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Original article

Shoulder kinematic features using arm elevation and rotation tests for classifying patients with frozen shoulder syndrome who respond to physical therapy ☆

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Abstract

Physical therapy is an intervention commonly used in the treatment of subjects with frozen shoulder symptoms, with limited proven effect. The purpose of this study was to identify the kinematic features of patients with frozen shoulder who are more likely to respond to physical therapy. Thirty-four subjects presenting frozen shoulder syndrome were studied to determine altered shoulder kinematics and functional disability. Subjects received the same standardized treatment with passive mobilization/stretching techniques, physical modalities (i.e. ultrasound, shortwave diathermy and/or electrotherapy) and active exercises twice a week for 3 months. Initially, subjects were asked to perform full active motion in 3 tests: abduction in the scapular plane, hand-to-neck and hand-to-scapula. During the test, shoulder kinematics were measured using a 3-D electromagnetic motion-capturing system. In the initial and follow-up sessions, the self-reported Flexilevel Scale of Shoulder Function (FLEX-SF) was used to determine functional disability from symptoms. Improvement with treatment was determined using percent change in FLEX-SF scores over three months of treatment [(final score−initial score)/initial score × 100, $>20\%$ improvement and $<=20\%$ nonimprovement]. Shoulder kinematics were first analysed for univariate accuracy in predicting improvement and then combined into a multivariate prediction method. A prediction method with two variables (scapular tipping $>8.4^\circ$ during arm elevation, and external rotation $>38.9^\circ$ during hand to neck) were identified. The presence of these two variables (positive likelihood ratio = 15.71) increased the probability of improvement with treatment from 41% to 92%. It appears that shoulder kinematics may predict improvement in subjects with frozen shoulder syndrome. Prospective validation of the proposed prediction method is warranted.

Keywords: Frozen shoulder; Shoulder kinematics; Likelihood ratio; Prediction method

0. Introduction

Patients exhibiting frozen shoulder symptoms typically suffer pain, a limited range of motion and muscle weakness from disuse for periods ranging from several months to many years (Reeves, 1976; Shaffer et al., 1992). These symptoms usually respond to stretching/mobilization (Griggs et al., 2000; Vermeulen et al., 2006), but many patients with frozen shoulder syndrome still have some degree of pain and stiffness several years after onset of the disease (Reeves, 1976; Shaffer et al., 1992). Indeed, for patients with persistent symptoms, more aggressive interventions such as hydrodilatation, arthroscopic release or manipulation under anesthesia have been advocated (Dias et al., 2005). A prospective study of 41 patients with 5–10 years' follow-up indicated

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that 39% had full recovery, 54% had clinical limitation without functional disability and 7% had functional limitation (Reeves, 1976). Research regarding the efficacy of the early use of treatment strategies is warranted.

Although physical therapy is an intervention commonly used in the treatment of subjects with frozen shoulder symptoms, the effectiveness of physical therapy intervention has been limited (Griggs et al., 2000; Diercks and Stevens, 2004). One possible explanation for the lack of positive effects is the inability to define subgroups of patients who are most likely to respond to physical therapy. Developing an effective method for classifying patients with frozen shoulder symptoms could improve decision making by determining the patients who are most likely to benefit from physical therapy. Thus, determining methods for classifying patients with frozen shoulder symptoms is an important priority in the clinic and research.

Some investigators have suggested that frozen shoulder symptoms may be related to persistent synovitis, capsule contracture, contracted soft tissues and/or shoulder kinematic features (Loyd and Loyd, 1983; Neviaser, 1987; Parker et al., 1989; Mao et al., 1997; Griggs et al., 2000). Regardless of the potential factors related to frozen shoulder symptoms, altered shoulder kinematics is believed to exacerbate the condition and predispose patients to subacromial impingement, rotator cuff tendonitis, altered shoulder joint forces and possible degenerative changes (Ludewig and Cook, 2000; Lin et al., 2006). Thus, a more difficult and chronic course of frozen shoulder symptoms may develop. Additionally, previous research has indicated that the course of other types of shoulder dysfunction such as impingement (Ludewig and Cook, 2000; Lin et al., 2005) and shoulder tightness (Lin et al., 2006) may be associated with altered shoulder kinematics. It was the object of this study to identify the kinematic features of patients with frozen shoulder syndrome who are more likely to respond to physical therapy. Specifically, this study used a prediction method modified from a clinical prediction rule (McGinn et al., 2000) to determine whether impaired shoulder kinematics are associated with the degree of symptom-related functional disability in patients with frozen shoulder syndrome.

1. Methods

1.1. Subject recruitment

This was a predictive validity/diagnostic test study. It was conducted at the outpatient clinic of the Department of Physical Medicine and Rehabilitation at National Taiwan University Hospital. All subjects gave written informed consent. Subjects were recruited if they fulfilled the following inclusion criteria: 50% loss of passive movement of the shoulder joint relative to the nonaffected side, in 1 or more of 3 movement directions (i.e. forward flexion, abduction in the frontal plane, or external rotation in 0° of abduction) (Lundberg, 1969; Rizk et al., 1994; Diercks and Stevens, 2004); and duration of complaints of at least 3 months. Exclusion criteria were a history of stroke with residual upper-extremity involvement, diabetes mellitus, rheumatoid arthritis, rotator cuff tear, surgical stabilization of the shoulder, osteoporosis or malignancies in the shoulder region. Subjects who had pain or disorders of the cervical spine, elbow, wrist, or hand, or who had pain radiating from the shoulder to the arm were also excluded.

1.2. Subjects

A sample of 40 subjects was selected, based on availability for interview at the time of initial presentation to the clinic between August 2004 and May 2006 (Table 1). Three subjects did not return after the first session and were not included in the analysis. Two subjects left the study because of personal or work-related circumstances. In addition, 1 subject was excluded from further participation in the study during the follow-up interview because she revealed the existence of bilateral frozen shoulder syndrome with severe and progressive symptoms, precluding the possibility of resolving the symptom course of a unilateral frozen shoulder. The final data analysis was therefore conducted on 34 patients. Two of these patients had had previous steroid injections at least 2 months before and none of them had had previous physical therapy treatments.

1.3. Shoulder kinematics assessments

The FASTRAK 3-D electromagnetic motion-capturing system (Polhemus Inc., Colchester, VT, USA) was

Table 1
Baseline ($n = 40$) and follow up ($n = 34$) conditions of patients with frozen shoulder syndrome receiving 3-month treatment

	Affected shoulder		
	Unaffected shoulder	Baseline	Follow up
FLEX-SF[a] score	–	27.5±6.3	34.2±5.8
Duration (months)[b]	–	6.4±8.3	–
Flexion	172±15°	122±8°	145±10°
Abduction	165±18°	105±13°	123±18°
External rotation	85±16°	32±16°	43±22°
Internal rotation	74±19°	22±13°	34±24°
Pain[c]	–	4±3	2±3

[a]FLEX-SF = Flexilevel Scale of Shoulder Function.
[b]Duration of symptom (pain or limited range of motion).
[c]Pain intensity at the time of evaluation as determined with a visual analog scale (0–10).