Assessing the Reliability of Digital Caliper Measurements in Shoulder Flexion Assessment: A Preliminary Study

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ABSTRACT

This initial study evaluated the reliability and validity of digital caliper measurements for assessing pectoralis minor muscle length through the tabletop test. Three evaluators assessed a total of 180 subjects, each documenting the average of three measurements. The findings demonstrated outstanding intra-rater and inter-tester reliability (intraclass correlation coefficient = 0.996 and 0.999, respectively) and exceptional internal consistency (Cronbach's α = 0.999). The assessments exhibited robust face, construct, and content validity, affirming their therapeutic significance. These data confirm that digital calipers are a dependable and valid instrument for measuring shoulder flexion impairment linked to pectoralis minor muscle tightness.

Keywords: Digital caliper, shoulder flexion, linear distance, reliability

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INTRODUCTION

Tightness of the pectoralis minor muscle frequently contributes to dysfunction in the shoulder and upper quarter. Precise evaluation of pectoralis minor length is crucial for diagnosis, treatment formulation, and result assessment.[1] The tabletop test, or acromion-to-table test, is a clinical technique employed to evaluate the length of the pectoralis minor by measuring the distance from the posterior part of the acromion to the examination table.[2-4] This study sought to determine the intra-rater and inter-tester reliability of digital caliper measures employed in the tabletop test for evaluating pectoralis minor muscle tension.

Tightness of the pectoralis minor may result in modified scapular kinematics, shoulder discomfort, and reduced functionality.[5,6] The tabletop test offers a quantitative evaluation of pectoralis minor length, enabling doctors to detect potential tightness and formulate focused therapies. The dependability of the measurement instrument employed in this test is essential for guaranteeing precise and consistent outcomes.[3]

Purpose

This study examined the intra-rater and inter-tester reliability of digital caliper measures utilised in the tabletop test to evaluate pectoralis minor muscle tension. By validating the reproducibility of these measurements, doctors can reliably utilise this test to evaluate pectoralis minor length and formulate successful treatment strategies.

METHODS

The linear distance from the acromion to the examination couch was quantified with a digital caliper.[7] Participants were instructed to remove clothing from the waist up and assume a supine position on the examination table. The lead investigator positioned themselves at the head of the participant. The digital caliper was aligned with the fixed jaw over the acromion process tip and the movable jaw at the examination couch level.[7,8] Three evaluators separately measured the distance, with each evaluator calculating the average of three readings per participant to reduce measurement variability.

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Significance of Assessing Reliability and Validity

Establishing the reliability and validity of digital caliper readings is crucial for ensuring precision and consistency in clinical environments.[9,10] The elevated intra-rater and inter-tester reliability (intraclass correlation coefficient [ICC] = 0.996 and 0.999, respectively) endorses the application of this method for assessing muscle length.[11-13]

Types of Reliability and Validity Evaluated[12,13]

This study evaluated many forms of reliability and validity to confirm that the digital caliper is a reliable measurement instrument.

Reliability

Intra-rater reliability

Assessed to ascertain the uniformity of successive measurements conducted by the identical examiner. The results exhibited outstanding reliability, shown by an ICC of 0.996.

Inter-tester reliability

Assessed by comparing measurements among various evaluators. An ICC of 0.999 signifies outstanding concordance, indicating that the tool is suitable for interchangeable use among many doctors.

Internal consistency

Cronbach's alpha was determined to be 0.999, signifying exceptional internal consistency and that all evaluators assessed the same construct.

Validity

Face validity

The instrument explicitly and accurately assesses the specified parameter – the linear distance from the acromion to the table – thereby demonstrating excellent face validity

Construct validity

The caliper measurement indicates alterations in pectoralis minor length, consistent with the biomechanical comprehension of shoulder flexion dysfunction

Content validity

The procedure conforms to clinical standards and best practices for evaluating muscle tightness, hence reinforcing the thoroughness of the measuring methodology.

The results validate that the instrument and methodology offer a dependable and accurate evaluation of shoulder posture associated with pectoralis minor tension.

Results

The study comprised 180 participants, each of whom submitted comprehensive data for examination. The measurements were acquired by three assessors: The principal investigator, Assistant 1, and Assistant 2. Each evaluator conducted three measurements for each participant and documented the average for analysis, thereby improving measurement stability and minimizing intra-observer variability [Table 1].

Table 2 demonstrates that the mean distance from the acromion process to the table exhibited remarkable consistency among evaluators. The negligible standard deviations and limited range (0.006 cm) indicate a significant degree of agreement in measurement results among evaluators.

Internal Consistency

Cronbach's alpha was calculated to assess internal consistency among the evaluators. The alpha coefficient was 0.999, signifying exceptional internal consistency and affirming that the various

raters were assessing the same concept with remarkable agreement [Table 3].

