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Comparison of Strength Testing of the Tensor Fasciae Latae Muscle Using the Kendall and Mccreary Method vs. the Daniels and Worthingham Method

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COMPARISON OF STRENGTH TESTING OF THE TENSOR FASCIAE LATAE

MUSCLE USING THE KENDALL AND MCCREARY METHOD VS.

THE DANIELS AND WORTHINGHAM METHOD

by

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This independent study report, submitted by Jodi R. W. Boettner in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Chairperson of the Physical Therapy Department under whom the work has been done and is hereby approved.

(Chairperson, Physical Therapy)

PERMISSION

Title: Comparison of Strength Testing of the Tensor Fasciae Latae Muscle Using the Kendall and McCreary Method vs. the Daniels and Worthingham Method

Department: Physical Therapy

Degree: Master of Physical Therapy

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Manual muscle testing is an integral part of the physical therapy evaluation. There are two methods of testing muscle strength, these being the Kendall and McCreary (KM) method and the Daniels and Worthingham (DW) method. The purpose of this study was to compare the force produced in each of these methods when testing the tensor fasciae latae muscle. Thirty healthy subjects ranging in age from 23 to 40 years participated in this study. The Dynatron II Dynamometer was used to measure force in pounds for each method. Each subject performed one trial and one test for each method for a total of four tests. Results showed that the intrarater reliability of the KM method was good at r = .878 while reliability for the DW method was substantially less at r = .136. Consequently, comparisons of KM trial vs. DW trial were also low at r = .225 as was KM test vs. DW test at r = .460. Results also showed that the force produced for the KM method was significantly less than the DW method for both trial and test. In summary, this study showed a significant difference in force produced between the KM and DW method and also showed a considerably higher intrarater reliability for the KM method versus the DW method. Reasons for these differences are discussed.

CHAPTER I

INTRODUCTION

The manual muscle test is an integral part of physical therapy evaluation. It provides information that is not readily available from other procedures and is extremely useful in differential diagnosis and planning appropriate treatment of neuromuscular and skeletal disorders. Information obtained in a manual muscle test is only useful if it is accurate, and accuracy depends on the knowledge, skill, and experience of the examiner. Two components of the manual muscle test are test performance and evaluation of muscle strength. The examiner must have comprehensive and detailed knowledge of muscle function including joint motion, origin and insertion of muscles, agonistic and antagonistic muscular action, in addition to fixation patterns and possible movement substitutions. It is also important to be able to palpate the muscle or tendon, distinguish between normal and atrophied contour, and recognize abnormalities of position or movement. Practice is a key component when grading muscle strength.

Robert Lovett (in Kendall and McCreary)[1] introduced the following grading system in 1932:

Gone or Zero - no contraction felt

Trace	-	produces movement with gravity eliminated but cannot function against gravity
Fair	-	can raise part against gravity
Good	-	can raise part against outside resistance as well as against gravity
Normal	-	can overcome a greater amount of resistance than a good muscle

This grading system is common today with some modifications.

While grading systems are generally based on Lovett's original scale, there are some differences found between methods of muscle testing. Two of these methods are the Kendall and McCreary[1] (KM) method and the Daniels and Worthingham[2] (DW) method. Kendall and McCreary[1] base their method on the premise that every muscle is a prime mover in some specific action and that each muscle can and should be tested individually. For example, the manual muscle test for the middle trapezius can be differentiated from the rhomboid action by placing the patient prone with the elbow extended and the shoulder placed in 90° abduction and lateral rotation. If medial rotation is allowed, the action becomes one caused by the rhomboids rather than the middle trapezius. In contrast, the Daniels and Worthingham[2] method tests the motion of scapular adduction with the prime mover being both the trapezius and the rhomboids, and does not differentiate the two muscles.

The intent of this study is to compare the Kendall and McCreary method with the Daniels and Worthingham method when performing strength testing of the tensor fasciae latae. (Appendix A) The tensor fasciae latae[1-3] is innervated by the superior gluteal nerve (L_{4-5}, S_1). It originates on the anterior part of the external lip of the iliac crest, the outer surface of the anterior superior iliac crest, the outer surface of the anterior superior iliac spine, and the deep surface of the fasciae latae. The tensor fasciae latae inserts into the iliotibial tract of the fascia lata at the junction of the proximal and middle thirds of the thigh. The action of the tensor fasciae latae is to flex, medially rotate and abduct the hip joint, tense the fascia lata, and possibly assist in knee extension.

