Original Research Paper

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Orthopaedics

ACCURACY OF TUNNEL PLACEMENTS IN ARTHROSCOPIC ANATOMICAL SINGLE BUNDLE ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION AND ITS IMPLICATION ON FUNCTIONAL OUTCOME

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ABSTRACT **Aim And Objectives:** To study the precision of bony tunnel placements in arthroscopic anatomical single bundle anterior cruciate ligament reconstruction using hamstring graft. **Materials And Methods:**Patients undergoing elective Arthroscopic anatomical ACL reconstruction using Hamstring autograft at the Department of Orthopedics & Traumatology in RajaRajeswari medical college.During the study period of June 2022 to June 2024 was included. Clearance was obtained from hospital ethical committee. During this period 30 patients were treated for ACL tear .All the required data was collected from the patients during their stay in the hospital, during follow up at regular intervals and from the medical records. The patients were then followed up at 2 weeks (X-RAY) , 6 weeks (CT),and 6 months(MRI), respectively during which time the anatomic and functional evaluation was done using the International Knee Documentation Committee Subjective Knee scoring. **Results And Conclusion:** The study concludes that ACL reconstruction is highly effective in improving knee function and stability, as evidenced by significant increases in IKDC and TL scores post-surgery. Biomechanical assessments through Posterior femoral tunnel (85.6), Anterior tibial tunnel (47.35) ,Medial tibial tunnel (46.95), and Lateral femoral tunnel (44.55) show that precise anatomical placement of grafts is critical for minimizing excessive translations and ensuring joint stability.

KEYWORDS : ACL injury; Hamstring graft; Arthroscopic reconstruction.

INTRODUCTION

The knee joint is very commonly injured and the Anterior Cruciate Ligament (ACL) is the most commonly injured ligament requiring surgery . The ACL forms the pivot in the functional congruence and stability of the knee in association with the other ligaments, capsule, muscles and bone .The ACL primarily stabilizes the knee and aids in preventing the knee against anterior translation . It is also important in counteracting rotational and valgus stress. The anterior knee instability due to tear of the ACL is an important clinical problem. Several studies have elaborated successful reconstruction of the ACL using autograft (bone patellar tendon, hamstring tendon, quadriceps tendon) and allograft (patellar tendon, hamstring tendon, tibialis anterior, Achilles tendons.

To date several different techniques have been described for Anterior Cruciate Ligament Reconstruction (ACLR) from open to arthroscopic technique. The hamstring's graft represents an alternative autograft material that may be used for ACLR without much trouble for extensor mechanism.

Arthroscopically assisted ACLR has the advantage of being minimally invasive, accurate graft placement, less damage of normal tissue resulting in quicker wound healing and rehabilitation, minimal hospital stay and very less infection rate. ACLR with Hamstring tendon has become in popular in patients with symptomatic instability and in appropriately chosen patients yields successful results . The quadrupled hamstring tendon graft is enriched by synovial fluid initially for its nourishment. Our study is designed for analyzing the outcome of arthroscopic ACLR with hamstring autograft fixed in femoral tunnel using Endo button and in the tibial tunnel using interference screw.

Aim

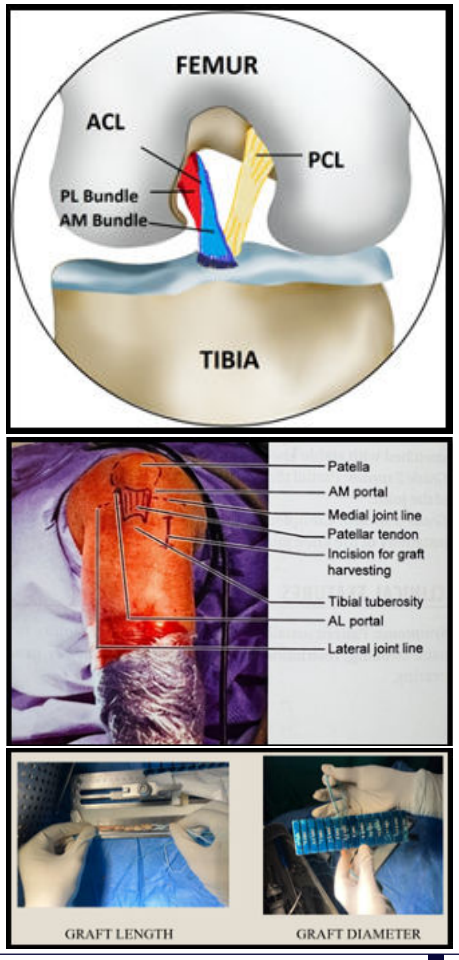
To study the precision of bony tunnel placements in arthroscopic anatomical single bundle anterior cruciate ligament reconstruction using hamstring graft.

