INFLUENCE OF ANTHROPOMETRIC AND PSYCHOLOGICAL VARIABLES, PAIN AND DISABILITY ON ISOMETRIC ENDURANCE OF SHOULDER ABDUCTION IN PATIENTS WITH ROTATOR TENDINOSIS OF THE SHOULDER

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ABSTRACT. Predictors of isometric endurance of shoulder abduction were investigated in 18- to 75-year-old women (n = 59, mean age 48 years) and men (n = 53, mean age 46 years) with unilateral rotator tendinosis of the shoulder (median duration 1–2 years). They were asked to keep both shoulders abducted at 45°, both wrists loaded with 2 kg, for as long as possible. The average force exerted to keep the required position was 17% higher in men compared to women. Mean times to exhaustion were: 103 seconds (SD 109) for the involved shoulder and 160 seconds (SD 81) for the uninvolved shoulder in women; compared to 159 seconds (SD 109) and 289 seconds (SD 109) in men. Increased pain, emotional distress and disability were associated with decreased endurance in the involved shoulder. Gender and emotional distress were the most powerful predictors of time to exhaustion in the uninvolved shoulder, and accounted for 41.7% of the total variance (R²). Age, body weight, self-efficacy for pain and active coping were poor predictors. This study indicates that isometric endurance is a psychophysiological measure in patients with shoulder pain. Reported pain, emotional distress and disability should be taken into account for interpretation of results.

Key words: emotional distress, isometric muscle endurance, pain, rotator cuff.

INTRODUCTION

Shoulder pain is often related to work situations with prolonged elevated arm position (21) and hand tools (23). Herberts & Kadeffors (24) using spectral analysis of electromyographs found a premature state of fatigue in the supraspinatus muscle of welders suffering from chronic tendinitis.

Fatigue is semantically the opposite of muscular endurance. More precisely, according to physiological terminology, fatigue is defined as decreased force-generating capacity. This is distinct from muscular exhaustion, which occurs when the required force can no longer be maintained (43). It is often questioned whether the cause of fatigue is located in the central nervous system or within the muscle. In well-motivated individuals a number of experimental studies of various forms of exercise indicate that fatigue is confined to the muscle and not to the central nervous system (2, 35). The maximal endurance time varies widely, and is influenced by factors such as force, muscle fibre composition, muscle structure and ischaemia.

Muscle strength correlates with age, body weight and gender (20, 29, 30, 36). However, recent studies have failed to observe the expected decrease in strength by age (29), and in women compared to men (17). Bläckman et al. (1) found that men had better shoulder abduction endurance than women, but did not observe a decline by age. Although recent findings may be explained by the wide variability observed for muscular strength and endurance, the presence of other significant predictors in these studies is suspected. In the clinical setting muscular exhaustion is usually measured as the endurance time in a standardized isometric test. Such tests are simple and inexpensive, and may be included at the clinical examination. Time to exhaustion for isometric trunk extension predicted the occurrence of low-back pain in a healthy population (9). Isometric shoulder flexion and abduction endurance times have previously been used as an outcome measure in patients with shoulder and neck pain (14, 15, 38). It has been claimed, however, that
such tests induce pain and require a high motivation (1, 9).

The degree of central activation of the muscle is affected by several factors including motivation, possible inhibition via nociceptors and other afferents arising in the muscle (18, 42). Studies examining muscle performance in patients with pain have reported conflicting results. In patients with rotator tendinosis of the shoulder, pain did not influence rotation strength, but reduced flexion strength and made isokinetic tests of abduction strength before treatment impossible in most patients (8). Reduced endurance which corresponded with electromyographic (EMG) signs of fatigue, was observed in patients with myofascial shoulder pain (21). In patients with the chronic fatigue syndrome no signs of contractile failure or lack of central motor drive were observed in a voluntary isometric endurance sequence as compared to electrical stimulation or controls (31).

Measures are indicators of an underlying phenomenon. A muscle strength or endurance test requires subjective action by the testee, and the result can thus be regarded as a manifestation of the patients' behaviour. Previous studies describe that pain-coping efforts and self-efficacy are associated with physical and psychological functioning (e.g. 7, 10, 27). Self-efficacy is a personal conviction that one can perform certain behaviours successfully in a given situation, for example continue with most activities despite pain. This is distinct from measures of coping with pain, which assess the kind of strategy the patient actually uses when he has pain, for example if he remains active.

