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Correlating Anthropometric Measurements with Length and Diameter of Hamstring Tendon Graft for Anterior Cruciate Ligament Reconstruction

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Abstract

Introduction: The anterior cruciate ligament (ACL) is an important stabilizing ligament of the knee that is frequently injured in athletes and trauma victims. We aimed to evaluate the correlation between anthropometric measurements of the patients and their graft dimensions. *Methodology:* This observational study was conducted on 50 patients with ACL injury treated by arthroscopic quadrupled hamstring graft reconstruction at AJ Institute of Medical Sciences and Research Centre, Mangalore between May 2017 and April 2018. Patient related data like age, gender, side involved, symptoms reported, anthropometric measurements, graft length and diameter was replace was with 'were' noted. Correlation of graft length and diameter with age and anthropometric measurements was assessed. *Results:* Mean graft length of all patients was 11.39±1.31 cms, and was significantly higher in male as compared to female patients (11.82 ±0.76 vs 9.13±1.36, p value <0.001). Average graft diameter was 7.24±0.75 cms and was also significantly larger among male patients as compared to female (7.40±0.69 vs 6.38±0.35, p value <0.001). Graft length was found to have a significant inverse correlation with age of the patient (r = -0.39, p value <0.01), significant direct correlation with height (r = 0.71, p value <0.001) and weight (r = 0.29, p value <0.05) of the patients. Diameter of graft used was found to have a significant positive correlation with height of the patients (r = 0.50, p value <0.001). *Conclusions:* Anthropometric measurements can be used for preoperative planning and to help counsel patients on appropriate graft choices prior to surgery.

Keywords: Anterior cruciate ligament; ACL reconstruction; Hamstrings; Anthropometry

Introduction

The anterior cruciate ligament (ACL) is an important stabilizing ligament of the knee that is frequently injured in athletes and trauma victims. ACL injuries can occur by a variety of mechanisms, including both high-energy (eg, motor vehicle collision) and low-energy (ie, noncontact field sports). Low-energy injuries may involve contact (eg, blow to the lateral knee), but non contact injuries are more common, accounting for approximately 70% of ACL tears [1]. Appropriate treatment for an ACL injury depends upon the extent of injury, patient characteristics and activities, and available resources. ACL reconstruction is generally performed with arthroscopy using a graft to replace the ruptured ACL. Graft selection remains a source of debate among orthopedic surgeons. The three most common grafts are the patellar tendon graft, the hamstring tendon graft, and the allograft and each has its advantages and disadvantages. Graft

length and diameter have been shown to affect the failure rates and overall functional outcome [2], however, it can be challenging for the surgeon to predict the size of these grafts prior to harvest. With pre-operative planning for ACL reconstruction, graft with adequate size can be harvested, or alternative graft options can be explored. We aimed to evaluate the correlation between anthropometric measurements of the patients and graft dimensions.

Methodology

Study design and sampling

This observational study was conducted on patients with ACL injury treated by arthroscopic reconstruction at AJ Institute of Medical Sciences and Research Centre, Mangalore. Reconstruction was done by trans-portal technique (anatomical) by a single surgeon using a quadrupled hamstring graft. Fifty consecutive cases operated between May 2017 and April 2018 were included in the study. Cases with bony avulsion of ACL, arthritic knee, associated ligament injuries, cartilage lesions, intra-articular fractures, and pediatric cases were excluded from the study. The diagnosis of ACL injury was made clinically by consultants using Lachman, Anterior Drawer and Pivot shift tests and were confirmed with magnetic resonance imaging. The study was approved by the institutional ethics committee. Patients were explained the purpose of the study and an informed written consent was obtained.

Operative technique

For majority of patients, general anesthesia was preferred as it allows for adequate joint exposure, complete muscle relaxation and tourniquet pain is more common under general anesthesia (53–67%) is minimal, but the choice depended on patients' general condition and the preference of the patient, surgeon and anesthesiologist. In all our patients, arthroscopic ACL repair was obtained through the accessory anteromedial portal technique (anatomical reconstruction). Anterolateral portal is the standard viewing portal where the arthroscope was first inserted and is usually located in the palpable lateral 'soft spot', approximately 1.5 cm above the lateral joint line and adjacent to the lateral margin of the patellar tendon. Remnants of the torn ACL were carefully inspected and an attempt was made to preserve large tibial stumps and ACL fibers with intact connections from the tibia to the femur. After selecting and confirming the desired location for the ACL femoral tunnel, a microfracture awl was used to mark the location along the lateral wall of the intercondylar notch. In our study, an endobutton was used for the femoral fixation in all cases. First we used a 4 mm drill Bit to drill a tunnel through the lateral femoral cortex. The depth of drilling was calculated by deducting the preferred endobutton length from the initial tunnel length and then adding 10 mm; required for the endobutton to flip. While viewing through the anteromedial and anterolateral portal, ACL tip aimer jig was inserted at a 55° angle through the anteromedial portal into the knee joint. In all we used a single bundle, quadrupled hamstring graft. An oblique incision was placed over the medial border of the proximal tibia, about one centimeter above the 'pes anserius'. The Sartorius fascia was split transversely and the semitendinosus and gracialis tendons were identified. These tendons were then separated from its tibial attachment with a #11 blade. Using a tendon stripper, they were then harvested. The tendons were then cleared off their muscle fibres and then fastened together with 'whip-stich' sutures using 2 ethybond. The prepared graft was then mounted on a graft preparation board and pre-tensioned. Using an arthroscopic probe or grasper, we retrieved the suture loop that was left in the ACL femoral tunnel and pulled the suture out of the knee joint through the tibial tunnel. The endobutton was then flipped and tension was applied to the free end of the graft. The knee was then completely extended and the free end of the graft was attached to the proximal medial tibia with the help of 'U' staple.

