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RANDOMIZED TRIAL COMPARING SINGLE VERSUS DOUBLE BUNDLE TECHNIQUE IN RESTORATION OF ANATOMICAL FOOTPRINT POST ACL RECONSTRUCTION.

Orthopedics

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ABSTRACT

Introduction: ACL (Anterior Cruciate ligament) tear has become one of the most common sports related injuries and its treatment has evolved tremendously. Anatomical restoration of footprint remains imperative. The author wishes to study the size(area) of Tibial ACL foot print in Indian population and efficacy of single versus a double bundle reconstruction in restoring anatomical landmarks.

Material & Methods: The randomized prospective study included 100 male patients with diagnosed isolated ACL tear divided into two groups of 50 each. Group A & Group B patients underwent a double & single bundle (SB) reconstruction irrespective of their anatomical foot-prints using autologous hamstring graft. All patients were followed up at 12 months for functional & radiological assessment in restoring the anatomical footprint. Measurements were done by two authors independently using the GE Optima™ MR450w MR scanner and Horos 3.0.0 RC 2 software.

Results: The patients of group A (DB) had a closer restoration of anatomical foot-print in comparison to patients of Group B (SB). Mean ACL tibial footprint area in normal limb were 153.9 mm2 in the cohort. The mean width and mid-sagittal depth of the foot-print were 9.5± 1.6mm & 16.2±2.0mm respectively on the unaffected side. Patients in Group A & Group B had a mean width & mid-sagittal depth of 8.9±1.1mm; 16.1 ± 1.7 mm & 7.9±1.3 & 15.6±1.3 mm respectively.

The mean area of the tibial footprint that a double bundle reconstruction could restore was 143.29 mm^2 and in the cases with single bundle reconstruction this was 123.24 mm^2. The area restored by a double bundle reconstruction was closer to the original anatomical Tibial footprint in comparison to a single bundle reconstruction when compared from the normal limb in the cohort.

Conclusion: Double bundle technique replicates the footprint anatomy more closely in comparison to a single bundle reconstruction. Anatomical replication remains imperative in restoration of the normal joint kinematics and so individualized treatment should be sought after identifying the morphometry of the foot-print.

KEYWORDS

ACL, Footprint, Single bundle, Double bundle, Anatomical.

What is known: Anatomical restoration of foot-print is imperative to restoration of native kinematics. Various techniques aim at anatomical reconstruction only.

What study adds to existing knowledge: Compares the techniques of reconstruction with regards to restoration of the anatomical footprint by comparing with the normal contralateral dimensions.

INTRODUCTION:

ACL surgery has been by far the most common sports related injury needing surgical care. Since the advent of arthroscopic techniques, there has been a constant evolution of surgical techniques. Embryology has defined ACL to be a group of fibers which twirls and forms a footprint for attachment on the femoral side.[13] The fan shaped footprint has been primarily divided into two bundles by various authors and it is advocated that the Postero-lateral bundle primarily acts as a restrain to pivoting and Antero-medial bundle controls anterio-posterior translation.[14] This concept lead to the birth of double bundle reconstruction of Anterior cruciate ligament.[1,2] There have been various studies which support double bundle over single bundle reconstruction but no conclusive superiority has been established of one over the other.[6] The author wishes to radiologically evaluate the efficacy of single versus double bundle reconstruction in restoring the native ACL foot-print & its functional results in Asian population.

MATERIAL AND METHODS:

The randomized prospective study included 122 male patients from the out-patient department with diagnosed isolated ACL tear divided into two groups of 54 each. Group A patients were taken up for a double bundle reconstruction and single bundle reconstruction was done in patients of group B irrespective of their anatomical foot-print measurements using autologous hamstring graft by the same surgeon. The patients with any evidence of an associated bony fracture, meniscal or cartilaginous lesion on MRI or Arthroscopic findings were excluded from the study as long term functional outcome would be altered. The progression has been briefly described in figure 1. The surgical procedure made use of a standard trans-portal technique with quadrupled hamstrings graft of 10 mm diameter for a single bundle reconstruction & a 8 mm tripled semi-tendinosus, 6 mm gracilis graft for an Antero-medial and Posterolateral bundle graft respectively for a double bundle reconstruction (Figure 2). All patients were followed up at 12 months with MRI for comparison of the reconstructed with natural footprint & the efficacy of single versus double bundle reconstruction in restoring it. The patients were assessed by Lysholm score at 12 months. Measurements of foot-print (area) were done by two authors independently using the GE Optima™ MR450w MR scanner & Horos v3.0.0 RC 2 on the normal limb and post-ACL R limb and mean was considered final.

