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PREDICTION OF QUADRUPLE AUTOLOGOUS HAMSTRING GRAFT DIAMETER IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING PREOPERATIVE ANTHROPOMETRIC MEASUREMENTS IN MIDDLE EAST POPULATION

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ABSTRACT

Background: Estimation of the final quadruple hamstring graft diameter in anterior cruciate ligament reconstruction could help surgeons to decide the type of graft and to be prepared for any additional procedures that might be needed to augment the unqualified grafts. We tried in this paper to investigate if there is any correlation between the preoperatively measured anthropometrics like height, weight, BMI index, and thigh circumference and the final diameter of the quadruple hamstring autograft in anterior cruciate ligament reconstruction. Hypothesis: Final Graft diameter would be influenced by Age, Thigh circumference (CM), Height (Meter), Weight (KG), and BMI index. Method: Anthropometric measurements of 70 consecutive adults who underwent arthroscopic ACL reconstruction in Queen Alia Hospital, Sport and Arthroscopy department between August-October 2021 were collected prospectively. The hamstring graft was prepared in a quadruple fashion and its final diameter was recorded intraoperatively. Multivariate linear regression was performed to assess the relation between quadruple hamstring graft diameter and the explanatory variables: Age, BMI Index, Height, weight, and Thigh circumference. Results: In multivariate analysis, age was the only factor that was associated with higher values of Graft diameter(MM). All other anthropometric measurements; Height (Meter), Thigh circumference (CM), Weight (KG), and BMI Index were not associated with the value of the final quadruple hamstring graft diameter(MM). Conclusion: The Results of this study demonstrate that apart from age all anthropometric measurements have no obvious relation with the final quadruple hamstring graft diameter on a sample of patients from The Middle East Region. Our recommendation is not to rely on these preoperative measurements to decide the type of the graft and to be always prepared for any additional procedures to augment the unqualified grafts.

KEYWORDS: Anthropometric measurements, Autologous hamstring graft diameter, anterior cruciate ligament.

BACKGROUND

There are multiple graft choices approved to be used for Anterior Cruciate Ligament Reconstruction. One of the most commonly used grafts is the Hamstring autograft which gained popularity due to improvements in Fixation methods.[1-3] Hamstring autograft reconstructions have similar objective instrumental laxity measurements and functional outcome scores compared with Bone Patellar Bone Graft (BTBG) reconstructions with a lesser donor site morbidity.[4-6] Estimation of the final quadruple hamstring graft diameter could help surgeons to decide the type of graft or to be prepared for any additional procedures that might be needed to augment the unqualified grafts. And of course to do appropriate patient's counselling regarding the graft type and the possibility for added procedures. We tried in this paper to investigate if there is any correlation between the preoperatively measured anthropometrics like height, weight, BMI index, and thigh circumference with the final diameter of the quadruple hamstring autograft in anterior cruciate ligament reconstruction.

Hypothesis

Final Graft diameter would be influenced by Age, Thigh circumference (CM), Height (Metre), Weight (KG), and BMI index.

MATERIALS AND METHODS

Anthropometric measurements of 70 consecutive adults who underwent arthroscopic ACL reconstruction in Queen Alia Hospital, Sport and Arthroscopy department between August-October 2021 were measured and documented on the ward the day prior to surgery. The thigh circumference was measured at a point 10 cm proximal to the superior border of the patella. The hamstring graft was prepared in a quadruple fashion and

its final diameter was recorded intraoperatively. Ethical approval for the study was obtained from our Institutional Review Board.

Surgical Technique

All ACL reconstructions and Graft harvestings were performed by one of the fellowship-trained Sport and Arthroscopic surgeons using the same harvesting technique. Through transverse incision over the pes anserinus, both the Gracilis and The Semitendinosus tendons were harvested using an open-closed graft harvester. The graft was then prepared over a graft preparation station using a single-bundle 4- strand technique. Both tendons are loaded in a suspensory endo button (Biomet) device in a reverse orientation. A nonabsorbable suture is passed twice around the 4 free ends of the graft. The graft is whipstitched distally with a nonabsorbable suture (Ethibond 2). The final graft diameter was measured using the graft diameter measurement guide (Biomet).