In the Kendall and McCreary[1] method, the position for testing of the tensor fasciae latae is to place the patient in supine and then abduct, flex, and medially rotate the hip with the knee extended. Resistance is then given against the leg (at the ankle) in the direction of extension and adduction. The rotation component is not resisted. In contrast, in the Daniels and Worthingham[2] method, the position for testing hip abduction from the flexed position with the prime mover being the tensor fasciae latae, is sidelying with the tested limb upward in a position of approximately 45° of hip flexion. The patient is then instructed to abduct the hip through approximately 30°. Resistance is given above the knee joint.

In order to objectively quantify and compare the amount of force produced in these two methods, the Dynatron II dynamometer[4] will be utilized.

The Dynatron II is a strength analysis system which has the capability to quantify the amount of force produced in manual muscle testing (dynamic testing) and also can be used for static muscle testing, such as common lifting tasks in functional capacity evaluations. For the purpose of this study, the dynamic testing mode is utilized. The Dynatron II consists of the main unit with the operating panel. The main unit is approximately 14 lbs. with dimensions of 5" h X 12" w X 12" d. Input on the main unit was set on "dynamic," as should be for manual muscle testing. Units were set at .10 to achieve results in tenths of pounds. Threshold was set at 5.0 as this is used for larger muscles when it is believed that a force of at least 5.0 pounds will be achieved with testing as is the case for the tensor fasciae latae. The output is measured in pounds and is displayed first in the current window and, after a second test, is displayed in the previous window. The hand-held transducer is connected to the main unit via the dynamic output jack. The hand-held transducer is lightweight and fits into the tester's hand. It accurately measures force, including forces measured with non-perpendicular loading. This is essential to accurately compare the force produced by the tensor fasciae latae using the Kendall and McCreary method versus the Daniels and Worthingham method. The null hypothesis of this study is that there will be no significant difference in force produced by the tensor fasciae latae muscle in the Kendall and McCreary method versus the Daniels and Worthingham method.

CHAPTER II

LITERATURE REVIEW

Perception and comparison of strength has been an area of significant interest in the literature. This is not unusual in light of the fact that strength assessment is an essential component of a physical therapy evaluation. As early as 1916, Lovett and Martin[5] found that 50% of a muscle's power may be lost before a subject has detectable difficulties with routine activities of daily living. Beasley[6] found that physical therapists using manual muscle testing were unable to detect up to a 50% loss of strength in the knee extensors in patients with poliomyelitis. Also, therapists were unable to detect a 20% to 25% difference in strength comparing strong and weak sides. In 1987, Frese[7] demonstrated that interrater reliability of manual muscle testing of the middle trapezius and gluteus medius muscles was low, with only 50-60% of therapists obtaining a rating of the same grade or within one-third of a grade for those muscles. In contrast, however, Florence, et al.[8] concluded that manual muscle test grades are reliable for assessing muscle strength in boys with Duchenne's Muscular Dystrophy when consecutive evaluations are performed by the same physical therapist.

Results of strength testing may not be reliable nor consistent for various reasons. For instance, there are two types of muscle tests, those being "make tests" and "break tests."[9] Make tests require that the examiner hold the dynamometer stationary while the subject exerts a maximal force against it. Make tests have been performed more recently with hand-held dynamometers. In contrast, break tests require that the examiner push against a subject's limb until the subject's maximum muscular effort is overcome, and the joint being tested gives way. Break tests are utilized by both Kendall and McCreary[1] and Daniels and Worthingham[2] and are most commonly used by physical therapists in the clinical setting. Bohannon[9] compared the "make test" and the "break test" for elbow flexion. He found that, although each testing type was reliable, "break tests" consistently produced greater force than "make tests," despite testing the same muscle.

Another reason for differences in results of strength testing may be due to differences between methods for manual muscle testing. Two common methods for manual muscle testing, the Kendall and McCreary method (KM) and the Daniels and Worthingham method (DW), do have differences in methodology.[1,2,10] These include test position, specificity of muscle tests, hand placement given for resistance, and holding a test position (KM) versus performing a test movement (DW).

In order to objectively compare the Kendall and McCreary method and the Daniels and Worthingham method, a hand-held dynamometer will be utilized in this study. The efficacy of hand-held dynamometers was investigated by Marino, et al[11] in 1982. In this study, bilateral measurements were taken for hip abduction and hip flexion using a hand-held dynamometer and compared the examiner's perception of muscle weakness. It was found that the scores obtained with the MMT were consistent with the examiner's perception of muscle weakness using a Chi-square analysis ($p < 0.001$).

