Comparison of Arthroscopic Transtibial and Transportal Techniques of Anterior Cruciate Ligament (ACL) Reconstruction by a Single Bundle (SB) Quadrupled Hamstring Graft

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ABSTRACT

Introduction: Ligament injuries of the knee are common in the general population, mostly occurring as a result of sports and high energy road traffic accidents. Study aimed to compare the results of Arthroscopic Transtibial and Transportal Techniques of Anterior Cruciate Ligament (ACL) Reconstruction by a Single Bundle (SB) Quadrupled Hamstring Graft.

Material and methods: The present study was conducted in the Post-graduate Department of Orthopaedics, SKIMS Medical College Hospital, Srinagar, J&K, India. It was a prospective hospital based study that included a total of 30 cases with a symptomatic ACL deficiency as a result of trauma, which were divided by random number table method into transtibial and transportal groups (fifteen each). Arthroscopic ACL reconstruction using quadrupled hamstring graft was performed using endobutton on the femoral side and interference screw fixation on the tibial side. All the patients were followed up for minimum two years duration with follow up visits at 2 weeks, 4 weeks, 8 weeks, 3 months, 4 months, 6 months, 1 year, 18 months and 2 years post operation.

Results: The mean ages in our series were 28 and 29.4 years for transtibial and transportal groups respectively. Majority of the patients were males (86.7%) in transtibial group and 80% in transportal group. Females represented only 13.3% and 20% in transtibial and transportal groups respectively. The male to female ratio was 6.5:1 and 4:1 in transtibial and transportal groups respectively. The right side was involved in 33.7% (transtibial and transportal each) and left side was 66.7% (transtibial and transportal each) cases respectively. Most frequent mode of injury was sports related injuries (33.3% in transtibial and 46.7% in transportal group) in our series followed by road traffic accidents (33.3% and 20%), falls from height (20% and 26.7%) and other forms of injury (2% and 6.7%). Time since injury ranged from 2 months to 10 years with mean of 3 years for transtibial and 2 months to 8 years with mean of 2.9 years in transportal group. The mean follow up duration in our study was 27 months, with minimum being 18 months and maximum 36 months.

Conclusion: Arthroscopic ACL Reconstruction using Transtibial and Transportal techniques are both effective modalities of treatment in patients with ACL deficient knees. Transportal technique gives superior patient defined functional results in terms of Lysholm score (statistically significant). Postoperative Pivot Shift Grading is statistically significant in transportal group. Single Bundle anatomic ACL Reconstruction decreases the pivot shift phenomenon and more closely mimics native ACL biomechanics.

Keywords: Arthroscopic Transtibial, Transportal Techniques of Anterior Cruciate Ligament, Single Bundle, Quadrupled Hamstring Graft

INTRODUCTION

Ligament injuries of knee are common in the general population, mostly occurring as a result of sports and road traffic accidents. Anterior Cruciate Ligament (ACL) is the most frequent disrupted ligament of the knee. The incidence of ACL injury has increased with the rise of participation in sports.[1-5] Most diagnosed ACL injuries are complete disruptions (85%), and partial sprains occur less (15%). ACL reconstruction is the sixth most common procedure performed in orthopaedics, and it is estimated that between 75,000 and 100,000 ACL repair procedures are performed annually in the United States alone.

The development of symptomatic knee instability after ACL injury ranges from 16% to almost 100%.[6] Meniscus injury occurs in association with 50% of acute ACL tears, and this figure rises to 90% in ACL-deficient knees assessed 10 years or more after the initial injury. The incidence of articular cartilage lesions rises from 30% in acute ACL injuries to approximately 70% of knees with chronic ACL instability. The progression to osteoarthritis in ACL-deficient knees is variable, between 15% and 65%.[7-11]

The rationale for reconstruction of the torn ACL is to stabilize the knee and prevent future meniscal tears and associated joint damage.[12]

The ideal graft material would reproduce the anatomy of the native ACL, provide the same biomechanical properties, permit secure fixation, promote rapid biologic incorporation to allow for accelerated rehabilitation, and minimize donor site morbidity. Graft choices for ACL reconstruction include autografts, allografts and synthetic grafts. Currently, commonly used autografts include bone-patellar tendon-bone (BPTB), quadrupled hamstring (STG) tendons and quadriceps tendon with or without bone. Allografts include BPTB, hamstring tendons, Achilles tendon, and tibialis

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anterior or posterior tendons. Synthetic grafts include Gore-tex Ligament, Stryker Dacron Ligament and Kennedy Ligament Augmentation Device. Allografts result in lower level of stability and higher failure rates than their autograft counterparts, besides risk of infection.[12] Synthetic grafts are not in vogue due to their high rate of rupture and recurrent sterile knee effusions.