Recently, in low-back pain patients, pain and disability ratings were found to have negative effects on isokinetic muscle strength, but self-efficacy was the most powerful predictor (17). The anthropometric variables were poor predictors.

Psychological variables have not been included in studies evaluating muscular strength and endurance in patients with shoulder pain. The aim of the present study was therefore to investigate how age, gender, anthropometric (height, body weight and the calculated shoulder torque) and psychological (emotional distress, coping strategies and self-efficacy beliefs) variables, pain and disability predicted the time to exhaustion in an isometric abduction test in patients with rotator tendinosis of the shoulder.

MATERIAL AND METHODS

Patients

One hundred and twelve patients (59 women and 53 men) aged 18-75 years who had unilateral shoulder pain and fulfilled the clinical criteria for rotator tendinosis, participated in the study. The patients were referred to the Department of Physical Medicine and Rehabilitation at Ullevaal University Hospital in Oslo for diagnostic evaluation and treatment. The clinical criteria for inclusion were dysfunction and pain on abduction; normal passive glenohumeral range of movement; pain on two of three isometric eccentric tests (abduction at 0° and 30° and external rotation) and a positive impingement sign (37), that is pain on passive internal rotation/flexion. The diagnosis was confirmed if pain was appreciably reduced on re-examination 15 minutes after injecting 6 ml Xylocaine (10 mg/ml) into the subacromial space (positive impingement space test). The duration of symptoms ranged from 3 months to more than 3 years, with 1-2 years as the median range. The dominant side was involved in 68 of the patients. Men and women differed on anthropometric variables and disability scores, but not on psychological variables and pain. Further patient characteristics are given in Table I. The time to exhaustion was 980 seconds bilaterally, twice as long as any other patient, in a 44-year-old male hairdresser and bodybuilder. He is not included in Table I. His shoulder torque was 21.7 Nm, scores on psychological measures in the normal range and pain scores in the lower range (27 for the involved and 5 for the uninvolved shoulder).

Predictors

Before the endurance test the body height (cm) and body weight (kg) were measured, and a standardized questionnaire comprising information about age in years, hand dominance, emotional distress, coping strategies, self-efficacy for pain and disability, was filled in by the patient. Emotional distress was assessed by the 25-items Hopkins Symptom Check List (13). Symptoms were ranged from 1 (not at all) to 4 (extremely). Active coping was scored from 1 (never use this strategy) to 7 (always use this strategy) (7) (low) to 7 (high) (32). The mean score for pain, active coping and emotional distress were calculated.

Disability consisted of 10 items: example the patients were asked, "Can you carry a 5 kg bag?", "Can you put things on a high cupboard?", "Can you carry a 5 kg bag?". The percentage of the scale, 100 = worst pain, 0 = no pain.

The Spearman correlation coefficient for emotional distress, active coping and pain disability were as follows: pain and active coping, r = −0.07; pain and emotional distress, r = 0.22; efficacy and pain disability, r = 0.33 (all p < 0.05).

Endurance test

The isometric abduction test was performed with the arms in a plane, the elbows extended and the shoulders at the side (Fig. 1). Each was instructed to keep the arms perpendicular to the body and to avoid any unnecessary verbal feedback during the test. If one of the shoulders was elevated above 90° until exhaustion, and the patient removed the hand with the uninvolved shoulder. One physiotherapist at a time examined all patients. Each patient exerted an isometric force with the gravitational force of the weight applied on the wrist. The test was ended as soon as the patient could no longer continue. The shoulder torque was calculated by subtracting the gravitational forces of the weights on the wrist from the sum of the isometric forces on the shoulder. The data is presented as mean ± SD. The statistical analysis was performed with the computer program Statistical Package for Social Sciences (SPSS, Chicago, Illinois). The level of significance was 0.05.

Table I. Characteristics of the patient population (n = 111). Mean values (±SD) for females and males are given

