Clinical Article

Accessory features of frozen shoulder

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Abstract
We have described nine clinical features to aid the clinical diagnosis of frozen shoulder. These include symptoms of pain and pins-and-needles radiating down the arm to the hand, feeling of lameness in the arm, tenderness over the medial border of scapula, rotator interval and supraclavicular fossa, reduction of pain with passive abduction and forward flexion of the shoulder, asymmetry of the arm position at rest with an increase in elbow-to-waist distance and apparent winging of the scapula. In this prospective study, we report the sensitivity, specificity, predictive values and diagnostic accuracy of each clinical test and discuss their probable causes and clinical relevance. The single most accurate diagnostic test was relief of symptoms with abduction and flexion. In the diagnosis of a patient with a painful stiff shoulder, if six of the accessory features with the highest correlation are present, the probability of having frozen shoulder is 80%.

Introduction
The term 'frozen shoulder' was first coined by Codman in 1934 to describe a condition which is 'difficult to define, difficult to treat and difficult to explain from the point of view of pathology'.[1] Other authors have used terms such as scapulohumeral periarthritis,[2] checkrein shoulder[3] and adhesive capsulitis[4] to describe this poorly understood disorder of the glenohumeral joint. The diversity of terms used to describe this condition adds to the difficulty in accurately defining and differentiating it from other disorders with similar features but distinctly different causes. The original description written by Codman more than 70 years ago is probably still the most accurate and comprehensive account. He described frozen shoulder as a condition characterised by a slow onset of pain, felt near the insertion of the deltoid, with inability to sleep on the affected side and restriction in both active and passive elevation and external rotation, yet with a normal radiographic appearance.[1] Although accurate, this description was too general and some argued that frozen shoulder was increasingly being used as a 'dustbin diagnosis' for any stiff and painful shoulder condition that was difficult to diagnose.[5]

The accuracy of diagnosing frozen shoulder by non-specialist orthopaedic surgeons has been found to be only 46%, compared with 96% for shoulder instability and 83% for impingement.[6] This was thought to be due to a lack of physical signs in frozen shoulder that could be easily elicited.

We have observed a set of clinical features, referred to as the accessory features of frozen shoulder, which we have found to be intimately associated with frozen shoulder. The aim of this study is to evaluate the clinical usefulness and accuracy of these accessory features. It is hoped that an awareness of these features will help the clinician to accurately diagnose this condition.

Methods
This is a prospective study of a consecutive series of patients diagnosed with primary idiopathic frozen shoulder between 2004 and 2006. The inclusion criteria were those defined by Codman and are listed in *Table I.* The exclusion criteria are shown in *Table II.* One hundred and ten patients were eligible for inclusion in the study. The average age was 52 years (range 34 to 80).

Table I: Inclusion criteria: patients diagnosed with primary idiopathic frozen shoulder as defined by Codman[1]

Symptoms
- Slow onset of pain
- Pain felt near the insertion of deltoid
- Inability to sleep on the affected side
- Able to continue daily habits and routines

Signs
- Painful and restricted elevation
- Painful and restricted external rotation
- Restriction of both active and passive movements

Investigation
- Normal radiographic appearance of the shoulder

Table II: Exclusion criteria

- History of trauma
- Presence of other coexisting pathology such as glenohumeral arthritis, rotator cuff pathology, calcifying tendinitis
- Post-surgical stiffness
- Presence of referred pain such as cervical spondylosis

Table III: Diagnoses of the control group

Diagnosis	Frequency (%)
Rotator cuff tear	48 (45)
Glenohumeral arthritis	14 (13)
Calcifying tendonitis	29 (26)
Glenohumeral instability	6 (5)
Referred pain including thoracic	
outlet syndrome, cervical spondylosis	7 (6)
Acromioclavicular joint related	6 (5)

There were 31 male and 79 female patients. The dominant arm was affected in 76 patients (69%). The mean duration of symptoms prior to consultation was 6.8 months (range 1 to 24). There were 18 patients with diabetes.

Control group

We have included a control group for statistical comparison with the study population.