ACL reconstruction can be performed with different techniques. The most popular technique for femoral tunnel placement is the transtibial technique[13], but studies have reported that it did not provide an anatomical placement of the tunnel resulting in rotational instability of the knee.[14] The advantage of the transtibial technique is that when the notch is widened and the tibial tunnel is placed correctly in the coronal and sagittal plane, the correct placement of the femoral tunnel is automatic. Howell et al.[15] working as a team they performed a comprehensive review of a large body of anatomic, histologic, biomechanical, and clinical data and recommend the use of the acronym 'I.D.E.A.L.' as an abbreviated nomenclature for describing the guidelines for placing the femoral tunnel.

1. ISOMETRIC: Graft will have a length tension relationship that is similar to the native ACL.
2. DIRECT FIBERS: Fibers that have direct insertion on the footprint and fibers that are closest to the ridge.
3. ECCENTRIC: Anterior or higher in the footprint and in the anterior-medial portion of the ACL.
4. EQUIDISTANT: Halfway between the top and the bottom of the notch, which is the inter-operative checkpoint.
5. ANATOMIC: Fibers within the bounds of the native ACL graft, which is anterior (higher) than the indirect fibers.
6. LOW TENSION: Tension of the native ACL should match the low tension-flexion pattern of the native ACL.

Study aimed to compare the results of Arthroscopic Transtibial and Transportal Techniques of Anterior Cruciate Ligament (ACL) Reconstruction by a Single Bundle (SB) Quadrupled Hamstring Graft.

MATERIAL AND METHODS

The present study was conducted in the Post-graduate Department of Orthopaedics, SKIMS Medical College Hospital, Srinagar, J&K, India. It was a prospective hospital based study that included a total of 30 cases with a symptomatic ACL deficiency as a result of trauma, which were divided by random number table method into transtibial and transportal groups (fifteen each). Arthroscopic ACL reconstruction using quadrupled hamstring graft was performed using endobutton on the femoral side and interference screw fixation on the tibial side. Patients in the age group of 18-50 years, with acute or chronic symptomatic unstable ACL ruptures with or without associated meniscal injuries were included in the study.[2,3,16] We excluded, from our study, patients with conditions in which knee arthroscopy was impossible or risky; including partial or complete ankylosis around the joint, knee deformities and unfavourable local skin condition, patients with previous ACL surgery, multiple ligament injuries to the same knee, major comorbidities (e.g., Grade 2 Osteoarthritis of knee joint) and mentally subnormal persons (unlikely to comply with advice during rehabilitation).[3,16]

All the patients were admitted, thorough clinical examination was done, routine investigations done to look for fitness for surgery. Pre-operative assessment included:

- Radiographs and MRI of the involved knee.[17]
- Lysholm score and Tegner activity level.

This also included various tests i.e. Pivot shift test, Lachman test, Anterior and Posterior drawer, Valgus and Varus stress tests, tests for meniscal pathologies and Tests for posterolateral and posteromedial instability.[3,6,17] Tegner activity level and Lysholm scoring were done and documented preoperatively. Circumferential measurements of both legs were done at defined landmarks (15 cm above the proximal pole of patella for thigh and 7 cm distal to tibial tuberosity for the calf).[3]

Radiography: Standard antero-posterior and lateral projections (standing views) of the involved knee, besides the condylar notch view (tunnel view) and axial view of patella. Notch width index was determined to estimate notch width (NWI).[18,19] MRI scan of the involved knee was done to increase the diagnostic accuracy and to assess the status of other soft tissue structures.

All the patients were followed up for minimum two years duration with follow up visits at 2 weeks, 4 weeks, 8 weeks, 3 months, 4 months, 6 months, 1 year, 18 months and 2 years post operation. Clinical examination and radiographic assessment was done. Functional scoring was done at each follow up and compared with pre injury scores using the above given scores. Stability tests like Drawer tests, Lachman, Pivot shift were also done.

STATISTICAL ANALYSIS

Statistical software SPSS (version 20.0) and Microsoft Excel were used to carry out the statistical analysis of data. Data was analyzed by means of descriptive statistics, viz., means, standard deviations and percentages and presented by means of Bar diagrams. For parametric data, Student's independent t-test and Mann Whitney U-test were employed. Chi-square test or Fisher's exact test, whichever appropriate, was used for non-parametric data. A P-value of less than 0.05 was considered statistically significant.

