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Original Research Article

Assessment of Pivot Shift Phenomenon Under Anesthesia in Anterior Cruciate Ligament-Deficient Knees

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Abstract: *Background*: The pivot shift phenomenon is a key indicator of rotational instability in ACL-deficient knees, typically assessed under anesthesia for diagnostic and surgical planning purposes. *Objective:* To determine the prevalence and grade of positive pivot shift tests under anesthesia in patients with confirmed ACL deficiency. *Methods:* A prospective study of 75 ACL-deficient patients (52 males, 23 females; mean age 28.5 years) was conducted at Jamalpur Medical College in 2023. Diagnoses were confirmed via clinical tests and MRI. An experienced orthopedic surgeon performed the pivot shift test under general anesthesia using a standardized technique. Grades were recorded per Noyes classification, along with reduction point and presence of clunk. *Results:* 68 patients (90.7%) showed a positive pivot shift: Grade I in 35 (51.5%), Grade II in 25 (36.8%), and Grade III in 8 (11.8%). Reduction commonly occurred at 20–30° knee flexion, with a clunk observed in 55 patients (80.9%). Seven patients (9.3%) showed no pivot shift. *Conclusion:* A high prevalence (90.7%) of positive pivot shift under anesthesia was observed, with most cases graded as mild to moderate. The test's reliability in evaluating rotational instability highlights its diagnostic and surgical planning value in ACL-deficient knees.

Keywords: Anterior cruciate ligament deficiency, ACL, Pivot shift test, Rotational instability, Knee examination under anesthesia, Noyes classification.

Introduction

Anterior cruciate ligament (ACL) injury is a common and often debilitating knee injury, particularly among active individuals. The ACL plays a crucial role in providing anteroposterior and rotational stability to the knee joint. A deficiency of the ACL can lead to symptomatic instability, characterized by episodes of giving way, and can increase the risk of secondary meniscal and chondral damage[1]. Clinical examination remains the cornerstone in the diagnosis of ACL deficiency. The Lachman test and the anterior drawer test are widely used to assess anterior tibial translation. However, rotational instability, another significant consequence of ACL injury, is best evaluated by provocative maneuvers such as the pivot shift test[2]. The pivot shift test is a dynamic clinical examination that assesses anterolateral rotational instability. It is performed by applying a valgus stress and internal rotation to the tibia while flexing the knee from near full extension. In an ACL-deficient knee with anterolateral rotatory instability, the lateral tibial plateau subluxates anteriorly in near extension and then reduces suddenly as the knee is flexed beyond approximately 20-40 degrees[3]. This reduction is

often accompanied by a palpable or audible "clunk" or "jerk," which constitutes a positive pivot shift test. While the pivot shift test is a valuable diagnostic tool in the awake patient, its reliability can be influenced by patient apprehension, muscle guarding, and pain[4]. Examination under anesthesia (EUA) eliminates these factors, allowing for a more relaxed and potentially more accurate assessment of knee ligamentous laxity, including the pivot shift phenomenon[5]. Assessment of the pivot shift under anesthesia is frequently performed before ACL reconstruction to confirm the diagnosis, evaluate the degree of rotational instability, and guide surgical decision-making, such as the need for additional anterolateral ligament (ALL) reconstruction or other augmentation procedures[6]. The grading of the pivot shift under anesthesia, typically using the Noyes classification, provides a semi-quantitative measure of rotational instability[7]. This prospective observational study aimed to systematically evaluate the prevalence and characteristics of the pivot shift phenomenon under general anesthesia in a cohort of patients with clinically and radiologically confirmed ACL deficiency. We sought to determine the proportion of ACL-deficient knees exhibiting a positive pivot shift under anesthesia and to describe the grade and other salient features of the observed pivot shift. The findings of this study will contribute to a better understanding of the utility of EUA in assessing rotational instability in ACL-deficient knees.

Objectives

To assess the prevalence and grade of the pivot shift phenomenon under general anesthesia in patients with clinically and radiologically confirmed ACL deficiency.

Materials and Methods

Study Design

This prospective observational study was conducted at the Department of Ortho Surgery, Jamalpur Medical College between January 2023 and December 2023. All patients provided informed consent before their participation.

Patient Selection

We included 75 consecutive patients who presented with knee symptoms and were subsequently diagnosed with ACL deficiency based on a combination of clinical examination and MRI findings. Clinical examination, performed by an experienced orthopedic surgeon, included the Lachman test (graded according to the International Knee Documentation Committee (IKDC) grading system), the anterior drawer test, and McMurray's test to assess for meniscal injury. MRI confirmed the diagnosis of ACL tear in all included patients. Patients with multi-ligament injuries, previous knee surgery on the affected knee, or evidence of significant osteoarthritis (Kellgren-Lawrence grade ≥ 2) were excluded from the study.

Examination Under Anesthesia

All patients underwent a standardized knee examination under general anesthesia prior to any surgical intervention (e.g., ACL reconstruction, arthroscopy). The examination was performed by a single experienced orthopedic surgeon who was not involved in the initial clinical diagnosis to minimize observer bias.

Pivot Shift Test Technique

The pivot shift test was performed using a standardized technique. The patient was positioned supine with complete muscle relaxation achieved under general anesthesia. The examiner held the patient's leg with one hand grasping the distal tibia and the other hand applying a valgus force at the level of the proximal tibia. The knee was then brought from near full extension into flexion while simultaneously applying an internal rotation force to the tibia.

Pivot Shift Grading

The grade of the pivot shift phenomenon was documented according to the Noyes classification [10]

Grade 0: No discernible pivot shift.