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Females (n = 59)</th>
<th>Males (n = 52)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>47.7 ± 11.1</td>
<td>45.9 ± 12.3</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>63.0 ± 10.2</td>
<td>79.3 ± 13.2</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.2 ± 5.8</td>
<td>178.3 ± 7.4</td>
</tr>
<tr>
<td>Shoulder torque (N.m)</td>
<td>16.2 ± 4.4</td>
<td>19.3 ± 2.3</td>
</tr>
<tr>
<td>Active coping (1-7)</td>
<td>3.9 ± 1.1</td>
<td>3.5 ± 1.3</td>
</tr>
<tr>
<td>Self-efficacy for pain (1-7)</td>
<td>3.3 ± 1.2</td>
<td>3.5 ± 1.4</td>
</tr>
<tr>
<td>Disability (1-7)</td>
<td>4.7 ± 1.9</td>
<td>3.0 ± 2.1</td>
</tr>
<tr>
<td>Emotional distress (1-4)</td>
<td>1.5 ± 0.3</td>
<td>1.5 ± 0.4</td>
</tr>
<tr>
<td>Pain (I) (0-100)</td>
<td>55.3 ± 24.4</td>
<td>55.4 ± 20.5</td>
</tr>
<tr>
<td>Pain (UI) (0-100)</td>
<td>17.8 ± 20.1</td>
<td>20.7 ± 19.7</td>
</tr>
<tr>
<td>Endurance time (I)</td>
<td>103.0 ± 109.0</td>
<td>159.4 ± 109.4</td>
</tr>
<tr>
<td>Endurance time (UI)</td>
<td>159.6 ± 80.7</td>
<td>289.3 ± 108.7</td>
</tr>
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</table>

1, involved shoulder; UI, uninvolved shoulder.
AND METHODS

Patients (59 women and 53 men) and unilateral shoulder pain and tenderness for more than 1 year, were referred to the Institute of Orthopedic Surgery, Oslo, Norway. For diagnostic purposes, a clinical criteria based on the following items were used: 1) pain with movement; 2) pain with movement; 3) limitation of movement; 4) positive impingement sign (S); 5) internal rotation/extension; 6) pain with movement; and 7) pain with movement.

The pain was assessed using a visual analog scale of 0-100, with 0 indicating no pain and 100 indicating the worst possible pain. The score was determined by asking the patient to mark a line on a 10-cm line where 0 indicated no pain and 100 indicated the worst possible pain.

Endurance test

The isometric abduction muscle endurance test was performed with the arm at 45° abduction in the scapular plane, the elbow extended and neutral rotation in the shoulder (Fig. 1). Each wrist was loaded with 2 kg. Both shoulders were tested at the same time, and the patients were asked to endure the position as long as possible. They were instructed to keep the arms and shoulders in the same position throughout the test. The patients were given verbal feedback during the test in order to adjust the position if one of the shoulders were elevated. The exercise was performed until exhaustion, and the endurance time was recorded for each shoulder. One physician (JIB) guided the tests and examined all patients.

Each patient exerted muscular force that includes the gravitational force of the arm–hand segments and the weight applied on the wrist. The lever arms can either be measured manually in each subject or calculated from anthropometric data (29). In this study the latter method was applied, and the weight of the upper extremity (W arm), length of the arm for the centre of upper extremity mass (L arm segment) and the length of the lever arm for the weight on the wrist (L hand segment), were calculated from measurements of body height and body weight. The torque (T) was calculated from the equation:

\[ T_{\text{shoulder}} = \left( W_{\text{arm}} \times L_{\text{arm segment}} + W_{\text{wrist}} \times L_{\text{wrist}} \times \sin 45° \right) \times 9.8 \times \sin 45° \]

Correlation coefficients for T shoulder and body weight or body height were 0.94 and 0.86, respectively.

Statistical analysis

Paired t-tests were used to compare the side difference in pain scores in men and women. The association between side differences in time to exhaustion and pain, were assessed by Spearman correlation coefficients. Multiple linear regression were performed in three stages. In each stage two dependent variables were considered: time to exhaustion in the involved (I) and uninvolved (UI) shoulder. Residual analysis was used to assess the appropriateness of each model. The assumptions for multiple linear regression analyses were improved by excluding the male patient with the extreme endurance. Analyses including this patient are commented in the results section. The significance of the effects in the equations was evaluated by t-testing. The computer package SPSS for Windows, version 6.0, was applied for statistical analyses.