RESULTS

The mean ages in our series were 28 and 29.4 years for transtibial and transportal groups respectively. Majority of the patients were males (86.7%) in transtibial group and 80% in transportal group. Females represented only 13.3% and 20% in transtibial and transportal groups respectively. The male to female ratio was 6.5:1 and 4:1 in transtibial and transportal groups respectively. The right side was involved in 33.7% (transtibial and transportal each) and left side was 66.7% (transtibial and transportal each) cases respectively. Most frequent mode of injury was sports related injuries

Lysholm Score	Transtibial		Transportal		p-value
	Number	Percentage	Number	Percenetage	
0-50	0	0.0%	0	0.0%	0.027 (Significant)
51-75	1	6.7%	0	0.0%	
76-90	8	53.3%	5	33.3%	
91-100	6	40.0%	10	66.7%	
Mean±SD	86.5±8.81		92.6±5.62		
Tegner Activity Level	**Transtibial**		**Transportal**		**p-value**
	Number	**Percentage**	**Number**	**Percentage**	
4	4	26.7	2	13.3	0.338 (Non-significant)
5	7	46.7	7	46.7	
6	3	20.0	5	33.3	
7	1	6.7	0	0.0	
8	0	0.0	1	6.7	
Mean ± SD	5.07±0.88		5.40±0.986		
Pivot Shift Results					
Pivot Shift Test	**Transtibial**		**Transportal**		**p-Value**
	Number	**Percent**	**Number**	**Percent**	
0	1	6.7	3	20.0	0.004 (Significant)
1	4	26.6	11	73.3	
2	10	66.7	1	6.7	
3	0	0.0	0	0.0	
Median	2 (0-2)		1 (0-2)		

Table-1: Pre-operative assessment of injured knees

Functional Scoring System		Type of Surgery		p-value
		Transtibail	Transportal	
Lysholm Score (Mean±SD)	Pre-op	56.4±11.41	55.3±13.52	0.817#
	Post-op	86.5±8.11	92.6±5.62	**0.027***
Tegner's Score (Mean±SD)	Pre-op	3.53±0.834	3.40±0.737	0.646#
	Post-op	5.07±0.88	5.40±0.986	0.338#
Single Leg Hop test (Mean±SD)	Pre-op	55.8±13.58	56.4±8.18	0.885#
	Post-op	87.4±6.83	89.2±7.05	0.484#
Manual Lachman grading (Mean±SD)	Pre-op	3 (1-3) 0.782#	3 (1-3)	0.782#
	Post-op	0 (0-3) 0.696#	0 (0-1)	0.696#
Pivot Shift test (Mean±SD)	Pre-op	2 (1-3) 0.597#	2 (1-3)	0.597#
	Post-op	2 (0-2)	1 (0-2)	**0.004***
Bold and asterisk * indicate statistical and # signifies 'non significance'				

Table-2: Post-operative assessment

(33.3% in transtibial and 46.7% in transportal group) in our series followed by road traffic accidents (33.3% and 20%), falls from height (20% and 26.7%) and other forms of injury (2% and 6.7%). Time since injury ranged from 2 months to 10 years with mean of 3 years for transtibial and 2 months to 8 years with mean of 2.9 years in transportal group. The mean follow up duration in our study was 27 months, with minimum being 18 months and maximum 36 months.

The pre-operative Lysholm score ranged from 32 to 79 with a mean of 56.4 in transtibial and 37 to 82 with a mean of 55.3 in transportal groups respectively. The pre-operative Tegner Activity Level ranged from 2 to 5 (mean = 3.53) in transtibial and 2 to 4 (mean = 3.4) in transportal groups respectively. (Table 1)

Medial meniscus injury was most common associated finding 40.0% (transtibial) and 46.7% (transportal) of the patients. Lateral meniscal tear was reported in 6.7% of the patients in both groups.

The postoperative scoring was done and tabulated for both groups. The Lysholm score showed improvement in both groups with transportal group showing a better outcome. (Table 2)

Post operative Tegner Activity Level also improved in both groups but there was no statistically significant difference between the two groups.

Postoperative Pivot Shift score showed consistent improvement in both groups with better results in transtibial group.

