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STUDY OF TIBIAL TUNNEL DIAMETER IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION BY MINIMAL IMPLANT SURGICAL TECHNIQUE

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ABSTRACT

Background: Knee injuries are more common now days due to increase case of RTA and active participation on sports activities. The ACL tear prevalence is rising in the modern setting, mainly due to increased participation of adolescents in high-risk sports and increased use of advanced diagnostic imaging measures for ligament injury detection. ***Objective:*** To assess the percentage change in tibial tunnel diameter at the time of stitch removal (10th post op day) to the at 6 months postoperative with the aid of Xray in cases of anterior cruciate ligament reconstruction by minimal implant surgical technique. ***Materials and Method:*** The Study was held at Sir Ganga Ram Hospital, New Delhi between January 2021 and June 2021. Calculated sample size was 24 patients who have undergone for the surgery for reconstruction of the anterior cruciate ligament with quadruple graft of semitendinosus tendon by minimal implant surgical technique. Patients with complete anterior cruciate ligament rupture with instability of the knee diagnosed by MRI. Patients undergone for minimal implant surgery. Radiographs of the operated knees of each patient were performed in the postoperative period, the anteroposterior (AP) and lateral (P) views at 6 months+/- 2 weeks. And we compared it with the tibial tunnel diameter at the time of stitch removal (10th post op day) to find out the percentage change in tibial tunnel diameter. ***Results:*** Mean age of the patients was 28.71±10. meantibial tunnel diameter of the patients at the time of stitch removal was 8.88±0.85mm. In AP and lateral view of x-ray tibial tunnel diameter was changed in only 4 patients at 6 month follow up study. ***Conclusion*** Study showed that there was no statistically significant percentage change in tibial tunnel diameter was present in AP and lateral view of x-ray at 6 month follow up study by minimal implant surgical technique.

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INTRODUCTION

Knee injuries are more common now days due to increase case of RTA and active participation on sports activities. Around the knee ACL injury is very common [1] and there is lots of controversy in treatment of ACL injury. Anterior cruciate ligament (ACL) is made of collagenous fibres and connective tissue. Its origin is from anteromedial aspect of intercondylar area .[2-3]ACL works like pivot and provide stability to knee joint, it prevents anterior translation of tibia over femur.[4] valgus and rotational stress also prevented by ACL. The ACL tear prevalence is rising in the modern setting, mainly due to increased participation of adolescents in high-risk sports and increased use of advanced diagnostic imaging measures for ligament injury detection. in United States alone ACL injury annual incidence is 1 in 3500 people[5] and its range from 30-78 per 100,000 person-years[6-8]. Most of the ACL tears occur in athletes by noncontact mechanism compare to contact mechanism. skiers and basketball players are at risk of non-contact injury and for contact injury football players are most at risk.

ACL injury have no gender and age bias but some studies suggest that females are more prone for ACL injury and possible reason for that is hamstrings of female may be weaker and predominant use of quadriceps muscle while decelerating which increases the stress on the ACL and second possible reason may be increased valgus angulation of the knee among the females[9-10]. Acute anterior cruciate ligament tear causes instability, pain and decreased motion. Anterior cruciate ligament injury and meniscal injury can occur together and may lead to early onset of osteoarthritis[11]. During the physical examination for ACL injury, we should include timing of injury, mode of injury, mobility, joint stability, strength, and evaluation of possible associated other injuries. To test the ACL, there are multiple manoeuvrers are employed and it includes pivot shift, anterior drawer and Lachman test.[12-13] clinically ACL injury can be diagnosed but magnetic resonance imaging (MRI) is quite often used for the confirmation of ACL injury diagnosis. gold standard for the diagnosis of ACL is arthroscopy but it is not initial step in diagnosis due to invasive in nature and required anaesthesia. Radiographs can only detect fracture during ACL tear [14]. Immediate treatment for the ACL injury consists of 'RICE' therapy that is rest, immobilization,