Inter-Rater Reliability

The ICC was employed to evaluate inter-tester and intra-rater reliability [Table 3]. The ICC for single measures was 0.996 (95% CI [0.995, 0.997]), signifying that individual assessments by various raters are almost indistinguishable. The ICC for average measures was 0.999 (95% CI [0.998, 0.999]), indicating exceptional reliability in averaging several data.

The results were statistically significant ($P < 0.001$), derived from an F-test with $df_1 = 179$ and $df_2 = 358$. The exceptionally high ICC values indicate remarkable concordance across raters, affirming the reliability of employing a digital caliper in clinical shoulder evaluation [Table 4].

These values indicate that digital caliper readings are consistently accurate among raters.

Discussion

The main objective of this study was to analyse the reliability and validity of digital caliper measurements utilized in the tabletop test for evaluating pectoralis minor muscle length. The findings demonstrated remarkably high intra-rater and inter-tester reliability, as well as robust internal consistency, signifying that digital caliper measures are both reliable and reproducible in evaluating shoulder flexion dysfunction.

The average measurements obtained by all three evaluators were virtually the same (2.66–2.67 cm), with limited variance (range = 0.006 cm). This consistency validates the utilization of digital calipers as a reliable instrument in clinical shoulder evaluations. The Cronbach's alpha value of 0.999 indicates near-perfect internal consistency, implying that all three raters assessed the same underlying construct–the linear distance from the posterior aspect of the acromion to the examination table surface–with exceptional agreement.

The ICCs further emphasize the reliability of this strategy. The ICC values of 0.996 for single measures and 0.999 for average measures demonstrate exceptional inter-rater reliability, consistent with the criteria established by Koo and Li (2016), which classify values beyond 0.90 as outstanding.[14] The significant consensus among evaluators reinforces the reliability and consistency of the tabletop test when utilized alongside a digital caliper.[15]

From a clinical perspective, these findings are substantial. The precise and dependable evaluation of pectoralis minor length is essential for detecting postural disorders, shoulder impingement, and scapular dyskinesis, diseases frequently linked to muscle

Table 1: Participants included in the study

Number of Participants	n	%
Valid	180	100.0
Excluded	0	0.0
Total	180	100.0

Table 2: Readings taken by the researchers for establishing reliability

Rater	Mean	SD	n
Chief researcher	2.66	0.58	180
Assistant 1	2.67	0.57	180
Assistant 2	2.67	0.58	180

Table 3: Internal consistency of the digital caliper

Statistic	Value
Cronbach's alpha	0.999
Standardized alpha	0.999
Number of items	3

Table 4: Representation of the intraclass correlation coefficient

Measure type	ICC	95% CI	F	df1	df2	P-value
Single measures	0.996	(0.995, 0.997)	733.630	179	358	<0.001
Average measures	0.999	(0.998, 0.999)	733.630	179	358	<0.001

ICC: Intraclass correlation coefficient

stiffness. The tabletop test, augmented with an accurate digital measuring device, enables clinicians to measure muscle length in a standardized and objective fashion, minimizing dependence on subjective assessment or palpation alone.[4]

The tool shows robust face, construct, and content validity. The measuring configuration explicitly addresses the specified anatomical distance, corroborates clinical hypotheses on shoulder posture and muscular imbalance, and aligns with established orthopedic assessment methodologies. This multifaceted validity increases the assurance with which clinicians can evaluate and respond to the test outcomes.

Although the results are encouraging, certain limitations must be recognized. This was an initial investigation involving a homogeneous sample population; outcomes may differ in individuals with shoulder pathology or post-surgical conditions.[16] Second, although averaging three measurements per assessor enhances accuracy, it may not be practical in time-restricted environments, such as uncooperative patients in severe myofascial pain conditions.[17,18] No contemporaneous validity testing, such as comparisons with imaging modalities such as ultrasound, was conducted, which could enhance the tool's external validity.

Notwithstanding these constraints, the study provides a robust basis for employing digital calipers in shoulder evaluation.[19,20] It adds to the increasing data endorsing quantitative methods in musculoskeletal assessment and promotes further standardization of physical examination procedures.[21]

The research indicates that the tabletop assessment, in conjunction with digital caliper readings, serves as an effective clinical instrument for identifying terminal shoulder flexion problems. The inclusion of many evaluators and statistical metrics enhances the scope and clinical applicability of the results.

CONCLUSION

This study demonstrates that digital calipers are a dependable and valid tool for evaluating pectoralis minor muscle length through the tabletop test. The elevated intra-rater and inter-tester reliability endorses the utilization of this instrument in clinical and research environments.

Recommendations

Clinicians are urged to implement the digital caliper and tabletop test in the standard evaluation of patients exhibiting terminal shoulder flexion dysfunction. Future studies should investigate its application in diverse groups and assess its longitudinal use to monitor intervention outcomes.

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