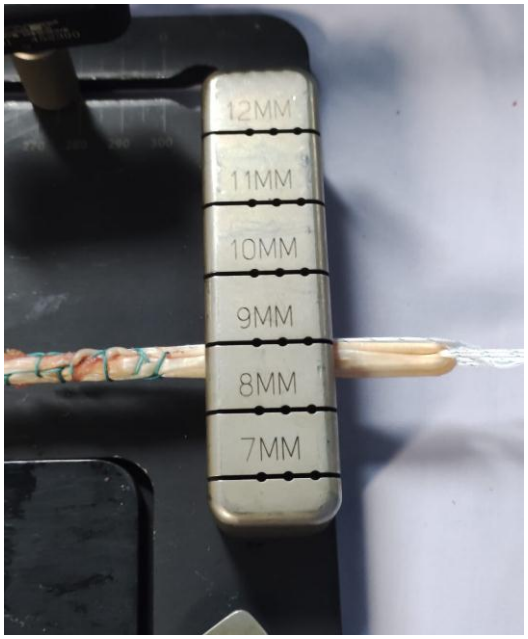


Figure 1: Final hamstring graft diameter measurement using a diameter measurement tool (Zimmer Biomet, USA).

STATISTICAL ANALYSIS

Multivariate linear regression was performed to assess the relation between Graft diameter(MM) and the explanatory variables: Age, Thigh circumference (CM), Height (Meter), Weight (KG), and BMI index. Data were checked for multicollinearity with the Belsley-Kuh-Welsch technique. Heteroskedasticity and normality of residuals were assessed respectively by the Breusch-Pagan test and the Shapiro-Wilk test. A p-value of 0.05 was considered statistically significant. Statistical analysis was performed with the online application EasyMedStat.

Table 1: Patients' characteristics.

Variable	n =	Mean *(μ)*	Median *(M)*	Min - Max	95% Confidence Interval
Height (Meter)	64	1.75	1.74	1.60 - 1.90	[1.730 - 1.763]
Weight (KG)	64	82.11	81.50	49.00 - 120.00	[78.266 - 85.953]
BMI Index	64	26.84	27.17	18.78 - 37.87	[25.737 - 27.944]
Thigh circumference (CM)	64	48.66	46.50	37.00 - 68.00	[46.938 - 50.374]
Age	64	28.36	27.00	18.00 - 45.00	[26.888 - 29.831]
Graft diameter(MM)	64	7.94	8.00	4.50 - 10.00	[7.698 - 8.177]

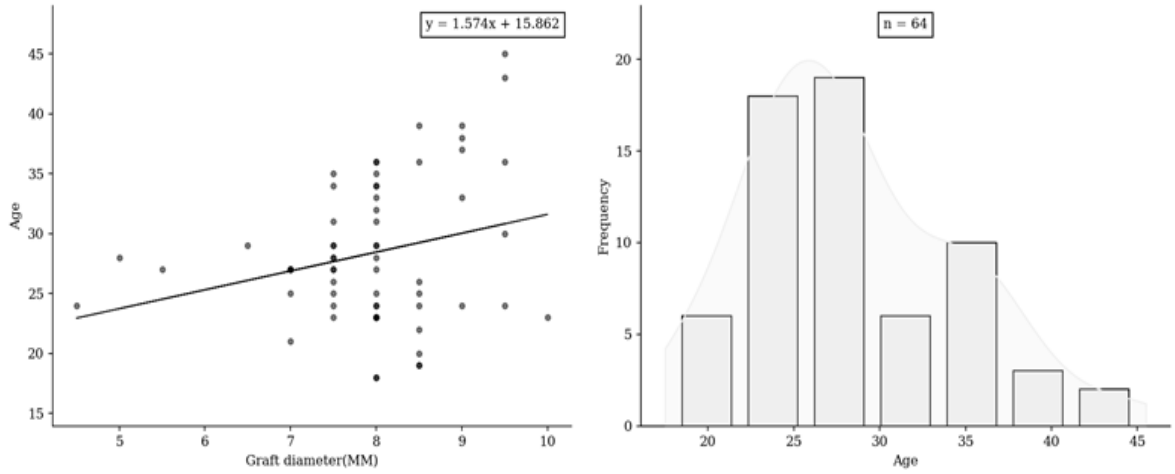
Table 2: Correlation coefficient between intraoperative Graft diameter measurement and anthropometric data.

