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ORIGINAL RESEARCH

Anterior cruciate ligament reconstruction using a combination of autograft and allograft tendon

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ABSTRACT

Aim: The aim of the present study to evaluate the anterior cruciate ligament reconstruction using a combination of autograft and allograft tendon

Methods: Twenty Total 44 patients were included in this study and divided into two equal groups 22 patients. Out of 44 patients, 22 were undergoing for auto graftsand 22 patients for hybrids process. These 22 patients were matched by age (within 1 year) and sex with 22 patients who underwent hamstring autograft ACL reconstruction during the same time period. Collected data included graft size, patient demographics, intraoperative findings, femoral tunnel drilling technique, and patient-reported outcome scores (International Knee Documentation Committee [IKDC],[13] Knee injury and Osteoarthritis Outcome Score [KOOS],[14] and Marx activity score [15]) prior to surgery.

Results: The final graft size was noted to be larger in the hybrid group (9.5+ 0.6 mm) than the autograft group (8.4 ±0.9 mm) ($P < .001$). 5 month postoperatively, no significant differences in KOOS, IKDC, or Marx activity score were noted between the hybrid and autograft groups (Table 5 and 6). Both groups demonstrated significant improvements in KOOS and IKDC compared with preoperative values ($P < .001$). Revision ACL surgery was performed in 5 patients in the hybrid group (22.73%) and 2 patients in the autograft group (9.9%).

Conclusion: Patients who undergo ACL reconstruction with hybrid hamstring grafts and hamstring autografts report similar patient-reported outcome scores at 15 months postoperative. Further work is required to investigate potential increased risk of revision ACL reconstruction.

Keywords: Anterior cruciate ligament, autograft, allograft, tendon

INTRODUCTION

Anterior cruciate ligament (ACL) reconstruction is currently regarded as the best treatment for physically active patients with ACL rupture. A variety of autograft, hybrid graft, and allograft tissues are used for primary ACL reconstruction. Hamstring autograft is a popular choice due to the advantages of low donor site morbidity, early graft incorporation, and no risks of immune re- actions and disease transmission.[1, 2]However, some patients may have small tendon diameters, which compromises the tensile strength of the grafts.[3] Clinically, this has translated to a higher likelihood of poor clinical outcomes as the graft diameter decreases. Previous studies have reported that the use of hamstring autografts with 8 mm in diameter or less resulted in increased graft failure risk and anterior knee laxity.[4–6]

Although autograft has the advantages of earlier incorporation and no rejection or disease transmission, it may result in donor-site morbidity. The advantages of allograft include the availability of numerous grafts, avoidance of donor-site morbidity, shorter operation time, and shorter rehabilitation time.[7-9] However, its major disadvantages are higher graft cost, disease transmission, delayed graft incorporation, and worse function- al outcome.[10] Gamma irradiation has been used to prevent infection caused by allograft. However, several studies have indicated that this sterilization method considerably change the biomechanical and biochemical properties of allograft.[11,12]The purpose of this study was to compare the 5 month postoperative outcomes of patients treated with hybrid ACL reconstruction with those who underwent hamstring autograft ACL reconstruction. We hypothesized that similar patient-reported outcomes and failure risk would be noted in the 2 groups.

MATERIAL AND METHODS

This study was carried out in the Department of Orthopaedic, IGIMS, Patna, Bihar, India from October 2019 to September 2020 after taking the approval of the protocol review committee and institutional ethics committee. Total 44 patients were included in this study and divided into two equal groups 22 patients. Out of 44 patients, 22 were undergoing for auto graftsand 22 patients for hybrids process. Collected data included graft size, patient demographics (sex, age at surgery), intraoperative findings (meniscus and cartilage status), femoral tunnel drilling technique (transtibial vs independent), and patient-reported outcome scores (International Knee Documentation Committee [IKDC],[13] Knee injury and Osteoarthritis Outcome Score [KOOS],[14] and Marx activity score [15]) prior to surgery.

