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Anthropometrics Correlation of Peroneus Longus and Hamstring Autograft for Anterior Cruciate Ligament: A Cross-sectional Study

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ABSTRACT

Introduction: The success of anterior cruciate ligament (ACL) reconstruction is highly correlated with the autograft diameter from either peroneus longus or hamstring. However, it is difficult to predict the graft diameter for ACL reconstruction preoperatively. Thus, this study is aimed to investigate the potential of using anthropometric measurements to predict autograft diameter.

Methods: A cross-sectional study was conducted using a consecutive sampling from January 2016 until December 2021 in Sanglah General Hospital, Denpasar Bali. We recorded patients' characteristics including gender, age, body weight, height, and Body Mass Index (BMI) preoperatively. We measured peroneus longus and hamstrings grafts diameter intraoperatively and analyzed data using Pearson correlation.

Results: Eighty-nine patients met inclusion criteria with 49 patients in receiving peroneus longus autograft and 40 patients receiving hamstring autograft. The peroneus longus group includes 36 males and 13 females while the hamstring group include 19 males and 21 females. Basic demographic characteristics of peroneus longus and hamstring groups, respectively, are as follows: age was 30.53 ± 10.86 and 32.22 ± 15.66 years; body weight 66.14 ± 10.55 and 63.80 ± 7.14 kg; height 167.31 ± 6.37 and 168.33 ± 2.49 (HT) cm; and BMI 23.59 ± 3.28 and 22.51 ± 2.48 kg/m2. Intraoperative peroneus longus and hamstring diameter measurement were 7.56 ± 1.21 and 6.59 ± 0.45, respectively. Pearson correlation showed significant correlation between intraoperative peroneus longus diameter with BMI with $p < 0.05$.

Conclusions: Anthropometric measurement, especially BMI, has potential to be used as a cheap and reliable method to predict ACL autograft preoperatively. Future studies should focus on developing a mathematical formula to predict ACL autograft using anthropometric measurement in clinical settings.

Keywords: anterior cruciate ligament, ACL reconstruction, autograft, anthropometric measurement

INTRODUCTION

ACL injury occurs frequently, and ACL reconstruction is among the most common procedures performed by orthopedic surgeons worldwide. One systematic review estimated ACL injury to occurs in 0.01% to 0.05% of a given population annually [(1)]. Another study give much higher incidence of 1.5% to 1.7% of the general population [(2)]. Considering the role ACL plays in human locomotion, its management is vital to ensure the patient's continued quality of life.

In recent years, it has been established that ACL reconstruction is the golden standard management for ACL injury [(3)]. This procedure involved the reconnection of the torn ACL using a grafted tendon, often

coming from patellar or hamstring tendon [4]. However, in recent years, there has been evidence that peroneus longus autograft can provide unique benefits to the procedure [5,6]. Considering the importance of ACL reconstruction procedure, the medical literature is replete with studies investigating best practices to obtain optimal results. Among the factors found associated with the outcome of ACL reconstruction are meniscus or cartilage status, graft choice, or surgical technique [7]. One graft-related factor often found associated with the success of ACL reconstruction procedure is the autograft diameter used in the procedure. Small autograft diameter is associated with increased risk of revision surgery requirement down the line. One study reported a diameter of 7 mm is adequate to prevent poor outcome [8]. However, more studies recommended autograft diameter of no less than 8 mm is required to prevent poor outcome [9,10].

This best practice is hard to implement into practice, however, as autograft diameter is hard to predict. Other than intraoperative measurement, by which time it is too late to switch autograft source, accurate prediction can only be obtained via magnetic resonance imaging (MRI) or ultrasonography (USG) [11]. Such equipment is rarely available in resource-limited settings. Consequently, there is a need to develop a method to predict autograft diameter that is affordable, readily available, and non-invasive.

