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Correlation of anthropometric parameters with semitendinosus tendon length in anterior cruciate ligament injured patients

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Anterior cruciate ligament reconstruction (ACLR) surgery is now a common procedure performed following a tear of the anterior cruciate ligament. The length of the harvested hamstring tendon is critical to the outcome of the surgery as it may influence the final length and thickness of the graft. The goal of this study was to attempt to establish a relationship between the height, weight and body mass index and the harvested length of the semitendinosus tendon of patients having ACLR surgery. This was a retrospective study. The weight, height, and body mass index (BMI) of patients for primary anterior cruciate ligament reconstruction were noted. The average length of the tendon was noted. The correlation between each of these anthropometric parameters and the tendon length was estimated. The range of values for the semitendinosus length, height and weight in males and females respectively were 24-39cm (31.26 +/- 2.93) and 26-35cm (29.26 +/- 2.08); 1.6-1.96 m and 1.65-1.8m; and 52-110kg and 60-106kg. Only the height revealed a moderate correlation with the length of the harvested tendon among the male patients. Linear regression analyses yielded the equation Semitendinosus tendon length = 23.25xheight-10.28 at a *p*-value of 0.002. Patient height could be predictive of the length of the harvested semitendinosus tendon.

Key words: Hamstring, semitendinosus, anthropometric measurements, correlation, height.

INTRODUCTION

Tears of the anterior cruciate ligament are common injuries among sporting individuals[1-3]. However, it may also follow road traffic injuries, falls from height or any other trauma to the knee. Injury to the anterior cruciate ligament causes knee instability that may lead to further damage to the structures in knee joint. This damage may include chondral injuries and meniscal damage, both of which further aggravate knee symptoms and impair functional activity[4].

Over the last decade, there have been an increasing trend towards reconstructing a torn anterior cruciate ligament arthroscopically[5]. The choice of autograft includes autogenous bone-patellar tendon-bone, hamstring, and quadriceps tendon grafts. In terms of biochemical analysis and clinical outcome, quadrupled hamstring autografts have been shown to have similar characteristics to central-third bone-patellar tendon-bone autografts[6-8]. The hamstring graft, however, offers the advantage of decrease in complications resulting from donor-site pain. A hamstring tendon graft may take the form of either a quadrupled semitendinosus graft or a quadrupled combined semitendinosus-gracilis autograft[9].

The diameter and length of hamstring tendon and resulting graft may vary with individual patient physical characteristics[10]. Such parameters would be useful in predicting the pre-operative length which would help in pre-operative planning such as planning for alternative autogenous grafts like quadriceps tendon graft: allografts or synthetic grafts in individuals who may likely have short grafts. This has the potential benefit of reduced operating time and reduced post-operative morbidity with possible early return to function and early return to performance.

Various methods to predict the length and diameter of the hamstring tendons pre-operatively have been devised in a bid to help in better planning of the operative approach to anterior cruciate ligament reconstruction. Clinical parameters such as lower limb length, width of the lower thigh, height and body weight have been correlated with tendon length and diameter. Pre-operative magnetic resonance imaging of

the tendon has also been used to determine hamstring tendon dimensions[11-12]. We are not aware of any of such studies in the west African sub-region.

The goal of this study was to attempt to establish a relationship between the height, weight and body mass index of patients and the harvested functional length of the semitendinosus tendon.

MATERIALS AND METHODS

This was a retrospective study conducted between January 2016 and December 2020 in our health facility. Ethical clearance was obtained from the institution's health research and ethics committee. Case records of consecutive patients undergoing a primary single bundle anterior cruciate ligament reconstruction with hamstring autograft tendon on account of symptomatic injury to the anterior cruciate ligament, which was confirmed on MRI, were reviewed for the purpose of the study. The gender, height, weight, length of harvested semitendinosus tendon and body mass indices of the patients were noted.

All procedures were performed under spinal anaesthesia with patient positioned supine. The surgery was preceded by an examination under anaesthesia and diagnostic arthroscopy was then performed to confirm the pre-operative clinical diagnosis. This was then followed by the harvest of the hamstring tendon which was usually done using an anterior approach on the side of the injured knee. The semitendinosus was identified below the Sartorius and gracilis tendon and lifted using a curved haemostat. A base-ball stitch was then applied using a size 2 vicryl suture. The semitendinosus was then detached from the tibia attachment and a closed tendon stripper used to detach the tendon from the distal musculo-tendinous junction. The gracilis tendon was in turn harvested in the same manner if the measured length of the semi-tendinosus was considered inadequate.