Grade I (Glide): A subtle glide of the lateral tibial plateau with no gross shift or clunk.

Grade II (Jump over the plateau): A more pronounced anterior subluxation of the lateral tibial plateau that reduces with a distinct jump or clunk as the knee is flexed beyond approximately 20-40 degrees.

Grade III (Gross rotation): A gross rotatory subluxation of the tibia that reduces with a marked clunk, often occurring earlier in flexion.

Additional Characteristics: In addition to the grade, the examiner also recorded

The approximate range of knee flexion at which the pivot shift reduction occurred.

The presence or absence of a palpable and/or audible clunk at the point of reduction.

Data Analysis

Descriptive statistics were used to summarize the prevalence and grading of the pivot shift phenomenon under anesthesia. Frequencies and percentages were calculated for categorical variables (pivot shift grade, presence of clunk).

Results

A total of 75 patients with clinically and radiologically confirmed ACL deficiency were included in the study. The demographic characteristics of the study population are summarized in Table 1.

Table 1: Demographic Characteristics of the Study Population (n=75)

Characteristic	Value
Mean Age (years)	28.5 (± 7.2)
Age Range (years)	18 - 45
Gender (Male: Female)	52:23

The results of the pivot shift assessment under anesthesia are presented in Table 2. Out of the 75 patients with ACL deficiency, 68 patients (90.7%) demonstrated a positive pivot shift test under anesthesia (Grade I, II, or III). The majority of the positive pivot shifts were Grade I (46.7%) and Grade II (33.3%). Grade III pivot shifts were observed in 10.7% of the patients. Seven patients (9.3%) did not exhibit a discernible pivot shift under anesthesia (Grade 0).

Table 2: Pivot Shift Phenomenon Under Anesthesia (n=75)

Pivot Shift Grade	Number of Patients (n)	Percentage (%)
Grade 0	7	9.3
Grade I	35	46.7
Grade II	25	33.3
Grade III	8	10.7
Total Positive (Grade I-III)	68	90.7

The pivot shift reduction typically occurred between 20 and 30 degrees of knee flexion in most cases with a positive test. A palpable and/or audible clunk at the point of reduction was noted in 55 out of the 68 patients (80.9%) who had a positive pivot shift.

Table 3: Characteristics of Positive Pivot Shift Under Anesthesia (n=68)

Characteristic	Value / Range	Number of Patients (n)	Percentage (%)
Knee Flexion at Reduction (degrees)	Typically, 20 - 30	Majority	N/A
Palpable and/or Audible Clunk	Present	55	80.9

Discussion

The findings of this prospective observational study indicate a high prevalence (90.7%) of a positive pivot shift test under anesthesia in patients with clinically and radiologically confirmed ACL deficiency. This suggests that the pivot shift phenomenon, a key indicator of rotational instability, is readily demonstrable under the relaxed conditions provided by general anesthesia in the vast majority of ACL-deficient knees. Our results show that the majority of positive pivot shifts were graded as Grade I (glide) or Grade II (jump over the plateau), indicating mild to moderate rotational instability according to the Noyes classification[8]. Grade III pivot shifts, representing gross rotational instability, were less frequent in our cohort (10.7%). This distribution of pivot shift grades may reflect the spectrum of chronicity and severity of ACL injuries in our study population. The observation that the pivot shift reduction typically occurred between 20 and 30 degrees of knee flexion is consistent with the biomechanical understanding of anterolateral rotatory instability in ACL-deficient knees[9]. In near extension, the lack of ACL restraint allows for anterior subluxation of the lateral tibial plateau. As the knee is flexed and the iliotibial band transitions from an extensor to a flexor of the knee, it exerts a posteriorizing force on the lateral tibia, leading to the sudden reduction of the subluxated plateau[10]. The presence of a palpable and/or audible clunk during the reduction of the pivot shift was a

common finding in our study, occurring in approximately 81% of patients with a positive test. This clunk is thought to be generated by the reduction of the subluxated lateral tibial plateau as it articulates with the lateral femoral condyle. The presence of a distinct clunk can provide additional confidence in the diagnosis of rotational instability. Interestingly, 9.3% of our patients with confirmed ACL deficiency did not exhibit a discernible pivot shift under anesthesia. Several factors could potentially explain this observation. The severity and pattern of the ACL tear, the presence and degree of secondary restraints (e.g., meniscal integrity, capsular structures), and individual anatomical variations may influence the clinical manifestation of rotational instability[11-20]. It is also possible that even under anesthesia, subtle degrees of rotational instability might not be consistently elicited or perceived as a positive pivot shift by the examiner. The findings of this study have implications for the clinical assessment and surgical management of ACL-deficient knees. The high prevalence of a positive pivot shift under anesthesia underscores the importance of EUA as a valuable adjunct to awake clinical examination in confirming the diagnosis and evaluating rotational instability. The grading of the pivot shift under anesthesia can provide the surgeon with important information regarding the degree of rotatory laxity, which may influence the choice of surgical technique, including the consideration of additional lateral extra-articular procedures in cases of high-grade pivot shifts.

Conclusion

The pivot shift phenomenon was highly prevalent (90.7%) under anesthesia in this cohort of patients with clinically and radiologically confirmed ACL deficiency. The majority of positive pivot shifts were graded as mild to moderate (Grade I and II), and a palpable/audible clunk during reduction was common. These findings support the utility of the pivot shift test under anesthesia as a valuable tool in the assessment of rotational instability in ACL-deficient knees and highlight its potential role in guiding surgical management strategies.

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