METHODOLOGY

The semitendinosus and gracilis tendons were harvested via a standard anterior approach, stripped of any remaining muscle, whipstitched on both ends, and doubled over to form a 4-strand graft. Grafts were then measured on the back table to determine the diameter. Grafts with a diameter of less than 8 mm were augmented with a semitendinosus tendon allograft at the discretion of the operating surgeon. All allografts were processed and sterilized using a proprietary technique involving aseptic harvest, antibiotic washes, and freezing that was free of high-dose irradiation (>2.5 Mrad) or ethylene oxide exposure. Some grafts received low-dose irradiation per the proprietary process depending on the findings of their analysis during preparation. In the majority of cases, only 1 autograft hamstring tendon, usually the semitendinosus, was combined with an allograft semitendinosus tendon to form the graft. When the native semitendinosus was too short, the native gracilis was combined with allograft tendon to form the hybrid graft. At times, both the native semitendinosus and gracilis tendons were combined with the allograft semitendinosus to make a 6-strand graft. An arthroscopic-assisted technique was then used to complete the ACL reconstruction. Femoral tunnels were drilled through a transtibial method or outside-in method per the preference of the attending surgeon. The femoral tunnel was consistently drilled to be the same diameter as the prepared graft. In all cases, femoral fixation was per- formed using a cortical button. Tibial fixation was achieved with the use of an interference screw backed up with either a staple or a screw and washer. An accelerated ACL postoperative rehabilitation was used in all patients.[16]

STATISTICS ANALYSIS

All statistical tests were performed using SPSS (version 25.0).

RESULTS

Out of 44 patients, 22 were undergoing for auto graftsand 22 patients for hybrids process. There were 8 males and 14 females in autografts and in hybrids males were 11 and females were 11. The patients number in below 30 age groups in each group were 10(45.45%) and 9(40.91%), however in above 30age group were 12 (54.54%) and 13(59.09%) respectively. No significant differences in preoperative IKDC, KOOS, or Marx activity score were noted between the 2 groups (Table 1). The final graft size was noted to be larger in the hybrid group (9.5+ 0.6 mm) than the autograft group (8.4 ±0.9 mm) (P < .001). 15 months postoperatively, no significant differences in KOOS, IKDC, or Marx activity score were noted between the hybrid and autograft groups (Table 5 and 6). Both groups demonstrated significant improvements in KOOS and IKDC compared with preoperative values (P < .001). Revision ACL surgery was performed in 5 patients in the hybrid group (22.73%) and 2 patients in the autograft group (9.9%).

Table 1: Demographic profile of the patients in both groups

Parameter	Auto grafts =22	Hybrids = 22
Age in years		
Below 30	10 (45.45)	9(40.91)
Above 30	12(54.54)	13(59.09)
Gender		
Male	8 (36.36)	11(50)
Female	14(63.63)	11(50)

Table: 2 Preoperative profile of the patients in both groups

Outcome	Auto grafts	Hybrids	P Value
KOOS-ADL	83.0 ± 17.0	78.0 ± 23.5	0.33
KOOS-Pain	72.1 ± 17.3	68.9 ± 19.9	0.51
IKDC	50.5 ± 18.1	47.4 ± 16.2	0.36
KOOS-Symptoms	69.4 ± 19.4	65.3 ± 20.6	0.38
KOOS-Sport	37.2 ± 23.7	80.3 ± 31.9	0.69
KOOS-QOL	30.9 ± 16.1	35.8 ± 24.3	0.37

Table 3: Marx activity score

	Auto grafts	Hybrids	P Value
Marx activity score, median (IQR)	12 (4-14)	14 (10-14)	0.11

Table 4: Intraoperative profile of the patients in both groups

Intra operative Data	Autografts	Hybrids	P Value
Collateral ligament injuries			≥0.99
None Grade 1 MCL	10 12	10 12	
Cartilage lesions Medial compartment			0.99
Grade 0/1	11	12	
Grade 2-3	7	6	
Grade 4	4	4	
lateral compartment			≥0.99
Grade 0/1	10	10	
Grade 2-3	12	12	
Grade 4	0	0	
Patello femoral compartment			0.19

Grade 0/1	17	21	
Grade 2-3	5	1	
Grade 4	0	0	

Table 5: outcomes

Outcome	Auto grafts	Hybrids	P Value
KOOS-ADL	98.1 ± 9.5	97.0 ± 9.9	0.71
KOOS-Pain	92.2 ± 11.8	92.4 ± 11.7	0.99
IKDC	83.5 ± 17.6	82.3 ± 15.2	0.82
KOOS-Symptoms	85.9 ± 14.7	86.1 ± 14.4	0.98
KOOS-Sport	82.1 ± 22.4	81.3 ± 22.5	0.93
KOOS-QOL	67.7 ± 23.5	71.9 ± 20.9	0.50

Data are reported as mean ± SD unless otherwise indicated. ACL, anterior cruciate ligament; ADL, activities of daily living; IKDC, International Knee Documentation Committee; IQR, interquartile range; KOOS, Knee injury and Osteoarthritis Outcome Score; QOL, quality of life.

