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Anthropometry based hamstring graft size prediction in Kashmiri population

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Abstract

Background and Aim: As the use of autograft hamstring tendons for ACL reconstruction increases, it becomes necessary to identify those patients at risk for having hamstring tendons of inadequate length or diameter. Preoperative estimation of graft parameters can be useful while using hamstring grafts. Anthropometric parameters may be an easy way to predict the length and diameter of hamstring tendons. Identifying patients who are at risk for inadequate graft dimensions allows for proper preoperative planning, arrangement of alternative graft sources (such as BPTB, quadriceps tendon, peroneal tendon or other allograft sources). A prospective study was conducted to find the correlation between different anthropometric parameters of the patients on the length and diameter of the graft in Kashmiri population.

Materials and Methods: In this study a total of 30 patients were included who underwent ACL reconstruction with hamstring autograft. The anthropometric parameters like age, height, weight, thigh length and girth, tibial length, calf girth etc were recorded prior to surgery. Intraoperative measurement of hamstrings was made, including absolute length of semitendinosus and gracilis and diameter of the final prepared graft. All measurements were obtained after blunt removal of attached muscle. Correlation coefficients were used to determine the relationship between the outcome variable (hamstring graft dimensions) and the predictor variables (age, gender, height, length, body mass index).

Results: This study showed a strong correlation between height of the patient and length of both semitendinosus and gracilis. Thigh length was found to be significantly correlated with graft length. Taller patients with longer limb lengths and thigh length tend to have a longer graft length. A statistically weakly significant correlation between weight and graft length was also noted. BMI, tibial length and calf girth didn't show any correlation with the graft parameters.

Conclusion: Anthropometric measurements such as weight, BMI, tibial length, calf girth cannot be used as definitive predictors for the hamstring graft diameter but height of the patients and thigh length can be taken as good predictor.

Keywords: Anthropometry, hamstring autograft, anterior cruciate ligament, ACL reconstruction

Introduction

The Anterior Cruciate Ligament is the most frequently disrupted ligament of the knee which can result in the significant dysfunction and is now one of the most commonly reconstructed ligament [1-6]. There are various types of grafts which are being used for ACL reconstruction e.g. Bone Patellar tendon Bone, Hamstring, Quadricep tendon etc. Traditionally, bone patellar tendon bone was considered the gold standard; however, nowadays hamstring tendon are being increasingly used for ACL reconstruction [7, 8]. The most commonly used autologous graft is Hamstring tendon graft because of its encouraging biomechanical characteristics and good clinical results [9, 10]. One of the major disadvantages of hamstring autologous graft is the possibility of getting stuck with a graft of smaller dimensions. There is a substantial variability in the length of tendons being harvested and, hence, the diameter of the graft. Despite the importance of hamstring autograft, individual variation in the width and length of the tendon remains a problem which can be solved if one can estimate the size of the graft pre-operatively. The decision of the hamstring Semi-tendinosus or both semitendinosus and gracilis is to be planned.

Scott and Insall reported that the length of normal ACL is 38mm (24-41mm) and diameter ranges from 7 to 12 mm (mean 10mm) [12].

It is widely accepted that about 70% of the footprint has to be occupied by the reconstructed graft to ensure optimal graft size. So, the final diameter of the prepared hamstring tendon graft has to be minimum 7 mm and the length has to be at least 8 cm [13-15]. In order to assure the optimal 8 cm (2 cm in the femoral tunnel, 4 cm intra articular, and 2 cm in the tibial tunnel) length and 7 mm thickness of hamstring graft construct for ACL reconstruction, it is essential to obtain a minimum tendon length of 24 cm. Some studies say it is possible to predict graft size using anthropometric measurements like gender, height, and body mass index. Hence this study is a plan to co-relate the association of the anthropometrical measurement of an individual to the pre-operative assessment of hamstring tendon and graft size, which may help in the proper planning of types of graft and adequate counseling to the patient.

Materials and Methods

This prospective study was conducted at Govt. Bone and Joints Hospital Barzulla, an associated Hospital of Govt. Medical College, Srinagar from May 2021 to April 2022. In this study a total of 30 patients from age 18-50 years with clinical and MRI evidence of anterior cruciate ligament insufficiency with no history of previous surgery on knee were included who underwent hamstring graft construct for ACL reconstruction. All patients were explained about the injury, diagnosis, various management options. Consent for surgery was obtained from all the patients. The anthropometric parameters like age, height, weight, thigh length and girth, tibial length and calf girth etc were recorded prior to surgery. Thigh girth and calf girth were recorded from uninjured limb. The graft was harvested in the same manner in all patients. Intraoperative measurement of semitendinosus and gracilis was made, including absolute length and diameter of the final prepared graft using 1 mm calibrated scale. The semitendinosus was harvested initially and length was measured. Gracilis graft was harvested despite the fact that the semitendinosus graft was adequate or not and its length was measured. With the use of semitendinosus and gracilis, there

was enough graft to maintain adequate graft diameter as well as graft length in all patients. All measurements were obtained after blunt removal of attached muscle and fat. Correlation coefficients were used to determine the relationship between the outcome variable (Hamstring graft dimensions) and the predictor variables (age, height, limb length, body mass index etc).