The control group consisted of 110 patients presenting to the shoulder clinic with diagnoses other than frozen shoulder. Their diagnoses are listed in *Table III*. The control group was matched to the study group for sex and age to within 2 years.

Clinical evaluation

All patients underwent a detailed clinical examination carried out by the senior author and one other examiner. Pain was assessed using a visual analogue scale. The ranges of active and passive glenohumeral movements were recorded. These included forward elevation in the sagittal plane, abduction in the scapular plane, external rotation with arm adducted and elbow flexed to 90 degrees, internal and external rotation at 90 degrees of coronal plane abduction (maximal abduction was used when less than 90 degrees of abduction could be achieved) and internal rotation with the arm in extension (recording the highest vertebral level reached by tip of the thumb).

Patients were evaluated for the presence of accessory features of frozen shoulder. These are divided into three groups as follows:

Group I consists of three symptoms:
1. pain radiating down the arm to the hand
2. pins-and-needles sensation down the arm
3. a feeling of lameness in the arm.

Group II consists of three palpation findings:
1. muscular tenderness over medial border of scapula
2. tenderness over the rotator interval
3. tenderness over the brachial plexus in the supraclavicular fossa.

Group III consists of three signs:
1. reduction of pain with slight passive abduction and forward flexion of the shoulder
2. asymmetry of the arm position at rest (elbow-waist distance)
3. apparent winging of the scapula.

In addition, all patients underwent a radiographic and ultrasonographic examination of the affected shoulder. Radiographic evaluation consisted of true anteroposterior, lateral and axillary views. The ultrasound evaluation consisted of a static and dynamic examination (Acuson Antares, Siemens). In the study population, an injection consisting of 3 ml of 1% lignocaine mixed with 2 ml of steroid (Celestone) was given into the glenohumeral joint under ultrasound guidance. The response to the injection was assessed 10 minutes later.

Statistical analysis

The data were entered into an Excel spreadsheet (Microsoft Corp, Redmond, WA) and subsequently analysed using Statistical data analysis software system, version 7 (Statsoft, Tulsa, Okla). For each accessory test, the sensitivity, specificity, positive and negative predictive values, likelihood ratios for a positive and negative test and diagnostic accuracy were calculated.

The single most accurate diagnostic test was relief of symptoms with abduction and flexion

Table IV: The range of active and passive movements in each plane of glenohumeral motion

Direction of motion	Mean	Range
Active forward elevation (degrees)	68	25-90
Passive forward elevation (degrees)	72	25-95
Active abduction (degrees)	70	40-90
Passive abduction (degrees)	75	50-95
Active external rotation at the side (degrees)	0	–30-0
Passive external rotation at the side (degrees)	0	–30-0
Active internal rotation (vertebral level)	L5	Sacrum to L1
Passive external rotation at 90 abduction (degrees)	0	–30-5
Passive internal rotation at 90 abduction (degrees)	15	5-30

To determine if there is an association between the incidence of positive accessory features and binary/categorical variables such as sex of the patient and the presence of diabetes, the Mann-Whitney U test was used. To determine if there is an association between the incidence of positive accessory features and continuous variables such as age of the patient, duration of symptoms and pain score, the Spearman rank correlation coefficient was used. P-values of less than 0.05 were considered significant. To determine which accessory tests are the main contributors to diagnostic accuracy of frozen shoulder, a stepwise logistic regression analysis was carried out with p-values for entering and deleting the regression equation set at 5%.

Results

The mean pain score on visual analogue scale was 6 /10 ± 3.0. Ninety-six per cent of patients had an improvement in pain scores following the intra-articular injection. The range of movement in each plane of glenohumeral motion is shown in *Table IV*. The sensitivity, specificity, predictive values, likelihood ratios and accuracy for each accessory test are shown in *Table V*. The most sensitive test was pain over the brachial plexus in the supraclavicular fossa (0.98) and the most specific test was apparent winging of the scapula (0.84). The single most accurate diagnostic test was relief of symptoms with abduction and flexion (85%).