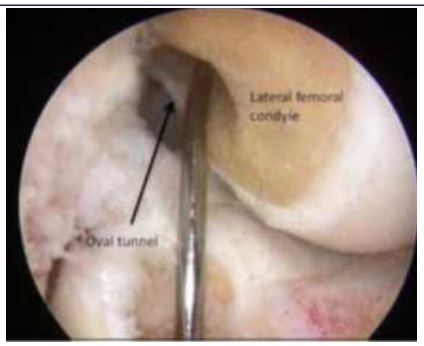
Objectives Of The Study:-

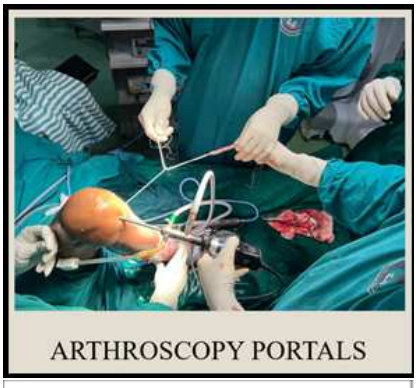
1. To study the Accuracy of femoral tunnel placement.
2. To study the Accuracy of tibial tunnel placement.
3. To study the functional outcome of single bundle anatomical anterior cruciate ligament reconstruction.

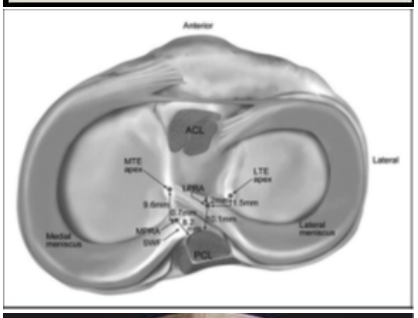
MATERIALS AND METHODS :

This is a study of arthroscopic management of accuracy of tunnel placements in single bundle anterior cruciate ligament reconstruction and its implication on functional outcome satisfying the inclusion criteria; admitted in the department of Orthopaedics at Rajarajeswari Medical College And Hospital Bangalore, during the study period of June 2022 to June 2024 was included. Clearance was obtained from hospital ethical committee. During this period 30 patients were treated for ACL tear .All the required data was collected from the patients during their stay in the hospital, during follow up at regular intervals and from the medical records.









Inclusion Criteria:-

- ACL tear diagnosed clinically and by MRI.
- Willingness to participate and follow up.
- Normal contralateral knee
- Age :- 18 to 50 years.

Exclusion Criteria:-

- Revision ACL reconstruction
- ACL injuries with associated intra articular fractures.
- Previous knee surgery.
- Anterior cruciate ligament tear with posterior cruciate ligament, collateral ligament requiring surgery, posterolateral complex injuries.
- Osteoarthritis of knee.(GRADE 3 & 4)

Period Of Follow-up:

The follow up was for one year with evaluation at 2 weeks, 6 weeks and 6 months.

Surgical Procedure:

At the aforementioned institute, four-strand hamstring tendon autografts were used for arthroscopic anatomical single-bundle anterior cruciate ligament restoration in each of these patients. Interference screws were used to firmly secure the grafts.

