ORIGINAL RESEARCH ARTICLE

CORRELATION OF HAMSTRING GRAFT SIZE WITH ANTHROPOMETRIC MEASUREMENTS IN PATIENTS UNDERGOING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION AT CHITWAN MEDICAL COLLEGE

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ABSTRACT

Background: Injury to Anterior Cruciate Ligament (ACL) commonly occurs in knee injury usually requiring surgical intervention. Use of hamstring autograft for ACL reconstruction (ACLR) is commonly practiced. Many factors govern the selection of graft. Literature lacks studies showing correlation between anthropometric measurements of patients and the size of hamstring tendon graft in ACLR in Nepalese population. This study aimed to correlate anthropometric measurements to diameter and length of graft obtained.

Methods: Cross sectional study was carried out from 17th April 2021 to 15th March 2022 and approved by CMC-IRC (Ref: CMC-IRC/078/079-094) and evaluating patients who have undergone surgery in Anthropometric measurements along with thigh length and circumference was measured pre-operatively. Length and diameter of prepared graft was measured intraoperatively before insertion. Forty (n=40) patients of mixed age, sex and ethnicity undergoing Arthroscopic ACLR were included. Statistical analysis was done to find correlation between anthropometric measurements and graft size harvested. Purposive sampling technique was used. Data collection was done in proforma. Data entry was done in Excel and and analysis was done in SPSS version 21.

Results: Statistical analyses showed strong positive correlation between patient's thigh length and graft diameter. Height shows positive correlation with graft length and diameter. Weight shows positive correlation with graft length. There was very low correlation of other variables with graft diameter and length which were statistically insignificant.

Conclusions: Positive correlation factors (thigh length, height and weight) can be utilized to anticipate good quality graft and can be used during ACLR.

INTRODUCTION

Anterior Cruciate Ligament (ACL) reconstruction is popular among orthopaedic surgeons due to improvements in fixation devices and acceptance by patients as a surgical modality. Being minimally invasive surgery, patients have quicker recovery, lesser hospital stay and earlier return to normal.

There is no clear consensus about predictors of quality of autograft pre-operatively.[1] Untreated ACL injuries lead to faster progression of wear and tear of joint leading to advanced osteoarthritis, meniscus tear and instability.[2,3] ACL is the most commonly reconstructed ligament of knee.[2] Selection of graft depends on factors such as surgeon's preference, age and level of activity of patient.[4] Hamstring autograft is preferred because of good graft diameter, appropriate length, easily harvested and lesser donor site morbidity.[3,5]

Scott and Insall concluded that length of normal ACL is 38(25–41 mm) and width is 10(7–12 mm), on average.[6] In order to have optimal 7 cm quadrupled graft length for ACL reconstruction (2 cm femoral tunnel, 3 cm intraarticular and 2 cm tibial tunnel),

it is essential to obtain minimum tendon length of 28(28 to 30 cm) and it should have minimum thickness of 7 mm.[7,8] Many studies recommend graft diameter greater than 8 mm to minimize chances of graft failure.[6–8] Quadrupled graft(doubled semi-tendinosus and gracilis tendons) is most frequently used hamstring graft.[6]

Various studies have been done to predict recommended graft diameter and still variation in result has been noted. No such study has been carried out to correlate anthropometric measurements in Nepalese population whose average built is lower than western population.

This study aimed to correlate anthropometric measurements to diameter and length of graft obtained

METHODS

This was a cross-sectional study done by evaluating patients who have undergone ACL reconstruction surgery in this medical college hospital from 17th April 2021 to 15th March 2022. Ethical clearance was obtained from Institutional Review Committee

–Chitwan Medical College prior to commencing the study. Demographic information like age, gender, anthropometric data like height, weight, mode of injury, injured side and level of activity of the patients were obtained and recorded from the patient's history. Body mass index (BMI) was calculated using World Health Organization formula. All patients underwent routine pre-anaesthetic check-up (PAC) and were operated as elective cases by trained Orthopaedics surgeons.

