

An Anatomic Investigation of the Ober Test

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Background: Recent studies have questioned the importance of the iliotibial band (ITB) in lateral knee pain. The Ober test or modified Ober test is the most commonly recommended physical examination tool for assessment of ITB tightness. No studies support the validity of either Ober test for measuring ITB tightness.

Purpose/Hypothesis: The purpose of this study was to assess the effects of progressive transection of the ITB, gluteus medius and minimus (med/min) muscles, and hip joint capsule of lightly embalmed cadavers on Ober test results and to compare them with assessment of all structures intact. In addition, thigh position change between gluteus med/min transection and hip capsule transection was also assessed for both versions of the Ober test. It was hypothesized that transection of the ITB would significantly increase thigh adduction range of motion as measured by an inclinometer when performing either Ober test and that subsequent structure transections (gluteus med/min muscles followed by the hip joint capsule) would cause additional increases in thigh adduction.

Study Design: Controlled laboratory study.

Methods: The lower limbs of lightly embalmed cadavers were assessed for midhigh ITB transection versus intact by use of the Ober ($n = 28$) and modified Ober ($n = 34$) tests; 18 lower limbs were assessed for all conditions (intact band, followed by sequential transections of the ITB midhigh, gluteus med/min muscles, hip joint capsule) by use of both Ober tests. Paired t tests were used to compare changes in Ober test results between conditions.

Results: No significant changes in thigh position (adduction) occurred in either version of the Ober test after ITB transection. Significant differences were noted for intact band versus gluteus med/min transection and intact band versus hip joint capsule transection ($P < .0001$) for all findings for both tests. Mean inclinometer measurements for the modified Ober were 4.28° ($n = 34$ for intact vs ITB transection comparisons), 3.33° ($n = 18$ for subsequent intact vs gluteus muscle and hip capsule transection comparisons), 5.00° ($n = 34$ for midhigh ITB transection), 11.20° (gluteus med/min transection), and 13.20° (hip capsule transection). For the Ober test, measures were -2.90° ($n = 28$ for intact vs ITB transection comparisons), -2.20° ($n = 18$ for subsequent intact vs gluteus muscle and hip capsule transection comparisons), -2.20° ($n = 34$ for midhigh ITB transection), 6.50° (gluteus med/min transection), and 9.53° (hip capsule transection). Statistically significant differences were also noted between test findings comparing gluteus med/min transection to hip capsule transection (Ober, $P < .0001$; modified Ober, $P = .0036$).

Conclusion: The study findings refute the hypothesis that the ITB plays a role in limiting hip adduction during either version of the Ober test and question the validity of these tests for determining ITB tightness. The findings underscore the influence of the gluteus medius and minimus muscles as well as the hip joint capsule on Ober test findings.

Clinical Relevance: The results of this study suggest that the Ober test assesses tightness of structures proximal to the hip joint, such as the gluteus medius and minimus muscles and the hip joint capsule, rather than the ITB.

Keywords: Ober test; modified Ober test; iliotibial band; knee pain; lightly embalmed cadaver

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The iliotibial band (ITB), also known as iliotibial tract, is a fibrous band that reinforces the fascia lata laterally and can be observed on the lateral aspect of the thigh as it continues inferiorly to the lateral tibial condyle.²² Pain on the lateral side of the knee near the lateral epicondyle in runners, cyclists, and other athletes who experience repetitive movement of the knee under loaded conditions has been attributed to irritation of the ITB.^{2,11,23} Tightness of the ITB is considered to be a possible contributing factor to irritation.⁴ In addition to palpation for localized tenderness of the area inferior to the lateral epicondyle of the knee (superior to the joint line), other key clinical examination tools frequently recommended are the Ober test (OT)

and modified Ober test (MOT). Both the OT and MOT are believed to assess extensibility of the ITB.²⁰

The OT was originally described in 1935 as a test for flexibility of the ITB.²⁴ The test consists of placing an individual in the side-lying position with the limb to be tested facing up. The examiner flexes the knee of the limb being tested to 90° followed by abduction and extension of the hip to place the thigh in line with the trunk. Next, the examiner allows gravity to lower the thigh into adduction as far as possible while not allowing a change of thigh position in the sagittal or transverse planes. A modification of the OT was described by Kendall et al¹⁹ in 1952. The MOT is identical to the OT except with the MOT, the knee is maintained in full extension and the pelvis is stabilized manually. The rationale for this modification is to reduce the potential influence of a tight rectus femoris muscle on the test findings.