The stepwise logistic regression analysis identified six accessory tests which had the highest correlation. In the order of entering the regression equation (i.e. in descending order of correlation or partial correlation), they were: relief of symptoms with abduction and flexion, pain over brachial plexus, apparent winging of scapula, pain over medial aspect of scapula, feeling of lameness and rotator interval tenderness. Using these six tests together as a diagnostic tool, the sensitivity was 0.80, specificity was 0.82, positive predictive value was 0.82, negative predictive value was

Table V: Sensitivity, specificity, predictive values, likelihood ratios and accuracy for each test

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Likelihood ratio for positive test	Likelihood ratio for negative test	Accuracy (%)
Pain radiating down the arm	0.46	0.71	0.62	0.57	1.64	0.75	59
Pins-and-needles	0.62	0.57	0.59	0.60	1.45	0.67	60
Lame feeling	0.55	0.72	0.66	0.61	1.94	0.63	63
Pain medial to scapula	0.79	0.66	0.70	0.76	2.29	0.32	72
Rotator interval tenderness	0.79	0.76	0.77	0.79	3.35	0.27	78
Pain over brachial plexus	0.98	0.65	0.74	0.97	2.77	0.03	81
Relief with abduction and flexion	0.93	0.76	0.80	0.91	3.92	0.09	85
Asymmetry of the arm position at rest	0.86	0.67	0.72	0.82	2.61	0.22	76
Apparent winging of scapula	0.84	0.84	0.84	0.84	5.11	0.20	84

0.80, likelihood ratio for a positive test was 4.40, likelihood ratio for a negative test was 0.24 and the diagnostic accuracy was 81%. In other words, if a patient has all six accessory features present, the probability of having frozen shoulder is 80%. This will be accurate in 81% of the time.

The incidence of positive accessory features was positively correlated with the visual analogue pain score ($p<0.0001$, Spearman rank correlation coefficient) and negatively correlated with the length of duration of symptoms ($p<0.0001$, Spearman rank correlation coefficient). We subdivided the study population into two groups based on the duration of symptoms. We compared the incidence of positive accessory features in the group with onset of symptoms of less than 6 months against the group with onset of symptoms of greater than 6 months. The group with less than 6 months' duration of symptoms was significantly more likely to have positive accessory features than the group with more than 6 months' duration ($p<0.01$, Mann-Whitney U test). There was no correlation between the incidence of positive accessory features with age ($p=0.5$, Spearman rank correlation coefficient), sex ($p=0.67$, Mann-Whitney U test) or presence of diabetes ($p=0.09$, Mann-Whitney U test).

Discussion

The accessory features described in this paper represent a cascade of events occurring in frozen shoulder which we believe are interconnected to one another. We postulate that pain arising from capsular inflammation acts as the initiating event, sending inhibitory impulses to the periarticular musculature including the axioscapular muscles which consist of trapezius, serratus anterior, rhomboids and levator scapulae. The rhomboids are particularly sensitive to this effect and this is manifested clinically by muscle spasm with tenderness felt on palpation just medial to the scapula (fourth accessory feature). Furthermore, the restriction in glenohumeral motion is compensated by an increase in scapulothoracic motion provided by the periscapular muscles which have to work in excess and eventually fatigue.[7] As the axioscapular muscles become dysfunctional, their scapular stabilising function is lost. This results in scapular dyskinesia in which there is alteration in the resting position of the scapula, manifested as an apparent winging of the scapula (ninth accessory feature).[7,8,9] In fact, scapular dyskinesis can occur in any painful condition of the shoulder and its occurrence has been reported in glenohumeral instability (100%), impingement syndrome (100%), labral tears (94%) and rotator cuff abnormalities (68%).[8,9,10] There were two findings in our study which support the theory of pain as an important factor in the pathogenesis of this cascade of events. Firstly, patients who report high pain scores were significantly more likely to have positive accessory features. Secondly, the incidence of positive accessory features was also significantly higher in the early stage (less than 6 months' duration) of the disease than in the late stages when there is typically little or no pain but stiffness.

