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Comparative outcome of single bundle and double bundle anterior cruciate ligament reconstruction techniques: A prospective study

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Abstract

Anterior cruciate ligament (ACL) damage or injury is the most frequent type of sports injury to the knee and could result in recurrent knee instability, meniscal tears, and articular cartilage degeneration. This study aim was to compare results of single bundle and double bundle double tunnel surgical procedures for anterior cruciate ligament reconstruction. Patients were enrolled from May 2018 to November 2018 and followed up for six months duration. Before surgery, we compared the mean Tegner Lysholm score between the SB and DB group which was 52.50 and 56.0 respectively and differences among them were not statistically significant ($p=0.076$). After 6 months of surgery TL score between SB and DB reconstruction were compared and differences among them were found to be statistically significant ($p<0.05$). We compared IKDC score before surgery between the two groups the SB and DB reconstruction before surgery, the mean IKDC score was 44.30 and 46.20 respectively and differences among them were not statistically significant ($p=0.314$). After 6 months of surgery SB and DB reconstruction groups were compared and differences among them were found to be statistically significant ($p<0.05$). After 6 months of surgery the mean IKDC score of SB was 71.25 and mean IKDC score of DB was 76.16 whereas mean TL score of SB reconstruction group was 81.15 and of DB was 86.71. Lachman and anterior drawer test results were also compared preoperatively and postoperatively but was not found to be significant. Study concluded that double bundle ACL reconstruction is better management for anterior cruciate ligament reconstruction as compared to single bundle ACL reconstruction in ACL injuries.

Keywords: Single bundle, double bundle double tunnel, anterior cruciate ligament

Introduction

The knee joint bear muscular and strapping ligamentous structures which includes the collateral ligaments, meniscus, the anterior and posterior cruciate ligaments all of which are involved in the kinematics of the knee. The anterior cruciate ligament (ACL) is made up of two bundles namely an anteromedial (AM) bundle and posterolateral (PL) bundle. AM bundle tightens in flexion while PL bundle tightens in extension. The two bundles work in conjunction to manage the axial rotary motion and translation. Anterior cruciate ligament (ACL) damage or injury is the most frequent type of sports injury to the knee and could result in recurrent knee instability, meniscal tears, and articular cartilage deterioration/degeneration [1]. The injury mechanism involves deceleration, hyperextension and rotation of the knee, inducing instability that interferes in patient's daily routine activities and work [2, 3]. Currently, the most common treatment strategies employed for an injured ACL is either a single-bundle (SB) or a double-bundle (DB) ACL reconstruction [4, 5]. Both surgical management approaches are relatively effective in restoring the native anatomy and kinematics of the joint [6]. The arthroscopic SB technique has been widely performed by creating one single femoral tunnel and one single tibial tunnel for decades [7]. Whereas this technique may provide good clinical outcomes and restore anterior stability following an ACL injury it may be suboptimal with regards to rotatory function [8]. Arthroscopic DB surgery, first described by Mott in 1983 [9], technically reconstructs the two functional bundles of the ACL, thereby more closely approximating the native anatomy.

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Moreover, it improves pivot shift resistance and increases rotational knee control [10] in comparison to SB ACL reconstruction. A good clinical history and a systematic physical examination are critical to establish an ACL injury. Multiple manoeuvres and scores have been recommended to diagnose ACL rupture, including Lachman test, pivot shift test, and anterior drawer test, as well as an objective KT1000 arthrometer test, Tegner-Lysholm, IKDC among other scores has been established to grade functional disability secondary to knee injury [11, 12].

In spite of various studies previously done, there exist a controversy regarding the best technique for ACL reconstruction. The purpose of this study is to compare the clinical results and functional outcome between the anatomical SB and DB ACL reconstruction methods after a 6 month follow-up and to evaluate the respective clinical outcomes.

Materials and Methods

A prospective randomized study to compare clinical outcome of knee stability after ACL reconstruction using an autograft, between two different techniques: SB and DB ACL reconstruction. The study was conducted in Department of orthopaedic surgery King George's Medical University Lucknow Uttar Pradesh, India.

Inclusion criteria: patients within 16 to 60 years of age with ACL rupture symptoms that agreed to participate after reading and signing an informed consent. Subjects were screened for eligibility, with manoeuvres including Anterior drawer, Lachman and pivot shift test and an MRI to verify the diagnosis. Patients with degenerative knee disease or knee prosthesis or with previous ACL reconstruction were excluded from the study. 65 subjects were screened for eligibility, 5 were excluded for presenting a re-rupture of the ACL. 60 subjects underwent randomization using the randomization table. Thirty subjects were randomly assigned to undergo SB ACL reconstruction, and 30 to DB ACL reconstruction procedure. Same clinician performed clinical evaluation to allow consistency. Tegner-Lysholm and IKDC tests were applied to the patients before surgery and at programmed visits. Tegner-Lysholm scores were classified as poor < 65; fair > 65 - 83; good 84 - 90 and excellent > 90. Anteroposterior stability of the ACL was measured before and after surgical procedure in both knees using anterior drawer test and Lachman and at each programmed visit.

