Original Article

Arthroscopic Anterior Cruciate Ligament Reconstruction Learning Curve: Analysis of Operating Time and Clinical Outcomes

Abstract

Background: Technical proficiency for arthroscopic anterior cruciate ligament reconstruction (ACLR) is complex and requires learning and practice. Achieving an appropriate level of competency with this surgery is important for patient safety and satisfactory surgical outcomes. There is limited literature about the learning curve in ACLR in Africa. **Objectives:** This study aimed to demonstrate the learning curve associated with ACLR. **Materials and Methods:** This retrospective study on arthroscopic ACLR was conducted between January 2020 and June 2023 with a minimum of 12 months follow-up. The primary outcome measure was operation time, whereas the secondary outcome measures were functional outcome and postoperative complications. **Results:** One hundred fifty-nine ACLR met the inclusion criteria and were analysed. The mean age of the patients was 31.47 ± 9.50 years. There were 148 (93.1%) males and 11 (6.9%) females. The median operation time was 50 min (45–190 min). There was progressively decreasing operation time with increasing number of cases done until after the first 19 cases. The mean operating time for the first 19 cases was 143.89 ± 32.84 min, whereas the mean operating time for the later 140 cases was 53.81 ± 9.72 min (P = 0.000). **Conclusions:** The operation time for arthroscopic ACLR progressively decreased until after the first 19 cases. There was, however, no significant difference in the clinical outcome between the cases done during the learning curve and those done at proficiency.

Keywords: *Anterior cruciate ligament, arthroscopy, learning curve*

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Introduction

Anterior cruciate ligament injury is the most common knee ligament injury. It may be severely disabling and can be a carrier-ending problem for athletes especially football players.[1] To restore knee stability and prevent secondary injuries, which may result in progressive degeneration of the knee joint, arthroscopic anterior cruciate ligament reconstruction (ACLR) is accepted globally as the treatment of choice for active individuals.[2] However, technical proficiency for arthroscopic ACLR is complex and requires learning and practice.[3] When a new procedure is being performed, efficiency tends to improve with experience, and graphically plotting performance against experience produces a learning curve.[4,5] Achieving an appropriate level of competency with arthroscopic procedures is important for patient safety and satisfactory surgical outcomes.[6]

There has been growing interest in arthroscopic surgeries in the past few decades in resource-constrained regions like ours. However, there is paucity of literature about the learning curve associated with arthroscopic ACLR in our subregion.

The purpose of this study, therefore, was to demonstrate the learning curve associated with arthroscopic ACLR and to demonstrate the path to its proficiency. Our hypothesis was that there would be a significant decrease in operating time and improved outcomes as the number of operative procedures increases.

Materials and Methods

This retrospective study evaluates patients from a prospectively collected database from a government orthopaedic referral hospital and three private orthopaedic hospitals in Northern Nigeria. The study included patients who underwent anatomical single bundle arthroscopic ACLR between January 2020 and June 2023 and were followed up for a minimum

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of 12 months. The exclusion criteria were multiligament knee reconstruction, knee cartilage surgery, revision ACLR, and bilateral ACLR. All patients were reviewed preoperatively using a standard hospital protocol for elective arthroscopic surgeries. Full clinical history and thorough physical examination were performed. Plain radiography and magnetic resonance imaging of the affected knee were done. Patients were operated upon by a single surgeon within the first 3 years of postfellowship training. Surgery was performed under general or spinal anaesthesia. Pneumatic tourniquet was applied to the upper thigh and inflated after graft preparation. Triple-weaved hamstring or peroneus longus autograft was used in all cases. The graft was harvested from ipsilateral limb and prepared by the same surgeon. Surgery was performed using standard anterolateral and anteromedial knee arthroscopy portals. Accessory anteromedial portals were made when indicated. Examination under anaesthesia was performed in all cases. Initial systematic diagnostic arthroscopy was performed to identify intra-articular pathologies. After addressing associated meniscal lesions, femoral and tibial tunnels were made using inside-out technique for femur and outside-in for tibia. Graft fixation was done using either bioabsorbable interference screws for both femur and tibia or endobotton with loop for femur and interference screw for tibia.

Postoperatively, patients underwent standardised program of rehabilitation. Functional evaluation was performed preoperatively and postoperatively at 6 weeks, 3 months, 6 months, and 1 year using Lysholm scoring system. Postoperative complications were also documented. The primary outcome measured in this study was operation time, which was calculated from portal incision time to portal closure time. The graft harvest and preparation times were excluded because graft preparation traditionally is usually prepared on a separate trolley during diagnostic arthroscopy. The secondary outcomes were functional outcomes and postoperative complications.