Post-operative rehabilitation program:

Before the patient was moved out of the operating room, a long knee extension brace was placed in five degree knee flexion position. Once the patient was no longer under the influence of anesthesia, isometric muscle strengthening activities were initiated. With crutches, weight-bearing was permitted starting the following day. Active range of motion exercises were initiated by gradually increasing the range in order to reach the goal of 0°-90° flexion by the fourth week and the full pre-operative range by the sixth week. The brace was taken off after four weeks. Swimming and straight-line jogging were introduced at three months. Competitive sports and squatting were postponed for six months.

Evaluation:-

Postoperative X rays - AP and Lateral views will be taken on the operated knee. The tunnel positioning and screw placement will be analysed. All patients will be reviewed periodically at 2 weeks (x ray), 6 weeks (CT scan), & 6 months (MRI to see graft uptake) for radiological & functional outcome of the patient. Clinically Lachman test, anterior drawer test was performed. Range of movements of the operated knee will be clinically examined. Patients will be subjected to Lysholm knee scoring scale questionnaire & IKDC score pre-operatively & post-operatively.

1. Posterior Femoral Tunnel (PFT)
PFT (in%)=(LM/LN) x 100
2. Anterior Tibial Tunnel (LFT)
ATT (in%)=(OP/OQ) x 100

1. Medial Tibial Tunnel (MTT)
MTT (in%)=(EF/DF) x 100
2. Lateral Femoral Tunnel (LFT)
LFT (in%)=(AB/AC) x 100

LYSHOLM KNEE SCORING SCALE

This questionnaire is designed to give your Physical Therapist information as to how your knee problems have affected your ability to manage in everyday life Please answer every section and mark only the ONE box which best applies to you at this moment.

Name: _____ Date: _____

SECTION 1 - LIMP
- ☐ I have no limp when I walk. (3)
- ☐ I have a slight or periodical limp when I walk. (2)
- ☐ I have a severe and constant limp when I walk. (0)

SECTION 2 - Using cane or crutches
- ☐ I do not use a cane or crutches. (5)
- ☐ I use a cane or crutches with some weight-bearing. (2)
- ☐ Putting weight on my hurt leg is impossible. (0)

SECTION 3 - Locking sensation in the knee
- ☐ I have no locking and no catching sensation in my knee. (15)
- ☐ I have catching sensation but no locking sensation in my knee. (10)
- ☐ My knee locks occasionally. (6)
- ☐ My knee locks frequently. (2)
- ☐ My knee feels locked at the moment. (0)

SECTION 4 - Giving way sensation from the knee
- ☐ My knee gives way. (25)
- ☐ My knee rarely gives way, only during athletics or rigorous activity. (20)
- ☐ My knee frequently gives way during athletics or other rigorous activities. In turn I am unable to participate in these activities. (15)
- ☐ My knee frequently gives way during daily activities. (10)
- ☐ My knee often gives way during daily activities. (5)
- ☐ My knee gives way every step I take. (0)

SECTION 5 – PAIN
- ☐ I have no pain in my knee. (25)
- ☐ I have intermittent or slight pain in my knee during rigorous activities. (20)
- ☐ I have marked pain in my knee during rigorous activities. (15)
- ☐ I have marked pain in my knee during or after walking more than 1 mile. (10)
- ☐ I have marked pain in my knee during or after walking less than 1 mile. (5)
- ☐ I have constant pain in my knee. (0)

SECTION 6 – SWELLING
- ☐ I have swelling in my knee. (10)
- ☐ I have swelling in my knee only after rigorous activities. (6)
- ☐ I have swelling in my knee after ordinary activities. (2)
- ☐ I have swelling constantly in my knee. (0)

SECTION 7 – CLIMBING STAIRS
- ☐ I have no problems climbing stairs. (10)
- ☐ I have slight problems climbing stairs. (6)
- ☐ I can climb stairs only one at a time. (2)
- ☐ Climbing stairs is impossible for me. (0)

SECTION 8 – SQUATTING
- ☐ I have no problems squatting. (5)
- ☐ I have slight problems squatting. (4)
- ☐ I cannot squat beyond a 90deg. Bend in my knee. (1)
- ☐ Squatting is impossible because of my knee. (0)

Total: _____/100

Instructions: Please place a mark on the line to indicate the amount of pain you have had in your knee(s) in the past 24 hours.

