ORIGINAL ARTICLE

Study of Relationship Between Diameter of Prepared Hamstring Graft Harvested for Anterior Cruciate Ligament Reconstruction and Anthropometric Measurements

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Abstract:

Introduction: If the possibility of obtaining a hamstring graft of substandard diameter can be predicted, the prolonged duration of surgery, donor site morbidity and graft wastage can be avoided. Previous studies have correlated anthropometric measurements of the patient as a predictor while some believe that the level of muscle activity that determines the quality of harvested graft. Our study aimed to determine whether a suboptimal graft diameter can be predicted beforehand using anthropometry. We also studied the correlation between level of sports activity by an individual and diameter of the hamstring graft obtained. *Methodology*: An observational descriptive study where anthropometric measurements were made on postoperative patients of Arthroscopic Anterior Cruciate Ligament Reconstruction (ACLR). The details of graft type used, and it's measured diameter was collected through operative notes retrospectively.For anthropometric measurements, every patient's Height (H), Weight (W), Body Mass Index (BMI), Thigh Girth (TG), Thigh Length (TL) were recorded. Data was represented in Microsoft Excel which was subsequently imported in SPSS software and statistically analyzed. *Results*: Height ($p<0.001$) and Thigh length ($p<0.001$) have the strongest correlation with graft diameter for quadrupled hamstring graft during ACL reconstructions in age group 16-50 years. Predictive value of other measurements such as Weight, BMI and thigh girth is statistically insignificant. More involvement in sports activity correlates with larger hamstring graft diameters with the correlation being statistically significant ($p<0.003$). *Conclusion:* Consideration of other graft options must always be explored while managing ACLRs with quadrupled hamstring graft in short and/or sedentary individuals.

Keywords: Quadrupled Hamstring graft, Anterior cruciate ligament reconstruction, Anthropometry, Gr aft diameter, Level of sports activity.

Introduction:

Anterior Cruciate Ligament (ACL) remains the most reconstructed ligament in knee surgeries [1]. The preferred graft choice by most surgeons is that of quadrupled hamstring graft (Semitendinosus or Gracilis) owing to its reliability, easy harvest, less donor site morbidity, and easy reproducibility during ACL reconstructions (ACLR). Dimensions of the prepared hamstring graft alone can affect the surgical outcomes of ACLRs [2]. A reconstructed ACL with minimum femoral and tibial intraosseous extent of 2 cm each and intra-articular extent of 3 cm is considered optimal to avoid graft failure [2,3]. Similarly, the diameter of prepared quadrupled hamstring graft is advised to be kept above 8 mm to avoid suboptimal surgical results such as knee laxity, graft rupture and lower return to sports [3]. Hence during ACLR, the surgeon should always be insightful to maintain a minimum graft diameter to avoid graft failure. If the possibility of obtaining a hamstring graft of substandard diameter can be predicted, the prolonged duration of surgery, donor site morbidity and graft wastage can be avoided. Previous studies have correlated anthropometric measurements of the patient as a predictor while some believe that the level of muscle activity that determines the quality of harvested graft[4,5,6]. With Indian average anthropometric measurements being shorter when compared to western counterparts and if anthropometric correlation holds true, then predicting a suboptimal hamstring harvest becomes even more important while managing Indian ACL tears. We tried to investigate the same and our study aimed to determine whether a suboptimal graft diameter can be predicted beforehand using anthropometry. We also studied the correlation between level of sports activity by an individual and diameter of the hamstring graft obtained. Data from this study can help surgeons predict a poor graft retrieval in either short statured or sedentary patients and other options for graft retrieval can be kept in mind.