Anthropometric measurement is one such potential method. Previous studies has established the potential of using anthropometric measurement to predict autograft diameter from multiple sources, including hamstring, gracilis, semitendinosus, and peroneus longus [12–14]. However, further studies are required to investigate the reliability of this association across multiple populations. Thus, our study was aimed to further establish the potential of using anthropometric measurement to predict autograft diameter, especially in a Balinese population.

MATERIALS & METHODS

This study employed a cross-sectional method where each subject undergoes single preoperative and postoperative measurements, respectively. Subjects were recruited consecutively at Sanglah General Hospital, a tertiary referral hospital in Bali, Indonesia, for a period of 6 years, from January 2016 to December 2021. Inclusion criteria were adult patients (aged 16-45) with ACL tear undergoing ACL reconstruction procedure with hamstring or peroneus longus autograft at the Central Surgical Installation of Sanglah General Hospital. ACL tears were diagnosed clinically through physical examination (Lachmann test and anterior drawer test). Patients with comorbid ligament, chondral, meniscus, or bone injury on the affected knee were excluded from analysis.

Anthropometrical measurements were obtained preoperatively. Body weight and height were measured as a standard preoperative examination and the data were obtained from the medical record. Similarly, patient's age and sex were obtained from the medical record. Meanwhile, body mass index (BMI) was calculated using the weight and height data.

Graft diameters were measured intraoperatively during a arthroscopic procedure. The peroneus longus autografts were stripped proximally to the fibular head using a tendon stripper to prevent damage to the peroneal nerve. Meanwhile, hamstring autografts were harvested from the gracilis tendon. Intraoperative graft diameters were measured in 0.5 mm increments using a published ACL reconstruction graft diameter measurement guide (ConMed®, USA).

The protocol for this study has been reviewed and approved by the appropriate ethical committee, the Ethical Committee of Sanglah General Hospital/Udayana University Faculty of Medicine.

Statistical analysis includes descriptive analysis, normality test, and bivariate analysis. All tests were conducted separately for peroneus longus and hamstring groups. Normality tests were conducted using Shapiro-Wilk test as none of the groups has more than 50 subjects. Afterward, descriptive analysis was conducted to obtain mean and standard deviation or median interquartile range values, depending on the result. Bivariate analysis was conducted using Pearson or Spearman correlation tests, depending on the result of normality tests. All statistical analyses were conducted using IBM SPSS 23.0 (IBM Corp., Chicago).

RESULT

Final analysis included 89 subjects. This figure includes 49 patients with peroneus longus autograft and 40 patients with hamstring autograft (Table 1). In the peroneus longus group, there were 36 males and 13 females while there are 19 males and 21 females in the hamstring group. Normality test using Shapiro-Wilk found normal distribution for all variables across both groups ($p > 0.05$). Accordingly, all data are presented as mean and standard deviation (SD).

The mean age, body weight, height, and BMI in the peroneus longus group were 30.53 ± 10.86 years, 66.14 ± 10.55 kg, 167.31 ± 6.37 cm, and 23.59 ± 3.28 kg/m^2 respectively. Whereas for hamstring group, it was 32.22 ± 15.66 years, 63.80 ± 7.14 kg, 168.33 ± 2.49 cm, and 22.51 ± 2.48 kg/m^2. The autograft diameter was 7.56 ± 1.21 mm for the peroneus longus group and 6.59 ± 0.45 for the hamstring group.

Table 1. Characteristics of subjects.

Variable	Peroneus Longus (n = 49)	Hamstring (n = 40)
Sex, n (%)		
Male	36 (73.5)	19 (47.5)
Female	13 (26.5)	21 (52.5)
Age (years), mean ± SD	30.53 ± 10.86	32.22 ± 15.66
Weight (kg), mean ± SD	66.14 ± 10.55	63.80 ± 7.14
Height (cm), mean ± SD	167.31 ± 6.37	168.33 ± 2.49
BMI (kg/m^2), mean ± SD	23.59 ± 3.28	22.51 ± 2.48
Autograft diameter (mm), mean ± SD	7.56 ± 1.21	6.59 ± 0.45

Bivariate analysis was conducted using Pearson correlation according to the result of normality test. The results (Table 2) showed significant correlation between BMI and autograft diameter in the peroneus longus group ($p < 0.05$). No other statistically significant correlations were found in the analysis.