compression, and elevation of injured limb. Patient should be non-weight bearing. NSAIDs can be used as pain killer. ACL injuries, can be managed operatively and nonoperative method according to severity.Decision of operative treatment is based upon many factors such as the patient's baseline level of physical activity, age, occupation, and other associated injuries.[15] Athletes and younger persons tend to opt for surgical repair and reconstruction.[16] Future complications like meniscal tears and laxity of knee joint decreases after reconstruction of ACL that's why ACL reconstruction is now the standard of care for athletically active person. Reconstruction can be done by various techniques, according to the preference and experience of the operating surgeon. The ideal selection of the auto graft is controversial between bone- patellar tendon graft and quadrupled hamstring auto graft. since the early 90s change in ACL diameter is very well known. Most commonly tunnel diameter change is noticed within 3 months of ACL reconstruction[17]. It is characterized by change in tunnel diameter in various postoperative image. For tibial tunnel its incidence is from 29 to 100%[18]. Its mechanism is also not yet fully understood. Biological factors associated with change in tunnel diameter include inflammatory response, toxic products like ethylene oxide, metal in the tunnel may cause necrosis, and heat necrosis as a response to drilling[19]. Graft-tunnel motion, improper tunnel placement, and aggressive rehabilitation are mechanical factor may cause tunnel widening. Graft-tunnel motion is movement of graft in bone tunnel in longitudinal and transverse direction that can lead to change in tunnel diameter. Aggressive rehabilitation programme can lead to change in tunnel diameter. It is topic of research to verify the effect of the various proposed factors responsible for change in bone tunnel diameter[19]. There are various methods for assessment of tibial tunnel diameter post operatively by XRAY, CT, MRI findings. We selected postoperative Xray for assessing the change in tibial tunnel diameter. neither short nor long-term studies correlate its occurrence to surgical failures, concern exists whether a surgical revision would be necessary. We intend to assess the percentage change in tibial tunnel diameter at the time of stitch removal (10th post op day) to the at 6 months postoperative value with the aid of Xray in cases of anterior cruciate ligament reconstruction by minimal implant surgical technique.

Objective: To assess the percentage change in tibial tunnel diameter at the time of stitch removal (10^{th} post op day) to the at 6 months postoperative with the aid of Xray in cases of anterior cruciate ligament reconstruction by minimal implant surgical technique.

Study Design: It was a hospital-based, prospective observational study.

METHODOLOGY

A total of 24 patients was chosen from casualty and orthopedic OPD with complete anterior cruciate ligament rupture with instability of the knee diagnosed by MRI which require anterior cruciate ligament reconstruction in Sir Ganga Ram Hospital, Old Rajinder Nagar, New Delhi, India, within study period.

MRI Scan: For the proposed study, Magnetic Resonance imaging scan was performed on all patients who suspected anterior cruciate ligament injury in the department of Radiology SGRH.

Minimal implant surgical technique of ACL reconstruction: After anaesthesia under all aseptic conditions first portal to be made is the mid patellar lateral portal. Advantage of this portal is the scope being away from the hypertrophied fat pad and synovium which obscure the visualisation in conventional portals. Arthroscopic evaluation continues as the surgeon and assistant look into the television screen opposite to the side operated. at 70 degrees of flexion at knee joint, 4 cm long incision is being made, under all aseptic condition, anteromedially on the tibia starting approximately 4cm distal to the joint line and 3 cm medial to the tibial tuberosity. The pesanserinusis being exposed with subcutaneous dissection. The upper and lower border of Sartorius tendon are palpated and semitendinosus and gracilis is identified, their insertion being below and behind that of sartorius. The semitendinosus mobilized proximally and the detached end of the semitendinosus is transfixed by ethibond no. 5 non absorbable suture. Ends of the suture is passed through the conical end of the tendon stripper. All sides of the tendon are palpated to make sure there are no fibrous extensions. With the knee in 70degree flexion, the surgeon passes the tendon stripper along the line of semitendinosus muscle as the assistant stabilizes the knee. The tendon is released proximally by controlled tension on the tendon while advancing the stripper proximally. Quadrupled graft is made and measured by keeping it along the sterile scale. Tibial tunnel is made in medial condyle using c angle guide which is tibial aiming device.6 mm diameter reamer is passed over the guide wire and reaming done to ream the tunnel. For femoral tunnel a long guide wire with eye is passed through tibia tunnel and tip is pointed to the junction of arch of the roof and the lateral wall of condyle. The guide wire tip is pointed at 11 o'clock position for right knee and 1 o'clock position for left knee. Calibrated reamer corresponding to the diameter of quadrupled graft as measured by the sizing tunnel is passed over the guide wire tibial end and reaming is started. This is followed by passing the graft through the tunnel and first fixed at the femoral side with washer. After that different bundle tightened and is fixed at the tibial side with cancellous screw.

