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Original Article

Hamstring graft size and anthropometry in south Indian population

Supradeeptha Challa M.S (Ortho), (D.N.B Ortho), M.Ch (Ortho)^{a,*},
Jonnalagedda Satyaprasad M.S (Ortho), M.Ch (NEUROSURGERY)^b^a Assistant Professor, Department of Orthopaedics, G.S.L. Medical College, Rajahmundry, Andhrapradesh 533296, India^b Professor, Department of Orthopaedics, G.S.L. Medical College, Rajahmundry, Andhrapradesh 533296, India

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ABSTRACT

Background and Aim: The role of anthropometric measurements in the prediction of hamstring autograft size in Indian population remains unclear. Till now, no studies have been done on Indian population.

Methods: We evaluated 41 consecutive patients (34 males, 7 females) prospectively with anterior cruciate ligament deficiency scheduled for reconstruction using hamstring autograft at our institution between June 2011 and June 2013. Preoperatively we recorded age, gender, height, weight, body mass index, and activity level. Intraoperative measurements of semitendinosus tendon like absolute length, diameter before fashioning the graft and final diameter of the tripled graft using sizing tubes calibrated to 1 mm. Correlation coefficient (Pearson's *r*) analysis was used.

Results: As per study there is no correlation between graft diameter, age, sex, weight, activity, and body mass index, of patients. Height of patients correlated to graft diameter in both Indian men and women ($p < 0.001$).

Conclusion: Anthropometric measurements such as weight, gender, activity level cannot be used as definitive predictors for the hamstring graft diameter during harvest but height of the patients can be taken as good predictor in Indian population.

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1. Introduction

The use of hamstring graft for ACL reconstruction has become increasingly popular because of morbidity associated with the other grafts and with reports of less graft harvest related morbidity and improvement in fixation devices.^{1–8}

Scott and Insall report that the length of normal ACL is 38 mm (25–41 mm) and the width is 10 mm (7–12 mm), on average.⁹ The minimum graft thickness recommended is

7 mm.^{10,11} Biomechanical studies have established that the load at which failure occurs in a hamstring graft is proportional to its diameter. As per study by A Waly (2002), ACL reconstruction using triple semitendinosus tendon, is a viable technique compared to others and preserving Gracilis tendon, decreases hamstring morbidity.¹² In a study by Miller et al, patients with quadrupled hamstring graft have some postoperative weakness with deep knee flexion due to loss of gracilis.¹³ Dirk Stengel et al used triple strand hamstring graft, showed that laxity after

* Corresponding author. Tel.: +91 9941528076.

E-mail address: supradeep_challa@yahoo.co.in (S. Challa).

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Table 1 – Variables and data.

Total number of patients – 41			
Age	(Mean $\pm$ S.D), (range)	27.9 $\pm$ 8.97	(15–54) years
Height	(Mean $\pm$ S.D), (range)	170.85 $\pm$ 5.25	(160–180) cm
Weight	(Mean $\pm$ S.D), (range)	66.49 $\pm$ 7.12	(50–80) kg
Body mass index	(Mean $\pm$ S.D), (range)	22.76 $\pm$ 2.79	(17.57–28.19)
Graft length	(Mean $\pm$ S.D) (range)	24.39 $\pm$ 1.3	(22–27) cm
Graft diameter	(Mean $\pm$ S.D) (range)	4.26 $\pm$ 0.46	(3.5–5.5) cm
Graft strand diameter	(Mean $\pm$ S.D) (range)	7.7 $\pm$ 0.8	(6–9.5) cm

surgery is due to fixation method i.e., screws and pins.¹⁴ Vipool K Goradia et al used triple strand hamstring graft in his study, and showed that 90% of patients can be expected to have a normal or near normal knee at short-to intermediate-term follow-up.¹⁵ Hiemstra et al identified eccentric knee flexion deficits at high velocities for the quadruple strand hamstring graft group, notable through 60–95° arc of knee motion which is consistent with the work of Coombs and Cochrane.¹⁶ Quadruple hamstring graft length, less than 8 cm associated with more complications.¹³ So studies showed, good results with triple strand hamstring graft by not using Gracilis tendon to prevent the flexion weakness of knee.^{12–16}

In order to assure the optimal 8 cm length and 7 mm thickness of triple strand hamstring graft construct for ACL reconstruction (2 cm in the femoral tunnel, 4 cm intra articular, and 2 cm in the tibial tunnel), it is essential to obtain a minimum tendon length of 24 cm. One of the disadvantages of using hamstring autograft is the possibility of obtaining a graft of a smaller diameter than optimally required. The surgeon may need to continue with an alternative graft source and fixation technique when such a situation is encountered during surgery. Therefore, preoperative prediction of the sufficiency of the hamstring graft thickness for ACL reconstruction would be useful in order to arrange alternative fixation methods or graft choices ready to use at the operation theater.