RIGHT KNEE
No pain at all _____ Worst pain possible

LEFT KNEE
No pain at all _____ Worst pain possible

2000 IKDC SUBJECTIVE KNEE EVALUATION FORM

Name: First Last Date:

Physician: Date of Injury:

SYMPTOMS*:

*Grade symptoms at the highest activity level at which you think you could function without significant symptoms, even if you are not actually performing activities at this level.

1.What is the highest level of activity that you can perform without significant knee pain?

- Very strenuous activities like jumping or pivoting as in basketball or soccer
- Strenuous activities like heavy physical work, skiing or tennis
- Moderate activities like moderate physical work, running or jogging
- Light activities like walking, housework or yard work
- Unable to perform any of the above activities due to knee pain

2.During the past 4 weeks, or since your injury, how often have you had pain?

0 1 2 3 4 5 6 7 8 9 10

Never ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Constant

3.If you have pain, how severe is it?

0 1 2 3 4 5 6 7 8 9 10

No pain ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Worst pain imaginable

4.During the past 4 weeks, or since your injury, how stiff or swollen was your knee?

- Not at all
- Mildly
- Moderately
- Very
- Extremely

5.What is the highest level of activity you can perform without significant swelling in your knee?

- Very strenuous activities like jumping or pivoting as in basketball or soccer
- Strenuous activities like heavy physical work, skiing or tennis
- Moderate activities like moderate physical work, running or jogging
- Light activities like walking, housework or yard work
- Unable to perform any of the above activities due to knee swelling

6.During the past 4 weeks, or since your injury, did your knee lock or catch?

○ Yes ○ No

7.What is the highest level of activity you can perform without significant giving way in your knee?

- Very strenuous activities like jumping or pivoting as in basketball or soccer
- Strenuous activities like heavy physical work, skiing or tennis
- Moderate activities like moderate physical work, running or jogging
- Light activities like walking, housework or yard work
- Unable to perform any of the above activities due to giving way of the knee

Page 2 – 2000 IKDC SUBJECTIVE KNEE EVALUATION FORM

SPORTS ACTIVITIES:

8.What is the highest level of activity you can participate in on a regular basis?

- Very strenuous activities like jumping or pivoting as in basketball or soccer
- Strenuous activities like heavy physical work, skiing or tennis
- Moderate activities like moderate physical work, running or jogging
- Light activities like walking, housework or yard work
- Unable to perform any of the above activities due to knee

9.How does your knee affect your ability to:

		Not difficult at all	Minimally difficult	Moderately Difficult	Extremely difficult	Unable to do
a.	Go up stairs	○	○	○	○	○
b.	Go down stairs	○	○	○	○	○
c.	Kneel on the front of your knee	○	○	○	○	○
d.	Squat	○	○	○	○	○
e.	Sit with your knee bent	○	○	○	○	○
f.	Rise from a chair	○	○	○	○	○
g.	Run straight ahead	○	○	○	○	○
h.	Jump and land on your involved leg	○	○	○	○	○
i.	Stop and start quickly	○	○	○	○	○

FUNCTION:

10. How would you rate the function of your knee on a scale of 0 to 10 with 10 being normal, excellent function and 0 being the inability to perform any of your usual daily activities which may include sports?

FUNCTION PRIOR TO YOUR KNEE INJURY:

0 1 2 3 4 5 6 7 8 9 10

Couldn't perform daily activities ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ No limitations in daily activities

CURRENT FUNCTION OF YOUR KNEE:

0 1 2 3 4 5 6 7 8 9 10

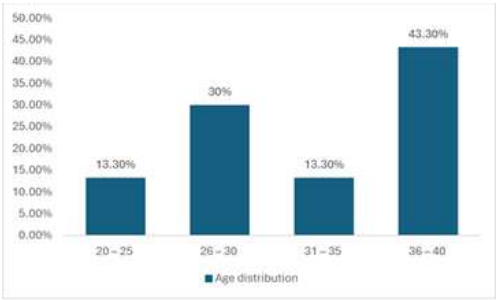
Cannot perform daily activities ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ No limitations in daily activities

