Kinesthetic sense of the shoulder in patients with impingement syndrome

Andreas Machner[1], Harry Merk[2], Roland Becker[1], Kerstin Rohkohl[1], Heiko Wissel[2] and Géza Pap[1]

Departments of Orthopaedics, [1]Otto-von-Guericke University, DE-39120 Magdeburg, [2]Ernst-Moritz-Arndt-University, DE-17487 Greifswald, Germany. Correspondence: Andreas Machner, Orthopädische Universitätsklinik, Leipziger Strasse 44, DE-39120 Magdeburg, Germany. andreas.machner@medizin.uni-magdeburg.de
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ABSTRACT – A proprioceptive deficit is an important determinant of disability in various shoulder disorders, such as instability and osteoarthrosis.

In 15 patients with impingement syndrome stage II (Neer 1983), who were treated by arthroscopic subacromial decompression, we measured movement sense by determining threshold levels for the perception of motion of the shoulder.

The patients were placed in a specially designed chair allowing continuous passive motion of the shoulder joint, while avoiding cutaneous, auditory and visual stimuli. To assess movement detection thresholds, passive abduction movements of the shoulder were performed at a starting angle of 60°, an amplitude of 10° and an angular velocity of 1.3°/s.

Before surgery, all patients had higher threshold levels for the perception of motion in their affected shoulders then in the other side. After decompression, proprioception had improved on the decompressed side, but was unchanged on the other side.

Proprioceptive deficits are an important determinant of disability in various conditions, such as instability or osteoarthritis in the knee, ankle and have even been used to evaluate the severity of disease (Barrack et al. 1989, Lephart et al. 1992, 1998, Pap et al. 1997, 1998, 1999).

The methods used to assess proprioception include measurements of joint position sense (Lephart et al. 1997) and kinesthetic sense (Borsa et al. 1997, Pap et al. 1998). They have been of value in shoulder and intraarticular injuries, for example, labral tears and shoulder instability, which are associated with alterations in proprioception (Lephart et al. 1994, Machner et al. 1998). Histological studies have shown the presence of mechanoreceptors in the shoulder capsule, bursae and coracoacromial ligament which would suggest that periarticular receptors play an important role in shoulder proprioception (Lephart et al. 1994, Ide et al. 1996, Gohlke et al. 1998, Machner et al. 1998, Morisawa 1998). It has therefore been assumed that these structures are involved in proprioception.

Impingement syndrome stage II (Neer 1983) mainly affects the subacromial bursa with an anterior subacromial spur. In a prospective study, we analyzed the kinesthetic sense of patients with impingement syndrome before and after arthroscopic subacromial decompression.

Patients and methods

We studied 15 patients (6 females) having a mean age of 46 (42–59) years, with unilateral impingement syndrome stage II (Neer 1983) (10 right shoulders) who were to undergo subacromial decompression (Ellman and Kay 1991). In all patients the dominant shoulder was affected. None of them had undergone previous shoulder operations or suffered from neurological or musculoskeletal disorders.

The clinical assessment was done using Constant's method (1991). Pain during activities of daily living was assessed with a visual analog scale ranging from 0 mm (no pain) to 10 mm (extreme

pain). The radiographic examinations (true anteroposterior and outlet views) showed a type II acromion (Bigliani et al. 1991) in all patients.

We evaluated shoulder proprioception by measuring the thresholds for the perception of passive joint motion, as described elsewhere (Machner et al. 1998). We first measured the unaffected shoulder. Patients were placed in a specially designed chair (Ortho-med Co., Lautertal, Germany) which permitted continuous passive motion (CPM) of the shoulder joint only in the abduction/adduction axis. The whole arm was immobilized by a rigid inflated air splint. The test was done with the patients wearing dark glasses while hearing white noise through headphones.

Each passive abduction test started at an abduction angle of 60°, with an amplitude of 10° and an angular velocity of 1.3°/s. The subjects were asked to press a button when they recognized the beginning of the movement and the thresholds for the perception of the start of motion (TPSM [°]) were determined by multiplying the time that passed from the start of the movement to the first press on the button (t_m [s]) with the angular velocity (v_a = 1.3°/s):

$$TPSM\ [°] = t_m\ [s] \times 1.3°/s$$

To exclude intraarticular pathology, the glenohumeral joint was examined arthroscopically (Peterson et al. 1998). The subacromial space was inspected, the degree of bursitis assessed and a subacromial bursectomy was done. The coracoacromial ligament was mobilized before acromioplasty, but not resected. An anterior acromioplasty was done with the 5.5-mm full-radius resector (Peterson et al. 1998).

Postoperative management included a standard rehabilitation protocol for 12 weeks, beginning with passive shoulder movement from the first postoperative day by a physiotherapist followed by an active assisted range-of-motion exercise program for about 12 weeks. All patients were managed on a continuous- passive- motion (CPM) chair followed by a gradual increase in motion for 6 weeks after surgery. The angular velocity of this CPM chair was 6°/s higher than that of the measurement chair. All patients were reexamined 6 months after surgery.

