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Postoperative radiological evaluation of anterior cruciate ligament reconstruction and its complications

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Abstract

Background: Postoperative Radiological Evaluation of Anterior Cruciate Ligament Reconstruction & Its Complications.

Method: In a comparative study in which patients were admitted and operated at Medical college & tertiary care hospital from January 2016 onwards. All patients who presented with symptoms after the surgery and whose data is available with the patients are considered. Plain radiograph which was taken after the surgery immediate postop, 2 weeks, 6 weeks and 3 months as routine follow-up, were documented for radiological evaluation. MR imaging which was done postoperatively during follow-up, was also documented for evaluation.

Result: Pain was the most common symptom (52%) followed by swelling (40%) and restricted movements (28%). There was significant widening of femoral and tibial diameter on plain radiograph in both the views anteroposterior and lateral during follow up period which started 2 weeks after surgery. There was increase in signal intensity in MR images for almost all the cases (92%). Femoral tunnel placement was perfect in 88 percent cases while tibial tunnel placement was perfect in 76 percent cases.

Conclusion: It can be concluded from the study that tunnel widening was unrelated to the postop complication as it was seen in all cases and Plain radiograph is a reliable measure to compare the tunnel widening on serial films as the results shows comparable data. There was increased graft intensity on MR images in maximum cases and this parameter is also unrelated to the complication. Tibial tunnel position is more important than femoral tunnel to prevent impingement as patient presented with restricted movements were having abnormal placement of tibial tunnel. Sterility is an important factor for surgical outcome as one of the patient developed septic like features after the surgery.

Keywords: ACL, MRI, complication

Introduction

Anterior cruciate ligament (ACL) tears are the most common complete ligamentous injury in the knee [1]. The importance of the anterior cruciate ligament in knee function has been emphasized for not only athletes who require knee stability in activities such as running and kicking but also in young and middle aged individuals who do not participate in sports. The management of ACL injuries is very complex and continues to evolve [2, 3]. ACL reconstruction has become the standard of care for ACL injuries in the active patient, and significant improvement in function can be achieved by present surgical techniques, although the anatomic and physiologic characteristics of the normal ACL may not be fully restored [4]. With current evolution, reconstructions are typically performed arthroscopically and with utilization of bone-patellar tendon-bone or hamstring autografts or allograft constructs. Surgical techniques of ACL reconstruction require proper placement and tensioning of the implanted graft with adequate fixation. Significant improvements have been made in performing arthroscopic anterior cruciate ligament reconstruction. With recent technique, restoration of stability with return to activity can generally be expected along with long term success rates of between 75% and 95% [4]. In spite of recent advancement in the management of ACL tear, almost 8-9 % of operated patient present with symptoms like swelling, persistent pain, laxity, decreased range of motion etc. [5]. The cause of the failure must be carefully identified and associated instability patterns must be recognized properly. The prevalence of recurrent instability after primary ACL reconstruction ranges from 1% to 8% [6, 7].

Early failures, those that occur within the first 6 months, often are secondary to poor surgical technique, failure of graft incorporation, or errors in rehabilitation. Late failures, those that occur more than 1 year after surgery, likely are related to new trauma and graft tearing [7]. Other complications of ACL reconstruction include roof impingement, postoperative stiffness, tunnel widening due to cyst formation, iliotibial band friction syndrome, hardware failure, and infection. The increased number of ACL reconstructions being performed [8] has led to an increased demand for postoperative knee evaluation when symptoms persist or recur after ACL reconstructive procedure. These all complication can be extensively studied by use of radiological tools like x-ray, CT scan, MRI etc.

Magnetic resonance (MR) imaging is the preferred advanced imaging modality for the evaluation of symptomatic ACL graft reconstructions [9, 10].

The aim of our study is to evaluate the radiological images of arthroscopically assisted anterior cruciate ligament reconstruction with autologous hamstring graft in patients presenting with symptoms after the surgery.

Materials and Methods

The record of 25 patients being treated for Anterior cruciate ligament tear who had undergone Arthroscopic repair of ACL With Autologous Hamstring Graft at medical college & tertiary care Hospital in 18 months from January 2016 to June 2017 were included in the study fitting into the inclusion criteria. The inclusion criteria: age group of 18 to 50 yr with complete tear of anterior cruciate ligament with or without meniscal injury presented with symptoms like pain, swelling, laxity, decreased range of motion after the surgery. Patients with multi ligament injury, previously operated knee and systemic illness were excluded.