Outcome measurements: tibial tunnel diameter

To collect data, we standardized the following periods:

a) T1 – At the time of stitch removal(at 10th post op day))
b) T2 – At 6months+/- 2 weeks of postoperative period

Xray Scan: For the proposed study, Xray scan was performed, on all follow-up enrolled patients who underwent ACL reconstruction by minimal implant surgical technique (except those patients who were eliminated as per the exclusion criteria). X ray imaging includes both knee AP and lateral view for assessment of bone tunnel diameters at the time of stitch removal (at 10^{th} post op day)) and at 6 months from the day of surgery.

Figure 1. xray showing measurement tunnel dimater in AP view

Figure 2. Xray lateral view showing measurment of tunnel diameter

Figure 3. Xray of a patients at 6 month follow-up

Method of measurement of outcome of interest[18]: For measuring the percentage change in tibia tunnel diameter at 6 months compare to stitch removal the diameter of the tunnel in the tibia was measured at 2.0 cm below the articular line of the medial tibial condyle from the sclerotic margins of the visible path of the drill. by drawing a line perpendicular to the tunnel, generating the variable "A". The values obtained was divided by the diameter of the bone, generating the constant "a". "a" was also measured at 2.0 cm below the medial joint line. to avoid the possible biased result by magnification of the Xray we studied relative results given by the ratio A/a in AP view and B/b in lateral view comparison of the variables found in the ratio A/a and B/b on radiographs in AP and lateral view respectively with respect to various times was done. Radiographs AP and lateral view of the operated knees of each patient were performed in the postoperative period, at the time of stitch removal (10 th post op day) and at 6 months+/- 2 weeks. And we found out the percentage change in tibial tunnel diameter.

Follow-up: Data collection from the patient was performed in prospective manner for all patients who satisfy the inclusion criteria. Tunnel diameter was measured by radiological method at the time of stitch removal (at 10 th post op day)) and at 6 months+/- 2 weeks follow up cases of anterior cruciate ligament reconstruction by minimal implant surgical technique.

Statistical Analysis: The data format was initially checked for completeness, and data was cleaned for errors and missing values. The corrected data was then entered into Microsoft Excel after preparing a Master-chart. After data entry of every ten questionnaires, one random form was picked and data entry was re-checked. An independent person verified data entry of two randomly chosen forms after entry of every fiftieth questionnaire. Data analysis was done using licensed SPSS software version 24.0 (Chicago, Illinois). Univariate analyses was done initially and the results were presented with the help of tables, text, bar-diagrams and pie-charts. Descriptive statistics were used to calculate frequencies of categorical variables, and measures of central tendencies and dispersion were used to describe continuous variables. Continuous variables was presented as mean ± SD. Before statistical analysis data was checked for normality. Student t-test or Man-Whiteny test/ Wilcoxon sign rank test were used for comparison. P value <0.05 was considered as statistically significant.

RESULTS

Current study showed that mean tibial diameter in AP view of the study participants was 89.17 mm with SD of 1.71.

Table 1. Tibial diameter in AP view (in mm) distribution of study participants

Mean	89.17
Median	89.00
Std. Deviation	1.711
Minimum	86
Maximum	92

Current study showed that mean tibial diameter in lateral view of the study participants was 50.67 mm with SD of 2.14.

Table 2. Tibial diameter in lateral view (in mm) distribution of study participants

Mean	50.6667
Median	50.0000
Std. Deviation	2.14003
Minimum	48.00

In our study, mean tibial tunnel diameter of the patients at the time of stitch removal was 8.88mm with SD of 0.85.

Table 3. Tibial tunnel diameter (in mm) distribution of study participants at the time ofstitch removal (10th post op day)

Mean	8.88
Median	9.00
Std. Deviation	.850
Minimum	7
Maximum	10

In the current study, out of 24 patients, 10 patients have 9.0 mm tunnel diameter and 7 patients were having 8mm tunnel diameter at the time of stitch removal. Current study showed change in tibia tunnel diameter only in 4 patients at 6 month follow up. And percentage change in tibial tunnel diameter observed in these 4 patients were not significant.

