DANISH MEDICAL JOURNAL

Original Article

The Teitge test

Rikke Dyhr Hansen[1], Jørgen Haraszuk[1], Robert Allan Teitge[2], Per Hölmich[1] & Kristoffer Weisskirchner Barfod[1]

1) Sports Orthopedic Research Center – Copenhagen (SORC-C), Department of Orthopedic Surgery, Copenhagen University Hospital – Amager and Hvidovre Hospital, Denmark, 2) Department of Orthopaedic Surgery, Wayne State University, Detroit, USA

Dan Med J 2024;71(12):A10230666. doi: 10.61409/A10230666

ABSTRACT

INTRODUCTION. High tibial osteotomy (HTO) is used to treat medial knee osteoarthritis (OA). A simple clinical test to select the patients most likely to benefit from the procedure was suggested by R. A. Teitge., MD, Professor Emeritus, a pioneer in osteotomies. This study aimed to investigate the interrater reliability of the Teitge test.

METHODS. A reliability study was performed. The Teitge test consists of a varus stress test to provoke the patient's known symptoms, followed by a valgus stress test to simulate the realignment achieved by HTO. The test is considered positive if valgus stress relieves pain. Two experienced orthopaedic surgeons performed the test. The inclusion criteria were unicompartmental medial knee OA Kellgren-Lawrence type 2-3, pain at the medial joint line, varus malalignment > 5 degrees and English or Danish proficiency. Reliability was determined using Cohen's kappa (κ).

RESULTS. A total of 18 patients, mean age (± SD) 56.7 (± 8.7), male/female 6/12 were included. Agreement was found in 12/18 cases, resulting in κ = 0.22 (95% confidence interval (CI): −0.29-0.72). Due to a weighted number of positive test results (11/18 and 15/18, respectively) a prevalence and bias-adjusted kappa was applied, reaching κ = 0.33 (95% CI: −0.1-0.77).

CONCLUSIONS. Fair agreement was found. We do not recommend the Teitge test for absolute decision-making, but it could be a valuable contributor to the complex mechanics of decision-making. Clinicians should be careful when interpreting the test due to the low interrater agreement.

FUNDING. None.

TRIAL REGISTRATION. Not relevant.

Knee osteoarthritis (OA) is a common disease worldwide. The incidence increases with age and the burden of OA is rising [1]. OA involves degeneration of articular cartilage, leading to narrowed joint space and periarticular bone changes, potentially inducing malalignment of the knee [2, 3]. In the case of unicompartmental OA and malalignment, correction of the mechanical axis may reduce pain [4] and improve function [5]. Permanent correction can be achieved by high tibial osteotomy (HTO) with a 77-98% satisfaction rate after more than ten years of follow-up [6]. To increase the HTO success rate, it is essential to select the patients most likely to benefit from the procedure. The criteria stated by the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) are valuable and generally accepted, but a clinical test can possibly complement the selection process to improve results. A simple clinical test to select the right candidates for HTO was suggested by Robert A Teitge, MD, Professor Emeritus, a pioneer in osteotomy treatment, a test that has remained unpublished until now.

This study aimed to describe the 'Teitge test' and investigate its interrater reliability. We hypothesised that the Teitge test has a high interrater reliability with a kappa value > 0.8.

Methods

Design

This was a prospective interrater reliability study. Testing occurred at Hvidovre Hospital from 11 August 2020 to 11 February 2022. The reporting follows the Guidelines for Reporting Reliability and Agreement Studies [7]. Based on a legal assessment from the Centre for Regional Development, The Capital Region of Denmark, it was concluded that the study did not require approval from the National Committee on Health Research Ethics in Denmark.

Patients

Patients eligible for HTO were recruited during their appointment in the outpatient clinic at the Department of Orthopaedic Surgery, Hvidovre Hospital. The inclusion criteria were unicompartmental medial knee OA Kellgren-Lawrence type 2-3, pain at the medial joint line, varus malalignment > 5 degrees on long weight-bearing X-rays, BMI 20-40 kg/m^2, age 30-70 years and ability to communicate in English or Danish. We excluded patients with lateral pain, mental illness, extension deficit (0 degrees), flexion deficit (90 degrees) of the knee or patients who were physically unable to stand without support. The subjects were informed in writing and verbally before signing a written consent form. None of the patients had prior experience with the test.