Material and Methods:

An observational descriptive study where anthropometric measurements were made on postoperative patients of ACL reconstruction. The details of graft type used, and it's measured diameter was collected through operative notes retrospectively. The study was conducted in a tertiary care Government Hospital in Mumbai, India. Patients in the age group of 16-50 years who had undergone isolated Arthroscopic ACLR done by a single surgeon in the previous one year (June 2022- June 2023)at our institute were considered. The graft used for ACLR in all these patients was a quadrupled hamstring graft, retrieved and prepared using a fixed protocol (mentioned below).Cases with any additional procedure or arthroscopic repair/reconstruction of menisci/collaterals/posterior cruciate ligament were excluded. Patients who did not have their operative records or notes without detailed information about graft diameter and type were excluded. Patients with any known status or history of neuromuscular disorder or its sequalae, any deformity/surgery/major trauma/ ACL tear involving contralateral lower limb were also excluded. Patients with history of any other surgery or deformity/disease involving the operated lower limb were excluded. Ethics approval was taken prior to start of the study. A similar graft preparation protocol was used. After harvesting Semitendinosus and Gracilis at their insertions, muscle fibres were separated, and the tendons folded to obtain a graft of minimum 7 mm. Whip stitch was done on both ends with Ethibond-2 and looped with Endobutton toobtain a quadrupled bundle. The diameter was recorded as the smallest tunnel size that graft could pass through completely and the same size femoral and tibial tunnels were drilled. This was considered as the graft diameter in this study. For anthropometric measurements, every patient's Height (H) (in centimetres), Weight (W) (in kilograms), Body Mass Index (BMI) (in kilogram/metre^2), Thigh Girth (TG) (in centimetres), Thigh Length (TL) (in centimetres) were recorded. The TG was measured 15 centimetres proximal to knee medial joint line. The TL was measured from the greater trochanter of femur to medial joint line of knee. Both TL and TG were measured on the contralateral unaffected thigh with hip and knee in extension. Patients were classified into three categories depending on their level of sports activity. Class 1 included professional athletes/sportsmen, while class 2 involved individuals who were involved in sports for recreation and class 3 individuals who had no active sports participation. Data was represented in Microsoft Excel which was subsequently imported in SPSS software and statistically analysed. Relationship between anthropometric parameters and graft diameter was correlated using Pearson's test. Categorical data was analysed using frequency analysis and continuous data using standard deviation (S.D.).

Results:

Out of 38 patients included in our study 25 (66%) were males while remaining 13 (34%) were females. The mean age of study participants was 27.87 years (S.D.=7.8) and range was 17-48 years. 15 participants involved their left lower limb while 23 showed involvement of their right lower limb. 22/38 (57.9%) participants belonged to Type 3 activity category while type 2 and type 1 activity categories contained 8 each (21.1%). The mean height was 167.67cm ranging from 155cm to 184cm.The average weight was 67.65 kgs. The mean BMI was calculated to be 24.15 kg/m^2 (S.D.=3.41, range=18-36). Similarly, data for TL (mean= 48.07cm, S.D.= 5.59) and TG (mean=50.74, S.D.=4.89) (Table 1). The Graft diameter in our study sample was never recorded below 8 mm. It ranged from 8 mm to 10 mm (Table 2). The Average diameter and S.D. being 8.75 and 0.601 respectively. Regression analysis was done. Graft diameter was the dependent variable. The independent variables were height, weight, BMI, thigh circumference and thigh length. While correlating sports activity level with graft diameter, the p value was calculated to be 0.003and an increase in level of sports involvement (type 1>type2>type3) correlated with an increase in diameter (Table 3).

Table 1: Anthropometric Data

Anthropometric Data	Mean	Std. Deviation	Minimum Recorded value	Maximum Recorded value
Age (years)	27.8	7.8	17.0	48.0
graft diameter (mm)	8.7	0.6	8.0	10.0
BMI (kg/m^2)	24.2	3.4	18.0	36.5
thigh circumference (cm)	50.7	4.9	40.0	63.0
thigh length (cm)	48.07	5.6	33.0	61.0

Table 2: Frequency of graft diameter

Graft diameter (mm)	Frequency
8	9
8.5	13
9	8
9.5	5
10	3

Table 3: Pearsons r value and p value for Graft diameter in relation to variables mentioned (*p<0.05)

Variable	Pearson's r value	p value
Height	0.719	<0.001*
Thigh Circumference	-0.133	0.425
Thigh Length	0.572	0.001*
BMI	0.358	0.027*
Weight	0.138	0.408