The following MR imaging findings were evaluated

1. Increased signal intensity of the ACL graft was analysed on images as increased signal intensity within the substance of the graft or normal (no increased signal intensity change).
2. The position of the ACL graft tibial tunnel was assessed relative to the Blumensaat line (slope of the intercondylar roof) on sagittal images. If the anterior margin of the articular orifice of the tibial tunnel was located posterior to the Blumensaat line, the distance was recorded as a negative value (mm), and if it was located anterior to the Blumensaat line, the distance was recorded as a positive value (mm). Posterior placement of tunnel was considered normal.
3. The position of the ACL graft femoral tunnel was assessed relative to the intersection of the posterior femoral cortex and the distal femoral physeal scar corresponding to the superior-posterior margin of the intercondylar roof on sagittal images. Positioning of the posterior margin of the articular orifice of the femoral tunnel at the intersection point was recorded as 0. If the posterior margin of the tunnel orifice was located below this intersection, the measured distance between these points was recorded as a positive value (mm). Exact positioning of tunnel was considered normal.
4. The slope of the graft in the coronal plane was assessed at the angle formed between a line drawn along the long axis of the ACL graft and the plane of the tibial articular surface.

The following x-ray findings were evaluated

1. Femoral tunnel diameter- tunnel diameter was represented as ratio of tunnel diameter at the femoral aperture to the femoral canal diameter at the same level. same protocol was followed for both the views anteroposterior and lateral.
2. Tibial tunnel-the ratio of tibial tunnel diameter 2cm below the joint line to the tibial canal diameter at same level, was calculated.

This method helps in removing the bias regarding the magnification as ratio is constant for all the levels of magnification. Serial x-rays (immediate postop, 2 weeks, 6 weeks and 3months postop) were evaluated for this purpose.

Statistical analysis: The level of statistical significance was taken as p value < 0.05 , i.e. whatever difference was observed (mean/distribution) was real and can be attributed to the intervention in the study.

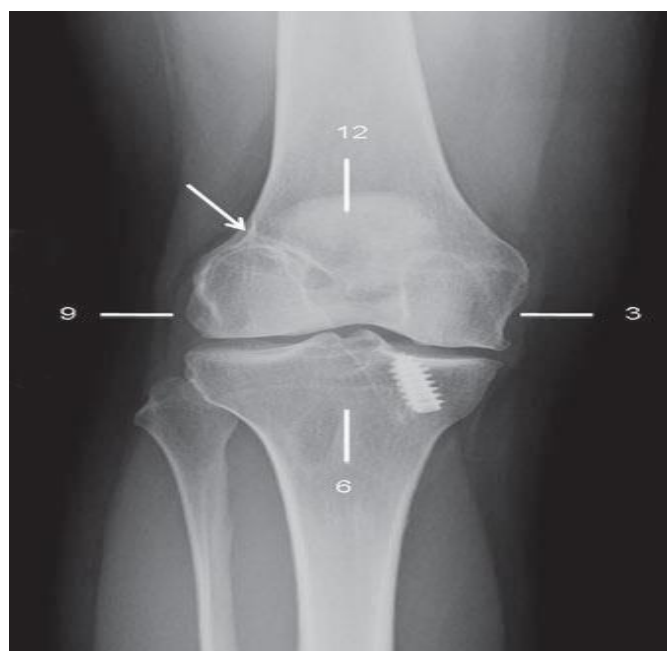


Fig 1: Anteroposterior view of operated knee



Fig 2: Lateral view of operated knee

Result

The mean age of the sample was 29.6 years. Out of 25 patients, 19 were male and 6 were female. 64% of the patients were having right sided tear while 36% were having left sided tear. There was statistically significant increase in tunnel diameter both tibial and femoral side in anteroposterior and lateral view of radiograph during postoperative period and it was most significant after 2 weeks of surgery. There was minimal or no widening of tunnel during first 2 weeks of postoperative period.

