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RESEARCH ARTICLE

STUDY ON ANTHROPOMETRIC MEASUREMENT AND HAMSTRING SINGLE BUNDLE GRAFT IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

*Supradeeptha Challa, Sudhir Mahadeo Shandilya and satyaprasad J

Department of Orthopaedics, G.S.L Medical College, Rajahmundry, Andhrapradesh, India

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ABSTRACT

The role of anthropometric measurements in the prediction of hamstring autograft size remains unclear. We evaluated 41 patients (34 males, 7 females) prospectively with anterior cruciate ligament deficiency scheduled for reconstruction using hamstring autograft at our institution between June 2011 and June 2013. Preoperatively we recorded age, gender, height, weight, body mass index, and activity level. Intraoperative measurements of semitendinosus tendon like absolute length before fashioning the graft and final diameter of the tripled graft using sizing tubes calibrated to 1 mm. Correlation coefficients and step-wise multiple linear regression analysis were used. Majority of patients were between 20-24 years. Most of the patients were between 65-75 Kgs. There is no correlation between graft diameter, age, sex, body mass index, and weight of patients. Physical activity, height of patients correlated to graft diameter in both men and women ($P = 0.01$).

INTRODUCTION

The use of hamstring graft for ACL reconstruction has become increasingly popular because of morbidity associated with the other grafts and with reports of less graft harvest morbidity and improvement in fixation devices¹⁻⁸. Scott and Insall report that the length of normal ACL is 38 mm (25–41 mm) and the width is 10 mm (7–12 mm), on average⁹. In order to assure the optimal 8 cm triple strand graft construct for ACL reconstruction (2 cm in the femoral tunnel, 4 cm intra articular, and 2 cm in the tibial tunnel), it is essential to obtain a minimum tendon length of 24 cm with a minimum thickness of 7 mm. Tuman et al¹⁰ study showed that older, shorter, female patients had an increased risk of having hamstring graft with inadequate diameter. The same study proposed that graft diameter = $2.4 + 0.03$ (height in cm). Biomechanical studies have established that the load at which failure occurs in a hamstring graft is proportional to its diameter. The mean tensile strength of the ACL is 1680 ± 95 N. The tensile strength of the patellar tendon graft is 2905 ± 127 N (168% of normal ACL). Semitendinosus and Gracilis tendons have tensile load of 1186 ± 85 (70% of normal ACL) and 980 ± 79 N, (49% of normal ACL) respectively. While quadruple graft has an ultimate tensile load as high as 4108 N (238% of normal ACL) which is almost three times that of a normal ACL. The cylindrical shape of the Hamstrings provides greater cross sectional area (55mm) than the bone-patellar tendon-bone graft¹¹. There is limited evidence supporting the relationship between fitness level and tendon morphologic characteristics¹². The aim of this study was to determine whether simple anthropometric measurements, such as height, weight, body mass index (BMI), age, can be used to accurately predict the diameter of hamstring tendons for anterior cruciate ligament (ACL) reconstruction surgery.

*Corresponding author: Supradeeptha Challa,
Department of Orthopaedics, G.S.L Medical College, Rajahmundry,
Andhrapradesh, India

METHODS

After ethical committee approval, we prospectively evaluated 41 (34 males, 7 females) consecutive patients with anterior cruciate ligament deficiency scheduled for reconstruction using triple strand hamstring graft from June 2011 to June 2013. Anthropometric measurements including age, gender, height, weight, body mass index, were taken preoperatively. Intraoperative measurement of semitendinosus was made, including absolute length and diameter of the triple strand graft using 1 mm calibrated scale. All measurements were obtained after blunt removal of attached muscle and fat but before any further postharvest alteration or trimming of the graft. Correlation coefficients (Pearson's r) and stepwise, multiple linear regression were used to determine the relationship between the outcome variable, triple strand hamstring graft thickness and the predictor variables (age, gender, height, length, body mass index). A p value of less than 0.05 was considered statistically significant.