Preparation

A detailed description of the Teitge test was written and depicted by Robert A Teitge, MD, Professor Emeritus. Based on the description, a detailed manual describing how to execute the test was developed. To standardise the verbal instructions to the patient, the manual contained a written patient instruction to be read aloud by the investigator during the test (Supplementary material). The investigators practised the test together by performing it on five healthy individuals to standardise the techniques.

The Teitge test

The Teitge test was designed to simulate the rearrangement of the mechanical axis as achieved by HTO. It consists of a varus stress test followed by a valgus stress test. The varus test loads the medial compartment, provoking the known medial OA symptoms. The valgus test repositions the knee into a neutral mechanical axis, thereby unloading the medial compartment and relieving symptoms. Testing was performed on the asymptomatic or less symptomatic knee before assessing the knee of interest.

The test was performed as described below:

Before testing, two lines were marked on the floor 30 cm and 45 cm from the wall (**Figure 1** A).

FIGURE 1 Two lines are marked on the floor (**A**). The patient is placed in the starting position for varus test (**B**). The patient performs a test squat in this position (**C**). The investigator applies varus stress (**D**), while the patient performs a single-leg squat (**E**). The patient is placed in the starting position for the valgus test (**F**) and performs a test squat. The investigator applies valgus stress (**G**), while the patient performs a single-leg squat (H).

Varus test

The patient was placed sideways to the wall with the leg that would be tested closest to the wall. The inner foot was placed on the inner line with the ipsilateral shoulder leaned against the wall. The contralateral outer foot was lifted from the ground, putting full weight on the tested leg. The tip of the toes of the contralateral leg was allowed to touch the floor to support balance (Figure 1 B).

Step 1: The patient was instructed to perform a single leg squat in this position with the widest range of motion (ROM) possible (Figure 1 C).

Step 2: The investigator manually applied firm pressure to the medial side of the knee, producing varus stress and loading the medial compartment. At the same time, the patient was instructed to perform a single leg squat with the widest ROM possible (Figure 1 D + E).

Valgus test

The patient was turned 180 degrees and placed with the foot of the tested leg on the outer line. The contralateral shoulder was leaned against the wall. The contralateral inner foot was lifted from the ground, putting full weight on the tested leg. The tips of the toes of the contralateral leg were allowed to touch the floor to support balance (Figure 1 F).

Step 3: The patient was instructed to perform a single leg squat in this position with the widest ROM possible.

Step 4: The investigator manually applied firm pressure to the lateral side of the knee, unloading the medial

compartment. At the same time, the patient was instructed to perform a single leg squat with the widest ROM possible (Figure 1 G + H).

After the last squat, the investigator asked the patient the standardised question: 'Did you experience a significant relief in symptoms from the inner part of your knee when doing the last squat?' The test was considered to be positive if the patient gave a clear indication of symptom relief. An ambiguous answer was considered a negative test result.

Reliability testing

Reliability testing was performed by two experienced orthopaedic surgeons with more than ten years of experience with knee surgery. Testing was done independently, and the investigators were blinded to each other's results. Patients were not informed of the test result and were asked not to disclose any details from their first test. Both tests were completed on the same day. Results were noted in separate scorecards that were collected and kept by the primary investigator.

Statistical analysis

Reliability was calculated as Cohen's kappa (κ) : $\kappa = (p_o - p_c) / (1 - p_c)$

p_o = observed agreement and p_c = agreement expected by chance.

The kappa value reflects the agreement between raters, with a value from −1 to +1, where 1 represents perfect agreement, and 0 represents the agreement expected from random chance. κ = 0.10-20 indicates slight agreement, κ = 0.21-0.40 indicates fair agreement, κ= 0.41-0.60 moderate agreement, κ = 0.61-0.80 substantial agreement and κ = 0.80-1 almost perfect agreement [8].