Irritation of the ITB, often called ITB friction syndrome, has been thought to be caused by a tight ITB rubbing on the lateral epicondyle of the femur during repetitive flexion and extension of the knee.^{11,13,17} Previous investigations have refuted this hypothesis.^{8,9,18} Fairclough et al⁹ concluded that the ITB is not a distinct anatomic structure but merely a thickened zone within the lateral aspect of the fascia lata, which is firmly connected to the linea aspera by an intermuscular septum. This description is consistent with an earlier study that also reported fascia lata attachment to the lateral epicondyle of the femur.¹⁸ Kaplan concluded his article as follows: "The importance of the tensor fasciae latae and of the ITB has been, possibly, overestimated as a deforming factor in patients."¹⁸ These anatomic considerations make it difficult to conclude that anterior-posterior glide of the ITB is even possible, and thus raise the question as to whether ITB friction can occur.

No studies have supported the validity of the OT or MOT for measuring a tight ITB. Melchione and Sullivan²¹ stated: "No studies have examined the reliability of judgments made by clinicians concerning ITB tightness through use of the test." Melchione and Sullivan²¹ designed a new method to measure the length of the ITB using their own modified version of the OT (5° of hip extension and 5° of knee flexion and a standardized procedure for maintaining pelvic position); the investigators tested their method for intra- and intertester reliability on patients with anterior knee pain and found the method to be reliable. Unfortunately, their research addressed method and reliability, but not validity, of ITB assessment.

Knowledge of the anatomic features of the ITB and experience with clinical examination and rehabilitation of athletes diagnosed with ITB syndrome lead to the question of whether the OT and MOT are valid assessments of ITB flexibility or whether more proximal tissues such as the hip abductor muscles or hip joint capsule may have a greater influence on OT or MOT findings. Access to lightly embalmed cadavers whose tissue mobility and extensibility is similar to those of live individuals enabled investigation of this question.^{3,28} The purpose of this controlled laboratory study was to determine whether progressive transection of the ITB, gluteus medius and minimus (med/min) muscles, and hip joint capsule of lightly embalmed cadavers would result in changes in OT or

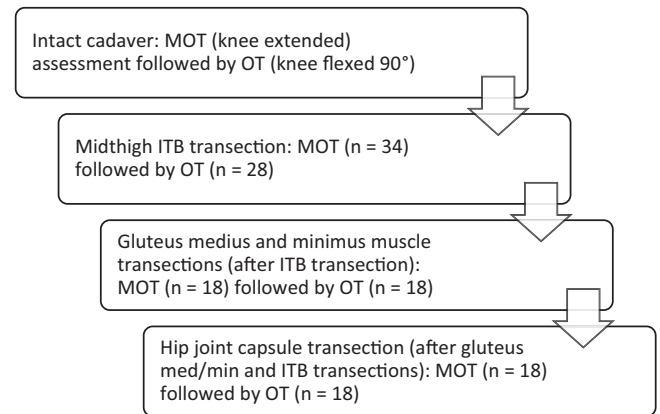


Figure 1. Order of conditions and measurements. ITB, iliotibial band; MOT, modified Ober test; OT, Ober test.

MOT results compared with assessment with all structures intact. The hypothesis was that transection of the ITB would result in a significant increase of thigh adduction during the OT and MOT and that subsequent tissue transections would result in further changes in thigh adduction.

METHODS

State anatomic review board approval was obtained for this study, in which 18 lightly embalmed cadavers were used (14 female, 4 male; average age, 78 years; range, 45-97 years). Thirty-four lower limbs were assessed for mid-ITB transection versus intact by use of the MOT (the initial 6 were pilot study data for a MOT vs OT midtransection change only) and 28 by use of the OT (the initial 10 were pilot study data for a MOT vs OT midtransection change comparison); 18 lower limbs were assessed for all 3 transection conditions by use of both the MOT and OT. Data from the 2 pilot studies were included with the 18 complete assessments to maximize the amount of data available for analysis. Limbs that had total hip arthroplasty or evidence indicating major surgery or trauma of the hip-thigh region (visible scars or deformities) were not included in the study. Two of the 36 available lower limbs were not used for this study based on these exclusion criteria.