In the first stage we examined how well the anthropometric measures (gender, age, shoulder torque) predict the patient's performance. Then we investigated how well the psychological variables (self-efficacy for pain, active coping and emotional distress) predict the time to exhaustion controlling for the anthropometric measures. The aim of the third stage was to evaluate how well pain intensity and disability predict the performance, controlling for anthropometric and psychological variables. Gender was treated as an indicator variable (1 = female, 2 = male), all others as numeric, linear predictors. The following models were fitted:

- Model 1 Time to exhaustion = Age + gender + torque
- Model 2 Time to exhaustion = Age + gender + torque + coping + efficacy + distress
- Model 3 Time to exhaustion = Age + gender + torque + coping + efficacy + distress + pain + disability

RESULTS

The mean time to exhaustion (Table I) in the involved shoulder was 64.5% that of the uninvolved shoulder in women and 55% in men. Pain scores at exhaustion were significantly (p < 0.001) higher in the involved shoulder in men and women. The difference in women was 37 (95% confidence interval: 30–44) and in men 34 (27–41). Significant (Spearman) correlations for
Isometric endurance as a function of psychological variables

The regression coefficients for model 2 are presented in Table III. Gender remained a significant predictor in the uninvolved shoulder and in the involved shoulder. Emotional distress was a highly significant predictor; increased reported distress was associated with a decreased endurance in both shoulders. Self-efficacy for pain and active coping did not achieve significance for either of the two dependent variables. By adding the psychological variables to the anthropometric measures, the explained variance increased considerably, and was 19.4% (I) and 43.0% (UI).

**Table III. Regression coefficients for model 2 separately fitted to the two dependent variables, and the percentage of variance (R²) explained by model**

<table>
<thead>
<tr>
<th></th>
<th>Involved</th>
<th>Uninvolved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex (female = 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(male = 2)</td>
<td>27.7</td>
<td>110.6***</td>
</tr>
<tr>
<td>Shoulder torque (N m)</td>
<td>10.6*</td>
<td>7.2</td>
</tr>
<tr>
<td>Total R² (%)</td>
<td>19.9</td>
<td>34.4</td>
</tr>
</tbody>
</table>

*p < 0.05; **p < 0.01; ***p < 0.001.

Isometric endurance as a function of pain and disability ratings

Pain and disability were significant predictors in the involved shoulder (Table IV). Emotional distress remained a significant predictor, but the influence of shoulder did not achieve significance (p = 0.11). In the uninvolved shoulder no linear effects of pain and disability were found. Gender and emotional distress remained highly significant predictors. The analyses were controlled for handedness and duration of symptoms, but this did not influence results. The total variance accounted for by the model was 30.6% (I) and 41.7% (UI).

The main findings in the three models were not changed if the male patient with the extreme endurance was included in the analyses.

**Table IV. Regression coefficients for model 3 separately fitted to the two dependent variables, and the percentage of variance (R²) explained by model**

<table>
<thead>
<tr>
<th></th>
<th>Involved</th>
<th>Uninvolved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex (female = 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(male = 2)</td>
<td>28.7</td>
<td>112.7***</td>
</tr>
<tr>
<td>Shoulder torque (N m)</td>
<td>9.6*</td>
<td>5.5</td>
</tr>
<tr>
<td>Coping score</td>
<td>-5.0</td>
<td>-9.1</td>
</tr>
<tr>
<td>Efficacy score</td>
<td>10.3</td>
<td>5.8</td>
</tr>
<tr>
<td>Distress score</td>
<td>-69.8**</td>
<td>-80.9***</td>
</tr>
<tr>
<td>Total R² (%)</td>
<td>19.4</td>
<td>43.0</td>
</tr>
</tbody>
</table>

*p < 0.05; **p < 0.01; ***p < 0.001.

D I S C U S S I O N

In the present study the effect of anthropometric and psychological variables, pain and disability ratings on isometric abduction endurance was investigated in a sample of patients with chronic shoulder pain. The results of this work indicate that isometric endurance test should be included in clinical practice more often than at present.

Following the introduction of the concept of pain, perceived exertion by Borg in 1929, this field has broadened to include healthy individuals (3, 4). Cues from muscles and joints, as well as estimating exertion during exercise, are important to the function of the respiratory and circulatory systems during long work periods. More recently, the concept of ‘tiredness’ has also been suggested as cues that may be important in the development of tendons (22). Since contraction is dependent on the joint position, the force of the muscle (33) and the speed of contraction (34), this relationship may be important in the development of tendinitis. The biceps muscle, which is involved in isometric abduction, and the supraspinatus muscle, which is involved in shoulder abduction, are also known to be involved in the development of tendinitis (22, 23). Therefore, it is possible that the increased pain and disability scores may be related to local lactate production and the development of hand and shoulder pain.

The patients in the present study who reported pain and disability in the shoulder are described as muscular, with pain developing in the shoulder after an acute phenomenon originating in the shoulder joint. Following this, expected in the involved shoulder, the increase in pain and disability level observed at different, we believe, that the increase in pain and disability is not fatigue.