To adjust for prevalence and bias, prevalence-adjusted bias-adjusted kappa (PABAK) was calculated as a secondary analysis [8].

Sample size

The estimated sample size was calculated using the minimum sample size requirements guidelines for Cohen's Kappa [9]. As the test is based on simple biomechanics and given the senior investigators' experience, we expected high agreement. Therefore, we hypothesised that the Teitge test would demonstrate a kappa value above 0.80 and and that it would perform significantly better than chance (null hypothesis κ = 0.0). With a power of 90%, an estimated proportion of positive ratings of 0.5 and a p value of 0.05, the estimated required sample size was 14 subjects.

Trial registration: not relevant.

Results

A total of 19 patients were included. One patient was subsequently excluded from analysis due to confusion regarding the side of the knee tested, resulting in 18 cases (six female and 12 male) for further analysis. The mean age was 56.7 (standard deviation (SD): ± 8.7) years and the mean BMI was 29.2 (± 3.5) kg/m^2. Investigator A had 11 positive test results and seven negatives. Investigator B had 15 positive test results and three negatives. The investigators agreed on a positive test result in 10/18 cases, a negative test result in 2/18 cases and disagreed in 6/18 cases (**Figure 2**). The observed agreement between the two investigators was 12/18 (67%).

FIGURE 2 Study results.

		Investigator A		Total
		Positive	Negative	
Investigator B	Positive	10	5	15
	Negative	1	2	3
Total		11	7	18

The interrater reliability for the Teitge test was k = 0.22 (95% confidence interval (CI): −0.29-0.72). Due to a weighted number of positive test results (11/18 and 15/18, respectively) the PABAK was applied, reaching κ = 0.33 (95% CI: −0.1-0.77).

Discussion

This is the first study to introduce and rigorously define the Teitge test developed to select the patients who will most likely benefit from HTO. The most important finding was the test's surprisingly low interrater reliability, with a kappa value of 0.22 and a PABAK of 0.33.

HTO was shown to reduce pain, increase function and delay the need for a total knee replacement (TKA) for up to more than 15 years in patients suffering from isolated medial OA and malalignment [2, 5, 6, 10]. HTO preserves the joint, and there are no absolute activity restrictions compared to TKA and unicompartmental knee replacement (UKA). This makes HTO a valuable treatment for younger patients with high activity demands [2, 10, 11]. The physiological mechanical axis passes from the hip's centre through the knee's centre. Varus malalignment leads to a shift of the weight-bearing line to pass through and load the medial compartment, inducing medial OA progression [3, 12]. Medial opening wedge osteotomy and lateral closing wedge osteotomy permanently correct the malalignment and unload the medial compartment, reducing pain and possibly slowing down OA progression. Return to sport and return to work rates in patients undergoing HTO were reported to be 75% and 80%, respectively [11]. These numbers leave room for improvement. Despite improving the surgical technique, selecting the patients most likely to benefit from the procedure is important to increase the success rate. Until now, non-obese patients with OA, medial joint line pain, varus malalignment of the knee have generally been considered suitable HTO candidates [13]. Some clinicians consider physical activity levels and physiological age, as patients who are less active or physiologically older may benefit more from UKA [13, 14]. The guidelines were stated by ISAKOS in 2005, and no significant adjustments have subsequently been introduced.

Unloading knee braces establish temporary axis realignment and have been reported to relieve pain and improve physical function in patients with medial OA and varus malalignment [4, 15], but evidence is inconclusive [16]. In the literature, unloading knee braces have also been suggested to predict HTO pain relief outcomes. A study found a decrease in VAS scores for 29 patients with a positive knee brace test following HTO, although the difference was not statistically significant [17]. The study was limited by not having a control group and by the risk of selection bias as not all patients who benefitted from knee brace treatment underwent HTO. Wearing a knee brace can be uncomfortable, and the evaluation process is more time-consuming than the Teitge

test.