Anterior drawer test measurement was done in supine position. The hip and knee were flexed to 45 and 90 degrees respectively. While the foot was stabilized on the examination table and the

hamstrings were relaxed, frequent manual gentle antero-posterior forces were applied to the proximal tibia, and tibia antero-posterior displacement in flexed knee was measured. The degree of displacement was compared with normal side. Displacement of more than 6mm comparing the opposite side with a soft end point was proposed as torn ACL.

The Lachman test was carried out in relaxed supine position, the examiner bends the knee to about 15-20 degrees. The examiner should place one hand behind the proximal tibia with the thumb on the tibial tuberosity and the other grasping the patient's thigh. The tibia is then pulled forward to assess the amount of anterior translation of the tibia in comparison to the femur. An intact ACL should prevent forward translational movement ("firm endpoint") while an ACL-deficient knee will demonstrate increased forward translation without a decisive 'end-point' - a soft or mushy endpoint indicative of a positive test. In normal response there should be a steady restraint to anterior movement. Anterior displacement of proximal tibia being felt by examiner thumb in a soft or mushy end point was associated with positive Lachman test. Grade of laxity was defined by the amount of anterior tibial movement.

Under spinal anaesthesia diagnostic arthroscopy was performed and ACL tear confirmed. Autograft harvested from the semitendinosus and gracilis tendon from the same knee. The Autografts obtained were soaked with gentamicin and saline. To the ends Krakow sutures applied with ethibond® #5. In SB group one anatomic femur tunnel made through the anteromedial portal and one tibial tunnel made over the original anteromedial bundle footprint. In DB group two anatomic tunnels on femur and one tunnel on tibia were made using anteromedial and posterolateral footprints and the graft fixed to tibial tunnel with bio absorbable interference screw.

Statistical analysis

Statistical analysis was performed by Graph Pad prism software. T test was done to compare the preoperative and post-operative scores among the two groups. Paired sample t test was performed to compare the preoperative and post-operative scores in each of the group. All the data presented in mean and standard deviation. P value less than 0.05 was considered to be significant.

Results

Demographic characteristic

Present study included 60 patients with single bundle and double bundle reconstruction

Table 1: Demographic characteristics

Characteristics	Mean±SD	SB	DB	Significance
Gender (M/F)	46/14	22/8	24/6	chi sq=0.373, p=0.542
Age	32.63 ± 12.53	34.19 ± 19.57	30.67± 9.52	t=0.89, p=0.379
Height (m)	1.57 ± 0.22	1.53 ± 0.19	1.61 ± 0.12	t=1.95, p=0.056
Weight (kg)	71.28 ± 22.69	70.06 ± 19.67	72.5 ± 11.31	t=0.59, p=0.558
BMI (kg/m ²)	27.28 ± 5.95	26.91 ± 6.88	30.11 ± 7.24	t=1.75, p=0.085
ACL rupture (Right/Left)	30/30	12/18	17/13	chi sq=1.67, p=0.196

The demographic characteristics between the two groups was not found to be significant. Hence these two groups are comparable.

Tegner-Lysholm score in single bundle and double bundle reconstruction

Single bundle (SB) reconstruction was performed and TL score was recorded before and after 6 months of SB reconstruction and differences among them were found to be statistically significant.

We compared the SB and DB reconstruction before surgery, the mean TL score was 52.50 and 56.0 respectively and differences among them were not statistically significant (p=0.076). After 6 months of surgery the mean TL score of SB was 81.15 while mean TL score of DB was 86.71 and the differences among them were statistically significant (p<0.05). (3 week, 6 week &

12 week no significant)

The mean TL scores in SB group before surgery was 52.50 while after 6 months of surgery it was 81.15 ($p < 0.05$). In patients who had undergone double bundle (DB) reconstruction, mean TL score before surgery was 56.0 while after 6 months of surgery it was 86.71 and differences among them were found to be statistically significant ($p < 0.05$). Thus within the single bundle group and the double bundle group it was found to be significant. However double bundle fared better than the single bundle.