RESULTS

This study consists of 34 males, 7 females with average age of 27.9 ± 8.97 years. Average height of patients is 170.85 ± 5.25 cm, average weight of patients is 66.49 ± 7.12 Kg. Intraoperative measurement of graft tissue yielded an average semitendinosus graft length of 24.39 ± 1.3 cm. the average graft diameter is 4.26 ± 0.46 cm. the average diameter of triple strand graft is 7.7 ± 0.8 mm. A total 42% of patients had a tripled graft diameter between 7 and 8 mm, 12% of patients' grafts were less than 7 mm, while 46% percent were greater than 8 mm in diameter. Four out of five patients with tripled graft diameter, less than 7mm have the height, less than 170cm. summary of data presented in Table 1. There was a positive relation between height, and graft length and diameter ($p < 0.001$ and $p = 0.018$, respectively). Taller patients tended to have thicker tripled hamstring grafts. However, age, gender, weight, body mass index, activity level did not correlate with graft length and thickness ($p = 0.985$, 0.598 , $p = 0.08$,

Table 1. variables and data

Total number of patients- 41		
Age	(mean± S.D), (range) →	27.9±8.97 (15-54) years
Height	(mean± S.D), (range) →	170.85±5.25 (160-180) cm
Weight	(mean± S.D), (range) →	66.49±7.12 (50-80) Kg
Body mass index	(mean± S.D), (range) →	22.76±2.79 (17.57-28.19)
Graft length	(mean± S.D) (range) →	24.39±1.3 (22-27) cm
Graft diameter	(mean± S.D) (range) →	4.26± 0.46 (3.5-5.5) cm
Graft strand diameter	(mean± S.D) (range) →	7.7±0.8 (6-9.5) cm

Table 2. correlation coefficient

Graft length	Age	Gender	Height	Weight	BMI	Activity level
Pearson's correlation	0.003	0.27	0.67	0.156	0.20	0.67
Significance	0.985	0.08	0.00	0.331	0.20	0.67

Graft diameter	Age	Gender	Height	Weight	BMI	Activity level
Pearson correlation	0.085	0.113	0.368	0.068	0.132	0.160
Significance	0.598	0.482	0.018	0.673	0.410	0.318

0.482 and p=0.67, 0.318 respectively). Correlation coefficients are presented in Table 2.

DISCUSSION

Studies have shown an increased incidence of anterior knee pain, arthrofibrosis, and quadriceps weakness associated with use of the bone-patellar tendon-bone autograft^{13,14}. The biomechanical strength of the 7 mm diameter, 3 or 4 strand graft is approximately 240% greater than that of the native ACL¹⁵⁻¹⁸. Grafts with smaller diameters are weaker than this, which will compromise the graft integrity and ultimately clinical outcome. The ability to predict which patients have relatively small hamstring tendons may be beneficial, in that alternate graft sources may then be considered when appropriate. In a cadaveric study, Tan et al¹⁹ reported that the anterior cruciate ligament in the Singapore Chinese was smaller than those reported in the Western literature. In the Western literature^{10, 20}, the mean sizes of hamstring grafts range from 7.9 to 8.6 mm, and our results showed that the mean hamstring graft diameter was 7.7mm. Tuman¹⁰ showed that height is the best predictor among anthropometric data in hamstring graft size. In his study, body mass index did not predict the hamstring graft diameter. Pichler²⁰, in a cadaver study, found a correlation between the cross-sectional area of the semitendinosus and gracilis tendons and the length of the femur, which also correlated to height. Pinherio et al²¹ in their study showed that height is most significant parameter for predicting the size of hamstring graft. Ma et al²² in their study showed that height is most significant parameter along with gender. Schwartzberg et al²³ showed in their study that weight and leg length has moderate correlation on hamstring graft size. Results of our study showed that hamstring graft length and diameter is correlates with the height of the patient but not correlating with the weight, body mass index, and activity level. The limitations of our study are, less sample size, no inter-observer readings of graft size.

Conclusion

We conclude that, anthropometric measurements such as weight, gender, activity level cannot be used as definitive predictors for the hamstring graft diameter during harvest but height of the patients can be taken as good predictor.

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