The magnitude of muscle strength, endurance, and performance may be affected by a variety of factors. Our results correlate well with the findings of previous studies, which found that blood lactate, but not heart rate, is elevated during exercise and generally higher rates of muscle fatigue are observed in patients with hyperthyroidism compared to healthy controls (5, 18). It has been shown that fear of activity and reduced self-efficacy are important predictors of disability scores in low back pain. Therefore, increased measures scored in a low back pain patient may be a significant predictor of disability scores in the shoulder. Moreover, our results indicate that a previous study on the...
isometric abduction endurance, were studied in a sample of patients with rotator tendinosis of the shoulder. The results indicate that the isometric endurance test should be regarded as a psychophysiological test more than a pure measure of physical capacity.

Following the introduction of the concept of perceived exertion by Borg and Dahlström (3) in 1959, this field has been extensively examined in healthy individuals (3–6, 22). Borg (6) proposed that cues from muscles and joints are important for estimating exertion during short-term, high-intensity work and that cues arising from the circulatory and pulmonary systems become more important during long work periods. Mechanoreceptors and lactate are suggested as cues that derive from the muscles and tendons (22). Since compartment muscles are involved in arm abduction, either as stabilizers (intraspinatus, teres minor and subscapularis) or as a prime mover (supraspinatus), the pain at and limitations of isometric abduction endurance may be well correlated to local lactate production. This was not investigated in the present study. Also, high tension in the rotator cuff and increased pressure in the subacromial bursa (40) may irritate mechanoreceptors and increase pain.

The patients in the present study were asked to rate pain and not fatigue at exhaustion. Grandjean (19) describes muscular fatigue as an acute painful phenomenon originating in overstressed muscles. Following this, equal pain intensity should be expected in the involved and uninvolved shoulder at exhaustion. As the observed scores were significantly different, we believe that we have measured pain and not fatigue.

The magnitude of various predictors for physical performance may be different in patients compared to healthy controls. By example perceived exertion correlates well with pulse rate and even better with blood lactate, but Borg & Linderholm (5) found generally higher rates of exertion in relation to pulse in patients with hypertonia and coronary diseases than in a healthy reference group. Waddel et al. (44) described that fear of avoidance beliefs about physical activity accounted for 23% of the variance in disability scores in low-back pain patients. Psychological measures scored in advance of the endurance test were significant predictors in the present study. Furthermore, our results supports the conclusion in a previous study on isokinetic performance in patients with low-back pain (17). However, the specific information about the factors related to performance is different.

Body weight or body mass were poor predictors in both studies, but in the present study gender and shoulder torque were significant predictors of performance. The torque in men was larger than in females, but it may be assumed that the relative torque was considerably higher in women. Maximal voluntary contraction (MVC) was not measured in this study. A recently published study found a large interindividual variation (29) with a mean MVC of 68 Nm in men and 29 Nm in women for abduction at 0°. If these results are used as a rough estimate of MVC in the present study, it means that women exerted a relative force about twice as high as men. This probably explains the large sex difference observed for the uninvolved shoulder, and the influence of torque on both sides. Nevertheless, when women are using the same kind of tools as men, the relative force is usually higher and may represent an increased risk of overload.

Age was a non-relevant predictor of endurance in this study which is in agreement with a previous report (1). As physically heavy work is less common than formerly, one possible explanation is that muscular strength has adapted to the reduced demands.

Self-efficacy and disability

Self-efficacy is judged in post-life experience and is a more or less realistic estimate of the capacity for certain behaviours. Estlander et al. (17) constructed a self-efficacy scale which measured how long the patient believed she would be able to endure eight separate activities, for example carry weights of 4–5 kg in both hands. Self-efficacy was the most powerful predictor of isokinetic trunk extension muscle strength. In the present study self-efficacy for pain and active coping were poor predictors, but the (dis)ability to carry a shopping bag of 5 kg contributed significantly on the involved side. For the patient the meaning of “Do you believe that you can?” may not be different from “Can you?”. Self-efficacy and disability may not be conceptually different, and future studies should compare these scales judging the same specific activities.

Disability is a composite measure, and in the present study, the (dis)ability to carry a shopping
bag was best correlated with torque, gender and emotional distress. Previous studies in patients with osteoarthritis of the knee or hip (12), and in elderly, have described disability as a result of physical impairment and emotional distress (45). This is not in disagreement with the findings in the present study, but disability may as well lead to decreased physical activity and result in decreased isometric endurance. Other types of evidence are necessary for further inference about causality.

