ORIGINAL ARTICLE

Reliability of Isometric Strength Measurements in Trunk and Neck Region: Patients With Chronic Neck Pain Compared With Pain-Free Persons

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ABSTRACT. Scheuer R, Friedrich M. Reliability of isometric strength measurements in trunk and neck region: patients with chronic neck pain compared with pain-free persons. Arch Phys Med Rehabil 2010;91:1878-83.

Objective: Evaluation of reliability of isometric strength measurements in the neck and trunk region and comparison of these measurements between patients with chronic neck pain and pain-free subjects.

Design: Nonrandomized controlled trial.

Setting: Institutional practice.

Participants: Patients with neck pain (n=53) and pain-free persons (n=42) (mean age ± SD, 49.7±10.74 vs 48.7±12.02; women, 73% vs 71%).

Interventions: Strength of flexion, extension, and lateral flexion in the neck and trunk were measured. Each participant underwent 2 measurement passes on each of 2 examination days; 3 were performed by the same investigator, 1 by a second.

Main Outcome Measures: Intrarater (short-term and long-term) and interrater reliability, differences in strength between both groups of probands.

Results: Reliability in both groups ranged from substantial to almost perfect (intraclass correlation coefficient: patients, .76–.89; control group, .80–.88). The patients' strength in the neck and trunk was significantly below that of the control group ($P<.002$).

Conclusions: Isometric strength measurement is a reliable and feasible way to estimate the possible benefit of specific strengthening programs. Patients with chronic neck pain showed strength deficits in all measured regions.

Key Words: Muscle strength; Neck pain; Rehabilitation; Reproducibility of results.

ALONG WITH LOWER-BACK pain, neck pain is one of the most common musculoskeletal complaints in patients in the industrialized world. A Scandinavian study shows that the point prevalences of chronic lower-back pain and chronic neck pain were 16% and 17%, respectively. Fifty-one percent of the subjects had both back and neck pain.[1] A Canadian study corroborates these results, finding that the age-standardized lifetime prevalence of neck pain is 66.7% and the point prevalence is 22.2%.[2] In Austria, a recent survey found that 36.4% of respondents had experienced musculoskeletal pain in the preceding 3 weeks, with pains in the spinal region the most prevalent. The complaints of the severest pain commonly were indicated in the neck.[3]

The fact that no other underlying condition was found in a large proportion of patients with chronic spinal pain suggests that both psychosocial factors and posture problems followed by painful muscle tension play a key role in the pathogenesis of these so-called nonspecific pains.[4] Posture problems are by definition correctable, by such means as targeted strengthening and stretching of the muscles. Even before the onset of pain, many of the affected patients were not in good physical condition, which only further deteriorated through their avoidance of movements that were painful or demanding. Neck pains are often associated with decreased strength in the musculature surrounding the spine,[5] with women displaying a higher incidence of neck pain[6] and taking longer to recover from whiplash.[7]

Numerous studies over the measurement of maximum muscle strength in the trunk[8,9] and neck region[10-16] support the reliability of these findings. However, in most of them, the apparatus used for measurement was self-made. Because of the differences in the construction of the machine—that is the measuring devices as well as the way the subject is belted—the reproducibility of the results is obviously affected. Furthermore, in many cases, only movements in a single direction in either the neck or lower back were measured, so the relative strengths of opposing muscle groups were scarcely calculated. This may be a result of the infeasibility of taking additional measurements under the limitations of the available equipment. Finally, to our knowledge, the muscle strength of patients with pain in the spinal region is rarely studied, while the investigation of the muscles surrounding the spine is of particular interest in these cases.

The large groups of muscles in the trunk and neck play a key role in the positioning of the spine, so imbalances in these muscles could cause posture problems. As a consequence, the following hypothesis can be posted: Measurements of the relative strengths of muscles in the spinal region of neck and trunk provide a means to calculate the risk of misalignment. Thus, in this study, we investigated the data from isometric measure-

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List of Abbreviations

ANOVA	analysis of variance
ICC	intraclass correlation coefficient

ments of maximum muscle strength in patients with neck pain and pain-free probands, as well as the reliability of these data.

This study is therefore assessed according to the following primary outcome criteria:

- Are isometric measurements of maximum muscle strength reliable in persons with chronic neck pain? Are there differences in variability compared with pain-free subjects?
- Are there significant strength deficits in the cervical and/or lumbar region in patients with chronic neck pain?

The main outcome measures of the study are the results of the isometric measurements of maximum muscle strength in the neck and back.

The secondary outcome criterion was as follows:

- Are patients with chronic pain able to tolerate the isometric measurement of maximum muscle strength?