Table 1: Distribution of symptoms

Symptom	Frequency	Percentage
pain	13	52
swelling	10	40
Restricted movement	7	28
Laxity	3	12
Redness	1	4

Table 2: Range of dispersion

	Age	Tibial Tunnel	Femoral Tunnel	Slope of Graft
Mean	29.64	-2.72	1.56	73.20
Median	29.00	-4.00	1.00	72.00
Std. Deviation	6.969	3.612	1.083	5.156
Minimum	19	-7	0	63
Maximum	43	6	4	84

There was increased signal on MR images in 23 cases (92 percent). Positioning of the femoral tunnel was perfect in 22 cases (88 percent) and tibial tunnel was perfect in 19 cases (76 percent)

Discussion

During the postoperative phase of first few months, a progressive vascularization of the soft tissues around the ligament with subsequent synovialization and remodeling results in graft ligamentization [11]. At this point the graft may normally show a degree of intrasubstance increased signal intensity on MR images, which is referred to as "neoligamentization" of graft tissue [12]. However, by the end of 2 years after ACL reconstruction, a normal graft tendon should resume a uniform normal low-signal-intensity on MR imaging appearance [13]. Previous studies [14] have revealed findings of increased intrasubstance graft signal as a sign of graft impingement. The findings of previous studies like Recht *et al.* [15], are similar with the results of our study, in which we observed increased intrasubstance graft signal intensity on MR images in the majority of patients imaged after ACL graft reconstruction. In our study, the observed increased intrasubstance graft signal intensity changes did not correlate with symptoms of the patient as all the patient presented within 2 years of surgery. Optimal positioning of the tibial tunnel is important to prevent graft impingement [16], which most commonly occurs when the graft tibial tunnel is positioned at a point anterior to the Blumensaat line. To recreate the anatomic origin of the ACL during graft reconstruction, optimal positioning of the femoral tunnel should be along the posterior margin of the femoral notch in the sagittal plane [17, 18]. A 62.5% incidence of graft failure has been described in cases where the femoral tunnel is placed too far anteriorly [19]. In our study, the anterior margin of the tibial tunnel was located adequately in 80% of cases, and the posterior margin of the femoral tunnel was positioned posteriorly, immediately at the intersection of the posterior femoral cortex and the posterior physeal scar, in 88% of

cases. Most of the patient presented with restricted movements of knee after surgery had abnormal placement of tibial tunnel. Optimal anatomic orientation of an ACL graft relative to the tibia in the coronal plane is similarly important in successful ACL reconstruction. To avoid graft laxity and loss of extension, a coronal ACL angle less than 75° has been described in the literature as optimal [20]. This result is in good correlation to our findings, with a mean slope of ACL graft tendons in our study group measuring 73.20° ± 5.126 in the coronal plane. In our study 32% patients were having slope angle more than 75°. It was seen that angle more than 80 were having significant postoperative complication. According to several studies conducted in the past like Crespo *et al.* [21], 3D CT is the best method for measurement of tunnel enlargement in ACL reconstruction but due to limited resources and retrospective nature of our study, tunnel enlargement was estimated on plain radiograph. Our method for tunnel enlargement assessment was a modification of Leonardi *et al.* [22], in which tunnel ratio was measured in place of tunnel diameter in both the views (anteroposterior and lateral) to minimize the effect of magnification factor. The results are comparable to the old studies which states that there is significant tunnel size increase in first few months of the postop period. Our study results are based on findings in a group of patients presumably not doing clinically well after surgery, and seeking medical or clinical reassessment. Not all symptomatic patients who underwent ACL reconstruction surgery were able to be successfully enrolled in the study. However, the study is likely to reflect the wide range of postoperative findings in symptomatic patients at follow-up after ACL surgery. In summary, mild degrees of increased intrasubstance graft signal intensity can be seen after ACL reconstruction on MR images in almost all the patients. In addition to that tunnel enlargement is a normal phenomenon after the ACL reconstruction and plain radiograph is an easier tool to assess it. This study has some limitations as study population was small, did not take any comparison group with such short duration but our analysis is fairly comparable with the results of previous studies.

Conclusion

There was significant widening of the femoral and tibial canal when serial x-rays were compared, widening was more prominent during postop period 2 weeks to 6 weeks with almost no change in first 2 weeks. It can be concluded from the study that tunnel widening was unrelated to the postop complication as it was seen in all cases and Plain radiograph is a reliable measure to compare the tunnel widening on serial films as the results shows comparable data. There was increased graft intensity on MR images in maximum cases and this parameter is also unrelated to the complication. Thus we conclude that arthroscopic ACL reconstruction is the standard of care for ACL injuries in the active patient, although it's quite difficult to restore exact anatomic and physiologic characteristics of the normal ACL. Significant improvement in function can be achieved by present surgical techniques, if done with proper knowledge of anatomy.

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