Apart from functional scoring systems, many other parameters were also compared. A statistically significant

S. No.		Age	Sex	SI	MI	DOS	LYS	TEG
Present Study	Transtibial	28.0	86.7% M, 13.3% F	33.3%R, 66.7%L	40.0 %	96.3 Min (80 to 110)	86.5	5.07 (4-7)
	Transportal	29.4	80 % M, 20% F	33.3%R, 66.7%L	46.7 %	104.1Min (90 to 130)	92.6	5.4 (4-8)
Mulcahey et al. 2014 [22]	Transtibial	30.3	66% M, 34 % F	51%R, 49%L	-	-	91(63-100)	6.8 (2-9)
	Transportal	29.9	67% M, 33% F	51%R, 49%L			94 (85-100)	6.5 (3-9)
Mirzatolooei 2012 [23]	Transtibial	26.6	95.5% M, 4.5% F	-	25.0%	80 min (60-120 mins)	78.32	5.75
	Transportal	26.6	98.75% M, 1.25% F		17.5%	100Min (70-150)	81.41	6.1
Zhang et al. 2012 [24]	Transtibial	-	-	-	-		94.5	-
	Transportal						95.1	
Mardani-Kivi 2012 [25]	Transtibial	-	-	-	-	-	92.2	-
	Transportal						96.1	
Alentorn-Geli et al. 2010 [26]	Transtibial	-	-	-	-	-	97.0	7.1
	Transportal						99.3	7.8

Description of abbreviations: SI- Side Involvement, MI- Meniscal Injury, DOS- Duration of Surgery, LYS- Lysholm Scoring, TEG- Tegner Activity Level

Table-3: Comparison of results between studies

Manual Lachman Grading)	Transtibial		Transportal		P-value
	Number	%age	No. of cases	%age	
0	12	80.0	13	86.7	0.696 (Non-Significant)
1	1	6.7	2	13.3	
2	1	6.7	0	0.0	
3	1	6.7	0	0.0	
Comparison of postoperative Pivot Shift Test in two groups (Present Study)					
Pivot Shift Test	**Transtibial**		**Transportal**		**P-value**
	Number	**%age**	**No. of cases**	**%age**	
0	1	6.7	3	20.0	0.004 (Significant)
1	4	26.7	11	73.3	
2	10	66.7	1	6.7	
3	0	0.0	0	0.0	

Table-4: Comparison of postoperative Manual Lachman Grading in two groups (Present Study)

difference between the two techniques was seen only in Lysholm scoring and pivot shift test. In others e.g Tegner's score, single leg hop test and manual lachman, no significant difference was observed. (Table 2)

Final Results: The Lysholm score at final follow-up of two years was excellent in 33.33% and 66.67% patients in transtibial and transportal groups respectively. None of the patients in either group had poor Lysholm score at final follow-up.

Range of Motion

Full range of motion was achieved in 22 cases (10 in transtibial group and 12 in transportal group) by 12 weeks, 4 patients (3 in transtibial group and 1 in transportal group) by 16 weeks while 4 patients (2 in each group) persisted with some motion deficit at final follow up. One patient in transtibial group had flexion deficit of 10 degrees and extension deficit of 5 degrees of the operated knee. Other patient in the same group had extension deficit of 5 degrees. In the transportal group, one patient had flexion deficit of 15 degrees and other patient had extension deficit of 10 degrees.

DISCUSSION

The mean ages in our series {28 (range 21 – 39) for transtibial and 29.4 (21 – 40) for transportal} were comparable to the other published series [Mulcahey et al. 2014[22], Mirzatolooei 2012[23].

Majority of the patients were males (86.7%) in transtibial group and 80% in transportal group. Females represented only 13.3% and 20% in transtibial and transportal groups respectively. The male to female ratio was 6.5:1 and 4:1 in transtibial and transportal groups respectively. Males dominated the study because of involvement in sports related activities and outdoor activities as compared to females. The results of gender comparison were comparable with other published series. [Mulcahey et al. 2014[22], Mirzatolooei 2012[23]. (See Table 3)

Forty percent (40.0%) (transtibial) and 46.7% (transportal) of the patients had associated tear of the medial meniscus (Non-significant p value of 0.714). Lateral meniscal tear was reported in 6.7% of the patients in both groups. Only one patient had both medial and lateral meniscal tear in

transportal group. The findings of Mirzatolooei 2012[23] were in consonance with our results. He reported that 25.0% (transtibial) and 17.5% (transportal) of the patients had associated tear of the medial meniscus. (Table 3)

In our study, the mean time taken for the surgery was 96.3 (80 to 110) and 104.1 (90 to 130) minutes in transtibial and transportal groups respectively. Mirzatolooei 2012[23] reported that mean operation time was 20 minutes longer for the transportal technique (100 min; range: 70 to 150 min.) than the transtibial technique (80 min.; range: 60 to 120 min.).