Informed consent was taken before including the patients under study. We included all adult patients greater than 18 years of age, documented clinically and by MRI with isolated ACL and combined menisco-ligamentous injuries, operated within 6 months from time of injury for ACL reconstruction surgery using hamstring tendon auto graft. Those under the age of 18 years, patients who had undergone previous ACL reconstruction, bilateral ACL injuries, patients treated using grafts other than hamstring, previous fracture in the same limb and patients with neuromuscular diseases and patients with missing details were excluded from the study.

Thigh length, and thigh circumference measurements were obtained from non-injured limb to avoid erratic measurements due to disuse atrophy of muscles in preoperative setup with the patient in supine position with fully extended knees. Thigh Length measured from the tip of the greater trochanter of femur to superolateral pole of patella and Thigh circumference measured 15 cm proximal from superior pole of patella. Techniques of graft harvesting and graft preparation was done in standard fashion as mentioned by Fritsch et al.[9] After muscle fibres were erased, we made quadruple bundle graft by folding semi-tendinosus tendon and Gracilis tendon twice each to make sure we had adequate length of graft. The graft was sutured by whip stitching on each end with number 2 Ethibond suture and prepared for looping giving it a formation of quadrupled bundled (two strands of Semi tendinosus and Gracilis tendons) in a Arthrex graft-master board with tightrope endo button to allow suspension mode of fixation in the femoral side. For tibial side, we used aperture fixation using poly-L-lactic (PLLA) or Bio-composite screws.

Intraoperative measurements of graft length and diameter were taken after making quadruple bundle and diameter of the graft using graft sizer (Arthrex Graft Measurement guide) and were recorded. The diameter was defined as the smallest tunnel the graft could pass through completely. Convenience sampling technique was used. Total of 40 cases met our inclusion criteria and were included in our study.

The collected data was entered in Microsoft Excel in a tabulated form in a master-chart. The data was imported in SPSS version 21 and analyzed for statistical purposes. Descriptive statistics with frequency and percentage analysis was used for categorical variables and mean and standard deviation were obtained for continuous variables. Pearson's test was used to identify correlations between anthropometric measurements (Age, Weight, Height, BMI, Thigh Length, Thigh Circumference) and quadruple bundled graft diameter and length.

RESULTS

We had a total of 40 patients included in the study who met our inclusion criteria. The mean age was 31.88 years (range 18 to 59). 23 of 40 patients (57.5%) were males and the rest 17 (42.5%) were females. The most common injured side was right side knee in 25(62.5%) patients. Thirteen of them had injured knee in sports activities, 12 in domestic falls, 9 others were in RTA and 5 of them were fall from height. Only one of them had injured knee in physical assault. Majority of our study participants i.e., 16 of them underwent surgery within 2-6 weeks of injury (Table 1 and 2).

Table 1: Patient data

Patient Characteristics	Mean	Range	SD
Age (years)	31.88	18-59	9.63
Weight (Kg)	72.15	56-90	7.21
Height (Cm)	167.25	152-182	6.74
BMI	25.80	21.26-29.64	2.22
Thigh Length (Cm)	41.55	32-48	4.00
Thigh Circumference (Cm)	42.75	38-48	3.32

Table 2: Patient characteristics

Characteristics		N (%)
Gender Distribution	Male	23 (57.5)
	Female	17(42.5)
Injured Side	Right	25(62.5)
	Left	15(37.5)
Mode of Injury	RTA	9(22.5)
	Domestic falls	12(30)
	Sports Injury	13(32.5)
	Fall	5(12.5)
	Physical assault	1(2.5)
Physical Activity	Mild/Sedentary	9(22.5)
	Moderate	22(55)
	Heavy	9(22.5)
Dietary Habits	Mixed diet	30(75)
	Vegetarian diet	8(20)
	High Protein diet	2(5)
	Vegan diet	0(0)
Duration of Surgery(weeks)	<2	7(17.5)
	2-6	16(40)
	6-12	11(27.5)
	>12	6(15)

Table 3: Relationship of gender with graft length (cm) and diameter (mm)

Variable	Mean	Std deviation	p value
Graft diameter			
Male	8.78 mm	0.61	0.00*
Female	7.71 mm	0.68	
Graft length			
Male	10.83 cm	1.19	0.11
Female	10.24 cm	1.09	

*Statistically significant, Independent t-test applied

After graft harvesting and final preparation, it was measured for final ACL graft diameter and length before insertion and the observed values are depicted in the table below.