The harvested tendon was then transferred to the first assistant who prepares the tendon on a tendon workstation. For the purpose of this study, the documented anatomic length of the tendon was considered as the portion of the tendon from the distal detachment on the tibia to the point at which no tendinous fibres are visible at its proximal extent. This is usually measured by laying the tendon fully stretched out on the tendon work station's metered portion (Figure 1). Next, the tendon was prepared by carefully stripping off all muscle fibers from its musculo-tendinous junction. The length of the semitendinosus tendon is the measured again using the same technique as the initial measurement. The documented average of these measurements was usually taken as the anatomic length of the semitendinosus. Our practice is to either triple the semitendinosus tendon if 30cm or more in length or harvest the gracilis tendon along with it if less than 30cm. The harvested gracilis tendon is prepared in a similar manner to the semitendinosus and then double-folded along with the semitendinosus to construct a quadruple-semitendinosus-gracilis hamstring autograft. The goal of the eventual tendon construct is to obtain a graft diameter of at least 7.5mm and a length of at least 10cm using either a tripled semitendinosus autograft or a quadrupled semitendinosus-gracilis autograft. The diameter of the resultant construct is in turn measured in slots on a cylinder block of 0.5mm diameter increments.

The mean tendon length was analyzed from the general data and between the genders. The anatomic length of the semitendinosus was correlated with the; height, weight and body mass index of the participants using Pearson's correlation. Using the length of the semitendinosus as the dependent variable and anthropometric characteristics of the patient as the independent variable, linear regression analyses was used to analyze the predictability of semitendinosus tendon autograft length.

RESULTS

A total of one hundred and four anterior cruciate ligament injuries were seen within the study period.

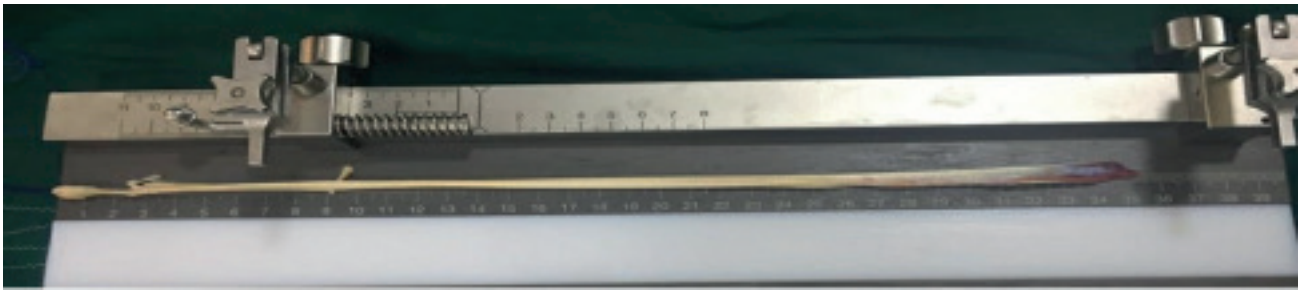

Fig. 1 — Measurement of anatomic length of harvested semitendinosus.

Table I. — Anthropometric characteristics of respondents

Gender	Total number	Age (years)	Weight (Kg)	Height (m)	BMI (kg/m^2)	Length of Semitendinosus (cm)
Male	49	32.23 (± 11.35)	79.56 (±10.76)	1.77(± 0.07)	25.38(± 3.40)	31.20 (±3.28)
Female	20	39.17 (±11.60)	76.79 (±14.19)	1.71 (±0.04)	28.63 (±2.87)	29.26 (±2.08)
Non-Gender Basis	69	34.21(±11.72)	78.79 (±11.77)	1.75(±0.07)	25.57 (±3.53)	30.70 (±2.85)

Table II. — Correlation between anthropometric measurements and length of semitendinosus