Results

Among 30 consecutive enrolled patients, there were 23 (76.67%) male patients and 7(23.33%) female patients. The mean age of the study population was 35.5 years (range 25-40 years). In our study, the mean height was 176.5 cm (range 162-183cm), Mean weight was 81.5 kg (range 55-90kg), Mean body mass index was 26.15 (range 21-30.1). Mean thigh length was 52.5, Mean tibial length was 39 cm, Mean thigh girth was 47.1 cm and mean calf girth was 32.30 cm (Table 1).

The mean length of the harvested Semitendinosus tendon was 301.1±23.6 mm. The mean length of harvested gracilis tendons was 280±24.45 mm. The mean diameter of prepared hamstring graft was 8.0 with a standard deviation of 0.38 (Table 1).

Table 1: Descriptive analysis of graft and anthropometric parameters

Parameters		Mean ± SD
Semitendinosus	Graft length (mm)	301.1±23.6
Gracilis	Graft length (mm)	280±24.45
ACL hamstring graft diameter (mm)		8.0±0.38
Age (Years)		35.5±5.2
Height (cm)		176.5±6.22
Weight (kg.)		81.5±12.66
Body mass index		26.15±2.52
Lower limb length (ASIS to MM)		91.5±4.34
Thigh length (ASIS to MJL)		52.5±2.93
Tibial length (cm) (MJL to MM)		39±2.42
Thigh girth (cm)		47.5±4.02
Calf girth (cm)		36±4.11

ASIS: Anterior Superior Iliac Spine, **MM:** Medial Malleolus, **MJL:** Medial Joint line

Table 2: Correlation Coefficient

Semitendinosus	Age	Height	Weight	BMI	Lower limb length	Thigh length	Tibial length	Thigh girth	Calf girth
Pearson's correlation	-.258	.944	.804	.529	.884**	.910**	.484	.166	.350
Significance	.472	.000	.005	.116	.001	.000	.156	.647	.322
Gracilis	Age	Height	Weight	BMI	Lower limb length	Thigh length	Tibial length	Thigh girth	Calf girth
Pearson's correlation	-.130	.904**	.594	.242	.876**	.927**	.449	-.034	.187
Significance	.721	.000	.070	.500	.001	.000	.193	.926	.604

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

This study showed a strong correlation between height of patients and both semitendinosus and gracilis graft length. Taller patients with longer limb lengths and thigh length tend to have a longer graft length. A statistically weakly significant correlation between weight and graft length was also noted. BMI, tibial length and calf girth didn't show any correlation with the graft parameters.

Discussion

The ability to predict the length of the hamstring graft preoperatively is of great importance and may help the surgeon to achieve an acceptable diameter for the graft in ACL reconstruction. The minimum size to avoid revision surgery is considered 7 mm. The latest study considered that the autograft diameter of no <8 mm is considered acceptable [17]. In our study a total of 30 patients with isolated ACL tear were included who

underwent ACL reconstruction with hamstring graft. Hamstring tendon grafts are one of the most popular autograft choices in ACL reconstruction. But their length and diameter may be unpredictable. Biomechanical studies have shown increased strength and stiffness of hamstring grafts with increased graft diameter [17]. According to Tuman JM, Height is the most predictable indicator of graft diameter and length in the literature [18]. Our study also showed a strong correlation between height and graft length.

In our study we added thigh length as an anthropometric parameter, which has been rarely described in previous studies [19, 20]. It was found to be significantly correlated with graft length. Thigh length might be an easy to measure and a sensitive tool for the prediction of graft length. Naiyer *et al* [21] had shown thigh girth as a predictive parameter, our study showed no correlation with thigh girth. Ravi Gupta *et al* [23], in their research

project, observed that the patient variable like height, weight, thigh circumference, and leg length were in significant positive correlation with semitendinosus and gracilis diameter. They concluded that the length of semitendinosus had a strong correlation with leg length, whereas that of gracilis had a strong correlation with height. Tarun Goyal *et al* ^[24] concluded that height and thigh length could be relayed upon to predict graft dimension, but they lacked a strong association. After multiple regression analyses, they noticed only height was significantly associated with graft dimension in their study population. They mentioned a height of less than 147cm as being at risk of graft diameter <7 mm. There are differences between authors regarding the relationship of gender to autograft size. The limitations of our study are small sample size with most of the patients belonging to a similar cohort and thus cannot be a true representative of the entire population.

Conclusion

Anthropometric measurements such as weight, BMI, leg length, calf girth cannot be used as definitive predictors for the hamstring graft diameter during harvest but height of the patients and thigh length can be taken as good predictor.

Conflict of Interest

Not available

Financial Support

Not available

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