AN EVALUATION OF THE CLINIC RADIOLOGICAL EFFECTS OF SINGLE-VERSUS DOUBLE-BUNDLE ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION.

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Abstract

Introduction:

The most common reconstructive procedure for the knee is anterior cruciate ligament (ACL) reconstruction. This research aimed to compare the clinical and radiological outcomes of arthroscopic ACL replacements using single- and double-bundles.

Method:

80 patients with isolated ACL injuries had surgery between July 2020 and July 2021, with groups for the single bundle (SB) and double-bundle (DB) reconstructions each consisting of 40 individuals. The GNRB arthrometer, the International Knee Documentation Committee, and the Lysholm scale were used to evaluate the results. The lateral pivot-shift test was used to evaluate rotational stability. To compare the repaired ACL graft orientation, postoperative magnetic resonance imaging (MRI) was done. Using a paired t-test, preoperative values, and values were compared and P $<$0.04 was significant.

Result:

The average follow-up was 18.2 months for the DB group and 14.8 months for the SB group. The mean Lysholm score was 94.12$\pm$2.66 in the SB group and 93.12$\pm$3.30 in the DB group at the time of the final follow-up (P value = 0.201, statistically insignificant). According to the objective IKDC scores, all of the patients, in both groups were in grade A or B. The mean differential anterior tibial translation in the SB group was 1.44 $\pm$ 0.5 mm and in the DB group, it was 1.16 $\pm$ 0.7 mm (P = 0.104, NS). In the DB group, all of the pivot shift tests were negative, whereas, in the SB group, three patients showed positive results. According to an MRI of surgically repaired knees, both groups' mean sagittal and mean coronal ACL graft-tibial angles were equivalent (P value $>$ 0.04, NS).

Conclusion:

At an average of 15 months of follow-up, there was no statistically significant difference between the single-bundle and double-bundle ACL repair groups in terms of knee stability, knee ratings, subjective assessments, or MRI examination of graft inclination angles.

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1. INTRODUCTION:

The most common reconstructive procedure for the knee is anterior cruciate ligament (ACL)

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reconstruction. Despite the long history and high success rate of single-bundle ACL repair (SBACLR), some papers have revealed postoperative instability and patient dissatisfaction. In recent years, acceptance of double-bundle ACL repair (DBACLR) has increased. The advantages of double-bundle reconstruction over single-bundle ACL reconstructions are based on biomechanical research that shows that each bundle—anteromedial (AM) and posterolateral (PL)—makes a specific kinematic contribution to knee function [1].

Together, the two bundles work to give some anterior constraint, although the AM bundle does so more effectively than the PL bundle, which works at extension and is more important for rotational stability [2]. Single-bundle ACL reconstruction, which most closely resembles AM bundle reconstruction, can successfully restore anterior knee stability but falls short of restoring rotational stability, according to an in vivo kinematics investigation [3]. Several clinical trials and meta-analyses show that DBACLR has greater anterior knee stability and rotational stability compared to SBACLR, but that the functional outcomes of the two procedures are not significantly different [4, 5].

The relative effectiveness of double-bundle vs single-bundle reconstruction for ACL rupture in adults was not determined by a Cochrane database systemic evaluation in 2012 [6]. In India, there are very few published prospective trials comparing the results of SB and DB ACL restoration. For the best clinical results in both single and double-bundle ACL repairs, precise anatomical location of the graft tunnels resulting in anatomic inclination angles of the grafts is crucial. After ACLR, early graft failure, a lack of extension and flexion, and persistent instability are frequently caused by improper graft placement [7, 8]. To establish the proper tunnel placement while undergoing ACL reconstruction with the single or double-bundle approach, numerous anatomical studies have recently assessed the femoral and tibial insertion sites of the ACL bundle [9–11].