Winging of the scapula has secondary effects. Since the position of the scapula is altered, the resting position of the arm will also change since the humerus must move in co-ordination with the scapula in a ball-and-socket configuration. When asked to rest both arms by the side, there will be obvious asymmetry with an increase in the distance between the elbow and the waist on the affected side (eighth accessory feature, *Figure 1*). This deformity is often accentuated by an internal rotation contracture. The capsular contracture causes effectively an ankylosis of the glenohumeral joint which in turn exerts a secondary tractional effect on the brachial plexus, especially the suprascapular nerve.

Figure 1: There is obvious asymmetry in the resting position of both arms with an increase in the distance between the elbow and the waist on the affected side (right) due to an internal rotation contracture

Figure 2: Pressure over the supraclavicular fossa exacerbates the tractional effect on the brachial plexus

Thus, neurological symptoms such as pain and paraesthesia radiating down the arm (first and second accessory features) and feeling of lameness (third accessory feature) are often encountered. This effect is exacerbated by direct pressure over the supraclavicular fossa (sixth accessory feature, *Figure 2*) and relieved by resting the arm in 20 degrees of flexion, abduction and internal rotation (seventh accessory feature, *Figure 3*). We have consistently noted that patients with frozen shoulder often volunteer during the history-taking that when they are resting in the sitting position, for example watching television, they would choose to place a cushion between the affected arm and the trunk with the hand resting on their abdomen, to replicate this position of comfort. Often, a reduction in the apparent winging of the scapula can be observed when the arm is held in the relief position *(Figure 4)*, thus lessening the traction effect on the brachial plexus. This situation is analogous to that of a shoulder arthrodesis in which the arm is rigidly fixed in a similar position of flexion, abduction and internal rotation. Several studies have reported that if the shoulder arthrodesis is carried out in excess flexion and abduction, chronic pain and winging of the scapula will ensue.[11,12]

Although the pathophysiology of frozen shoulder is still not fully understood, involvement of the rotator interval and coracohumeral ligament have been found by many researchers.[13,14,15] We have found in our study that tenderness in the rotator interval is a reliable clinical sign with an accuracy of 78% in diagnosing frozen shoulder (fifth accessory feature, *Figure 5*). To locate the rotator interval readily, we use the coracoid as a landmark since its base forms the medial wall of this triangular space. Furthermore, by rotating the arm from internal rotation to neutral position, the surface area of the interval is maximised.[16]

Figure 4A: Apparent winging of the scapula

Figure 4B: Reduction in the apparent winging of the scapula when resting the arm in the 'relief position'

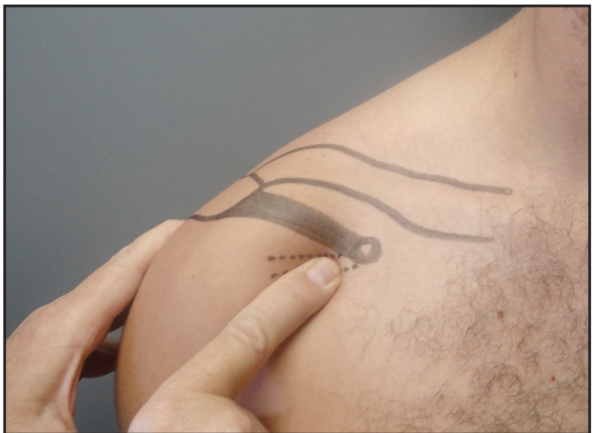

Figure 5: The coracoid serves as a useful landmark in locating the rotator interval

Figure 3: Position of relief - in about 20 degrees of flexion, abduction and internal rotation

There are limitations in this study. Firstly, the diagnosis of frozen shoulder in the study population was made by clinical assessment supplemented by radiological evaluations to exclude other pathologies. There were no arthroscopic or histological findings to confirm. Secondly, the clinical assessment of the patients for the presence of accessory features was not blinded. Although there was a concurrence rate of 100% between the two examiners, the inter-observer validation will be subject to bias.

In conclusion, we have described nine accessory tests for the diagnosis of frozen shoulder, supplementing the original description made by Codman. These tests are most useful in the acute, painful stage of the disease when symptoms have been present for less than 6 months. In the diagnosis of a patient with a painful stiff shoulder, if six of the tests with the highest correlation are positive, the diagnosis of frozen shoulder is likely.

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