The cadavers used in the study were embalmed with a glutaraldehyde-based embalming fluid (Champion Millennium Alpha Factor Arterial 24; The Champion Company of Springfield). Twenty-four ounces of the concentrated chemical per 2½ gallons of water were used for an average-sized cadaver.^{3,28}

Initial pilot data (first 6 lower limbs, 34 total) were obtained by use of the MOT and ITB transection only, followed by inclusion of the OT (28 lower limbs; 10 were pilot data comparing the MOT and OT after ITB transection). Gluteus med/min transection and hip capsule transection in addition to ITB transection were performed on 18 lower limbs. The order of conditions and measurements (2 measurements were performed for each condition) are shown in Figure 1.



Figure 2. Modified Ober test performed on cadaver.

The tests were performed on the lightly embalmed cadavers as described by Ober²⁴ and Kendall et al.¹⁹ The same assistant helped manually stabilize the pelvis during all tests on all cadavers. An inclinometer placed at the lateral epicondyle of the femur was used to measure limb position (Figure 2). Horizontal was considered 0°; an adducted position or below horizontal was recorded as a positive number and an abducted position or above horizontal was recorded as a negative number.²⁵ This approach to measurement of ITB flexibility has been found to be reliable and simple to perform.²⁵

The MOT and OT were assessed twice for each condition by a board-certified orthopaedic physical therapist who was blinded to the measurements. The blinded measurements were read and recorded by the same individual for all conditions on all cadavers. All transections were performed by the same individual (anatomist with 20 years of experience). Transections were performed as follows:

1. *ITB*: Midthigh (based on tape measure from greater trochanter to lateral epicondyle of femur), 5.08 cm in length, beginning at the lateral intermuscular septum of the thigh and proceeding anteriorly, perpendicular to the longitudinal fibers of the ITB (Figure 3)
2. *Gluteus med/min*: Lateral approach through the tendinous attachment of the muscles to the greater trochanter¹⁶ (Figure 4)
3. *Hip joint capsule*: In an arc through the superior-distal attachment on the greater trochanter, deep to the gluteus med/min attachments

Statistical Analysis

Descriptive statistics including the mean, standard deviation, minimum, and maximum were provided for each variable as well as the difference in variables that were compared.

SAS for PC (version 9.4; SAS Institute Inc) was used for data analyses. The statistical level of significance for analyses was .05. The 2 goniometer measurements were averaged before analysis, and the averages were then used in the statistical calculations. The data were tested for normality with the Shapiro-Wilk test. Since each variable passed the test of normality, paired *t* tests were used to make the following comparisons:



Figure 3. Iliotibial band transection.

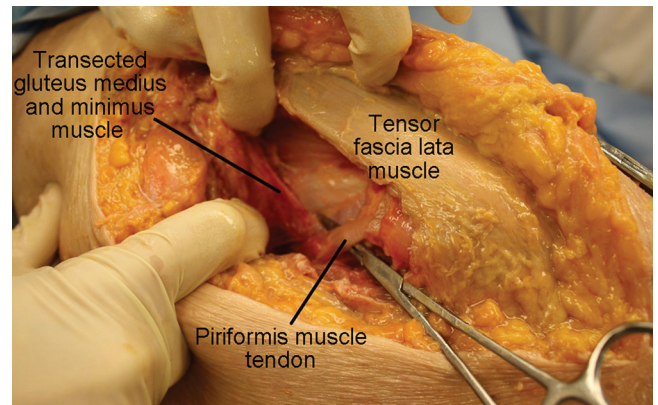


Figure 4. Gluteus medius and minimus transection.

MOT:

1. Intact versus ITB transection
2. Intact versus gluteus med/min transection
3. Intact versus hip capsule transection
4. Gluteus med/min transection versus hip capsule transection

OT:

5. Intact versus ITB transection
6. Intact versus gluteus med/min transection
7. Intact versus hip capsule transection
8. Gluteus med/min transection versus hip capsule transection

RESULTS

Table 1 provides descriptive statistics for the inclinometer measurements of the conditions and the *t* test statistics for comparisons between conditions.