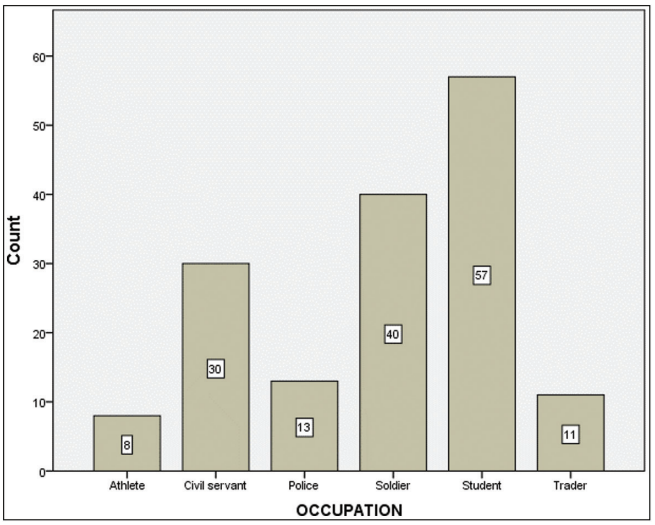

Figure 1: Patients' occupational distribution

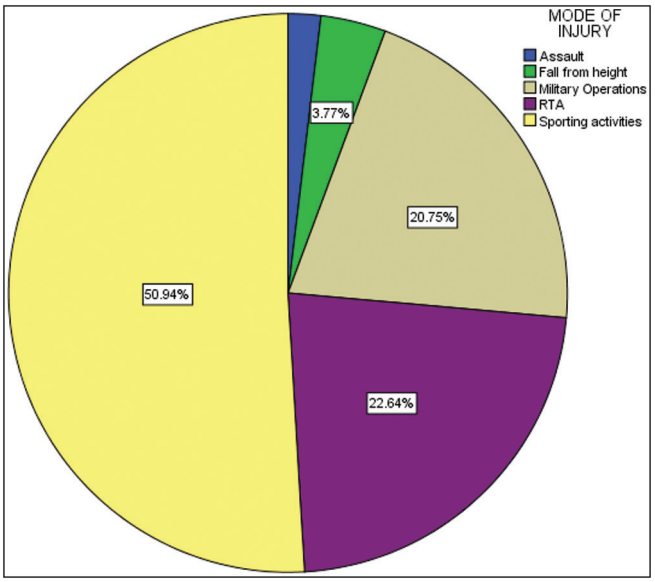

Figure 2: Mode of injury

Results

Patients' demographics

During the study period, 176 arthroscopic ACLR was performed on 172 patients by a single surgeon. Of these, 159 ACLR met the inclusion criteria and were analysed. The mean age of the patient was 31.47 ± 9.50 years. There were 148 (93.1%) males and 11 (6.9%) females. Eighty-two (51.6%) knees were left and 77 (48.4%) were right. Most of the patients were students followed by military personals accounting for 57 (35.8%) and 40 (25.2%), respectively [Figure 1]. Mode of injury was sporting activities in 81 (50.9%) patients and military operations in 33 (20.8%) patients. Others include road traffic accident and fall from height [Figure 2].

Operation time

The median operation time was 50 min (45–190 min). The line graph in Figure 3 shows progressively decreasing operation time with an increasing number of cases done, which flattens out after the first 19 cases. The mean operating time for the first 19 cases was 143.89 ± 32.84 min, whereas the mean operating time for the remaining 140 cases was 53.81 ± 9.72 min. There was significant difference in the mean operation time between the first 19 cases and the remaining 140 cases ($P = 0.000$).

Functional outcome

The mean preoperative and postoperative Lysholm scores were 46.79 ± 10.17 and 96.92 ± 2.06, respectively. There was a significant difference between the preoperative and postoperative Lysholm scores ($P = 0.000$). The preoperative and postoperative Lysholm scores for the initial 19 cases with longer operation time were also found not to be different from the remaining 140 subsequent cases with optimal operation time. Table 1 summarises the preoperative