The Teitge test is a practical clinical procedure that mimics the effect of axis realignment achieved from HTO. The test is meant as a supplement to clinical history and examination.

The low interrater reliability for the Teitge test is in line with that of other well-known physical examination tests used in everyday clinical work. When examining for meniscal pathology, McMurray's test has kappa values ranging from 0.16 to 0.38, and the values for joint line tenderness range from 0.11 to 0.25. Among meniscus tests only, the Thessaly test is more reliable with an interrater kappa value of 0.54 (95% CI: 0.37-0.72) [18]. The same problem applies to examination tests for shoulder pathology. Only the Full-can-test has been found to have a good interrater reliability. The remaining tests have kappa values ranging from 0.25 to 0.54, representing fair to moderate agreement [19]. Thus, most generally accepted and widely used physical examination tests only have fair to moderate reliability, in line with the finding for the Teitge test. This is discouraging, but no other test has proven to be a better alternative.

Consensus is lacking concerning what may be considered an acceptable kappa value for a test to be reliable in a clinical setting. Clinicians commonly acknowledge that test results should be interpreted and weighted according to each individual patient. Regarding the kappa value, clinical decision-making should always rely on a combination of clinical examination, patient history and professional experience and knowledge. The Teitge test can contribute by adding information about the patient's pain level and testing the effect of unloading the medial compartment mechanically. We do not recommend the Teitge test for absolute decision-making but find it valuable as an addition to the clinical examination. When selecting candidates for HTO based on the ISAKOS guidelines from 2005, the Teitge test may serve as a supplement. The test also holds potential for further development and evaluation.

Limitations

Due to the small sample, few cases can considerably affect the result. The uneven case distribution contributes to a low kappa value, the so-called Kappa paradox. Additionally, part of the Teitge test is a provocation test, and we cannot exclude the possibility of symptom exacerbation after the first test. This would potentially interfere with the subsequent test results. The investigators had no prior experience with the test. Even though they practised on five individuals together and used a written standard description, they might have executed the test slightly differently. Cibere et al. assessed the reliability of physical examination of the OA knee and the effect of standardisation. They showed an improvement in reliability for several of the 42 physical examination signs following a comprehensive standardisation process [20]. Further standardisation would potentially also have improved our results.

Conclusions

Fair agreement was found for the Teitge test, which therefore require careful interpretation. The test is not recommended for absolute decision-making but may supplement the ISAKOS guidelines when selecting candidates for HTO.

Correspondence *Rikke Dyhr Hansen.* E-mail: dyhrhansenrikke@gmail.com

Accepted 26 September 2024

Conflicts of interest Potential conflicts of interest have been declared. Disclosure forms provided by the authors are available with the article at ugeskriftet.dk/dmj

References can be found with the article at ugeskriftet.dk/dmj

Cite this as Dan Med J 2024;71(12):A10230666

doi 10.61409/A10230666

https://content.ugeskriftet.dk/sites/default/files/2024-09/a10230666-supplementary.pdf