Figure 1: Correlation Plot for Thigh Length and Graft diameter

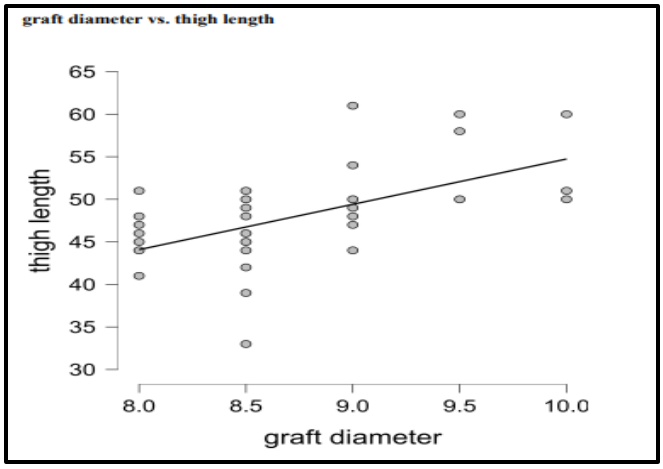
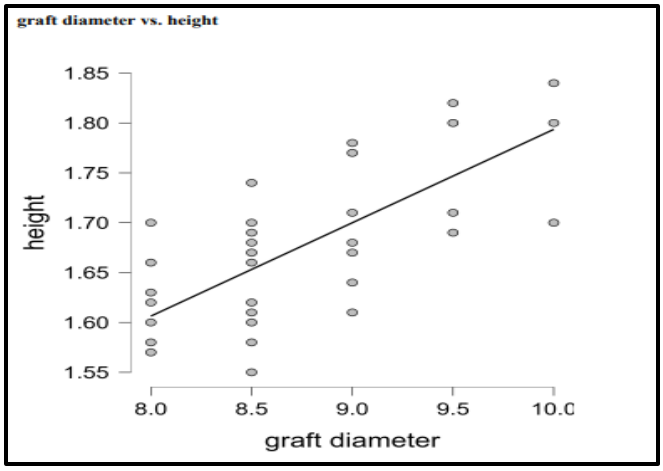


Figure 2:Correlation Plot for Height and Graft diameter



Discussion:

The age of the participants for this study (17-48 years) is like the age range of previous studies [4,5,6].As correlation between age and graft diameter was proven to be insignificant statistically by these studies, we did not research this possibility further. The average height of our study population was 167 cm which was nearly same as published in previous studies conducted on different ethnic populace i.e.- Nepalese, Indian and Caucasians [4,6,7]. Hence findings of this and previous studies can be applied to a similar set of patients who frequently undergo ACLR. Height and TL were both found to have strong statistical correlation (p<0.001) with graft diameter in our study(Figure 2). This has been previously demonstrated repeatedly by researchers and height can be safely considered as a strong predictor of diameter[4-9]. Treme et al kept a <140cut offcm height as a marker for expecting graft diameter < 7 cm. This however will denote one extreme of the population undergoing ACLR and an observant surgeon will always consider other graft choices in such patients. Nevertheless, in our study the lowest recorded height was 155 cms and we did not register any diameter less than 7. This may not hold true everywhere and more research is needed to safely rule out the risk of small graft using height as a parameter. Similarly, thigh length being a regional representation of overall height of the individual also can be used to predict graft diameter(Figure 1). An important finding of our study was the comparison of level of sports activity to the yield of the graft quality obtained. We had specifically classified patients into three groups depending upon an easy system of classification. Type 1 being the most athletic group had most instances (6/8 i.e. 75%) of yielding grafts of diameter over 9. Type 3 which involved patients with almost no physical involvement in sports had the lowest instances of an above average graft (5/22 i.e. 22.7%). A statistically significant correlation was noted (p<0.003) which confirmed that physical activity apart from height and TL also affected the graft diameter. This also strengthens the belief that instances of obtaining a substandard graft diameter can be expected more while dealing with ACL injuries of sedentary patients as compared with managing athletic ACL tears. This study did not find any significant correlation between graft diameter and anthropometric parameters of Weight, BMI, and Thigh Girth. Weight and BMI being poor indicators of lean body mass, have been refuted predictive value for graft diameter, in recent literature and we concluded the same [4,5,6,8]. As if et al in their study on Indian knees have reported significant predictive value of TG for graft diameter. This contrasts with findings by others; however, their studies were not based on Indian anthropometry [4,7]. Moreover, Treme et

