BRIEF REPORT

Test Position and Hip Strength in Healthy Adults and People With Chronic Stroke

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ABSTRACT. Barbic S, Brouwer B. Test position and hip strength in healthy adults and people with chronic stroke. Arch Phys Med Rehabil 2008;89:784-7.

Objective: To determine if peak torques generated by the hip flexors and extensors are dependent on test position in healthy adults and in people with chronic stroke.

Design: Cross-sectional study.

Setting: Motor performance laboratory.

Participants: Volunteers were 10 young (20.7±1.5y), 10 older adults (62.1±7y), and 10 stroke survivors (60.6±10y) who were an average of 5 years poststroke.

Interventions: Not applicable.

Main Outcome Measures: Isokinetic (60°/s) peak concentric hip flexor and extensor torques (in Nm/kg) generated in supine and standing positions.

Results: Peak flexor torques measured in standing were generally higher than in supine (P=.018); a pattern evident in all groups, but significant only in stroke. An interaction between test position and group for hip extensor strength (P=.016) reflected 2 distinct patterns in which torques were highest in standing among the young subjects and highest in supine after stroke.

Conclusions: Isokinetic hip flexor and extensor strength measured in standing and supine are comparable in young and older healthy people. In chronic stroke, the test position may over or underestimate maximum peak torque depending on the muscle group tested, particularly on the side ipsilateral to the lesion. These findings may have implications for predicting functional ability from strength measurements.

Key Words: Rehabilitation; Stroke.

MUSCLE STRENGTH IS important to examine in rehabilitation because it provides an indication of physical capacity and function, including a person's ability to perform activities of daily living and maintain independence.[1,2] In clinics and laboratories isokinetic dynamometry is commonly used to assess muscle function and the reliability of peak torque measurements has been well established in healthy subjects[3] and in people with neurologic impairments due to stroke.[4,5] Factors such as angular velocity, stabilization, and subject positioning, however, are important because they can influence the ability to generate torque.[3,6] It follows that the conditions under which strength is measured may influence its ability to explain variance in task performance.

When evaluating lower-limb muscle strength, the conventional test positions are either seated or supine depending on the muscle group of interest. Several authors[4,7,8] have suggested that more accurate predictions of performance limitations based on strength measures might be achieved if the test position emulates how the muscles are used during functional activities. In this way the biomechanic relationship between segments is preserved and any neural or mechanical effects associated with body position are replicated.[7] Little is known about the influence of test position on strength yet the information could be clinically relevant.

This study explored whether positioning subjects in supine or standing influenced torque production of the hip flexors and extensors and if the findings were consistent across different groups of subjects.

METHODS

Participants

We recruited convenience samples from the community. Ten young (mean age, 20.7y; range, 19–23y) and 10 older (mean age, 62.1y; range, 52–74y) healthy adults participated. Ten people (mean age, 60.6y; range, 48–77y) who had experienced a hemispheric stroke an average of 5 years before the study (range, 2.5–9.9y) volunteered. Seven had left and 3 had right hemiparesis; 5 used a cane when walking outdoors, but all ambulated without aids in their home. Each group included 6 women and 4 men.

All participants provided informed consent and the protocol was approved by the university's research ethics board.

Protocol

Participants reported to the Motor Performance Laboratory for a single 1-hour session. Reciprocal concentric hip flexor and extensor strength was measured isokinetically[a] (60°/s) in standing and supine positions; the order of testing was decided by coin toss. For stroke survivors, a second coin toss determined which side was evaluated first (ipsilateral or contralateral to the lesion); for all others the right side was tested.

Testing in the standing position required subjects to stand straight with their backs supported against the padded chair back of the dynamometer. Shoulder straps were pulled taut across the chest and held secure by buckles located on the sides of the chair and another strap was tightened across the pelvis for stabilization (fig 1A). The dynamometer's mechanical axis was aligned with the greater trochanter and the pad of the leg attachment strapped tightly in place one hand breadth above the patella.

When testing in supine, the chair back was set horizontally in line with the seat pan and subjects lay on their backs so that their lower limbs hung freely over the edge of the seat. Straps stabilized the trunk, pelvis and the nontest limb, which was supported by a stool (fig 1B).