REFERENCES

1. Long H, Liu Q, Yin H et al. Prevalence trends of site&;specific osteoarthritis from 1990 to 2019: findings from the Global Burden of Disease Study 2019. Arthritis Rheumatol. 2022;74(7):1172-83. https://doi.org/10.1002/art.42089
2. Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. Lancet. 2019;393(10182):1745-59. https://doi.org/10.1016/S0140-6736(19)30417-9
3. Sharma L, Song J, Dunlop D et al. Varus and valgus alignment and incident and progressive knee osteoarthritis. Ann Rheum Dis. 2010;69(11):1940-5. https://doi.org/10.1136/ard.2010.129742
4. Hunter D, Gross KD, McCree P et al. Realignment treatment for medial tibiofemoral osteoarthritis: randomised trial. Ann Rheum Dis. 2012;71(10):1658-65. https://doi.org/10.1136/annrheumdis-2011-200728
5. Brouwer RW, Huizinga MR, Duivenvoorden T et al. Osteotomy for treating knee osteoarthritis. Cochrane Database Syst Rev. 2014;12:CD004019. https://doi.org/10.1002/14651858.CD004019.pub4
6. Ollivier B, Berger P, Depuydt C, Vandenneucker H. Good long-term survival and patient-reported outcomes after high tibial osteotomy for medial compartment osteoarthritis. Knee Surg Sports Traumatol Arthrosc. 2021;29(11):3569-84. https://doi.org/10.1007/s00167-020-06262-4
7. Kottner J, Audige L, Brorson S et al. Guidelines for Reporting Reliability and Agreement Studies (GRRAS) were proposed. Int J Nurs Stud. 2011;48(6):661-71. https://doi.org/10.1016/j.ijnurstu.2011.01.016
8. Sim J, Wright CC. The kappa statistic in reliability studies: use, interpretation, and sample size requirements. Phys Ther. 2005;85(3):257-68. https://doi.org/10.1093/ptj/85.3.257
9. Bujang MA, Baharum N. Guidelines of the minimum sample size requirements for Kappa agreement test. Epidemiol Biostat Public Health. 2017;14(2). https://doi.org/10.2427/12267
10. Spahn G, Hofmann GO, von Engelhardt LV et al. The impact of a high tibial valgus osteotomy and unicondylar medial arthroplasty on the treatment for knee osteoarthritis: a meta-analysis. Knee Surg Sports Traumatol Arthrosc. 2013;21(1):96-112. https://doi.org/10.1007/s00167-011-1751-2
11. Kunze KN, Beletsky A, Hannon CP et al. Return to work and sport after proximal tibial osteotomy and the effects of opening versus closing wedge techniques on adverse outcomes: a systematic review and meta-analysis. Am J Sports Med. 2020;48(9):2295-304. https://doi.org/10.1177/0363546519881638
12. Sharma L, Song J, Felson DT et al. The role of knee alignment in disease progression and functional decline in knee osteoarthritis. JAMA. 2001;286(2):188-95. https://doi.org/10.1001/jama.286.2.188
13. Brinkman JM, Lobenhoffer P, Agneskirchner JD et al. Osteotomies around the knee: patient selection, stability of fixation and bone healing in high tibial osteotomies. J Bone Joint Surg Br. 2008;90(12):1548-57. https://doi.org/10.1302/0301-620X.90B12.21198
14. Amendola A, Bonasia DE. Results of high tibial osteotomy: review of the literature. Int Orthop. 2010;34(2):155-60. https://doi.org/10.1007/s00264-009-0889-8
15. Moyer RF, Birmingham TB, Bryant DM et al. Valgus bracing for knee osteoarthritis: a meta-analysis of randomized trials. Arthritis Care Res (Hoboken). 2015;67(4):493-501. https://doi.org/10.1002/acr.22472
16. Duivenvoorden T, Brouwer RW, van Raaij TM et al. Braces and orthoses for treating osteoarthritis of the knee. Cochrane Database Syst Rev. 2015;3:CD004020. https://doi.org/10.1002/14651858.CD004020.pub3
17. Minzlaff P, Saier T, Brucker PU et al. Valgus bracing in symptomatic varus malalignment for testing the expectable “unloading effect” following valgus high tibial osteotomy. Knee Surg Sports Traumatol Arthrosc. 2015;23(7):1964-70. https://doi.org/10.1007/s00167-013-2832-1

18. Décary S, Ouellet P, Vendittoli PA, Desmeules F. Reliability of physical examination tests for the diagnosis of knee disorders: evidence from a systematic review. Man Ther. 2016;26:172-82. https://doi.org/10.1016/j.math.2016.09.007
19. Apeldoorn AT, Den Arend MC, Schuitemaker R et al. Interrater agreement and reliability of clinical tests for assessment of patients with shoulder pain in primary care. Physiother Theory Pract. 2021;37(1):177-196. https://doi.org/10.1080/09593985.2019.1587801
20. Cibere J, Bellamy N, Thorne A et al. Reliability of the knee examination in osteoarthritis: effect of standardization. Arthritis Rheum. 2004;50(2):458-68. https://doi.org/10.1002/art.20025