al reported thigh circumference < 37cms as a high-risk factor for getting a graft diameter < 7cms [9]. We however were unable to replicate this finding in our population and we believe that this may be partly contributed by the fact that even TG is a poor measurement of lean body mass. We encountered 8/38 participants who belonged to overweight category owing to their BMI being > 27. 7/8 of these had TG more than the average of 50cms while the same was not replicated in their measurements for graft diameter. This obviously can be because of the increased girth being a result of obesity rather than that of a superior built. The importance of this study is that it generated data for surgeons who while managing ACLR's in a tertiary care setup, in the age group 16-50 years can continue considering other graft choices to hamstring graft while dealing with shorter individuals and/or individuals without much sports activity as these are the two factors influencing graft diameter in this group. This is necessary to lessen morbidity and operative time of the procedure. Our study had several limitations. Not even one diameter was recorded below 8 mm which is the cut off for a substandard graft. This can be attributed to a small sample space of 38 and more active and well-built individuals presenting to our tertiary center which may not be representative of the population. Secondly, the study was based on prerecorded operative data and hence a margin for error exists. Study involved anthropometry measurement by three different observers.

Conclusion:

Height ($p<0.001$) and TL ($p<0.001$) have the strongest correlation with graft diameter for quadrupled hamstring graft during ACL reconstructions in age group 16-50years. Predictive value of other measurements such as weight, BMI and thigh girth is statistically insignificant. More involvement in sports activity correlates with larger hamstring graft diameters with the correlation being statistically significant ($p<0.003$). Consideration of other graft options must always be explored while managing ACLRs with quadrupled hamstring graft in short and/or sedentary individuals.

Sources of supports: Nil

Conflicts of Interest: Nil

References

1. Kaeding CC, Léger-St-Jean B, Magnussen RA. Epidemiology and Diagnosis of Anterior Cruciate Ligament Injuries. *Clinics in Sports Med*icine 2017;36(1):1-8.
2. Evan J. Conte, Adam E. Hyatt, Charles J. Gatt, Aman Dhawan, Hamstring Autograft Size Can Be Predicted and Is a Potential Risk Factor for Anterior Cruciate Ligament Reconstruction Failure, *Arthroscopy: The Journal of Arthroscopic & Related Surgery* 2014; 30(7): 882-890.
3. Mariscalco MW, Flanigan DC, Mitchell J, Pedroza AD, Jones MH, Andrish JT, Parker RD, Kaeding CC, Magnussen RA. The influence of hamstring autograft size on patient-reported outcomes and risk of revision after anterior cruciate ligament reconstruction: a Multicenter Orthopaedic Outcomes Network (MOON) Cohort Study. *Arthroscopy* 2013 ; 29 (12): 1948-1953.
4. Neupane G, KC S. Correlation of hamstring graft size with anthropometric measurements in patients undergoing anterior cruciate ligament reconstruction at Chitwan Medical College. *Journal of Chitwan Medical College* 2022;12(40):125-129
5. Aljuhani, W.S., Alamri, S.G., Alsharif, S., &Annaim, M.M. Correlation between body mass index and quadruple hamstring auto graft size. *Journal of Musculoskeletal Surgery and Researc*h 2019; *3*:200- 203.
6. Asif N, Ranjan R, Ahmed S, et al. Prediction of quadruple hamstring graft diameter for anterior cruciate ligament reconstruction by anthropometric measurements. *Indian Journal of Orthopaedics* 2016;50(1):49-54.
7. Boisvert CB, Aubin ME, DeAngelis N. Relationship between anthropometric measurements and hamstring autograft diameter in anterior cruciate ligament reconstruction. *American Journal of Orthopedics* 2011;40(6):293-295.
8. Salman LA, Moghamis IS, Hatnouly AT, Khatkar H, Alebbini MM, Al-Ani A, Hameed S, AlAteeq Aldosari M. Correlation between anthropometric measurements and graft size in anterior cruciate ligament reconstruction: a systematic review and meta-analysis. *European Journal of Orthopaedic Surgery and Traumatology* 2024;34(1):97-112.
9. Treme G, Diduch DR, Billante MJ, Miller MD, Hart JM. Hamstring graft size prediction: a prospective clinical evaluation. *American Journal of Sports Medicine* 2008;36(11):2204-2209.

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