Data Collection and Data Analysis

Patients were encouraged to walk from the next day and active straight leg raises, active knee curls against the resistance, isometric exercise of quadriceps and active knee bending was initiated. Using a predesigned semi-structured form patient related data were collected. Demographic data like age and gender, side involved, symptoms reported, anthropometric measurements were noted for all patients. The graft diameter was measured using the ACL reconstruction graft diameter measurement guides (Smith and Nephew, Andover, USA), with increments of 0.5 mm. Graft length and diameter was noted and gender specific differences were analysed. Correlation of graft length and diameter with age and anthropometric measurements was assessed. The statistical analysis was done with SPSS Version 18.0 (SPSS Inc, USA) and p value less than 0.05 was taken as statistically significant.

Results

Table 1 describes the distribution of patients according to their demographic and clinical characteristics. Forty-six percent of all patients were from 21 to 30 years age group; 84% were males. Left side was involved in approximately two thirds of all patients. Instability of knee was reported by three fourths of all patients. Mean height of patients was 1.66 meters, weight was 72.98 kgs and mean body mass index was 26.39 kg/m^2. Mean graft length of all patients was 11.39±1.31 cms, and was significantly longer in male as compared to female patients (11.82±0.76 vs 9.13±1.36, p value <0.001). Average graft diameter was 7.24±0.75 cms and was also significantly larger among male patients as compared to female (7.40± 0.69 vs 6.38±0.35, p value <0.001). Graft length was found to have a significant inverse correlation with age of the patient (r = -0.39, p value <0.01), significant direct correlation with height (r = 0.71, p value <0.001) and weight (r = 0.29, p value <0.05) of the patients. Graft length was also found to have an inverse correlation with body mass index but it was not statistically significant (Table 3). Diameter of graft used was found to have a significant positive correlation with height of the patients (r = 0.50, p value <0.001). Age, weight and body mass index were not correlated with the graft diameter.

Discussion

Hamstring grafts are preferred by many surgeons due to low morbidity of the donor site and good cosmetic results [3]. However, graft failure may occur if the diameter of the graft is small and poor clinical outcome scores have been reported especially using grafts less than 8 mm in diameter [4]. The present study was done to understand the correlation of patient's anthropometric measurements with graft

Table 1: Distribution of patients according to their demographic and clinical characteristics

Variables	n (%)
Age distribution	
Less than 20 years	06 (21%)
21 to 30 years	23 (46%)
More than 30 years	21 (42%)
Gender distribution	
Females	08 (16%)
Males	42 (84%)
Side involved	
Left	32 (64%)
Right	18 (36%)
Symptoms reported by patients	
Pain in knee	13 (26%)
Instability of knee	37 (74%)
Anthropometry	
Height (in meters)	1.66 ± 0.08
Weight (in kilograms)	72.98 ± 11.75
Body mass Index (kg/m2)	26.39 ± 4.32

All number are numbers (%) or mean ± standard deviation

Table 2: Graft length and diameter of the patients included in the study

	Graft length		Graft diameter	
	Mean ± SD	p value	Mean ± SD	p value
All patients (in cm)	11.39 ± 1.31		7.24 ± 0.75	
Females	9.13 ± 1.36	<0.001	6.38 ± 0.35	<0.001
Males	11.82 ± 0.76		7.40 ± 0.69	

Table 3: Correlation of graft length and diameter with patient related variables

Patient variables	Graft length		Graft diameter	
	Correlation coefficient	p value	Correlation coefficient	p value
Age	-0.39	<0.01	-0.21	0.14
Height	0.71	<0.001	0.50	<0.001
Weight	0.29	<0.05	0.09	0.51
Body mass index	-0.16	0.25	0.22	0.11

length and diameter in ACL injury reconstruction surgery. Previous authors have found a significant association between gender of the patient with hamstring graft length. Xie et al. described that women had significantly shorter hamstring tendons than men [5] and Treme et al. found that women had significantly smaller and shorter grafts compared to men [6]. Concurring with these results, our study also found gender to be significantly correlated with the length and diameter of semitendinosus and gracilis tendon. The present study also found a strong positive correlation of the quadrupled hamstring graft length and diameter with patient's height. Janssen et al. demonstrated that among the anthropometric measures, the patients height was more important in predicting the quadrupled hamstring graft dimensions [7]. Chiang et al. studied a group of 100 Chinese patients and found a significant correlation between height and length of both semitendinosus and gracilis tendons after multiple linear regression analysis [8]. This is similar to the results of a study by Boisvert et al., who found correlation between height and graft diameter [9].