	Correlation coefficient	p-Value
Weight (KG)	0.00945 [-0.0116 ; 0.0305]	0.372
Thigh circumference (CM)	0.00945 [-0.0116 ; 0.0305]	0.372
BMI Index	0.0113 [-0.129 ; 0.151]	0.872
Height (Metre)	0.336 [-3.42 ; 4.09]	0.858
Age	0.0418 [0.0018 ; 0.0817]	0.0408

Age

Table 3: Bivariate table.

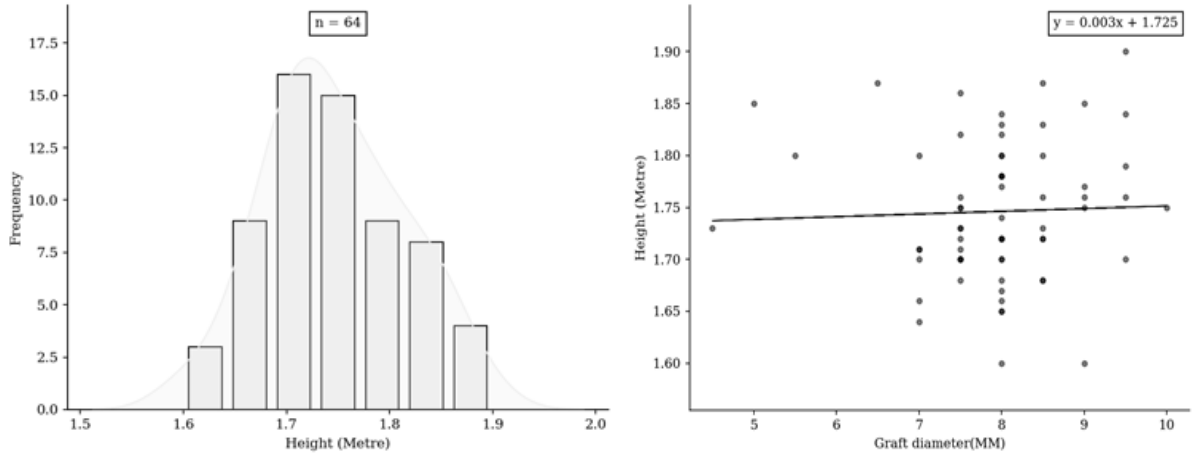
Statistics	Age	Graft diameter(MM)
N	64	64
Mean ± SD	28.36 ± 6.05	7.94 ± 0.99
Min; Max	18.0 ; 45.0	4.5; 10.0
Median	27.0	8.0
Q1; Q3 (IQR)	24.0 ; 33.0 (9.0)	7.5 ; 8.5 (1.0)



Height

Table 4: Bivariate table.

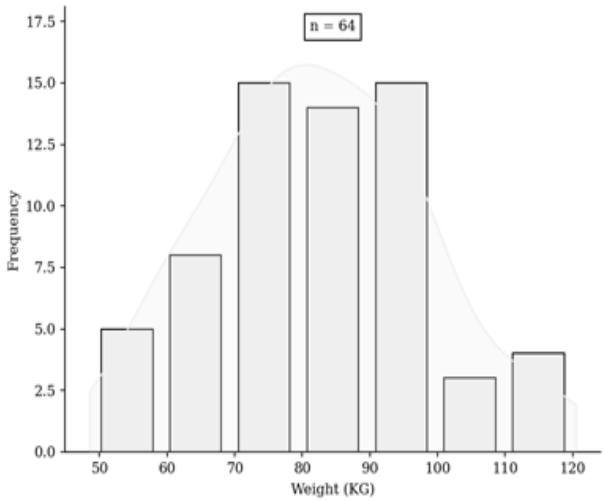
Statistics	Height (Meter)	Graft diameter(MM)
N	64	64
Mean ± SD	1.75 ± 0.07	7.94 ± 0.99
Min; Max	1.6; 1.9	4.5; 10.0
Median	1.73	8.0
Q1; Q3 (IQR)	1.7 ; 1.8 (0.1)	7.5 ; 8.5 (1.0)