METHODS

We recruited subjects from the general population according to the following eligibility criteria:

- Men or women
- 18–70 years old
- Informed consent
- Among patients with neck pain:
  Pain that had lasted at least 12 weeks
  Neck pain both with and without emanation into the back of the head, shoulder girdle, and proximal upper arm
- Among the pain-free control group:
  No pains originating in the spinal region in the previous 12 months

The risk to the participants was minimized by the exclusion criteria provided by the manufacturer of the testing apparatus, which mainly exclude persons with clinically significant cardiovascular diseases and musculoskeletal pathologies.

All procedures followed protocol and accorded with the ethical standards of the responsible ethics committee.

Because the isometric measuring procedure has certain advantages for persons with musculoskeletal pains,[17] and the standing position supports physiologic lumbar lordosis,[13] the following apparatus turned out to be well suited for this study. It is furthermore able to measure many directions of movement.

The Back Check 607[a] (fig 1) is commercially available equipment that has 3 adjustable arms for fastening the subject (see fig 1A) as well as 2 adjustable measuring mechanisms (see fig 1B).

For the measurements in the neck region, we fastened the subject into the apparatus at scapula level,[18] with the measuring mechanism positioned just above eye level. In measurements of the lower back, we fastened the subject into the apparatus at the pelvis, with the measuring mechanism positioned at sternum level. The measurements were taken in kilograms.

We measured the strength of extension, flexion, and lateral flexion in the neck and lower back. As figure 2 shows, on each of 2 separate days (see fig 2: day 1 + 2) within a 5-day span, we took 2 measurements (see fig 2: t1-4). As far as possible, we arranged the examinations of each subject at the same time of both days. The first 3 measurements were taken by the same male investigator (see fig 2: R1), while the last was conducted by a female investigator (see fig 2: R2). The second investigator was chosen to be female because we assumed this could affect probands' (male and female) behavior and ambition doing strength measurements more than another male investigator.

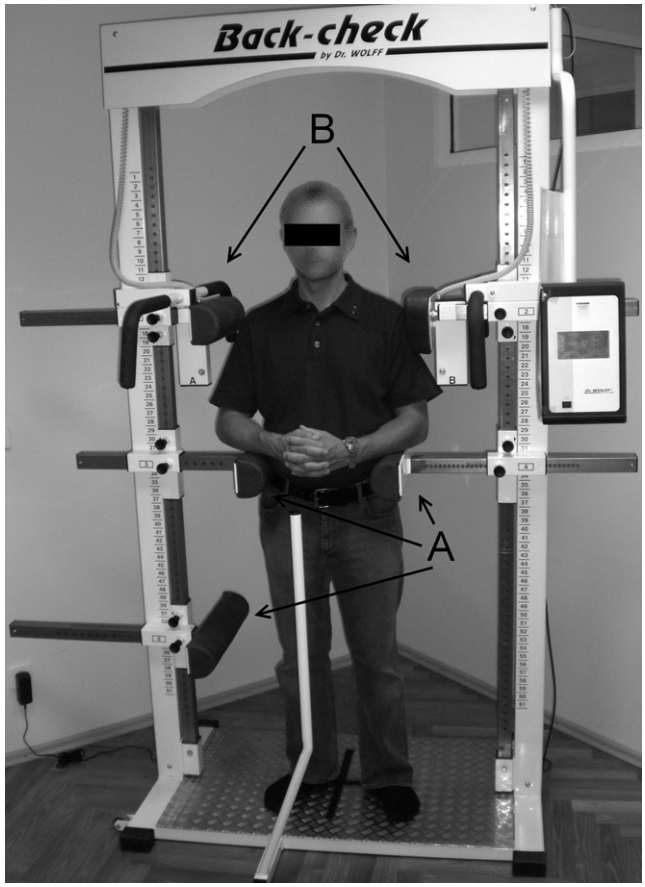

Fig 1. Back Check 607—lumbar lateral flexion left. (A) Three adjustable arms for fastening the subject. (B) Two adjustable measuring mechanisms.

Thus, we assessed short-term, long-term, and interrater reliability: short-term comparing t1 and t2, long-term comparing t1 and t3, and interrater comparing t3 and t4.

After each measurement, we asked subjects to quantify pain they experienced meanwhile on the 11-level numeric rating scale. We also performed 2 measurements of 30% to 50% strength before measuring the maximum muscle strength, which allows the required muscle groups to warm up.

The duration of the examinations was measured using a stopwatch, including the time needed for adjusting and fastening the subject into the apparatus.

Statistical Analyses

We analyzed test groups, measurements of muscle strength, pain intensity during the examinations, and the length of the examinations using descriptive statistics (mean, SD, maximum, minimum).

Furthermore we calculated an ANOVA for repeated measurements for each variable, accounting for the fixed-effects group, sex, measurement pass (4 time points) (see fig 2: t1-4), age, height, and weight and with the random effect test subject in order to investigate the difference in the measured target variables between the test groups. There are 9 degrees of freedom for the model, 89 for the patients, and 282 for the residuals.