Table 4. Distribution of study participants according tibial tunnel diameter (in mm) at thetime of stitch removal (10th post op day)

		Number	Percent
Tibial tunnel diameter (inmm)	7 mm	1	4.2
	8mm	7	29.2
	9mm	10	41.7
	10mm	6	25.0
	Total	24	100.0

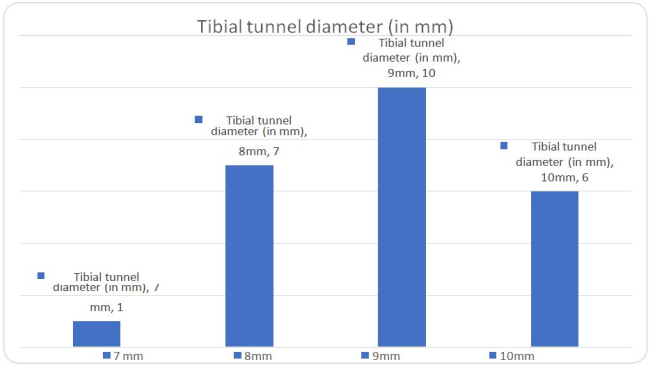
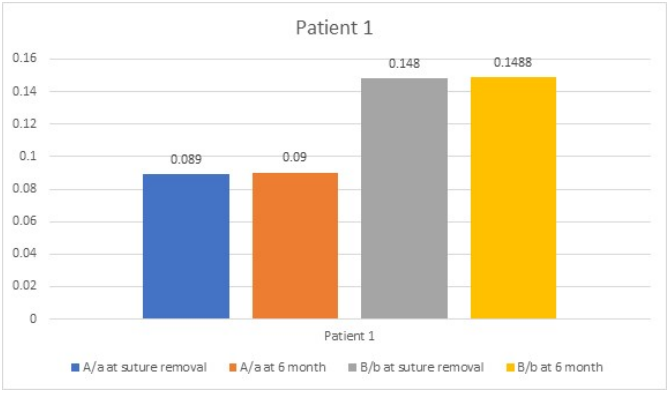
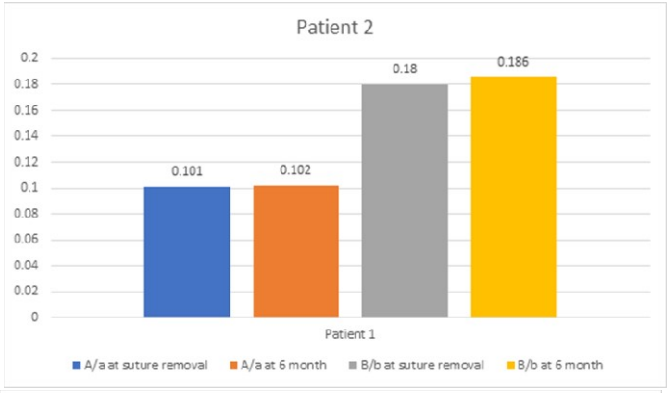
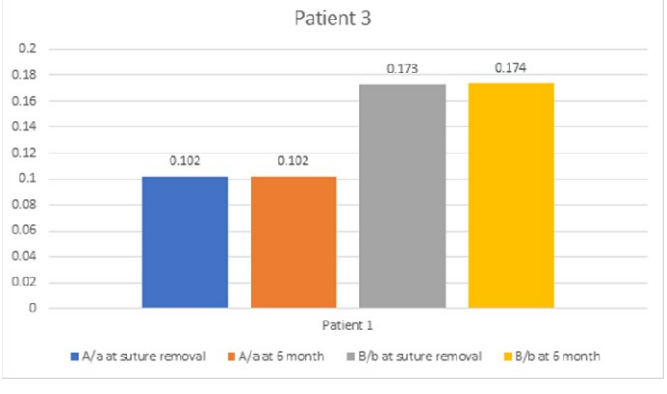


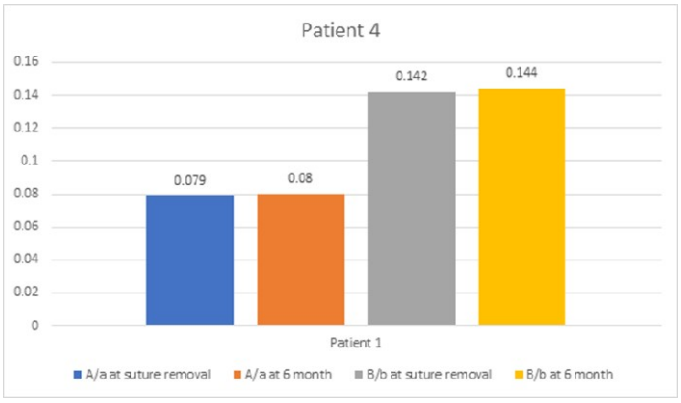
Table: Comparison of ratio of tibial tunnel diameter (in mm) and Tibial diameter in AP (A/a) and (B/b) in lateral view at stitch removal to 6 month follow up:

In our study we found tunnel widening in only 4 patients. In all 4-patient percentage change in tibia tunnel diameter was insignificant at 6 months follow up.