RESULTS:

The study consisted of adult males between 18-45 years with the mean ACL Tibial footprint dimensions in normal limb to be 153.9 mm2 ± 32.21 (Figure 3) in the cohort. The mean width and mid-sagittal depth of the foot-print were 9.5± 1.6mm & 16.2± 2.0mm respectively on the unaffected side. Patients in Group A & Group B had a mean width & mid-sagittal depth of 8.9± 1.1mm; 16.1 ± 1.7 mm & 7.9± 1.3 & 15.6± 1.3 mm respectively. The mean area of the tibial footprint that a double bundle reconstruction could restore was 143.29 mm2 ± 28.22 mm2 (Figure 4) and in the cases with single bundle reconstruction this was 123.24 ± 26.87 mm2(Figure 5). Double bundle reconstruction could more closely replicate the area of ACL tibial footprint as compared to single bundle reconstruction. The mean difference between the reconstructed and biological foot-print coverage was 10.61 mm2 ± 3.99mm2 in group A and 30.66 mm2 ± 5.34mm2 in group B when compared to the mean values in each group. This difference was statistically significant ($p<0.05$) (Table1). The mean lysholm score improved from 71.7± 7.6 at 6 months to 88.3 ± 5.3 at 12 months in group A and 69.2 ± 7.1 at 6 months to 82.3± 6.9 in group B. There was no statistically significant difference between subjects of both the groups(Table2). Four patients in each group reported loss to follow up.

DISCUSSION:

Arthroscopic ACL reconstruction has been a topic of constant research since its emergence. Double bundle reconstruction has been argued to have superior objective and subjective results as compared to single bundle reconstruction but no conclusive superiority has still been declared by systematic reviews. Literature documents double bundle reconstruction to more closely replicate the functions of the native ACL and a greater rotational stability in comparison to single bundle reconstruction.[9]

The purpose of the study is to evaluate the efficacy of double versus

single bundle reconstruction in restoring the anatomical foot-print of the ACL. Literature is scarce with regards to which of the two techniques is superior. Various authors have studied the anatomical landmarks and dimensions of the native ACL but its correlation with technique of reconstruction is yet unexplored.[8]

DB ACL R has been supported by studies with regards to better rotational stability but there is lack of an objective documentation & a long term randomized comparison between both techniques. Also, there has been an increasing role of anatomical reconstruction restoring the native angulation of fibres and footprint at both tibial and femoral ends. There is paucity of radiological evidence regarding the replication of the anatomy by the reconstructed ligament. For ascertaining the reproducibility of both techniques of reconstruction the authors have chosen an objective radiological parameter for measuring the post-surgical tibial foot-print area in single and double bundle reconstruction and compare the same with the normal side. Our surgical procedure made use of a standard trans-portal technique with quadrupled hamstrings graft of 10 mm diameter for a single bundle reconstruction & a 8 mm tripled semi-tendinosus, 6 mm gracilis graft for an Antero-medial and Posterolateral bundle graft respectively for a double bundle reconstruction (Figure2). The ACL foot print has been documented to be of various different shapes and several consistent patterns have been identified[10,12,5].

The study puts light on the fact that surgical technique in a single bundle reconstruction usually reconstructs a circular footprint whereas the double bundle technique resulted in an '8' shaped footprint post reconstruction. So, the center of rotation of the ligaments differ and so does their individual function due to differential tightening of these bundles. Postero-lateral is tightened first, as described, in full extension and the Antero-medial bundle is tensioned in 30 degrees of flexion. [4,7]

This also supports the different (Translational & pivoting restrain) but overlapping function of the ACL & that DB ACL R has better rotational stability. Authors wish to reinforce the need for a more anatomical footprint for the ACL to function like the native ACL. [11]

This was to standardize the graft diameter in all the cases. It might be an interesting topic to further study the anatomy of the ACL footprint before its reconstruction to as closely replicate biology as possible and individualize treatment based on MR assessment of ACL footprint.[3]

Double bundle reconstruction has proven better with regards to restoration of the native foot-print in the present study. However, there was no difference between the two groups with respect to functional outcomes at 12 months follow up.