The reliability of hand-held dynamometers has also been investigated. In 1987, Bohannon[12] investigated test-retest reliability of hand-held dynamometry in a single session of strength assessment using one tester. He found that the correlations for the 18 muscle groups tested ranged from .84 to .99 ($p < 0.01$) and were demonstrative of good to high reliability with the least reliable groups found to be the hip and shoulder abductors.

In 1988, Bohannon and Williams[13] found that the correlations between two raters' means for six muscle groups ranged from .84 to .95 ($p < 0.001$) and were consistent with good to high reliability. Highest reliability was found for elbow flexors, hip flexors, knee extensors, and ankle dorsiflexors, with less reliability found for shoulder internal rotators and wrist extensors.

Also in 1988, Stuberg and Metcalf[14] found that a hand-held dynamometer could be used to reliably assess strength in both healthy children and children with Duchenne muscular dystrophy. Correlation coefficients for the dystrophic group ranged from .83 to .99 and for the healthy group ranged from .74 to .99.

The intent of this study will be to compare the force produced by the tensor fasciae latae in the Kendall and McCreary method versus the Daniels and Worthingham method using the Dynatron II Dynamometer. The expectation is that the force produced for each method will be equal if, in fact, each method tests the same muscle; i.e., the tensor fasciae latae muscle.

CHAPTER III

METHODOLOGY

Subjects

Thirty healthy subjects participated in this study after providing informed consent. (Appendix B) Twenty-two of the subjects were female, eight were male. Their ages ranged from 23 to 40 years, with the mean age being 30.5 years. To eliminate any bias that might accompany the testing of a single side, subjects were randomly assigned by coin toss so that 15 had their left lower extremity tested and 15 had their right lower extremity tested. In addition, the method to be tested first was also randomly assigned by coin toss with 16 of the subjects first tested with the Daniels and Worthingham method and 14 of the subjects first tested with the Kendall and McCreary method. This was done in order to prevent any bias that may occur due to fatigue while testing.

Procedure

Each subject performed one trial and one test for each method of testing of the tensor fasciae latae. A trial was done for each method in order to familiarize the subject with the test method in order to maximize force produced. In the Kendall and McCreary method, the subject was positioned in supine with the tested limb placed in abduction, flexion, and medial rotation of the hip with the knee extended. Pressure was given just proximal to the lateral malleolus via the hand-held dynamometer in the direction of extension and adduction. The rotation component was not resisted as this is not required in the test as stated by Kendall and McCreary, and is difficult to incorporate. The test was completed when the subject's leg began to lower.

In the Daniels and Worthingham method, the subject was positioned in sidelying with the lower knee slightly flexed for balance. The leg to be tested was on top and flexed to about 45 degrees at the hip joint. The subject's leg was then placed at approximately 30 degrees of abduction. Pressure was given just above the lateral knee joint via the dynamometer. The test was complete when the subject's leg began to lower.

The method to be tested first was randomly selected by a coin toss. The leg to be tested, right versus left, was also determined by a coin toss. Each subject had only one leg tested with both methods. Each subject had a 90-second rest interval between the trial and test for each method, and also a 90-second rest interval between the two methods. This was to allow full recovery of a muscle so fatigue would not be a factor to decrease force in any of the subsequent tests.

Fourteen subjects performed the Kendall and McCreary method first, and 16 subjects performed the Daniels and Worthingham method first. Fifteen subjects had their right leg tested first and 15 subjects had their left leg tested first.

Data Analysis

Descriptive statistics and a two-way analysis of variance (ANOVA) were calculated to determine whether there was a significant difference between Kendall and McCreary[1] (KM) trial vs. test, between Daniels and Worthingham[2] (DW) trial vs. test, between KM trial vs. DW trial, and between KM test vs. DW test. Pearson product-moment correlation coefficients (r) were calculated to determine the relationship of force produced during each of these comparisons. Also, t values were calculated for each of the above comparisons.

CHAPTER IV

RESULTS

The mean force for the KM trial was 14.467 lbs. with a range of 8.0-28.0 lbs., while the mean force for the KM test was 14.613 lbs. with a range of 7.0-33.0 lbs. In contrast, the mean force for the DW trial was 28.433 with a range of 19.0-51.0 lbs., while the mean force for the DW test was 26.933 lbs. with a range of 17.0-41.0 lbs. (Table 1) This represents a substantially greater force produced for both the DW method in trial and test, compared to the KM method. (Specific subject results are noted in Appendix C.)