Posterior femoral tunnel (PFT)
PFT(in%)=(LM/LN)x100
Anterior tebial tunnel (ATT)
ATT(in%)=(OP/OQ)x100

1.Medial tibial tunnel (MTT)
MTT(in%)= (EF/DF)x100
2.Lateral femoral tunnel (LFT)
LFT(in%)= (AB/AC)x100

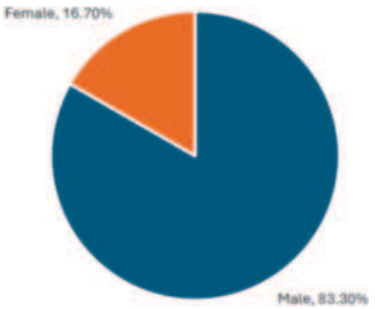
RESULTS:

Table 1: Distribution based on Age



This table presents the distribution of study participants based on their age. It shows the frequency and percentage of individuals across four age groups. Specifically, there are 4 participants (13.3%) aged between 20-25 years, 9 participants (30%) aged between 26-30 years, another 4 participants (13.3%) aged between 31-35 years, and 13 participants (43.3%) aged between 36-40 years.

Table 2: Distribution based on Gender

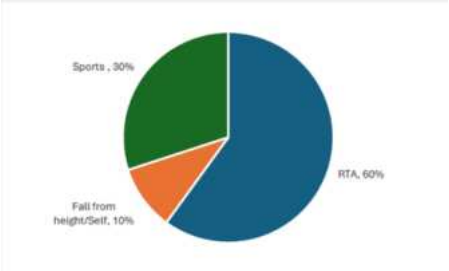


This table details the gender distribution of the participants. The majority of the participants are male, with 25 individuals making up 83.3% of the total. Female participants account for 5 individuals, or 16.7% of the total.

Table 3: Distribution based on Site of Involvement

This table shows the distribution of participants based on the site of involvement. It is nearly evenly split, with 16 participants (53.3%) having right-side involvement and 14 participants (46.7%) having left-side involvement.

Table 4: Distribution based on Mode of injury



This table outlines the distribution of participants based on their mode of injury. The majority of injuries were due to road traffic accidents (RTA), accounting for 18 participants (60%). Injuries from falls or self-inflicted sources were reported in 3 participants (10%), while sports-related injuries were noted in 9 participants (30%).

Table 5: Posterior femoral tunnel (PFT)

	Minimum	Maximum	Mean ±SD
PFT	84.6	86.8	85.69 ± 0.62

This table presents the results of the PFT among participants, showing the minimum, maximum, and mean values along with the standard deviation. The minimum PFT value recorded is 84.6, the maximum is 86.8, and the mean is 85.69 with a standard deviation of 0.62.

Table 6: Anterior tibial tunnel (ATT)

	Minimum	Maximum	Mean ±SD
ATT	46.50	48.10	47.35 ± 0.43

This table provides the ATT values, including the minimum, maximum, and mean values with the standard deviation. The minimum ATT recorded is 46.50, the maximum is 48.10, and the mean value is 47.35 with a standard deviation of 0.43.

Table 7: Medial tibial tunnel (MTT)

	Minimum	Maximum	Mean ±SD
MTT	45.50	48.40	46.95 ± 0.88

This table shows the MTT results, listing the minimum, maximum, and mean values along with the standard deviation. The minimum MTT recorded is 45.50, the maximum is 48.40, and the mean is 46.95 with a standard deviation of 0.88.

Table 8: lateral femoral tunnel (LFT)

	Minimum	Maximum	Mean ±SD
LFT	43.10	46.0	44.55 ± 0.88

This table details the LFT results, including the minimum, maximum, and mean values with the standard deviation. The minimum LFT recorded is 43.10, the maximum is 46.0, and the mean is 44.55 with a standard deviation of 0.88.