Independant t-test was applied between graft diameter and length with gender. Statistically significant difference was found between graft diameter and gender (p value = 0.00) (Table 3).

The mean value of graft length and diameter was 10.58 cm and 8.33 mm respectively (Table 4).

Table 4: Graft size outcome

Graft size outcome	N	Mean	SD
Quadrupled Graft Length (cm)	40	10.58	1.17

Table 5: Graft Correlation with Anthropometric Parameters

Variables	Graft Length correlation Coefficient	Graft Length p value	Graft Diameter correlation coefficient	Graft Diameter p value
Age	-0.12	0.45	-0.17	0.28
Weight	0.30	0.05*	0.29	0.06
Height	0.39	0.01*	0.34	0.02*
BMI	-0.17	0.91	0.013	0.93
Thigh Length	0.23	0.15	0.65	0.00*
Thigh Circumference	-0.09	0.56	0.04	0.77

*Statistically significant, Pearson's correlation coefficient applied

Pearson's test was used to identify the correlation between the anthropometric measurements of the patients and graft dimensions. Thigh length has strong positive correlation with graft diameter and low positive correlation with graft length. There was a low positive correlation betweenn weight and height with both graft length and diameter. There was very low negative correlation between age, BMI and thigh circumference with graft length and diameter which are insignificant (Table 5).

Simple linear regression curve was plotted along weight in x-axis and graft length in y-axis in figure 1 showing positive correlation. Similarly graft diameter in x-axis and thigh length in y-axis, a simple linear curve was plotted which showed low positive correlation.
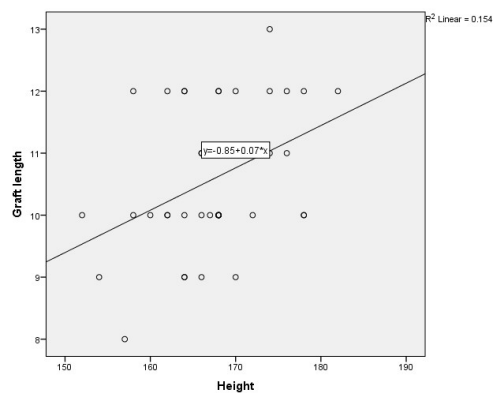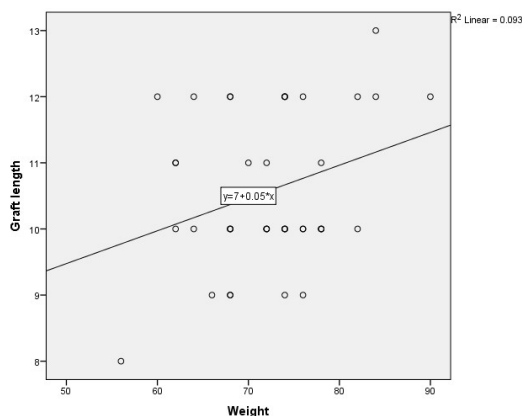

Figure 2: Correlation between graft length and height

Simple linear regression curve was plotted along height in x-axis and graft diameter in y-axis in figure 3 showing positive correlation. Similarly graft diameter in x-axis and thigh length in y-axis, a simple linear curve was plotted which showed low positive correlation.

Figure 1: Correlation between graft length and weight

Simple linear regression curve was plotted along height in x-axis and graft length in y-axis in figure 2 showing positive correlation. Similarly graft diameter in x-axis and thigh length in y-axis, a simple linear curve was plotted which showed low positive correlation.
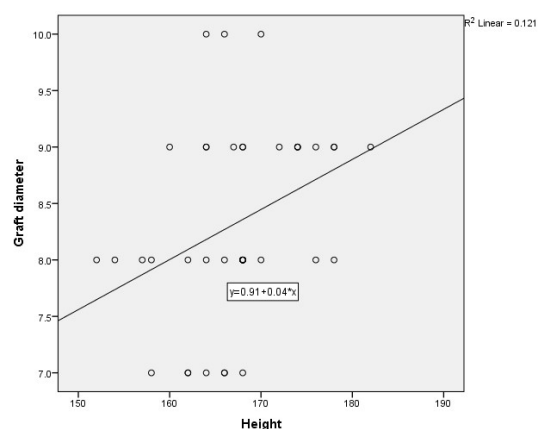