DISCUSSION

According to Marchant MH et al tibial tunnel widening mainly occurred after the 3 months of ACL repair but it may be continued till 2 years after the surgery. Variety of factors, interplay of biologic and mechanical factors probably contributes to tunnel widening. In biologic factors include immune-mediated increased cytokine levels or the inflammatory response caused by synovial fluid leakage within the bone tunnel. Mechanical factors include the types of graft, various methods of fixation and rehabilitation protocols. There are various methods for assessment of tibial tunnel diameter post operatively by XRAY CT, MRI findings. In our study, it was selected postoperative Xray for assessing the change in tibial tunnel diameter. Although short- and long-term studies do not correlate its occurrence to surgical failures, concern exists whether a surgical revision would be necessary. In current study, to assess the percentage change in tibial tunnel diameter at the time of stitch removal to the at 6 months postoperative value with the aid of Xray in cases of anterior cruciate ligament reconstruction by minimal implant surgical technique which is developed at current institute itself. Current study showed that mean tibial diameter of the study participants was 89.17 mm with SD of 1.71, mean tibial tunnel diameter of the patients at the time of stitch removal was 8.88 mm with SD of 0.85. In the current study, there was no statistically significant percentage change in tibial tunnel diameter was present at 6 months follow up. Current study revealed that there was no statistically significant difference found between tunnel diameter and age, gender, weight, height, BMI and side of injury.

Raj MAV et al found that the tibial bone tunnels were significantly widened and it was concluded that tibial diameter and its widening of bone tunnel during the interval follow-up is correlated with functional outcome following arthroscopic reconstruction of anterior cruciate ligament using hamstring tendon autograft.in our study there was no significant change in tunnel diameter. In contrast to our study, Debnath A et al in his study of 10 patients who underwent arthroscopic ACL reconstruction with hamstring autograft and fixation by biodegradable interference screw. with mean of 18% enlargement in the tibial tunnel. This study showed more tibial tunnel widening compare to our current study and possible reason could be different technique of ACL reconstruction and use of biodegradable screw for ACL reconstruction. Similarly, to above study, Tommikiekara et al study which was conducted among 31 patients where anatomic double-bundle ACL reconstruction with hamstring grafts and interference screw fixation were followed with MRI and clinical evaluation at 2 and 5 years of post-operative period. The mean tunnel enlargement at 2 years was estimated to be 58% In this study tunnel widening is greater than our study. Possible cause could be use of different technique for ACL reconstruction and use of interference screw .in this technique he put implant inside the tunnel which can cause significant tunnel widening but, in minimal implant surgical technique, we don't put implant inside tunnel. Sabet D et al in 2011 conducted a prospective study among 30 patients and concluded that decreased tunnel widening at the aperture on the tibial side was observed when the tip of the screw was 10 to 15 mm away from the aperture.He used endo button or transfix at femoral side and interference screw at tibial side. Jagodzinski et al reported 121.9% ±

9.0% tunnel enlargement in the AP plane and 121.5% ± 10.1% enlargement in the coronal plane in their subset of patients whose ACL reconstruction was done with hamstring graft but in this study, ACL was repaired by fixed interference screws, measurements of which were done using CT scan. in this study also Tunnel widening was higher than our study. Study by Buelowet al compared the effect of extracortical suspension fixation with anatomical fixation using interference screws on the tunnel enlargement. In this study author found that insertion of large interference screws not only compresses the graft in the bone tunnel but also significantly enlarges the bone tunnel itself. In minimal implant surgical technique, we do not use interference screw that may be the cause of non-significant widening in only 4 cases at 6 month follow up cases.

CONCLUSION

Current study showed change in tibial tunnel diameter in only 4 patients at 6 month follow up. Study Showed that there was no statistically significant percentage change in tibial tunnel diameter was present in AP and lateral view of x-ray at 6 month follow up study by minimal implant surgical technique. Possible reason may be no use of biodegradable implant inside the bone tunnel and mobilization started at 3 weeks leads to healing of bone tunnel interface so graft tunnel moves as one.

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