In addition to its footprint size and tunnel placement, postoperative MRI scanning is a good imaging technique to describe graft orientation and inclination angles. However, only a small number of recently published research [12, 13] have used postoperative MRI scans to assess the graft morphology between repaired SB and DB ACLR. These factors led to the current prospective study being carried out to compare the clinical and radiological outcomes of anatomical SBACLR versus arthroscopic DBACLR. It was predicted that DBACLR with hamstring tendon autograft using two tibial tunnels and two femoral tunnels would be superior to anatomical single-bundle restoration in restoring anterior and rotational stability as well as delivering better subjective as well as objective clinical results.

2. METHOD AND MATERIALS:

2.1. ***BIAS:***

The articles were chosen without taking the writers into account in order to prevent biases.

The senior surgeon underwent 80 ACL reconstruction operations between July 2020 and July 2021 by a prospective study design. Based on the order in which they were admitted to our hospital, the patients were sequentially chosen to undergo either single-bundle or double-bundle repair alternately.

Primary ACL tears without concomitant PCL damage, lateral collateral ligament injury, PL rotatory instability, or knee fracture were the inclusion criteria. No arthritic changes, no partial or total meniscectomy, no malalignment, and a normal contralateral knee were the exclusion criteria. ACL tibial insertion site of less than 10 mm, PCL dominant intercondylar notch, and patient height less than 170 cm were all deemed contraindications to doing a DBACLR.

Before surgery, each patient underwent a preoperative evaluation that included a review of medical history, physical examination, knee assessment (Lachman test, pivot shift), Lysholm score, [14] International Knee Documentation Committee (IKDC) scale [15] (subjective as well as objective), standard radiographs (AP and lateral view), and magnetic resonance imaging

(MRI). After receiving their written agreement, all patients had arthroscopic ACL reconstruction (SB or DB) while under regional anesthesia.

*2.2. **Statistic evaluation***

To evaluate the data, IBM SPSS version 19 was used. Using a paired t-test, preoperative values, and values at the last follow-up were compared. It was deemed statistically significant when $P < 0.04$ was used.

3. RESULTS:

The average age was 24±7.44 years for the DB group and 23.72±5.81 years for the SB group. In the DB group, every patient was a man, while just three patients in the SB group were female. Following up on average took 18.4 months for the SB group and 14.2 months for the DB group. In both groups, the right knee was the joint that was injured the most. Sports injury-related pivot stress was the most prevalent type of trauma in both groups. Meniscal injury and an isolated ACL tear were both observed in 34 instances (21 in the SB group and 13 in the DB group).

The mean Lysholm score was 94.0±2.66 in the SB group and 93.13±3.31 in the DB group at the time of the last follow-up (P value = 0.201, non-significant - NS) (**Table 1**).

The ultimate follow-up postoperative subjective IKDC score for the SB group was 94.92±2.77 and for the DB group, it was 93.86±2.86. (P value 0.150, NS). At the time of the last follow-up, every patient in both groups had an objective IKDC score of A or B. When measured using a GNRB arthrometer, the mean differential anterior tibial translation was 1.46±0.5 mm in the SB group and 1.16± 0.7 mm in the DB group (P = 0.104, NS) (Table 1).

Despite the fact that the majority of patients had a very good range of motion restored (0-125° or higher), 4 cases in the SB group and 3 instances in the DB group had a mean 150 loss of terminal flexion. In either group, there were no patients with terminal extension loss. At the final follow-up, all patients in the DB group demonstrated a negative pivot shift test, but 3 instances in the SB group demonstrated a positive pivot shift (P = 0.471). Endobutton flipping (>1 mm) in soft tissue outside the femoral cortex was present in 3 patients from each group.

At a 1-year follow-up, MRI scans of the operated knees revealed that the mean postoperative sagittal tibial-ACL angle was 56.0±5.067 in patients who underwent double-bundle reconstruction and 58.3±4.87 in those who underwent single-bundle surgery (P = 0.075). For patients with closed physes, the normal score is 58.8 ± 4.98. After surgery, the mean coronal tibial-ACL angle was 73.6 ± 5.17 in the single-bundle group and 74.86 ± 5.698 in the double-bundle group (P = 0.4090). 69.0±7.47 is the typical value for patients with closed physes. Regarding all of the discussed criteria, there was no statistically significant difference between the two groups (Table 1).

