



Original Article

Magnitude, validity and responsiveness of dynamometer measured neck retraction strength in patients referred with neck pain to out-patient physical therapy

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Abstract. [Purpose] The magnitude, validity, and reliability of dynamometer measures of neck retraction strength have been reported but not for individuals referred with neck complaints to physical therapy. The purpose of this study, therefore, was to describe neck retraction strength and its responsiveness and validity as a correlate of neck pain and disability among patients referred for physical therapy. [Participant and Methods] Twenty-six consecutive patients referred with neck pain participated. Their neck retraction strength was measured with a handheld dynamometer using a standardized procedure. Neck pain and disability were quantified using a numeric pain rating scale and the Neck Disability Index, respectively. [Results] Measurements of neck retraction strength increased significantly over the episode of care from 76.5 N to 119.5 N (standardized response mean=1.57 N). The correlation of retraction strength with neck pain was significant ($r_s=-0.550$); however, the correlation between retraction strength and Neck Disability Index scores was not significant ($r_s=0.155$). [Conclusion] Neck retraction strength measured with a hand-held dynamometer was informative and responsive for patients treated with neck pain. Retraction strength was correlated significantly with neck pain but not neck disability. This apparent inconsistency warrants further investigation.

Key words: Neck, Pain, Muscle strength

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INTRODUCTION

Neck pain is a highly prevalent cause of physical disability^{1,2)}. Dysfunctions of the cervical muscles³⁾, particularly those that retract the neck and reduce forward head posture have been identified as related to underlying neck pain⁴⁾. The magnitude, validity, and reliability of dynamometer measures of neck retraction strength have been reported but not for individuals referred to physical therapy (PT)⁵⁾. The purpose of this pragmatic study, therefore, was to describe neck retraction strength and its responsiveness and validity as a correlate of neck pain and disability among patients referred for PT.

PARTICIPANTS AND METHODS

This was a multicenter, registered clinical trial (NCT04334655), approved by the institutional review boards of Campbell University and the University of Tennessee-Chattanooga. All participants were referred consecutively between February and December of 2020 to 1 of 4 PT outpatient sites for neck pain. All participants provided written informed consent. A sample size of 3 was determined as necessary based on a paired samples t-test analysis and an assumed mean (standard deviation)

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change of 35 (7) N in neck retraction strength ($\alpha=0.05$, $\text{power}=0.80$). Based on possible differences in the study sample and in attrition, we enrolled 26 participants, of whom 21 were available for testing on admission and at discharge. The 5 participants who had incomplete data were discarded. Although all participants had neck pain, their therapist designated diagnoses fell into 3 categories⁶: mobility deficits ($n=15$), headache ($n=5$), and radicular pain ($n=6$). Thirteen participants were males and 13 were females. Participants ranged from 21 to 82 years of age, 1.5 to 1.9 meters of stature, and 49.9 to 102.0 kg of body mass. Their episodes of care averaged 26.4 days.

The primary measure of interest in this study was neck retraction force. It was measured as described previously with participants supine⁵, the dynamometer endplate placed by the therapist under the occiput of the skull, and the dynamometer zeroed by the therapist to negate the weight of the head and neck. Unlike the previous study, however, the position of the handheld dynamometer (HHD) was not adjusted to accommodate the degree of patients' forward head (Fig. 1).

Prior to data collection participating PTs was given written instructions and a video on how to use the HHD and perform the strength assessment. They were also given an opportunity to ask questions. After the start of the study, monthly calls to PTs were executed by the primary investigator to determine if any questions or problems had arisen. The average of 2 trials was used in all initial and final strength analysis. Secondary measures, (e.g., the numerical pain rating scale (NPRS) and the Neck Disability Index (NDI)), were used to characterize neck pain and disability^{7,8}.

Following the calculation of basic descriptive statistics and paired t-tests, the standardized response mean (SRM) was used to describe the responsiveness of neck retraction forces over the episode of care in patients receiving therapy for neck pain. Convergent validity was examined by calculating Spearman correlations (r_s) between baseline neck retraction force and NPRS and NDI scores.

RESULTS

Table 1 summarizes neck retraction forces and measures of neck pain and disability. Paired t-tests showed all measures improved significantly ($p<0.001$) between the initial and final visit of the episode of care. A high SRM of 1.57 N showed neck retraction strength to increase meaningfully over time. On the initial visit, neck retraction strength was correlated significantly with neck pain ($r_s=-0.550$) but not neck disability ($r_s=-0.049$) (Table 2).



Fig. 1. Photograph of hand-held dynamometer being used to measure neck retraction strength. On the left the head is resting on the dynamometer. On the right the neck retraction force is being actively measured with the dynamometer.

Table 1. Measurements of neck status obtained at initial examination and discharge

Measure	Initial examination	Discharge examination	Difference
	Mean (SD)	Mean (SD)	Mean (T)
Neck retraction force (N)	76.5 (53.2)	119.5 (47.2)	35.7 (-7.2)
Numerical pain rating (n)	5.4 (2.2)	1.8 (1.9)	3.1 (2.2)
Neck Disability Index (%)	33.2 (17.7)	16.6 (15.3)	16.6 (4.4)

N: Newtons; n: number (0–10); T: t-test value, 26 patients were measured initially and 21 were measured at discharge. The difference is for the 21 patients who were measured initially and at discharge. All measures obtained initially and at discharge improved significantly ($p<0.001$).

Table 2. Spearman correlations (and associated p-values) between neck retraction force and two measures of neck status

	Numerical pain rating	Neck Disability Index
Retraction force	-0.550 (0.004)	-0.049 (0.812)
Numerical pain rating		0.155 (0.448)

DISCUSSION

Research has previously shown that neck retraction strength can be measured with a HHD in adults without neck pain⁵. The present study demonstrated that neck retraction strength can be measured using a similar procedure in patients with neck pain. Notable is that the patients in the current study had a baseline neck retraction force of 76.5 N, which is considerably less than the average of 166.7 N reported previously for pain-free individuals⁵. Moreover, neck retraction strength increased over time in the present study while it remained essentially stable in the previous study of pain free individuals⁵. That this change was significant and accompanied by a large, SRM speaks to the responsiveness of the measure.

Significant changes in neck retraction strength over time were accompanied by significant changes in neck pain and disability. This point notwithstanding, retraction strength was correlated with pain but not disability. This warrants further investigation as pain and disability, as measured in this study were not correlated significantly ($r_s=0.155$). They were correlated significantly ($r=0.52$ and $r=0.55$) in a sample of participants with neck pain studied by Fejer and Hartvigsen⁹.

This study had several limitations. First, 5 of the initial 21 participants did not have discharge data secondary to missing their follow-up appointment because of COVID and other reasons and were not included in the data analysis. This limited the sample size analyzed across time. Second, patients had different neck pain diagnoses. Third, the participants were from 4 sites and were treated by therapists using their best judgment of intervention rather than a standardized protocol. This may have affected the results. Still, the focus was on neck retraction strength, not treatment effectiveness, per se.

In conclusion, this study showed that neck retraction strength measured with a hand-held dynamometer is possible in a clinical setting and is responsive and valid relative to neck pain in patients referred to PT for neck problems.

Conflict of interest

None.

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