Table 2: Intergroup Comparisons of Tegner-Lysholm score

Tegner-Lysholm score	SB		DB		t-value	p-value
	Mean	SD	Mean	SD		
Before Surgery	52.50	7.01	56.00	7.96	1.81	0.076
After Surgery	58.10	7.89	59.60	8.11	0.73	0.471
6 wk	63.20	6.88	65.80	8.35	1.32	0.193
12 wk	73.30	9.56	78.18	10.08	1.92	0.059
6 months	81.15	10.13	86.71	9.33	2.21	0.031

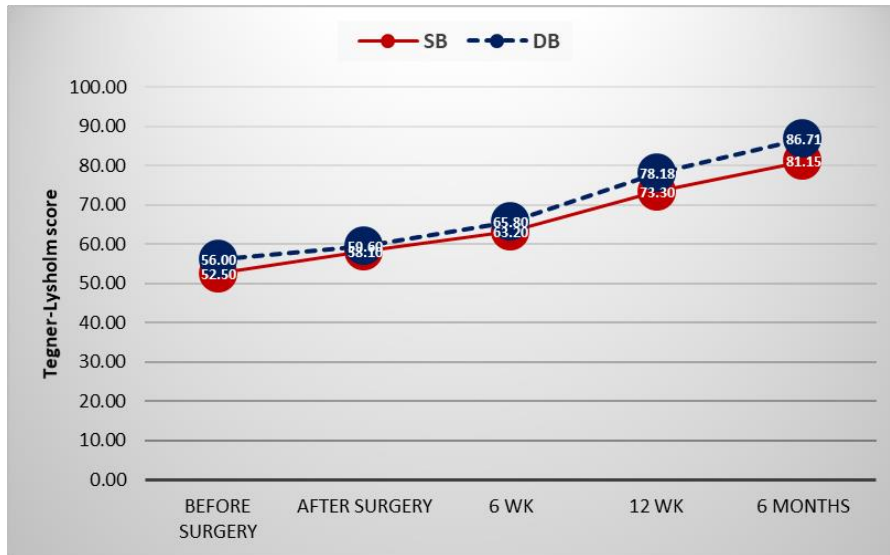


Fig 1: Intergroup Comparisons of Tegner-Lysholm score

Table 3: Paired Comparisons of Tegner-Lysholm score within the Groups

Tegner-Lysholm score	SB			DB		
	Mean change	t-value	p-value	Mean change	t-value	p-value
Before vs After	5.60	3.12	0.003	19.60	10.20	<0.001
After vs 3 wk	1.10	0.62	0.54	1.50	0.77	0.446
After vs 6 wk	2.20	1.22	0.23	2.58	1.31	0.196
After vs 12 wk	3.05	1.66	0.10	3.72	1.84	0.071

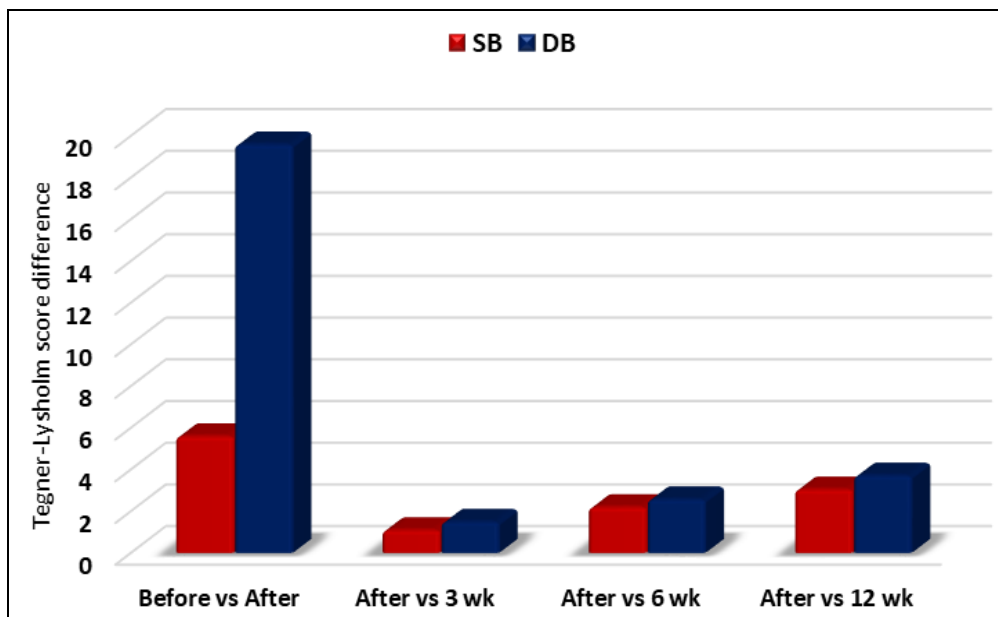


Fig 2: Paired Comparisons of Tegner-Lysholm score within the Groups

IKDC score in single bundle and double bundle reconstruction

Single bundle (SB) reconstruction was performed and IKDC score was recorded before and after 6 months of SB reconstruction and differences among them was found to be significant. We compared the SB and DB reconstruction before surgery, the mean IKDC score was 44.30 and 46.20 respectively and differences among them were not statistically significant ($p=0.05$). After 6 months of surgery SB and DB reconstruction was compared and differences among them was found to be significant ($p<0.05$).