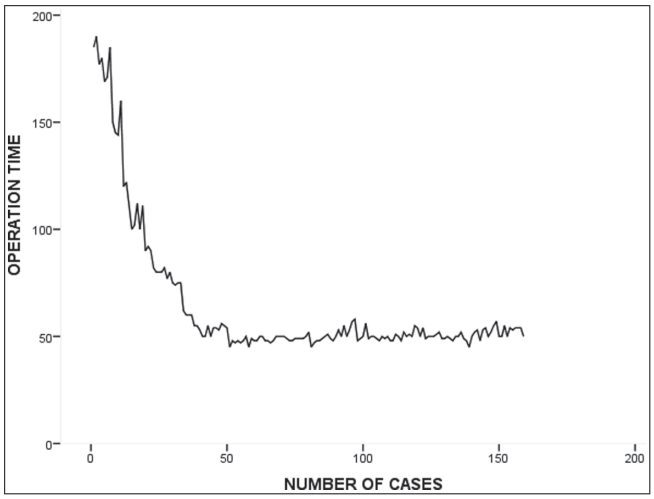

Figure 3: Graphical representation of operation time against number of cases

Table 1: Comparing preoperative and 1-year postoperative functions of the knee and comparing the outcomes of initial cases during the learning curve and those at proficiency

Number of cases	Preoperative Lysholm Score	Postoperative Lysholm Score	*P* value
All patients (*n* = 159)	46.79 ± 10.17	96.92 ± 2.06	0.000
Cases with longer operation time (*n* = 19)	44.74 ± 9.31	97.42 ± 1.92	0.360
Cases with shorter operation time (*n* = 140)	47.06 ± 10.28	96.85 ± 2.07	0.368

and postoperative Lysholm scores of all the patients and comparison of initial cases with longer operation time and subsequent cases with shorter operation time.

Complications rate

The overall complication rate in this series was 6 (3.8%). One patient had femoral fixation screw pull-out and subsequent graft failure, which necessitated revision ACLR within 3 weeks. This patient was the seventh patient in the series of the surgeon. Two patients had postoperative septic arthritis, which necessitated arthroscopic washout with preservation of the ACL graft. This did not affect the postoperative function of the patients. One of the patients was the first case in the series, whereas the second was the 42nd patient. The other three complications were knee stiffness that later resolved with prolonged rehabilitation protocols.

Discussion

Operative time has been the most used tool to assess the surgical learning curve. This is because it tends to decrease with surgeons' experience with the procedure.[7-9] This study shows that the operation time progressively decreased with a number of arthroscopic ACLR done by the surgeon and the decrease was noticed to flatten out after the first 19 cases. This is in consonance with previous studies on arthroscopic learning curve. Negru *et al*.[10] reported that the learning curve in arthroscopic ACLR has a positive impact on the operation time as they were able to demonstrate a significant reduction in tourniquet time with an increasing number of cases until a plateau was reached. This progressive reduction in operation time with an increasing number of cases is not exclusive to arthroscopic surgeries. Li *et al*.[11] noted that with an increasing number of InterTan intramedullary nail in treating femoral intertrochanteric fractures, the surgical technique was gradually improved and the operation time reduced with number of cases.

The current study also analysed the impact of learning curve on clinical outcomes of arthroscopic ACLR. It was noted that there was a significant difference between preoperative and postoperative clinical outcomes ($P = 0.000$). It is interesting to know that there was no significant difference ($P = 0.368$) in postoperative clinical outcomes between initial 19 cases with longer operation time and subsequent cases after the end of the learning curve. This may be partly because the surgeon was being extra careful not to make mistakes during surgery and that was why the operation time was longer. However, more complications were noticed in the first series of 19 cases with longer operation time. These include graft fixation pull out from femoral tunnel necessitating revision surgery in one patient. But these complications did not affect the overall clinical outcome in general. Many studies similar to that of Lee *et al*.[12] have also reported that there is no difference in clinical outcomes between the initial cases and subsequent cases during the learning curve period. While we recognise some studies[5,13] that demonstrated improved clinical outcomes with increasing number of cases, many others found no difference in outcomes.[14]

The limitations of this study include being a retrospective and single-surgeon study. The generalisation of the findings may be inappropriate because the findings would be dependent on training and skills of the surgeon. However, single surgeon studies have advantages of reducing some confounding factors. Nonetheless, multicentre studies with multiple surgeons and large sample sizes are required to further validate the findings of the current study.

Conclusion

The operation time for arthroscopic ACLR progressively reduced until the end of learning curve. There is, however, no significant difference in the clinical outcome between the cases done during the learning curve and those done at proficiency. Technicality-related complications do occur during early arthroscopic learning by the surgeon.

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Conflicts of interest

There are no conflicts of interest.

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