The mean goniometric measurements of thigh position for the intact ITB versus ITB transection during the MOT were 4.28° (intact) and 5.00° (ITB transection), with the thigh below the horizontal plane. For the OT,

TABLE 1
Descriptive Statistics for Modified Ober and Ober Test Results and Statistical Comparison Between Conditions^a

Condition	No. (per Group)	Inclinometer Measurement, deg, Mean $\pm$ SD (Range)	Difference Between Conditions		
			SD (95% CI), deg	<i>t</i> Value	Pr > <i>t</i>
Modified Ober test					
ITB intact vs ITB transected	34	Intact: 4.28 $\pm$ 5.53 (−8.00 to 15.50) Transected: 5.00 $\pm$ 4.48 (−4.00 to 15.50)	3.69 (−2.00 to 0.57)	−1.14	.2629
ITB intact vs gluteus med/min transected	18	Intact: 3.33 $\pm$ 5.40 (−8.00 to 10.00) Transected: 11.20 $\pm$ 3.92 (5.00 to 19.50)	4.55 (−10.12 to −5.60)	−7.33	<.0001 ^b
ITB intact vs hip cap transected	18	Intact: 3.33 $\pm$ 5.40 (−8.00 to 10.00) Transected: 13.20 $\pm$ 4.98 (4.50 to 22.00)	5.17 (−12.40 to −7.26)	−8.07	<.0001 ^b
Gluteus med/min transected vs hip cap transected	18	Gluteus med/min: 11.20 $\pm$ 3.92 (5.00 to 19.50) Hip cap: 13.20 $\pm$ 4.98 (4.50 to 22.00)	2.48 (−3.21 to −0.74)	−3.37	.0036 ^b
Ober test					
ITB intact vs ITB transected	28	Intact: −2.90 $\pm$ 7.88 (−23.00 to 9.00) Transected: −2.20 $\pm$ 8.29 (−22.00 to 11.50)	3.37 (−1.93 to 0.68)	−0.98	.3353
ITB intact vs gluteus med/min transected	18	Intact: −2.20 $\pm$ 6.31 (−15.00 to 9.00) Transected: 6.50 $\pm$ 6.86 (−7.00 to 16.50)	3.95 (−10.63 to −6.70)	−9.31	<.0001 ^b
ITB intact vs hip cap transected	18	Intact: −2.20 $\pm$ 6.31 (−15.00 to 9.00) Transected: 9.53 $\pm$ 6.51 (−1.00 to 21.00)	4.93 (−14.14 to −9.24)	−10.07	<.0001 ^b
Gluteus med/min transected vs hip cap transected	18	Gluteus med/min: 6.50 $\pm$ 6.86 (−7.00 to 16.50) Hip cap: 9.53 $\pm$ 6.51 (−1.00 to 21.00)	2.42 (−4.23 to −1.82)	−5.30	<.0001 ^b

^acap, capsule; med/min, medius and minimus; ITB, iliotibial band.

^bStatistically significant ($P < .05$).

the findings were -2.90° (intact) and -2.20° (ITB transection), with the thigh above the horizontal plane. These comparisons were not statistically significantly different for either the MOT or OT (MOT, $P = .2629$; OT, $P = .3353$) (Table 1). These results indicate that the thigh did not move further into adduction after ITB transection when assessed with either version of the Ober test.

The mean inclinometer measurements of thigh position for the intact ITB versus gluteus med/min transection during the MOT were 3.33° (intact) and 11.20° (gluteus med/min transection), thigh below horizontal plane. For the OT, the findings were -2.20° (intact), thigh above horizontal plane, and 6.50° (gluteus med/min transection), thigh below horizontal plane. These comparisons were statistically significant different for the MOT and OT (MOT, $P < .0001$; OT, $P < .0001$) (Table 1). These results indicate that the thigh did move further into adduction after

transection of the gluteus med/min muscles relative to the intact ITB condition when assessed with both versions of the Ober test.

The mean goniometric measurements of thigh position for the intact ITB versus hip joint capsule transection during the MOT were 3.33° (intact) and 13.2° (hip cap transection). For the OT, the findings were -2.2° (intact) and 9.53° (hip cap transection). These comparisons were statistically significant for the MOT and OT (MOT, $P < .0001$; OT, $P < .0001$) (Table 1). These results indicate that the thigh did move further into adduction after transection of the hip joint capsule relative to the intact ITB condition when assessed with both versions of the Ober test.