Table 6: Marx activity score

	Auto grafts	Hybrids	P Value
Marx activity score, median (IQR)	10 (5-14)	9 (4-15)	0.86
Revision ACL surgery Performed, n (%)	2 (9.9)	5 (22.73)	0..31

DISCUSSION

Hamstring autografts are commonly used for ACL reconstruction, with successful clinical results and low donor site morbidities.[17,18]However, the recent literature suggests that a small graft diameter (especially those less than 8 mm) would biomechanically decrease the tensile strength [3], and clinically cause high revision risk and poor patient-reported outcomes.[5, 6] Unfortunately, the harvested hamstring tendons showed significant variability in size [19,20], with 7 to 8 mm being most common for quadruple-stranded grafts.[6] For example, Prodromos et al [21] reported a 5% failure rate for autograft compared with 14% for allograft in their study. Kaeding et al [22] reported a 3.5% failure rate for autograft versus 8.9% for allograft in their cohort. There was significantly less clinical failure in the autograft group in our meta-analysis. In a recent meta-analysis, Prodromos et al, [21] Yao et al, [23] and Zeng et al [24] found that autograft gained significantly less clinical failure compared with allograft. Although the finding was consistent with ours, our study included all the available evidence, which generally coincided and further strengthened earlier findings of previous meta-analyses. Additionally, the TSA was used in this meta-analysis to generate more conservative estimates. Hybrid grafts were suggested as a potential solution to the problem of small hamstring graft harvest because they do offer several advantages, the most important of which is the avoidance of a small graft without additional harvest morbidity.[25] The mean hybrid graft diameter in the current study was 9.5 ± 0.6 mm in a group of patients in whom a standard doubled gracilis/semitendinosus graft diameter was less than 8 mm. Because previous publications have associated small graft diameter with increased revision risk,[26,27,28] it was hypothesized that increasing the graft size through allograft augmentation may decrease failure risk. The findings of the current study and that by Burrus et al [29] bring this hypothesis into question.

The reason for the relatively high failure risk of hybrid grafts is not completely clear, although the presence of allograft material in the graft is clearly a concern, given the increased risk of allograft failure in young, active patients.[30] while the etiology of increased

allograft failure rates is likely multifactorial, different patterns of revas- cularization and ligamentization may contribute. Numerous animal studies[31,32,33]and as well magnetic resonance imaging (MRI) studies 34 in humans have demonstrated slower revascularization and ligamentization in allografts. The presence of allograft tissue in a hybrid graft may thus potentially compromise graft mechanical properties. The mean time to hybrid graft revision in the cur- rent study was 11.3 months; in the study of Burrus et al,[29] all hybrid graft failures occurred within 9.7 months of surgery. It has been suggested that patients with allograft reconstructions should return to sport at a slower pace than the traditional 6-month mark to allow the graft to incorporate.[30]

Allograft processing has also been shown to influence allograft mechanical properties.[35,36] Thus, one must care- fully consider the allograft processing technique that was utilized when evaluating any graft that contains some allograft tissue. Both the current study and that by Burruset al[29] utilized grafts without high-dose terminal irradiation. Low-dose irradiation such as that utilized in these studies has been shown to have minimal effect on graft mechanical properties.[37,35] Grafts processed with other techniques or fresh-frozen grafts may yield different results.

Another explanation of the high failure risk of hybrid grafts is that the patient population that has smaller ham- string tendons is simply a higher risk group than those with larger grafts for reasons other than graft size. Younger age has been shown by several authors to be associated with smaller graft size,[27,28] although graft size has been shown to be an independent predictor of revision risk when controlling for age.[26] Ma et al [38] looked at 536 patients who underwent autograft ACL reconstruction and found that height and female sex were indicators of a small graft size, while Treme et al [39] showed that weight or a body mass index less than 18 kg/m2 and height were risk factors for small graft diameter.

CONCLUSION

Patients who undergo ACL reconstruction with hybrid hamstring grafts and hamstring autografts report similar patient-reported outcome scores at 15 month postoperative. Further work is required to investigate potential increased risk of revision ACL reconstruction.

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