrently clinically treated with a corticosteroid injection and stretching exercises. Secondly, as this study used patients undergoing normal clinical management, it was not ethically possible to administer a local anaesthetic injection without the simultaneous corticosteroid component. In some patients this may have resulted in a corticosteroid reaction that was not sufficiently negated by the local anaesthetic (Cardone 2002), although all participants were re-measured within one hour. A further limitation of this study was the large number (N = 191) of potential participants who were excluded. The requirement to use strict inclusion/exclusion criteria to obtain a homogeneous sample resulted in recruitment being slower than projected and the sample size accordingly modest. Interestingly, earlier authors have reported similar recruitment difficulties

(Carette, Moffet et al. 2003; Buchbinder, Green et al. 2004), perhaps supporting recent opinions that the incidence of the disorder is overestimated (Bunker 2009). Although intrarater reliability was not specifically determined for the measurements due to the ethical consideration of patient pain provocation, previous published reports support the reliability of the method on which it was based (Clarke, Willis et al. 1974, Strout and Fleiss 1979, Bower 1982, Green, Buchbinder et al. 1998). Finally, the study may have been strengthened if participants had been randomly sampled over a wider area and as such the generalisability may be limited if these patients are not representative of other areas.

In conclusion, the early diagnosis of adhesive capsulitis remains problematic. Clinicians should be aware that commonly used clinical identifiers may not be applicable to this stage, which may also explain some of the poor reported outcomes of treatment to date. Recognition that the features of adhesive capsulitis in its early stage are likely to differ from the later stages is also required to correctly diagnose this disorder. This study raises a number of issues that may warrant exploration in future research. Firstly, given the reported confusion with impingement syndrome (Lubiecki and Carr 2007, Manske and Prohaska 2008), it may be worthwhile to include patients with 'general' shoulder pain and assess the presence of any of the agreed identifiers in a heterogeneous group. Secondly, analysis of sub-groups of movement deficit and pain at the end of range of groups of movements, rather than global movement, may also be worthy of further exploration.

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