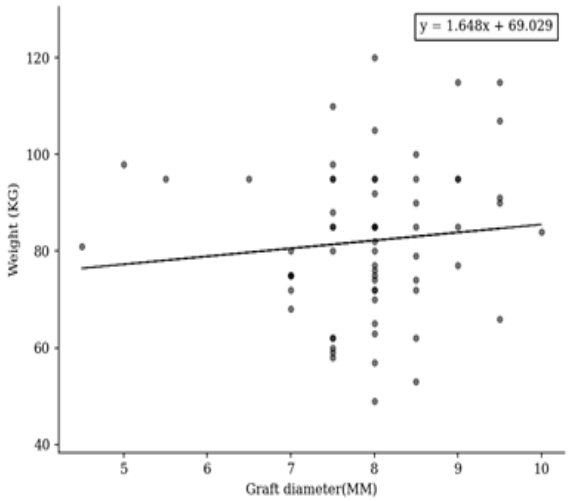


Weight

Table 3: Bivariate table.

Statistics	Weight (KG)	Graft diameter(MM)
N	64	64
Mean ± SD	82.11 ± 15.81	7.94 ± 0.99
Min; Max	49.0 ; 120.0	4.5; 10.0
Median	81.5	8.0
Q1; Q3 (IQR)	72.0 ; 95.0 (23.0)	7.5 ; 8.5 (1.0)

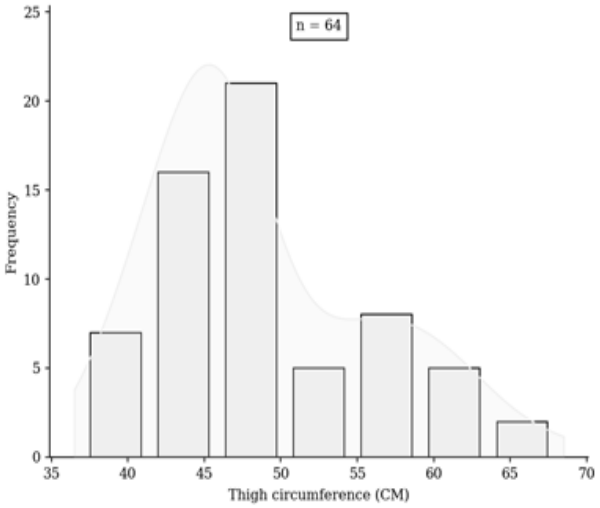


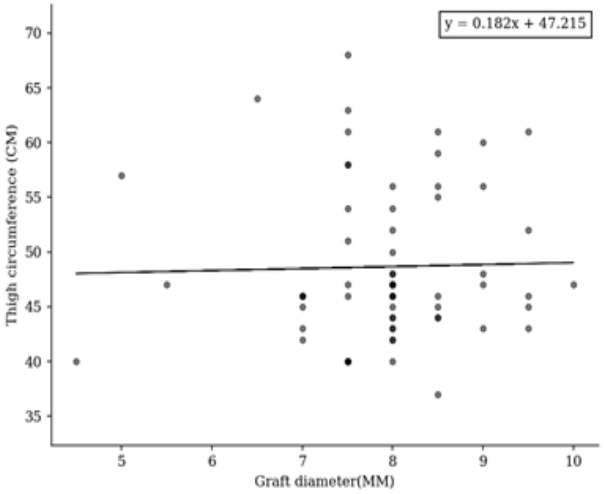


Thigh circumference

Table 4: Bivariate table.

Statistics	Thigh circumference (CM)	Graft diameter(MM)
N	64	64
Mean ± SD	48.66 ± 7.07	7.94 ± 0.99
Min ; Max	37.0 ; 68.0	4.5 ; 10.0
Median	46.5	8.0
Q1 ; Q3 (IQR)	44.0 ; 54.0 (10.0)	7.5 ; 8.5 (1.0)