TABLE 1

Descriptive Statistics of Forces* Produced During Two Consecutive Tests of the KM Method and the DW Method

	X	Range
KM Trial	14.467	8.0-28.0
Test	14.613	7.0-33.0
DW Trial	28.433	19.0-51.0
Test	26.933	17.0-41.0

*Force in pounds

The forces produced in the KM trial and the KM test correlated strongly (r = .878). In contrast, the correlations between the DW trial and test (r = .136), the KM trial and DW trial (r = .225), and the KM test and the DW test (r = .460) were all lower. It was demonstrated by the t value that there was a significantly different force production between the KM trial versus the DW trial (t = -10.57) and between the KM test versus the DW test (t = -11.63).

TABLE 2

Comparison of Forces Produced Between Methods

and Trial vs. Test

	Correlation (r)	2 Tail Prob.	t Value	2 Tail Prob.
KM trial vs. test	.878	.000	- .34	.737
DW trial vs. test	.136	.474	.97	.342
KM trial vs. DW trial	.225	.232	-10.57	.000
KM test vs. DW test	.460	.010	-11.63	.000

CHAPTER V

CONCLUSION

Intrarater reliability for the KM method was found to be good (r = .878).[15] Surprisingly, in contrast, intrarater reliability for the DW method was found to be poor (r = .136).[15] One contributing reason for the poor intrarater reliability for the DW method may be due to the fact that the force produced in the DW method was consistently and significantly greater than the KM method, making an accurate test more difficult. In fact, the FET System Manual states that the Dynatron II "may be better suited for testing the weak, diseased, and injured muscles of a patient but can still be used for healthy athletes."[4(p1-1)] The DW method with its increased force produced may be comparable to force produced by a healthy athlete, whereas the lesser force of the KM method may be compared to an injured weak muscle. In addition to the reliability of machine, reliability of the examiner also may be a contributing factor in the low intrarater reliability of the DW method. With the DW test of the tensor fasciae latae, the examiner found that it was more difficult to actually "break" the subject's maximal force, requiring the examiner to recruit more muscle groups to do so. In addition, it was also more difficult for the examiner to accurately judge the exact moment at which a subject's force was broken which could lead to variable results.

The mean for the DW trial (X = 28.433) and the DW test (X = 26.933) do not initially appear to indicate the poor intrarater reliability until each subject's actual force measurements are compared. Trial-to-test differences vary from a little as 0.2 lbs. for subject #10 to as great as 27.6 lbs. for subject #8. (Appendix C) Noting the actual raw data shows the great variability in the DW trial versus test.

When comparing the KM trial to the DW trial and the KM test to the DW test, it would be expected that there would be a strong positive correlation despite the fact that the DW trial and test produced a consistently greater force than the KM trial and test. The greater force produced in the DW method can be explained by the fact that resistance is given just above the knee, resulting in a shorter lever arm requiring more force to break a maximal contraction compared to the KM method where resistance is given just above the ankle resulting in a longer lever arm requiring less force to break a maximal contraction. Another explanation for the increased force produced by the DW method could also be due to the fact that Daniels and Worthingham tend to test a movement which may lead to a group of muscles contributing to the force produced. In contrast, Kendall and McCreary tend to test each muscle separately, so it would be expected that one muscle would produce less force than a group of muscles. However, because the reliability of the DW method was poor, comparisons between the two methods cannot be adequately assessed.

In summary, intrarater reliability for testing of the tensor fascia latae using the KM method was good while the DW method was poor. The DW method did produce significantly and consistently greater force than the KM method. Because of the poor intrarater reliability of the DW method, adequate assessment between the two methods could not be made. It is felt that further research is warranted regarding intrarater reliability for other muscles using the KM and DW methods and also for reliability of use of the Dynatron II Dynamometer.

APPENDIX A

UNIVERSITY OF NORTH DAKOTA'S
INSTITUTIONAL REVIEW BOARD

DATE: November 4, 1992

NAME: Jodi Boettner **DEPARTMENT/COLLEGE** Physical Therapy

PROJECT TITLE: Comparison of Strength Testing of the Tensor Fasciae Latae Muscle Using the Kendall and McCreary Method vs. the Daniels and Worthingham Method (Protocol Change)

The above referenced project was reviewed by a designated member for the University's Institutional Review Board on November 9, 1992 and the following action was taken:

☒ Project approved. **EXPEDITED REVIEW NO.** 9.
Next scheduled review is on November, 1993.

☐ Project approved. **EXEMPT CATEGORY NO.** ____. No periodic review scheduled unless so stated in REMARKS SECTION.

☐ Project approval **deferred.**
(See REMARKS SECTION for further information.)

☐ Project **denied.**
(See REMARKS SECTION for further information.)