The Lysholm functional score improved from a mean pre-operative value of 56.3 (range 32 – 79) in transtibial group to final mean Lysholm score of 86.5 (range 68 – 96) while in the transportal group it improved from 55.3 (range 37 – 82) to 92.6 (range 84 – 98). There were significant statistical differences between the two groups ($p = 0.027$). The findings of Mirzatolooei 2012[23] were similar with our results. He reported that Modified Lysholm daily activity score indicated better results in the transportal technique (mean: 81.41) than then the transtibial technique (mean: 78.32) ($p = 0.037$). Similar changes were also observed for the Lysholm score by Mulcahey et al. 2014[22], Zhang et al. 2012[24], Mardani-Kivi 2012[25], Alentorn-Geli et al. 2010[26]. However, Kim et al. 2011[27] reported that the Lysholm score was higher in the transportal group than transtibial group, but there was no significant statistical difference between the groups ($p > 0.05$). (Table 1 and 2)

The Tegner activity level improved from a mean pre-operative value (post injury) of 3.53 (range 2–5) in transtibial group to final mean level of 5.07 (range 4 – 7) while in the transportal group it improved from 3.4 (range 2 – 4) to 5.4 (range 4 – 8). There were no significant statistical differences between the two groups ($p = 0.338$). Mulcahey et al. 2014[22] reported that the Tegner activity level showed a greater increase in activity levels in the transportal group, although this was not statistically significant ($p > 0.7$). Similar findings were observed by Koutras et al. 2013[28], Mirzatolooei 2012[23], and Alentorn-Geli et al. 2010[26]. (Table 1 and 2)

The single leg hop test measurements improved from a mean preoperative value of 55.8 (range 25 – 72) in transtibial group to final mean level of 87.4 (range 71 – 97) while in the transportal group it improved from 56.4 (range 44 – 73) to 89.2 (range 74 – 99). There were no significant statistical differences between the two groups ($p = 0.484$). Similar comparative studies have not recorded the functional outcome on the basis of this test. (Table 1 and 2)

Stability Tests

The manual Lachman grading improved from a median preoperative value of 3 (range 1 – 3) in transtibial group to final median level of 0 (range 0 – 3) while in the transportal group it improved from median preoperative value of 3 (range 0 – 3) to 0 (range 0 – 1). At final follow up one patient each in transtibial group had grade 3 and 2 Lachman respectively. No patient in transportal group had Lachman grading beyond 1. There were no significant statistical differences between the two groups ($p = 0.696$), which were in consonance with the following reports. (Table 4)

The Pivot shift grading improved from a median preoperative value of 2 (range 1 – 3) in transtibial group to final median level of 2 (range 0 – 2) while in the transportal group it improved from median preoperative value of 2 (range 1 – 3) to 1 (range 0 – 2). At final follow up, ten patients in transtibial group and one in transportal group had Pivot shift grade 2 respectively. No patient in either group had Pivot shift grade 3 at final follow up. There were significant statistical differences between the two groups ($p = 0.004$), which were in consonance with the findings ($p = 0.04$) of Kim et al. 2011[27]; however, Guglielmetti 2014[30] reported no-significant differences (0.173) between the two groups. (Table 4)

Complications

Intraoperative fluid extravasation into the subcutaneous tissue around knee joint occurred in one patient belonging to the transportal group that resolved spontaneously. In one patient, in transtibial group, due to short graft length washer had to be used on tibial side for graft fixation.

Postoperative complications

- Seven patients complained of numbness and paraesthesia over the anterolateral aspect of leg (4 in transtibial group and 3 in transportal group). Plaweski et. al. 2009[30] reported sensitivity at the hamstring harvest site in 7 (6.7%) of the cases. Sanders et al 2007[31] reported postoperative paraesthesia in infra patellar branch of saphenous nerve in 19% of patients. Sgaglione et. al. described 37.5% incidence of nerve injury with semitendinous augmentation. Spicer et. al. reported after two year follow up 50% patients had disturbed sensation in anterior knee and 86% of these are found in infra patellar branch of saphenous nerve.
- One patient in transportal group had post-operative tourniquet palsy (resolved of its own after 72 hours).
- Limitation of movement of knee in four patients, two from each group.

CONCLUSION

Arthroscopic ACL Reconstruction using Transtibial and Transportal techniques are both effective modalities of treatment in patients with ACL deficient knees. Transportal technique gives superior patient defined functional results in terms of Lysholm score (statistically significant). Postoperative Pivot Shift Grading is statistically significant in transportal group. Single Bundle anatomic ACL Reconstruction decreases the pivot shift phenomenon and more closely mimics native ACL biomechanics.

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