The mean IKDC scores in SB group before surgery was 44.30 while after 6 months of surgery it was 71.25 ($p<0.05$). Patients who had under gone double bundle (DB) reconstruction, before surgery mean IKDC score was 46.20 while after 6 months of

surgery it was 76.16 and differences among them was found to be significant ($p<0.05$). Thus within the single bundle group and the double bundle group it was found to be significant individually. However double bundle faired better than the single bundle.

Table 4: Intergroup Comparisons of IKDC score

IKDC score	SB		DB		t-value	p-value
	Mean	SD	Mean	SD		
Before Surgery	44.30	7.82	46.20	6.61	1.02	0.314
After Surgery	58.50	6.52	60.50	7.16	1.13	0.263
6 wk	66.80	7.76	70.20	8.12	1.66	0.103
12 wk	69.15	7.05	72.82	7.45	1.96	0.055
6 months	71.25	7.68	76.16	8.75	2.31	0.024

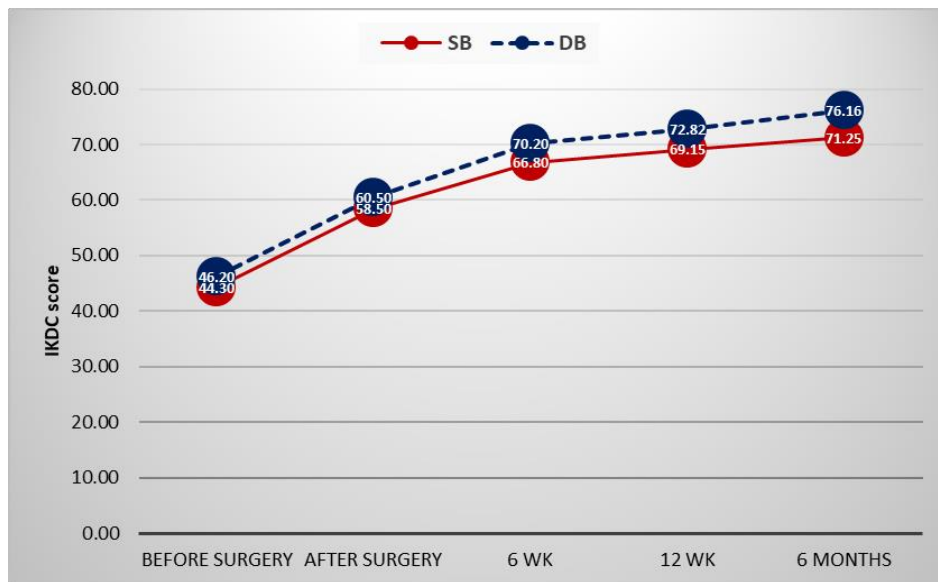


Fig 3: Intergroup Comparisons of IKDC score

Table 5: Paired Comparisons of IKDC score within the Groups

IKDC score	SB			DB		
	Mean change	t-value	p-value	Mean change	t-value	p-value
Before vs After	14.20	7.64	<0.001	14.30	8.04	<0.001
After vs 6 wk	8.30	4.49	<0.001	9.70	4.91	<0.001
After vs 12 wk	10.65	6.08	<0.001	12.32	6.53	<0.001
After vs 6 month	12.75	6.93	<0.001	15.66	7.59	<0.001

