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Clinical tests versus KT-1000 instrumented test in ACL injuries

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Abstract
Data from 515 knee arthroscopies performed at IMS&SUM Hospital, Bhubaneswar between September 2015 and December 2018 for ligament injuries, loose body removals, lateral release of the patellar retinaculum, plica division, and adhesiolysis was prospectively collected. A subset of 360 patients from the above group who sequentially had clinical examination, KT-1000, MRI and arthroscopy for ACL injuries were considered for the present study and 155 patients without ACL injuries served as control group and the data was reviewed. In these patients, the results of clinical tests and instrumented laxity tests without anesthesia prior to the arthroscopy were analyzed. An experienced surgeon performed KT-1000 assessment. Clinical and KT-1000 findings were compared with Arthroscopy as the gold standard. A thorough clinical examination along with KT-1000 performed by a skilled examiner more accurately correlated at Arthroscopy. The KT-1000 knee arthrometer (KT-1000) is an objective instrument to measure anterior tibia motion relative to the femur for anterior cruciate ligament (ACL) reconstruction. The Lachman test and the maximum anterior pull KT-1000 instrumented test revealed abnormal laxity in 159 and 162 of 168 cases of acute ACL injuries whereas 141 and 150 of 152 cases of chronic ACL injuries respectively.

Keywords: Transverse process, spinal fracture, spine trauma, lumbar spine, injury, sports

Introduction

ACL deficiency can be evaluated using clinical tests (namely the anterior drawer test, Lachman test, and pivot shift test), magnetic resonance imaging, arthroscopy, and arthrometric testing. Comparing surgical outcomes using imaging modalities or arthroscopy is not objective. Although clinical tests are useful for diagnosis and treatment, their interpretation can vary among clinicians. The KT-1000 knee arthrometer (KT-1000) is an objective instrument for ACL reconstruction, which measures anterior tibia motion relative to the femur. The test involves strapping the KT-1000 to the leg, pulling the tibia anteriorly, and quantifying the amount of movement in millimeters (mm). A KT-1000 score is derived by subtracting the anterior tibia motion relative to the femur of the injured knee to that of the uninjured knee. Most acute tears of the anterior cruciate ligament (ACL) should be detected using the Lachman test, popularized by Torg.*et al*. under anesthesia [5, 6]. However, the reported sensitivity of the Lachman test performed in acute cases without anesthesia range from 24 to 99 percent [1, 3, 5-7].With KT-1000 diagnosis and preferably grading of abnormal laxity, could be done in the consultation room without anesthesia. The purpose of the study was to compare the ability of clinical and instrumented (KT1OOO) laxity tests to reveal subsequently arthroscopically verified partial or total tear of the ACL.

Material and Methods

In our study, 168 patients with acute ACL injury (<3wks), 152 patients with chronic ACL injury (>3wks) and 155 patients with no ACL injuries (control) confirmed by diagnostic arthroscopy were assessed. The comparative gold standard was a history and clinical examination. Patient demographics (age and gender distribution) were reported. All patients underwent clinical examinations and KT-1000 test by an experienced examiner as well as magnetic resonance imaging by a team of radiologists. It was concluded that the KT-1000 score of >3 mm was diagnostic of an ACL disruption. All patients referred to IMS&SUM Hospital, Bhubaneswar after sustaining knee injury are subjected to a standardized set of anamnestic questions, clinical tests and instrumented laxity tests by the KT-1 000 when an injury of the ACL is suspected anamnestically (an audible pop at the time of injury, immediate swelling, Hemarthrosis, sensation of instability when attempting walking and episodes of subluxation). In 320 consecutive patients, found by means of arthroscopy to have a total or partial rupture of the ACL, the results of the prior clinical and instrumented laxity tests were examined to evaluate the ability of the tests to reveal the After aspiration of hemarthrosis, if present, standard clinical tests were performed, i.e., the Lachman test, the anterior drawer test and the pivot shift test, and for all tests the result was graded as positive (abnormal laxity) or negative (normal laxity), or if the test could not be performed adequately due to

Pain or muscle spasm, equivocal. The clinical evaluation was followed by instrumented measurement of anterior knee laxity in the Lachman position with the KT-1000 arthrometer. Anterior laxity using manual maximum anterior pull was recorded to the nearest 0.5 mm for the injured and non-injured normal knee and injured-normal (l-N) laxity differences were calculated. A laxity

difference of 3 mm or more was considered pathologic, while a difference from 2 to 3 mm was considered equivocal [4]. The clinical laxity tests were repeated in anaesthesia at the time of arthroscopy. Limitations in the methodology were [1] the examiner was not blinded to the patients' injury status. Selection bias may therefore have been present [2]. Patients with chronic ACL injuries may respond differently to those with acute injuries [3]. Adequate anterior pul has to be used to overcome muscle tension to reveal abnormal laxity in acute ACL tears using the KT- I 000 arthrometer [4]. In the present study, adequate anterior pull has to be used to overcome muscle tension in acute ACL tears. This is accomplished by the maximum anterior pull instrumented test, but the anterior force used is not measured, and therefore is not standardized.