4. DISCUSSION:

Even though it may potentially result in anterior-posterior instability when the knee is in its terminal extension position, single-bundle repair has allegedly been demonstrated to partially decrease rotational instability [16, 17]. Double bundle ACL reconstruction, in which each ACL bundle is rebuilt separately with the proper tensioning pattern for each bundle, has grown in favor recently. Whereas the AM bundle is tight throughout the range of motion of the knee, the PL bundle is mostly tight in extension [16] and reaches its tightest point between 458 and 608 [16].

The AM and PL bundles are therefore fixed appropriately to return them to their original tensioning behavior. The AM and PL bundles are therefore fixed appropriately to return them to their original tensioning behavior. Conventional single-bundle ACL reconstruction, which most closely resembles AM bundle reconstruction, can successfully restore anterior knee stability, but it cannot sufficiently restore rotational stability, according to an in vivo kinematics study [3]. Additionally, cadaveric biomechanical investigations have indicated that double-bundle ACL re-

Table 1:

Criteria	Single bundle group	Double bundle group	P-value
Pre-op Lysholm score	49.75±9.91	46.32±12.11	0.2351
Post-op Lysholm score	94.12±2.66	93.12±3.30	0.201
Pre-op subjective IKDC	47.55±7.86	43.51±9.21	0.0726
Post-op subjective IKDC	94.92±2.77	93.86±2.86	0.150
Post-op objective IKDC	99% normal or near normal (A+B)	99% normal or near normal (A+B)	-
Differential anterior tibial translation (mm)	1.46±0.5	1.16±0.7	0.104
Post-op mean sagittal tibial ACL angle	58.3±4.7	56.0±5.05	0.075
Post-op mean coronal tibial ACL angle	73.2± 5.0	74.85±5.68	0.4090
Post-op Pivot shift	3 positive cases	All negative	0.471

constructions are superior to single-bundle ACL reconstructions in restoring knee kinematics, particularly rotator stability [10].

The pivot shift test was positive in 3 patients (6.5%) in the single-bundle group in the current study, but it was negative in none of the patients in the double-bundle group, indicating postoperatively weaker rotatory control. It was not statistically significant with a P value of <0.471. Double-bundle reconstruction did not produce clinically meaningful differences in KT-1000 measures for anterior stability or in pivot shift tests for rotational stability, according to Meredick et al. [18] in a meta-analysis of the randomized controlled studies comparing single- vs DBACLR.

In their recent conceptual assessment of anatomic DBACLR, Yasuda et al. [19] evaluated 10 prospective randomized studies contrasting single- and double-bundle ACL repair. The anterior and/or rotational stability of the knee was greatly enhanced with the anatomic DBACLR compared to the standard single-bundle reconstruction in 8 (80%) of the 10 examinations. DBACLR produced considerably greater anterior and rotational stability and higher IKDC objective scores compared to single-bundle reconstruction, according to a meta-analysis of random controlled trials by Xu et al. [2].

The Lysholm score, Tegner activity scale, and IKDC subjective score show that this meta-analysis did not find any appreciable changes in subjective outcome measures between double-bundle and single-bundle reconstruction. The Lysholm score, subjective and objective IKDC, differential anterior tibial translation, and post-operative mean sagittal and coronal tibial ACL angles on MRI scan did not show a statistically significant difference between the two groups in our research, either [Table 1].

The primary goal of our study was to evaluate the postoperative clinical-radiological results of single-bundle arthroscopic ACL surgery vs double bundle arthroscopic ACL restoration. We evaluated the postoperative coronal- and sagittal-tibial angles of the rebuilt ACL graft in patients from both groups using MRI scanning at a follow-up of around two years. There was no statistically significant variance between the participants in the two groups for different tibial-ACL graft angles (Table 2).