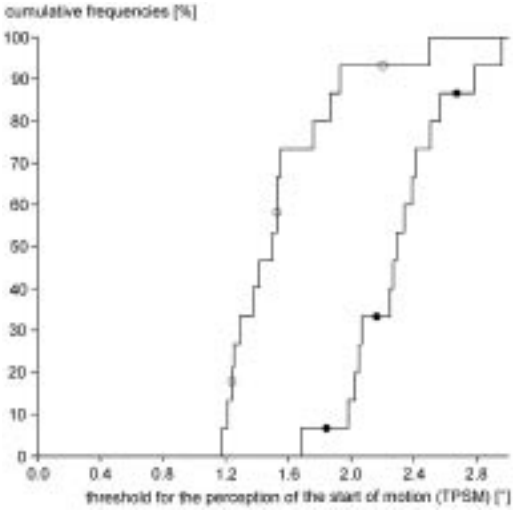

Figure 1. Preoperative TPSM in cumulative frequencies. The data in Figures 1 and 2 were sorted in ascending order and the function rises vertically by the reciprocal of the number of data points when scanning the ordered points from left to right. This function permits visualization of the data points without requiring the arbitrary choice of a smoothing parameter to construct a histogram. The vertical distance of the lines shows the differences between the measurements.
Dashed circles: unaffected sides.
Filled circles: affected sides.

Each patient was given verbal information about the study and each gave informed consent.

Statistics

Comparison between measurements was performed using the Wilcoxon test. P-values < 0.05 were considered significant. Some of the TPSM results are shown as cumulative distribution functions (Awiszus 1997).

Results

Before surgery, the measurements of thresholds for the perception of the start of motion (TPSM) were higher on the affected sides, median 2.3 (1.7–2.9)°, than on the other sides, median 1.5 (1.1–1.8)° ($p < 0.05$) (Figure1).

At follow-up, thresholds for the perception of the start of motion (TPSM) on the affected sides had decreased while those on the contralateral side were unchanged (Figure 2).

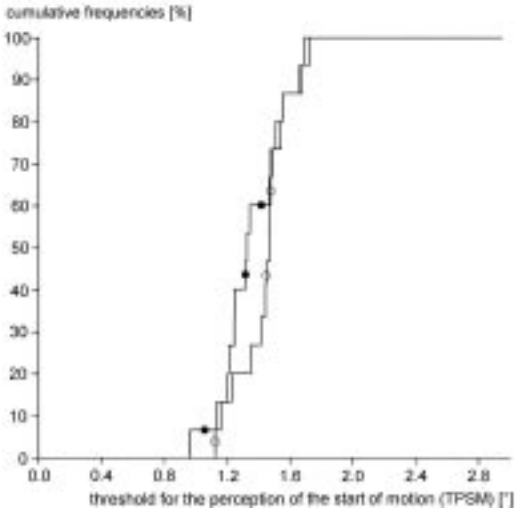

Figure 2. TPSM in cumulative frequencies at follow-up. Dashed circles: unaffected sides. Filled circles: affected sides.

Clinical evaluation

On the affected sides, the median Constant score improved at follow-up. The mean pain value for activity of daily living on the visual analog scale decreased significantly at follow-up (Table). During the measurements, none of the patients complained about pain or discomfort. All patients were satisfied with the outcome of the operation, and none of them needed additional surgery.

Discussion

We measured movement sense with a method (Machner et al. 1998) similar to one we have used to measure knee proprioception (Brindle et al. 1999). To facilitate comparison of our results with those published in the literature, we used an angular velocity from 1.3°/sec, as reported by other groups (Warner et al. 1996, Machner et al. 1998).

The demographic data of our patients resemble those of other clinical studies on impingement syndrome (Ellman and Kay 1991). Intraoperative assessment showed Neer's stage II impingement syndrome in all patients, in which the rotator cuff has no degenerative changes on visualization. All patients had a similar history, clinical and radiographic findings.

Assessment of pain (VAS) and shoulder function (the Constant score) in affected sides before surgery and at follow-up. Mean (SD)

	Affected sides	
	before surgery	at follow-up
Constant score	71 (17) [a]	86 [a] (15)
VAS (mm)	6.8 (2.8)	2.2 [a] (1.9)

[a] $P < 0.05$ compared to preoperative assessment on the affected side (Wilcoxon test)

The mean TPSM of the unaffected shoulders in our patients were similar to those described by Warner et al. (1996) in normal subjects; the movement detection thresholds were markedly increased in shoulders with impingement syndrome. Our findings therefore indicate a severe proprioceptive deficit in patients with impingement syndrome of the shoulder.

This accords well with the findings in pathological inflammations in other joints (Ferrell et al. 1992, Sharma et al. 1997). We suggest that the changes in mechanoreceptors described in the subacromial bursa and the coracoacromial ligament (Ide et al. 1996, Morisawa 1998) may cause the changes in movement sense we found.

It should be noted that 6 months after arthroscopic subacromial decompression, during which the inflammed bursa, but not the coracoacromial ligament were resected, the subjects had completely recovered their sense of kinesthesia in the affected shoulders, which had become the same as in the normal contralateral shoulders. This suggests that surgical treatment of impingement syndrome may not only markedly improve the clinical symptoms, but also reduce neuromuscular deficits resulting from this condition. This accords with the findings of other studies, in which recovery of impaired proprioception has been reported after shoulder stabilizing procedures (Jerosch et al. 1993, Machner et al. 1998).

Several aspects concerning the origin, the extent and the consequences of proprioceptive deficits in the shoulder joint are still unclear. In particular, the exact relationship between clinical symptoms and proprioceptive deficits still remains uncertain. Therefore, to date, it is still not possible to determine the diagnostic value of movement sense measurements.

No competing interests declared.

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