Statistical analysis

The results obtained from clinical findings, MRI and arthroscopic examination of the study population were analyzed. The clinical and MRI diagnoses were placed into one of the four categories after arthroscopic evaluation. True positive, when an abnormal finding (ACL) reported by KT-1000 or clinical examination and confirmed at arthroscopy surgery. True negative: had no abnormalities noted clinically or by KT-1000 or at Arthroscopy. False positive: if the clinical examination or KT-1000 reported an abnormality but was not confirmed at arthroscopic operation. False negative: had a negative clinical examination or KT-1000 report and a positive finding at operation.

Based on the above categories, five parameters were calculated to assess the reliability of the KT-1000 results. Sensitivity is the Ability of clinica examinations or KT-1000 to detect the proportion of abnormal cases (Tear) in the study population that are correctly identified as such by Arthroscopy. It is determined by the equation: True-positive/ (True-positive + False negative) X 100 per cent. Specificity is the ability of clinical examination or KT-1000 to detect the proportion of normal cases (Without Tear) that are correctly identified as such by Arthroscopy. It is determined by the equation: True-negative/ (True-negative + False-positive) X 100 per cent. Positive predictive value / Precision is the proportion of actual abnormal cases (With Tear) among the cases that are detected as abnormal by clinical examination or KT-1000. It is calculated by the equation: True-positive/ (True-positive + False-positive) X 100 per cent. Negative predictive value is the proportion of actual normal cases (Without Tear) among the cases that are detected as normal by clinical examination or KT-1000. It is calculated by the equation: True-negative/ (True-negative + False-negative) X 100 per cent. Accuracy is the ability of clinical examination or KT-1000 to detect the actual normal cases (With Tear) and actual abnormal cases (Without Tear) among the total study population. It is calculated by the equation: (True-positive + True-negative)/ (True-positive + False-positive + True-negative + False-negative) X 100 per cent.

All the analyses were done by using SPSS 21 version. The compiled data along with the analytical results are represented in the tables and charts. Forward step wise logistic regression analysis was used to explore the relationship between arthroscopic verified diagnosis, partial/complete ACL tear (dependent variables) and the possible predictor variables (independent variables), results of Lachman test, pivot shift test and instrumented measurement of anterior knee laxity. McNemar's test for binomial proportions for matched-pair data was used to compare the Lachman test and KT-1000 instrumented tests using maximum anterior pull as these comparisons were thought to be of prime interest (4 comparisons). To permit statistical analyses the results of the clinical and instrumental laxity tests were categorized as 1: unstable or 0: stable or equivocal result. In the instrumental test, I-N difference >3 mm was categorized as 1 and < 3 mm as 0.As comparing multiple groups introduces greater probability of type1 error, the required P-value(0.05) was divided by the number of comparisons (Bonferroni's correction); $p<0.012$ (0.05/4) was regarded as significant.

Table 1: (Clinical and KT-1000 anterior laxity tests without anaesthesia in acute ACL injuries)

	Negative	Equivocal	Positive
KT-1000	1	5	162
Lachmen	3	6	159
Pivot Shift	5	89	74
Anterior drawer	12	87	69

Table 2: (Clinical and KT- 1000 anterior laxity tests without anesthesia in chronic ACL injuries)

	Negative	Equivocal	Positive
KT-1000	1	1	150
Lachmen	2	9	141
Pivot Shift	3	62	87
Anterior drawer	9	64	79

Table 3: (Clinical and KT- 1000 anterior laxity tests without anesthesia in control group)

	Negative	Equivocal	Positive
KT-1000	153	1	1
Lachmen	148	5	2
Pivot Shift	153	1	1
Anterior drawer	9	67	79

Table 4: Shows comparison of the findings of KT-1000 with those of arthroscopy with regards to tears of Anterior Cruciate Ligament

Clinical Arthroscopy	Tear	Normal
Tear	300(True Positive)	20(False negative)
Normal	7(False positive)	153(True negative)

Sensitivity-93.75%, Specificity-95.62%, positive predictive value-97.71%, Negative Predictive Value- 88.43%, Accuracy- 94.37%