Figure 3: Correlation between graft diameter and height

Simple linear regression curve was ploted along thigh length in x-axis and graft diameter in y-axis in figure 4 showing positive correlation. Similarly graft diameter in x-axis and thigh length in y-axis, a simple linear curve was plotted which showed strong positive correlation.
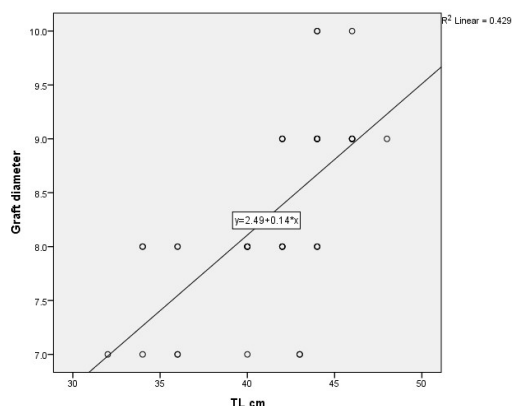

Figure 4: Correlation between thigh length and graft diameter

DISCUSSION

Although various studies have been done to predict the recommended graft diameter and length, variation in the result has been noted.[3,11] In addition, no such study has been carried out to correlate the anthropometric measurements like height, weight, body mass index, thigh length and thigh circumference and hamstring graft diameter and length in Nepalese population whose average height is lower than the western population. It is now beyond doubt understood that arthroscopic ACL reconstruction surgery is most performed surgical procedure by sports surgeons worldwide and is among successful surgeries.

We found patient thigh length has strong positive correlation with graft diameter. Height of the patient has significant positive correlation with both graft diameter and length. Similarly, weight of the patient has significant positive correlation with graft length. In our study age of the patient shows negative correlation with graft diameter but was insignificant. Other variables correlation like thigh length to graft length, weight of patient to graft diameter, thigh circumference and BMI of the patient to both graft length and diameter were non-significant.

Western literature showed that height and thigh length is the best predictor among anthropometric data in hamstring graft size[10,11] and in our study thigh length has the best predictor with graft size(diameter) followed by height of the patient . This shows that thigh length and height can be measured preoperatively to predict the graft size as per our study. Similarly Moghamis[3] et al has shown the relatable positive factors for obtaining good quality graft in thigh length & circumference. Our study demonstrated a positive correlation between the patient thigh length with graft diameter only; this positive correlation was also reported in previous literatures[12–14]. This similar finding is attributed to abundance of collagen in tall person with longer thigh length as graft length increases with increase in thigh length and height. Our study did not show positive prediction of thigh circumference to good quality graft (diameter and length) however previous studies [3],[11] showed positive prediction.

The previous studies had demonstrated a negative correlation with age as a predictor of final graft diameter[15,16] which is similar to this study. In our study age group from 17 to 59 years younger people tends to have good graft diameter.

The study carried out in our institute is first of its type. It is reproducible to general public as the sample population is of mixed gender and ethnicity. However, our study is limited by a moderate sample size because of limited frequency of surgery at our institute, patients needing other graft sources and choosing non-operative treatment due to financial constraints. We recommend larger multicentric studies in this area to ascertain these findings in Nepalese population.

CONCLUSION

The thigh length of patient measured preoperative has strong positive correlation with diameter of graft taken. Height of the patient has significant positive prediction to graft diameter and length. Similarly, weight of patient may also be considered preoperative which has positive correlation for graft length. These factors mentioned above point towards collagen abundance in individuals, hence good quality graft is expected. These factors can be considered to anticipate the adequacy of graft diameter and length preoperative. If needed, the alternative graft sites can be prepared primarily and counsel-led prior accordingly.

CONFLICT OF INTEREST: None

FINANCIAL DISCLOSURE: None

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