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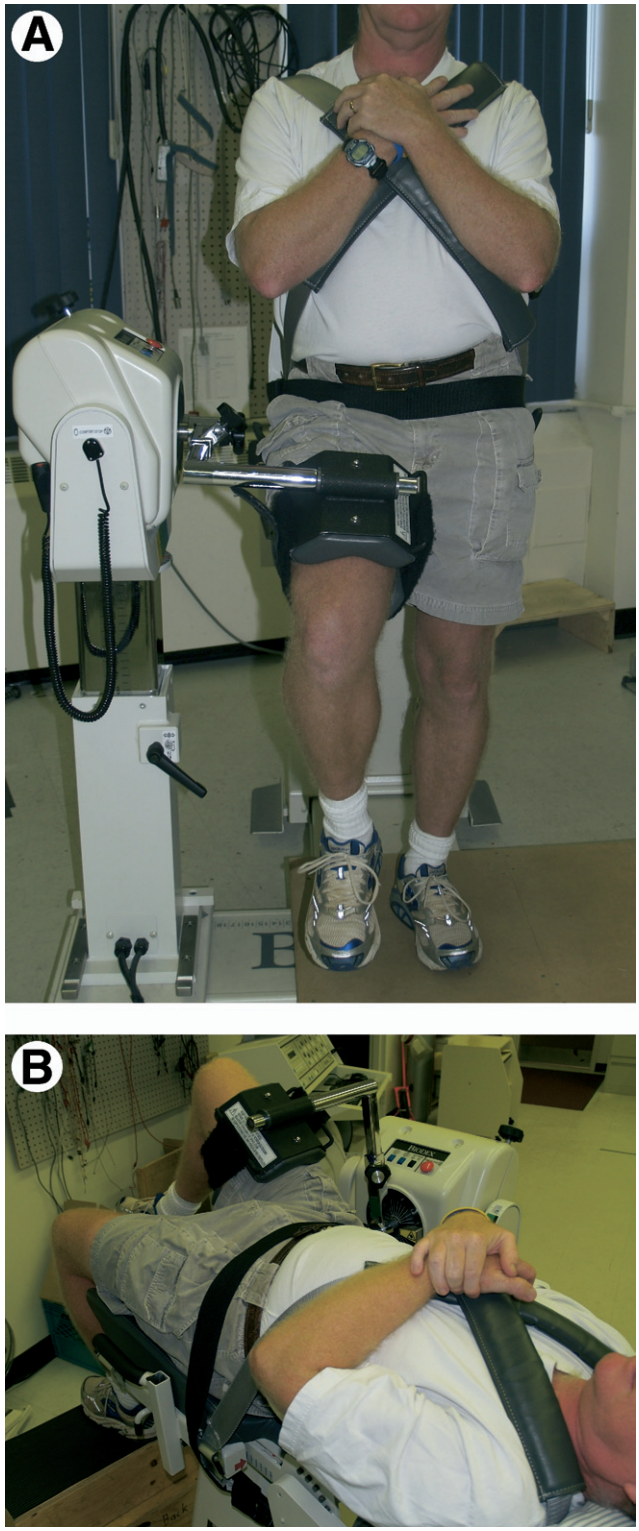

Fig 1. Subject position when testing in (A) standing and (B) supine.

After several submaximal practice trials, subjects were instructed to flex and extend as hard and as fast as possible throughout their full range of motion (ROM) until instructed to stop after 6 trials (1 trial = 1 flexion-extension cycle). The first trial was discounted because we have observed that it is often an outlier. The peak, gravity-corrected flexor and extensor torques were determined from the constant velocity portion of the remaining 5 trials for each limb (stroke only) and position.

Data Analysis

Descriptive statistics (means and standard deviations) were calculated and 2-way analysis of variance determined if there were main effects of group and position and an interaction effect on torque production (ipsilateral side in stroke). Additionally, main effects of side and position and their interaction were analyzed for the stroke group. SPSS[b] was used and a significance level of P less than .05 adopted.

RESULTS

All subjects produced consistent efforts, as evidenced by coefficients of variation that ranged from 9% to 21%. Peak flexor torques were about 28% higher when tested in a standing position compared with supine ($F=6.37$, $P=.018$). This pattern appeared in all groups (interaction $F=.01$, $P=.997$), though it was significant for the stroke group only ($P=.023$). Hip flexor strength varied by group ($F=22.5$, $P<.001$); the youngest being strongest ($P\leq.027$) and the stroke group being the weakest ($P<.001$). In contrast, test position had no general influence on extensor torque ($F=.02$, $P=.954$) although a significant position by group interaction ($F=4.85$, $P=.016$) reflected the existence of 2 different patterns. Young subjects produced higher extensor torques when standing, whereas in stroke, the extensors were strongest when tested in supine; test position was less relevant in older subjects. Hip extensor strength differed by group ($F=14.01$); the young group being strongest ($P\leq.002$) and although the older normative subjects appeared stronger than those with stroke, this was not borne out statistically ($P=.091$). Data from the contralateral limb showed the same pattern as the ipsilateral side, but as expected the flexors and extensors were significantly weaker ($P\leq.02$). These data are summarized in figure 2.

DISCUSSION

A main finding of this study was that in the absence of impairment and disability, young and older subjects produce comparable hip flexor and extensor torques whether tested in supine or standing. This, however, was not the case in people with chronic stroke, which may have implications for predicting functional ability based on strength tests conducted in positions that deviate from those adopted during normal activities.

In contrast to our findings in healthy subjects, Porter et al[7,8] reported consistently higher peak concentric dorsi- and plantarflexor torques in an upright position compared with supine in young and older healthy adults (76% and 90% of all subjects, respectively). In their study, subjects bore weight through the test limb when standing and could shift their weight ad libitum during testing. Consequently the 2 test positions differed biomechanically because the support moment contributed to the torque levels recorded in the upright position only.[8] This was not the case in the current study because subjects supported their body weight exclusively on the nontest limb so the torques measured reflected activation of contributing muscles. The correspondence in mean peak hip flexor torques reported for skilled soccer players tested in standing[9] and supine[10] (within 6Nm) suggest that test position may not be an important factor, at least at the hip. The present study directly addressed this issue, determining that it may not be critical in