Table 5: Shows comparison of the findings of clinical examination with those of arthroscopy with regards to tears of Anterior Cruciate Ligament

KT-1000 Arthroscopy	Tear	Normal
Tear	312(True positive)	8 (False Negative)
Normal	1(False Positive)	148 (True Negative)

Sensitivity- 97.50%, Specificity- 99.32%, Positive Predictive Value-99.68%, Negative Predictive Value- 94.87%, Accuracy- 98.08%

Results

The Lachman test and the maximum anterior pull KT-1000 instrumented test revealed abnormal laxity in 159 and 162 of 168 cases of acute ACL injuries whereas 141 and 150 of 152 cases of

chronic ACL injuries respectively. No significant difference was found between the Lachmen and maximum anterior pull instrumented test (p>0.012)

Discussion

All patients submitted to the outpatient clinic after sustaining a knee injury have been included in the study which has made calculation of sensitivity and specificity of the clinical tests and the KT-1000 laxity test possible. However, it is neither ethical nor possible due to practical reasons to subject all patients who have sustained a knee injury to an arthroscopic examination of the knee without proper suspicion of a major intra-articular injury. Further, suspected ACL tears tend to predominate as the cause of referral of patients with knee injuries to our hospital as we take special interest in the treatment of such injuries. Thus, the objective of this study was to compare the ability of clinical and instrumented (KT- 1 000) laxity tests to reveal subsequently arthroscopically verified acute partial or total tear of the ACL. To obtain a standardized execution of the clinical tesla and the KT-1000 laxity tests, the following. measures were taken [1]: all tests were performed by the same surgeon, eliminating inter-observer variance [2]; the clinical tests were always done first, before the KT- 1 000 laxity test [3]; the neutral point was established by calibration during repeated tests. Daniel *et al.* found that instrumented measurement of anterior laxity with KT-1000 with 89N revealed abnormal anterior laxity in 62% and normal anterior laxity in 9 of acute ACL tears, whereas abnormal anterior laxity was revealed in 91% by maximum anterior pull test [4]. In our study…..Dahlstedt and Dalton reported a sensitivity of 56 using 89N anterior load, but did not discuss the sensitivity obtained using maximum anterior pull test without anaesthesia [3]. Aderson *et al*, reported a sensitivity of 75% using 89N, compared to 91 % using Lachmen test [1]. Like Dahlstedt and Dalton they did not report the maximum anterior pull instrumented test. In the present study, adequate anterior pull has to be used to overcome muscle tension in acute ACL tears. This is accomplished by the maximum anterior pull instrumented test, but the anterior force used is not measured, and therefore is not standardized. Another way of increasing thesensitivity of instrumented testing with low anterior loads could be to set the limit of normal I-N laxity difference at 2 mm. Bach *et al*. stated that 89 N test with a cutoff point of 2 mm and a maximum manual force test with a 3 mm cutoff point both gave a similar sensitivity of 90 % [2]. It is reported, however, that [s] % of right-to-left differences in normal knees would be outside this range [4], which would decrease the specificity of the test. A cutoff point of 3 mm, therefore, should be recommended. We conclude that with KT-1000 diagnosis and preferably grading of abnormal laxity, could be done in the consultation room without anesthesia and the present study supports the contention that adequate anterior pull has to be used to overcome muscle tension to reveal abnormal laxity in acute ACL tears using the KT-1000 anthropometer.

Fig 1

Fig 2

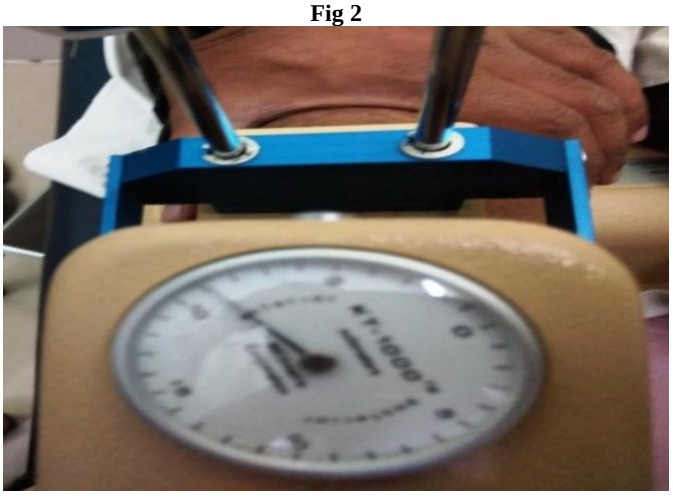

Fig 3

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