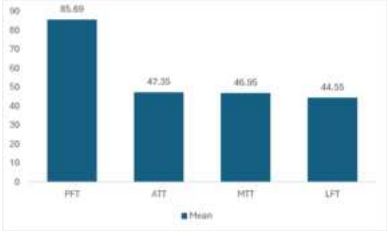


Table 9: IKDSC Score

	Pre op	Post op	P value
IKDC score	20.43 ± 2.26	80.56 ± 2.47	0.0001*

This table compares the IKDSC scores pre-operatively and post-operatively, also providing the P-value to denote statistical significance. The pre-operative IKDSC score is 20.43 with a standard deviation of 2.26, while the post-operative score significantly improves to 80.56 with a standard deviation of 2.47. The P-value is 0.0001, indicating a highly significant improvement.

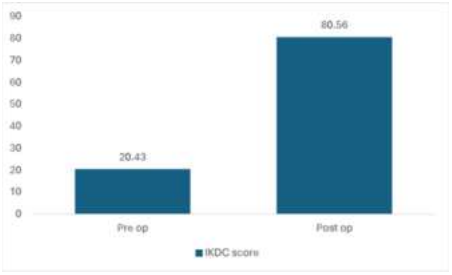
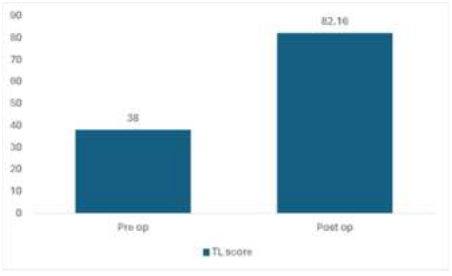


Table 10: TL score

	Pre op	Post op	P value
TL score	38.0 ± 6.24	82.16 ± 4.85	0.0001*

This table illustrates the TL scores before and after the operation, along with the P-value for statistical significance. The pre-operative TL score is 38.0 with a standard deviation of 6.24, and the post-operative score significantly improves to 82.16 with a standard deviation of 4.85. The P-value is 0.0001, indicating a highly significant improvement.



DISCUSSION:

Study	Femoral Tunnel Placement (mean)
Current Study	30% anterior to posterior femoral cortex
Nema et al[45]. (2017)	30% ± 1% anterior to posterior femoral cortex
Kim et al[46]. (2018)	29.5% ± 2.8% anterior and 38.5% ± 3.2% distal
Debnath et al[49] (2019)	84.8% posterior along Blumensaaat line

Study	Mean ATT ± SD
Current Study	47.35 ± 0.43
Debnath et al[49] (2019)	46.8% along tibial plateau

Study	Mean MTT ± SD
Current Study	46.95 ± 0.88
Debnath et al[49] (2019)	45.6%

Study	Mean LFT ± SD
Current Study	44.55 ± 0.88
Debnath et al[49] (2019)	43.2%

CONCLUSION:

The study concludes that ACL reconstruction is highly effective in improving knee function and stability, as evidenced by significant increases in IKDC and TL scores post-surgery. The demographic analysis suggests that males in their late 30s are the most common recipients of ACL reconstruction, likely due to higher engagement in high-risk activities. The distribution of injury sites and modes

underscores the need for targeted preventive measures in road safety and sports.

Biomechanical assessments through Posterior femoral tunnel (85.6) , Anterior tibial tunnel (47.35), Medial tibial tunnel (46.95), and Lateral femoral tunnel (44.55) show that precise anatomical placement of grafts is critical for minimizing excessive translations and ensuring joint stability. This finding aligns with prior research emphasizing the importance of surgical accuracy in ACL reconstruction to prevent long-term complications and enhance functional outcomes.

Overall, the study reinforces the significance of tailored surgical techniques and comprehensive patient assessment in optimizing ACL reconstruction outcomes. Future research should focus on refining surgical methods and developing preventive strategies to reduce the incidence of ACL injuries in high-risk populations.

Limitations:

1. This study has some limitation. conclusion drawn from this analysis cannot be generalized because of Small number cases Short duration Single centre study.
2. Surgery was performed by different surgeons with variation in exposure and technique which could be a confounding factor in assessing the outcome.

Conflicts Of Interest:

Nil

Financial Disclosure:

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