Graft diameter has been shown to affect final clinical outcomes in patients. Significantly higher graft failures were noted by Park et alwith graft diameter less than 8 mm [10]. We found the graft diameter to be significantly larger in males and correlated with height of the patients alone. Similarly, Ma et al. found positive correlation between height and graft diameter in a multivariate regression analysis and that men had significantly larger grafts than women [11]. In contrast, correlation between graft diameter and body weight and leg length has been described by Schwartzberg et al. [12] Variations in study population sex ratio, ethnicity and sample size might explain these difference in results.

There are a few limitations of this study. Firstly, though the anthropometric measurements were performed by the same investigator, removing inter-observer bias, percent of body fat and lean body mass were not assessed, which are more specific measurements. Secondly, we did not assessthe clinical outcomes after the reconstruction procedures. Lastly, surgeon specific variations in graft harvesting technique, method of graft stitching and tensioning may potentially affect the over all length and diameter of the graft. Multi-centric studies utilizing a standardized surgical technique are needed in future.

Conclusion

We found that female patients were more prone to have quadrupled hamstring graft of smaller dimensions, irrespective to their height, weight or body mass index. Graft length was found to have a significant correlation with patient height and weight. Graft diameter was found to have a significant relation only to patient's height. These measurements can be used for preoperative planning and to help counsel patients on appropriate graft choices prior to surgery.

References

1. Boden BP, Dean GS, Feagin JA Jr, Garrett WE Jr. Mechanisms of anterior cruciate ligament injury. Orthopedics. 2000;23:573.
2. Conte EJ, Hyatt AE, Gatt CJ, Dhawan A. Hamstring autograft size can be predicted and is a potential risk factor for anterior cruciate ligament reconstruction failure. Arthroscopy. 2014;30(7):882–90.
3. Prodromos CC, Han YS, Keller BL, Bolyard RJ. Posterior mini-incision technique for hamstring anterior cruciate ligament reconstruction graft harvest. Arthroscopy. 2005;21(2):130–37.
4. Park JH, Lee YS, Park JW, Wang JH, Kim JG. A com- parative study of screw and helical proximal femoral nails for the treatment of intertrochanteric fractures. Orthopedics. 2010;33(2):81–85.
5. Xie G, Huangfu X, Zhao J. Prediction of the graft size of 4-stranded semitendinosus tendon and 4-stranded gracilis ten- don for anterior cruciate ligament reconstruction: a Chinese Han patient study. Am J Sports Med. 2012;40(5):1161–66.
6. Treme G, Diduch DR, Billante MJ, Miller MD, Hart JM. Hamstring graft size prediction: a prospective clinical evaluation. Am J Sports Med. 2008;36(11):2204–09.
7. Janssen RP, van der Velden MJ, van Den Besselaar M, Reijman M. Prediction of length and diameter of hamstring tendon autografts for knee ligament surgery in Caucasians. Knee Surgery, Sports Traumatology, Arthroscopy. 2017;25(4):1199-204.
8. Chiang ER, Ma HL, Wang ST, Hung SC, Liu CL, Chen TH. Hamstring graft sizes differ between Chinese and Cauca- sians. Knee Surg Sports TraumatolArthrosc. 2012;20(5):916–921.
9. BoisvertCB, Aubin ME, DeAngelis N. Relationship between anthropometric measurements and hamstring autograft diameter in anterior cruciate ligament reconstruction. Am J Orthop. 2011;40(6):293–95.
10. Park SY, Oh H, Park S, Lee JH, Lee SH, Yoon KH. Factors predicting hamstring tendon autograft

diameters and resulting failure rates after anterior cruciate ligament reconstruction. Knee Surgery, Sports Traumatology, Arthroscopy. 2013;21(5):1111-8.

11. Ma CB, Keifa E, Dunn W, Fu FH, Harner CD. Can pre- operative measures predict quadruple hamstring graft diameter? Knee. 2010;17(1):81–83.
12. Schwartzberg R, Burkhart B, Lariviere C. Prediction of hamstring tendon autograft diameter and length for anterior cru- ciate ligament reconstruction. Am J Orthop. 2008;37(3):157–59.