Correlations r (*p* value) with graft length	**Age**	**Height**	**Weight**	**BMI**
Non-Gender Basis	-0.067 (0.675)	0.41 (0.001)	0.21 (0.09)	- 0.10 (0.95)
Males	0.075 (0.695)	0.30 (0.02)	0.30 (0.05)	0.15 (0.32)
Females	-0.023 (0.943)	0.30 (0.22)	0.13 (0.69)	0.19 (0.44)

Sixty-nine cases had their surgeries done during this period and were all included in the study. Of, these forty–nine (72%) were males and twenty (28%) were females. The mean (± SD) values of the age, height, weight, and body mass indices are as displayed in Table I. The range of values for the semitendinosus length in males was 24-39 cm (31.26± 2.93) and females was 26-35 cm (29.26 ± 2.08). The range of values for the height was 1.6-1.96 m and 1.65-1.80m in males and females respectively. The corresponding values for the weight ranged from 52-110kg and 60-106kg for males and females respectively.

Using a Pearson's correlation co-efficient, the relationship between the various anthropometric parameters and the length of the harvested semitendinosus tendon was estimated and results are as in Table II.

Using the length of the semitendinosus as the dependent variable and height of the patient as the independent variable, linear regression analyses yielded the equation Semitendinosus tendon length = 23.25xheight -10.28 at a *p*-value of 0.002, with a moderate correlation of 0.45 and suggesting that height may account for 20.2% variability in the length of the tendon

DISCUSSION

The place of graft size in a successful primary ACL reconstruction has assumed center stage over the last few years[13-14]. Hamstring tendon graft length available to the surgeon determines the number of times it can be folded to get a graft of adequate diameter and length for anterior cruciate ligament reconstruction (ACLR). Studies by Pichler et al.[15] and Hamada et al.[16] reveal that hamstring tendon may vary in length and diameter among individuals. MRI and ultrasonography are methods in current practice used to pre-operatively determine the size of the hamstring tendon. However, anthropometric measurements represent a convenient and affordable means of predicting graft size. In a setting such as our study environment where the full armamentarium for investigation such as an MRI may not always be available, these measurements can be a good guide to planning for the surgeon.

In our study, height revealed a significant correlation with the length of the semitendinosus among the male participants and in the general population of patients recruited for the study. This is similar to the findings of Treme et al.[17], Xie et al.[18] and Chang et al.[19] in their study on hamstring size in relation to patient height. Similar studies that have focused on the resultant diameter of the hamstring tendon after folding it, have also shown good correlation with the height of the patient[20-22]. Similarly, Papathanasiou et al.[23] in their study discovered that only height correlated with the length of semitendinosus. The study by Chang et al.[19] was among a Chinese population while those of Treme et al.[17] was in a Caucasian population. However, our study presents a peculiarity in that unlike these previous studies, ours was conducted among a black population of respondents which to the best of our knowledge represents the first of such a study.

We found no correlation between the weight and the length of the semitendinosus tendon, and between the BMI and the length of the semitendinosus tendon in the group and in either gender. The sample size for the female population in this study was relatively lower and may explain the absence of any significant correlation between the length of semitendinosus tendon and anthropometric measurements in the female population in our study. However, the findings in our study were similar to the findings of Atbazi et al.[24] who found no correlation between the hamstring tendon length and patient's height, weight and BMI despite having a larger sample size.

The mean values for the length of semitendinosus tendon observed in males in our study was slightly higher than that in females. Females have been observed to have a smaller and thinner graft than males[17]. Treme et al.[17] in their study noted that women who were shorter, lighter, and had smaller body mass indices were more likely to have smaller graft diameters and shorter graft lengths. Xie et al.[18] in their study also noted that women had significantly smaller GT and ST graft diameters and shorter tendon lengths than did men. In our study, an equation to predict the tendon length using height as the independent variable predicts that the semitendinosus tendon length = (23.25xheight) -10.28

Our study is not without a few limitations. Our sample size is small when compared to some other studies. This is understandable bearing in mind that only very few centers across the country routinely offer arthroscopic anterior cruciate ligament reconstruction surgeries.

In conclusion, the height of a patient could be predictive of the length of the harvested semitendinosus tendon in patients with anterior cruciate ligament injury. This could serve as a guide to surgeons in planning for ACLR surgeries and the need to have alternative graft options preparatory to ACL reconstruction.

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