The study limitations included short term results & a small study population. Authors have considered both limbs to have same anatomic dimensions which may be variable.

CONCLUSION:

Double bundle technique replicates the footprint anatomy more closely in comparison to a single bundle reconstruction. Anatomical replication remains imperative in restoration of the normal joint kinematics and so individualized treatment should be sought after identifying the morphometry of the foot-print. Studies need to evaluate surgical techniques for the same.

Table 1: Comparative dimensions of the Foot-print in both groups.

Parameter	Group A	Group B
Mean width	8.91.1 mm	7.91.3 mm
Mean Mid-sagittal depth	16.1 1.7 mm	15.61.3 mm
Mean area of the tibial footprint (post-surgery)	143.29 mm2 28.22 mm2	123.24 mm2 26.87 mm2
Mean Difference B/W normal and post-surgical area	10.61 mm2 3.99 mm2	30.66 mm2 5.34 mm2

Table 2: Lysholm Scores in both groups

	6 months	12 months
Group A	71.7 7.6	88.3 5.3
Group B	69.2 7.1	82.3 6.9

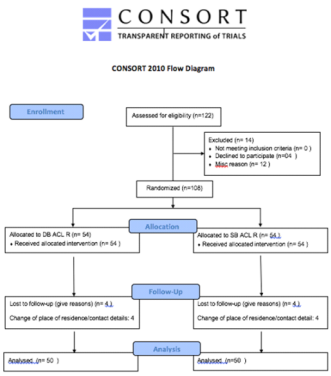


Figure 1: Flowchart showing CONSORT diagram as per guidelines for randomized trials

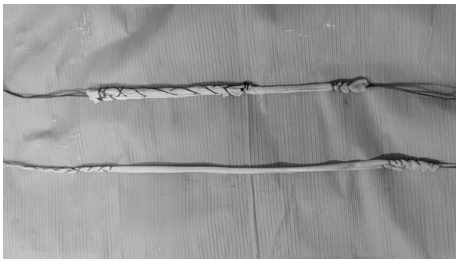


Figure 2: Graft used in a DB-ACL R case. Authors made use of a Tripled Semi-tendinosus (AM) and a gracilis graft (PL) as shown.

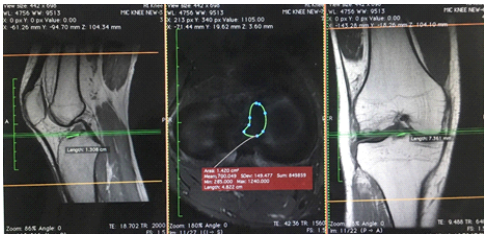


Figure 3: Showing the normal dimensions of ACL dimensions and footprint.

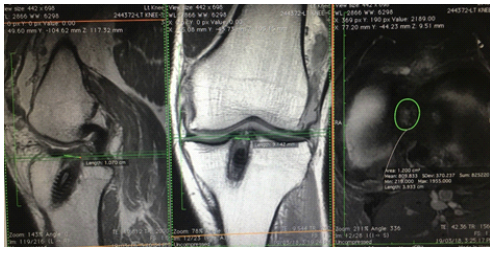


Figure 4: Showing the dimensions post SB-ACL-R dimensions and footprint of ACL. Note the circular shape of new Footprint.

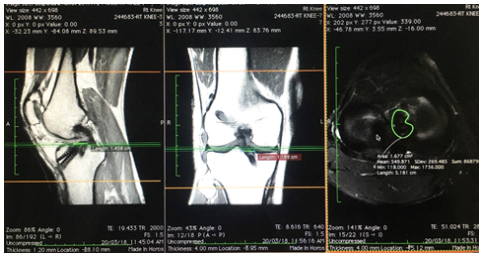


Figure 5: Showing the dimensions post DB-ACL-R dimensions and footprint of ACL. Note the '8' shape of new Footpr

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