Last, the mean goniometric measurements of thigh position after transection of the gluteus med/min versus after hip capsule transection during the MOT were 11.2° (gluteus med/min transection) and 13.2° (hip cap

transection). For the OT, the findings were 6.5° (gluteus med/min transection) and 9.53° (hip cap transection). These comparisons were statistically significant for the MOT and OT (MOT, $P = .0036$; OT, $P < .0001$) (Table 1). These results indicate that the thigh did move further into adduction after transection of the hip joint capsule relative to after gluteus med/min muscle transection when assessed using both versions of the Ober test.

DISCUSSION

Lateral knee pain is a common occurrence in athletes and active individuals that is frequently attributed to tightness of the ITB.^{7,14,20,26} The most commonly recommended physical examination procedure for assessment of ITB tightness is the OT or MOT.^{1,7,10,12,15,27} Recent studies have challenged whether the ITB is the problematic tissue in cases diagnosed as ITB syndrome.^{8,10} In addition to recent evidence questioning the cause of lateral knee pain commonly attributed to ITB tightness, our study results also question the validity of the OT and MOT for determination of ITB extensibility and tightness.

Authors of several studies of ITB stretches propose that hip and thigh muscle extensibility changes may be responsible for increased adduction of the hip rather than changes in the ITB.^{9,13} Fredericson et al¹³ noted that it is possible that changes in the gluteal muscles, tensor fascia lata, and vastus lateralis could have contributed to increased hip adduction range of motion during stretches meant to stretch the ITB versus actual changes in ITB band length. Falvey et al¹⁰ expanded on these findings and concluded that the fascial component of the ITB plays a limited role in lengthening of the ITB–tensor fascia lata muscle complex and that the muscular components in the hip area are the key factors to consider.

Our study results concur with the above-mentioned findings. No notable changes in MOT or OT hip adduction range of motion were recorded after transection of the ITB (mean change $<1^\circ$ for both tests) (see Table 1). Statistically and clinically significant increases in hip adduction range of motion with MOT and OT assessment were found after gluteus med/min transection (MOT mean change $>7^\circ$, OT mean change $>8^\circ$) and after hip joint capsule transection (MOT mean change $>9^\circ$, OT mean change $>11^\circ$). For a change in goniometric measurement to be considered clinically significant, a minimum difference of 3° to 4° is necessary when the same examiner performs a measure.⁵ One study supported interchangeable use of goniometric and inclinometer measurements of the hip based on the findings of high interrater reliability (intraclass correlation coefficient, 0.91–0.92) between use of these instruments.⁶

Comparisons between changes in hip adduction range of motion measures with the MOT and OT after hip joint capsule transection after gluteus med/min transection revealed statistically significant increases in hip adduction (MOT mean change, 2° ; OT mean change, $>3^\circ$). The OT measurement of increased hip adduction change for hip joint capsule transection versus gluteus med/min transection is considered to be within the clinically significant

range. This finding regarding the influence of the hip joint capsule on MOT and OT measures has never been addressed in the literature. Based on our study, hip joint capsular tightness should also be considered as a potential factor contributing to the findings of the MOT and OT.

Drawbacks of this study include use of lightly embalmed cadavers and the age of the cadavers tested. Tissue extensibility is likely to have been influenced somewhat by the chemicals used during embalming. However, Anderson³ reported the tissue of lightly embalmed cadavers to be “close to that found in the living body, both in color and texture.” Information concerning the premorbid physical activity levels of the cadavers was not available. Since the cadavers were much older than typical athletes, the muscle bulk of the cadavers was likely not equivalent to that of healthy athletes. However, the primary focus of this investigation was to determine the contribution of different anatomic structures to MOT and OT findings. The robust results lead one to consider the possibility that these findings may indeed be applicable to live individuals.

CONCLUSION

The findings of this study refute the hypothesis that the ITB plays a role in limiting hip adduction during either version of the Ober test. The gluteus medius and minimus muscles as well as the hip joint capsule appear to influence MOT and OT findings. These findings question the validity of the Ober tests for determining ITB tightness but underscore the influence of the gluteus medius and minimus muscles as well as the hip joint capsule on MOT and OT findings. The results of this study suggest that the Ober test is an assessment of tightness of the gluteus medius and minimus muscles and the hip joint capsule rather than the ITB.

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