REMARKS: Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRB Chairman or ORPD.

cc: H. C. Wessman, Adviser
Dean, Graduate School

[signature] 11/9/92

Signature of Chairperson or designated IRB Member — Date
UND's Institutional Review Board

If the proposed project (clinical medical) is to be part of a research activity funded by a Federal Agency, a special assurance statement or a completed 596 Form may be required. Contact ORPD to obtain the required documents. (9/87)

APPENDIX B

You are invited to participate in a study of two methods of strength testing for the tensor fasciae latae muscle which is a muscle in the leg. We hope to learn if these two methods yield results of equal amounts of force.

You have been selected because you fit in the test population of being between 23 to 45 years old with no pain or fractures in your legs for the last 5 years.

You will be asked to undergo two methods of testing for the muscle of the leg, the tensor fasciae latae. The order of the methods tested will be randomized. You will have a practice session for each method. In one method you will be lying on your back and will be asked to lift the entire leg out to the side and upward while turning inward at the hip with the knee straight. The examiner will then use a dynamometer, a device that measures force, to push your leg downward and inward while you resist the pressure. This test is complete when your leg begins to lower.

In the second method, you will be lying on your side with the leg to be tested on top. You will bring your leg forward to approximately 45 and then will be asked to lift the leg to approximately 30 . Pressure will again be given to the leg via the dynamometer by the examiner. This test will be completed when your leg starts to lower.

There is a small possibility that you may experience minimal muscle cramping or fatigue but it is expected that this would be temporary.

You will be identified by number in this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission.

Your decision whether or not to participate will not prejudice your future relations with the University of North Dakota nor the physical therapy program. If you decide to participate, you are free to discontinue participation at any time without prejudice.

The investigators involved are available to answer any questions you have concerning this study. In addition, you are encouraged to ask any questions concerning this study that you may have in the future. Questions may be asked by calling Jodi Boettner PT at 746-8963 or 780-2315.

You will be given a copy of this form.

All of my questions have been answered and I am encouraged to ask any questions that I may have concerning this study in the future.

I have read all of the above and willingly agree to participate in this study explained to me by Jodi Boettner Pt.

____

Patient's Signature   Date

____

Witness (Not the scientist)   Date

APPENDIX C

RAW DATA

				Kendall & McCreary		Daniels & Worthingham		
Date	Subject #	M/F	L. or R.	Trial	Test	Trial	Test	Age
10-21	9	M	L.	20.2*	19.4	23.2	25.4	31
10-21	2	F	L.	14.6*	12.2	29.2	25.8	34
10-22	10	F	L.	22.4	14.2	29.4*	29.2	26
10-22	5	F	L.	12.4*	14.0	18.8	25.3	34
10-22	6	F	R.	14.6*	17.2	35.2	31.6	24
10-26	1	F	R.	13.6*	15.0	24.6	30.4	36
10-26	7	M	R.	28.0*	33.0	31.8	36.0	28
10-26	13	F	R.	18.0*	18.8	28.8	30.6	28
10-28	14	F	R.	14.6	12.0	30.2*	36.8	33
10-28	11	F	R.	13.6	13.0	34.8*	27.0	23
10-29	15	F	L.	10.8	14.6	31.2*	24.0	24
11-2	17	F	R.	10.2*	11.0	22.6	17.4	28
11-2	18	F	R.	9.6	10.6	22.4*	25.8	24
11-4	19	F	L.	19.0*	20.8	26.4	28.6	31
11-4	12	F	R.	12.0	11.6	23.2*	27.2	31

11-4	8	M	L.	18.8	20.4	50.6*	23.0	29
11-4	20	F	L.	16.6	16.6	26.0*	29.4	35
11-4	21	F	R.	13.4*	11.2	19.6	24.8	25
11-5	22	F	R.	9.6*	9.2	30.0	21.4	36
11-5	23	M	R.	15.6	17.8	37.0*	40.8	24
11-5	24	F	L.	17.2	17.8	24.6*	30.4	40
11-9	25	F	R.	15.2*	12.6	22.6	18.6	39
11-9	27	F	L.	15.0*	15.0	30.2	39.2	36
11-12	28	F	L.	10.2	11.6	37.0*	18.2	28
11-12	29	M	R.	12.8	13.4	25.0*	29.4	32
11-12	26	M	L.	15.2*	17.0	37.4	21.8	30
11-12	3	F	R.	7.8	7.0	28.0*	20.6	36
11-12	16	M	L.	12.8	12.2	19.2*	17.8	39
11-12	30	M	L.	10.8	10.2	32.4*	23.0	28
11-12	29	F	L.	9.4	9.0	21.6*	28.2	23

* Method tested first

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