Emotional distress and pain

Endurance time in both shoulders declined with increased emotional distress. Patients who reported increased emotional distress, independent of pain severity, were less able to endure the burden of a 2 kg handhold. This finding supports the results reported by McCue & Newham (34) who investigated hand grip strength in 30 patients after surgery. Voluntary muscle force after intermediate and major surgery correlated with the patient’s state of well-being, but maximal tetanic (stimulated) contraction was unaltered.

The present study measured endurance time, included a larger number of patients, and did not use stimulation or EMG registration to assess the degree of fatigue at exhaustion. Emotional distress and pain may inhibit neural input to the muscles, and therefore the patients may have terminated the test before they were exhausted in the physiological meaning of the word.

However, it has been postulated that pain may increase muscle activation (28). This hypothesis is supported by other authors reporting an inability to relax muscles that are painful (16). Although the present study included patients with symptoms and signs of tendinopathy, inability to relax shoulder muscles, dysfunctional movement patterns and painful muscles were commonly present at clinical examination. A premature state of fatigue, caused by physiological and possibly psychological factors, may have been revealed upon EMG examination, as shown previously for this patient group (24).

Emotional distress is a composite measure, which includes depression, various aspects of anxiety and somatization. These components may not have a uniform effect upon muscle activity. Future studies should address the impact of emotional distress and pain on fatigue, and preferably differentiate between various aspects of emotional distress.

In contrast to other studies including patients with chronic musculoskeletal pain (11, 33, 41) emotional distress was not correlated with pain in the present study. This is difficult to explain, but different from previous studies pain was assessed at exhaustion in a particular muscle test. Other factors which may have contributed to the reported increased emotional distress, appeared at the clinical examination such as personality traits, family conflicts, economic difficulties, retired from job for other reasons than the painful shoulder or poor social support.

Side difference

Emotional distress contributed to 7.2 and 11.4% of the explained variance in the involved and uninvolved shoulder, respectively. For the uninvolved shoulder, independent of sex, torque and pain, the endurance time decreased by 80.9 seconds for a 1.0-point increase in emotional distress. Thus, at least in patients who reported increased emotional distress, it seems not reasonable to consider the endurance time in the uninvolved shoulder as a normal value. Nevertheless, the mean endurance time in the involved shoulder was less than 60% of the uninvolved shoulder. In a previous study isometric shoulder flexor endurance was measured in 75 women with unilateral shoulder/neck pain (15, 38). The endurance time before treatment was 74–80% of the uninvolved shoulder, and 65–75% of the mean values for a comparable group without shoulder/neck pain. Improvements after 3 months were found only in those who subjectively stated that their symptoms were reduced.

In previous investigations the activity in the supraspinatus and infraspinatus muscles were found to be more load–hand dependent and vulnerable for ischaemia than the trapezius and deltoid muscles (25, 26, 39). However, since registration of intramuscular pressure, muscle size or fatigue was not included, this study does not allow for further speculations about the limiting factors.

The concept of endurance in everyday language refers to toleration of an even painful and uncomfortable state, and goes beyond the physiological limitations. According to this definition, the influence of emotional distress, pain and disability is not surprising. This study illustrates the presence of these predictors in patients with chronic shoulder pain.
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ABSTRACT. The aim of the study was to assess the reproducibility of muscle performance measurements with different degrees of activity in healthy volunteers, 20 men, and patients with severe low back pain. Kinetic measurements. Lifting was used. The movements were performed with the subjects standing and 120°/second. Five repetitions were done at each velocity. All subjects performed the tests in a 1-week interval between the two tests. Mean peak torque, coefficient of variation and peak torque to body mass were calculated for each velocity for both groups. The results showed that in every position the mean peak torque, coefficient of variation and total work done correlated strongly both in flexion and in extension. Average peak torque in the two measurements. The change had a mean value of the Oswestry Disability Scale value of 2.5% above this mean. When the values were above or below the mean, the difference between measurements.

Key words: isokinetic measurement, repetition.

INTRODUCTION.

Measurements of muscle activity are commonly used for the assessment of muscle function. However, the reproducibility of these measurements has not been well documented. The aim of this study was to assess the reproducibility of muscle performance measurements in healthy volunteers and patients with severe low back pain.