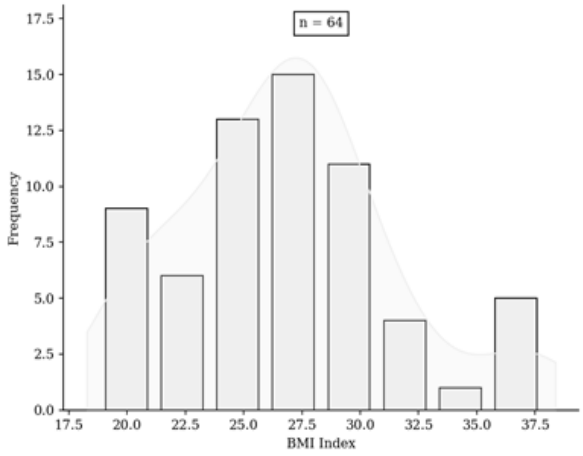


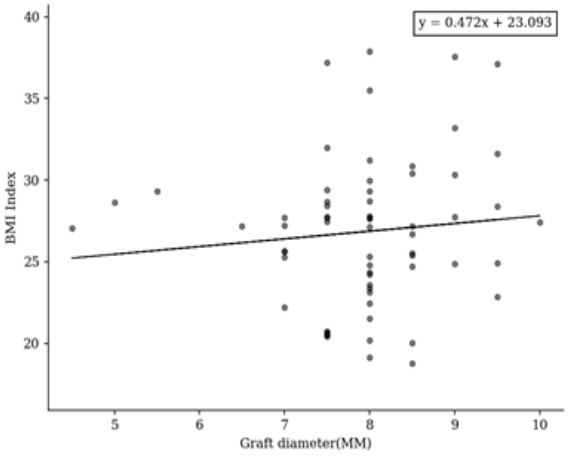


BMI Index

Table 5: Bivariate table.

Statistics	BMI Index	Graft diameter(MM)
N	64	64
Mean ± SD	26.84 ± 4.54	7.94 ± 0.99
Min; Max	18.78; 37.87	4.5; 10.0
Median	27.17	8.0
Q1; Q3 (IQR)	24.06 ; 28.88 (4.82)	7.5 ; 8.5 (1.0)





RESULTS

This study consisted of 61 male and 3 female subjects as six patients had missing data of the final graft diameter and were excluded from the study. Three patients upon the remaining 64 patients (4.69%) had an unqualified graft size (diameter < 7 mm) which was augmented by the AHPL autograft and was included in the study.

In multivariate analysis Age (β=0.04, [0.0 ; 0.08], p= 0.0408) was the only factor that was associated with higher values of Graft diameter(MM). All other anthropometric ; Height (Meter) (β=-0.33, [-4.73 ; 4.06], p= 0.8801), Thigh circumference (CM) (β=-0.01, [-0.06 ; 0.04], p= 0.6626), Weight (KG) (β=0.01, [-0.01 ; 0.03], p= 0.3874) were not associated with the value of Graft diameter(MM).

Table 6: Regression results of the study.

variable	modality	odds ratio	p-value
const		8.19 [1.09;15.29]	0.0246
Height (Metre)		-0.333 [-4.73;4.06]	0.88
Weight (KG)		0.0102 [-0.0133;0.0337]	0.387``
Thigh circumference (CM)		-0.0104 [-0.0579;0.0371]	0.663
Const		6.75 [5.59;7.91]	2.93e-17
Age		0.0418 [0.0018;0.0817]	0.0408
Const		7.34 [5.85;8.83]	2.92e-14
BMI Index		0.0223 [-0.0326;0.0771]	0.42

DISCUSSION

There are many studies in the literature that show variable results regarding the correlation between final hamstring graft diameter and different anthropometric measurements. While some of these studies show a positive correlation between the final graft diameter and Height[7-9,11,12], BMI Index[7,10], Weight[7,8,10,12], and Thigh circumference[7,8], other studies couldn't demonstrate any relation between the final graft diameter and Height[10,13], BMI Index [8,9,11,13], Weight[11,13], and thigh circumference.[13]

Among the above-mentioned studies, only one demonstrates comparable results with our study in terms of positive correlation between final graft diameter and age[13], while all others couldn't demonstrate any strong relation between them.

Limitations of the study include lack of gender variability and small sample size. However, we believe that this patient group represents an appropriate sample of our ACL reconstruction population. Another limitation is the probability that final graft size measurement may be affected by the harvesting technique and the amount of tension that has been applied during passing the graft through the measurement device. We tried to overcome this limitation by adhering to the same graft harvesting and preparation technique which is our routine by a fellowship-trained Sport and Arthroscopic surgeon.

CONCLUSION

The Results of this study demonstrate that apart from age all anthropometric measurements have no relation with the final quadruple hamstring graft diameter on a sample of patients from The Middle East Region. Our recommendation is not to rely on these preoperative measurements to decide the type of the graft and be always prepared for any additional procedures to augment the unqualified grafts.

Conflict of interest: The authors declare that they have no conflict of interest.

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