There has never been a study done in English literature that looked at the radiological results of arthroscopic ACL restoration using the single-bundle technique and double-bundle approach. The location of the tunnels was satisfactory in both groups, according to an MRI of the oper-

ated knees, and this resulted in similar tibial angles for the ACL grafts in both groups. The grafts must be placed precisely for the best clinical result. With the single-bundle approach, improper graft placement is the main cause of early graft failure, a lack of extension and flexion, and persistent instability [20]. These results indicate that a more anatomical ACL reconstruction is required, one that closely mimics the two bundles of the ACL in terms of anatomical tunnel location, resulting in anatomical ACL graft angles and inclination in both sagittal and coronal planes. The objective anteroposterior stability measurements obtained by the GNRB arthrometer in our investigation showed marginally improved outcomes in the DBACLR group, but these differences were not statically important (P value = 0.104, NS) in comparison to those in the SBACLR group.

The mean differential anterior tibial translation in both patient groups in our investigation was consistent with the value noted over time in other studies. Better anteroposterior and rotator stability may be caused by more collagen in ACL footprints and differential tensioning of the two bundles in DBACLR. Additionally, it was shown that the mean anterior tibial translation in the single-bundle group was lower than in all other reported studies. That might have been crucial in lessening the translational disparity between the single-bundle and double-bundle groups. The factors that may have contributed to tighter single-bundle constructs include accurate anatomical tunnel placement with maximum coverage of the native femoral and tibial footprint, pre-tensioning of the graft, proper seating of the femoral endo button by the cycling of the knee after graft passage, and tibial fixation at approximately 5-10° of knee flexion.

Therefore, our study not only demonstrated statistically comparable functional outcomes (Lysholm and IKDC scores) and objective findings (arthrometer-based anteroposterior translation measurement) in the two groups, but it also demonstrated radiologically (MRI) that the grafted ACLs in both groups had similar anatomic inclination angles. As a result, functionally speaking, DBACLR does not considerably outperform SBACL reconstructions. Due to the higher cost of additional implants, DB reconstructions are also more expensive, which is a key consideration to take into account in underdeveloped countries.

5. CONCLUSION:

Both surgical methods used in our study for ACL restoration were shown to have comparable/similar clinical and radiological outcomes. Rotatory instability was present in 6.5% of patients in the single-bundle group but not in the double-bundle group (NS). At an average of 15 months of follow-up, there was no clinically or radiologically significant difference between the single-bundle and double-bundle ACL restoration groups. To confirm any long-term benefits of Double bundle ACL reconstruction over conventional Single bundle ACL reconstructions, additional long-term evaluation research with a bigger cohort is required.

6. STUDY LIMITATION:

This research has several restrictions. A lateral pivot-shift test, which is subjective and necessitates the patient's cooperation, was used in our investigation. In the DBACLR group, we observed an improvement in rotational stability as measured by the pivot shift, which may be related to the additional PL bundle reconstruction and the differential tightness of the two graft bundles. It is also possible to infer that the high number of negative pivot shift tests may be connected to the four-tunnel approach, which expands the footprint of the reconstruction. However, we currently lack a precise objective measurement method to examine rotational stability in the knee. The pivot shift test is a subjective clinical tool for doing so. Another drawback is that the distinctive proprioceptive function, which is considered to be one of the benefits of double-bundle reconstruction, was not evaluated. The small number of cases also prevents a power analysis from being performed. Also, the strategy of randomly assigning patients to the two groups in a sequential order is not very effective. Yet, the study's strength is that it is prospective in nature.

7. ACKNOWLEDGMENTS:

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8. LISTS OF ABBREVIATIONS:

9. CONFLICT OF INTEREST:

The authors state that they have no conflicts of interest.

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Table 2:

ABBREVIATIONS	FULLFORM
ACL	anterior cruciate ligament
SB	single bundle
DB	double bundle
MRI	magnetic resonance imaging
SBACLR	single-bundle ACL reconstruction
DBACLR	Double-bundle ACL reconstruction
AM	anteromedial
PL	posterolateral

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