Table 2. Correlation analysis results.

Variable	Peroneus Longus (n = 49)		Hamstring (n = 40)	
	Coefficient	p	Coefficient	p
Sex	0.457	0.232	0.453	0.233
Age	0.206	0.587	0.210	0.754
Weight	0.188	0.107	0.172	0.191
Height	0.171	0.691	0.182	0.148
BMI	0.399	0.021*	0.318	0.102

***p < 0.05**

DISCUSSION

The use of peroneus longus in ACL reconstruction procedure is a comparatively new innovation compared to the more traditional hamstring or patellar autograft. One study compared the outcome of peroneus longus and hamstring autografts in ACL reconstruction and found peroneus longus to be non-inferior compared to hamstring after a 2-year follow up [15]. Its main advantages, however, lie in its comparatively simple harvesting and autograft preparation procedures with fewer donor-site complications [16,17].

One more advantage to consider is peroneus longus autograft are consistently found to have larger diameter compared to its hamstring counterpart. It has also been

observed in previous studies comparing peroneus longus and hamstring [12,18]. This finding is important as previous studies has established the importance of autograft diameter in predicting the outcome of ACL reconstruction procedure with a recommendation of autograft diameter no less than 8 mm [9,10].

This brings us back to the finding of this study. We similarly found peroneus longus autograft to have a larger diameter (7.56 ± 1.21 mm) compared to hamstring (6.59 ± 0.45) although the mean of both groups did not surpass the 8 mm recommendation. While similar finding has been described previously [12,18], there is a possibility that the larger diameter in peroneus longus group in our study is associated with the sex distribution which were disproportionately male compared to the hamstring group. Sex is known to be associated with autograft diameter as described in a previous study [12]. However, our own analysis did not find this association (Table 2).

The main finding of our study is the potential of anthropometric measurements, especially BMI, as predictor of autograft diameter, especially for peroneus longus. This finding has been described previously [12]. Few other studies has also described the association between other anthropometric measurements, such as height and weight, with peroneus longus autograft diameter [13,19,20]. This can be attributed to the peroneus muscle mass development associated with supporting a larger body weight [13].

Meanwhile, the association between anthropometric measurements and hamstring tendon diameter is much more inconclusive. There has been some evidence supporting the association [21,22]. Conversely, there are also evidence showing there are no association between anthropometric measurement and hamstring tendon diameter [23,24].

This result further establishes the potential of peroneus longus in ACL reconstruction procedure. Other than non-inferiority in outcome, simpler procedure, and lower donor-site complication outlined above, the ability to predict autograft diameter is important in preoperative consideration for ACL reconstruction. Whereas MRI or USG is required to predict hamstring or patellar autograft diameter [11], there are mounting evidence showing the possibility of anthropometric prediction of peroneus longus autograft diameter [13,19,20]. This study adds to this list of evidence.

Nevertheless, this study is not without its limitations. Similar to other studies we referenced here, our study is a single-site study which limits our observation to a small target population. Such limitation can be overcome by a multi-centered study, observing people from diverse population. Another issue is the fact that the surgical procedures described in our study were not performed by a single surgeon which has a risk of clinical bias.

CONCLUSION

Our findings reinforce previous evidence on the potential of peroneus longus autograft for ACL and the use of anthropometric measurement to predict its diameter. We confirm previous evidence on peroneus longus autograft having a larger average diameter compared to hamstring autograft. We also confirm the potential of using anthropometric measurements, especially BMI, to predict its diameter. Further studies should be directed to developing a reliable mathematical formula to predict peroneus longus autograft diameter using anthropometric measurements preoperatively.

Declaration by Authors

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