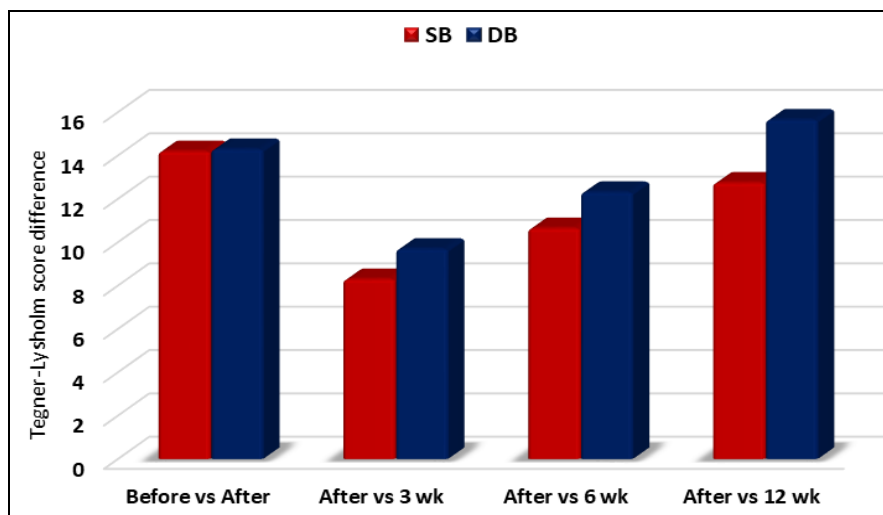


Fig 4: Paired Comparisons of IKDC score within the Groups

Lachman Test and anterior drawer test results

Pre operatively Lachman test and anterior drawer test grade 3 was seen in 43.3% cases of SB group and 60.0% cases of DB group. Remaining cases had grade 2 in both the groups. Pre operatively no significant difference was found in between the two groups ($p=0.196$).

Post operatively after 6 weeks Lachman test and anterior drawer test grade 3 was eliminated from both groups. Grade 2 was seen in 6.7% cases of SB group and 0% cases of DB group. Majority had grade 1 in both SB and DB groups with proportion 93.3% and 100% respectively. However no significant difference was found in grades improvement between the two groups ($p=0.15$).

Post operatively after 12 weeks Lachman test and anterior drawer test grade 3 was eliminated from both groups. Grade 2 was seen in 13.3% cases of SB group and 6.7% cases of DB group. Majority had grade 1 in both SB and DB groups with proportion 86.7% and 93.3% respectively. However no significant difference was found in grades improvement between the two groups ($p=0.389$).

Post operatively after 6 months Lachman test and anterior drawer test grade 3 was eliminated from both groups. Grade 2 was seen in 16.7% cases of SB group and 10.0% cases of DB group. Majority had grade 1 in both SB and DB groups with proportion 83.3% and 90% respectively. However no significant difference was found in grades improvement between the two groups ($p=0.448$).

Table 6: Lachman Test and anterior drawer test results

Lachman's test and anterior drawer test		Type			
		SB		DB	
		No.	%	No.	%
Pre-operative	Grade 2	17	56.7%	12	40.0%
	Grade 3	13	43.3%	18	60.0%
	chi sq	1.669			
	p-value	0.196			
6 week Post-operative	Grade 1	28	93.3%	30	100.0%
	Grade 2	2	6.7%	0	0.0%
	chi sq	2.069			
	p-value	0.15			
12 week Post-operative	Grade 1	26	86.7%	28	93.3%
	Grade 2	4	13.3%	2	6.7%
	chi sq	0.741			
	p-value	0.389			
6 month Post-operative	Grade 1	25	83.3%	27	90.0%
	Grade 2	5	16.7%	3	10.0%
	chi sq	0.577			
	p-value	0.448			

Discussion

Multiple scoring system have been recommended to diagnose ACL rupture or injury such as, pivot shift test, anterior drawer test, lachman's test, objective KT1000 arthrometer test, Tegner-Lysholm, IKDC scores have been established to grade functional disability secondary to knee injury^[11, 12]. Pivot shift tests the rotational stability^[13].

According to Tashman., *et al.* SB has been proven to successfully re-establish the anterior-posterior movement of the knee, but patients failed to re-establish rotational strength^[14]. DB repair shows better rotational stability of the knee, due to a closer anatomical reconstruction of AM and PL bundles^[15, 16].

Present study showed that the TL score in SB before surgery and after 6 months of surgery was 52.50 to 81.15, however the improvement was better in DB, TL score before surgery and after surgery was 56.0 to 86.71 the improvement was good. Similar finding was observed with IKDC score and better

improvement was observed with DB reconstruction. IKDC score for SB reconstruction was before and after 6 month of surgery 44.30 to 71.25 while for DB reconstruction before and after 6 month of surgery IKDC score was 46.20 to 76.16. It was noted that better improvement with double bundle reconstruction was observed. DB technique showed better knee stability as well as less time to return to pre-injury level activities, and with lower association rate of new meniscal tears and repeated ACL injuries.

Conclusion

Present study concluded that double bundle reconstruction was better and improvement was high compared to single bundle ACL reconstruction. Double bundle reconstruction of knee injury is better technique to manage patients.

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