Tuman et al¹⁷ study showed that older, shorter, female patients had an increased risk of having hamstring graft with inadequate diameter. WL Loo et al¹⁸ study showed that in Asian male patients, height, weight, and body mass index cannot be used for preoperative prediction of graft size. The world's average height of youth (20–30 years) is 170.6 cm, whereas in Europe, Asia, and India it is 177 cm, 168.8 cm, and 165.3 cm respectively.¹⁹ The average height of people in Andhra Pradesh is 165 cm which is equal to average height of entire India.²⁰

As the average height of Indian's is low, and to our knowledge, there is no literature, correlating anthropometric measurements and hamstring graft diameter in the Indian population, the aim of this study was to determine whether anthropometric measurements, such as age, gender, height, weight, body mass index (BMI), and level of activity, can be used to accurately predict the diameter of hamstring tendons for anterior cruciate ligament (ACL) reconstruction surgery in Indian population.

2. Materials and methods

After ethical committee approval, we prospectively evaluated 41 (34 males, 7 females) consecutive patients with anterior cruciate ligament (ACL) deficiency scheduled for reconstruction using triple strand hamstring graft from June 2011 to June 2013. Anthropometric measurements including age, gender, height, weight, body mass index, and level of activity were taken preoperatively. Intraoperative measurement of semitendinosus was made, including absolute length and diameter of the triple strand graft using 1 mm calibrated scale. All measurements were obtained after blunt removal of attached muscle and fat but before any further postharvest alteration or trimming of the graft.

Correlation coefficients (Pearson's *r*) and stepwise, multiple linear regression were used to determine the relationship between the outcome variable, triple strand hamstring graft thickness and the predictor variables (age, gender, height, length, body mass index). A *p* value of less than 0.05 was considered statistically significant.

3. Results

This study consists of 34 males, 7 females with average age of 27.9 $\pm$ 8.97 years. Average height of patients was 170.85 $\pm$ 5.25 cm, average weight of patients was 66.49 $\pm$ 7.12 kg intraoperative measurement of graft tissue yielded an average semitendinosus graft length of 24.39 $\pm$ 1.3 cm, average graft diameter of 4.26 $\pm$ 0.46 cm and average diameter of triple strand graft of 7.7 $\pm$ 0.8 mm. A total 42% of patients had a tripled graft diameter between 7 and 8 mm, 12% of patients' grafts were less than 7 mm, while 46% percent were greater than 8 mm in diameter. Four out of five patients with tripled graft diameter, of less than 7 mm had height, less than 170 cm. Summary of data is presented in Table 1.

Table 2 – Correlation coefficient.

Graft length	Age	Gender	Height	Weight level	BMI	Activity
Pearson's correlation	0.003	0.27	0.67	0.156	0.20	0.67
Significance	0.985	0.08	0.00	0.331	0.20	0.67
Graft diameter	Age	Gender	Height level	Weight	BMI	Activity
Pearson's correlation	0.085	0.113	0.368	0.068	0.132	0.160
Significance	0.598	0.482	0.018	0.673	0.410	0.318

There was a positive relation between height, and graft length and diameter ($p < 0.001$ and $p = 0.018$, respectively). Taller patients tended to have thicker tripled hamstring grafts. However, age, gender, weight, body mass index, activity level did not correlate with graft length and thickness ($p = 0.985$, 0.598 , $p = 0.08$, 0.482 and $p = 0.67$, 0.318 respectively). Correlation coefficients are presented in Table 2.

4. Discussion

Studies have shown an increased incidence of anterior knee pain, arthrofibrosis, and quadriceps weakness associated with use of the bone-patellar tendon-bone autograft.^{21,22} The biomechanical strength of the 7 mm diameter, 3, or 4 strand graft is approximately 240% greater than that of the native anterior cruciate ligament.^{23–26} Grafts with smaller diameters are weaker than this, which will compromise the graft integrity and ultimately clinical outcome. The ability to predict which patients have relatively small hamstring tendons may be beneficial, in that alternate graft sources may then be considered when appropriate.

In the Western literature,^{13,26} the mean sizes of hamstring grafts range from 7.9 to 8.6 mm, and our results showed that the mean hamstring graft diameter was 7.7 mm.

Most of the Western literature showed that height is the best predictor among anthropometric data in hamstring graft size.^{27–29}

A cadaveric study by, Tan et al³⁰ has reported that the anterior cruciate ligament in the Singapore Chinese was smaller than those reported in the Western literature and that the size of native anterior cruciate ligament is shorter, narrower and more vertical. So in people who are short, the native anterior cruciate ligament in this population was shorter and narrower.

Results of our study showed that hamstring graft length and diameter correlates with the height of the patient but not with the weight, body mass index, and activity level.

The limitations of our study are small sample size, lack of inter-observer readings of graft size.

5. Conclusion

We conclude that, anthropometric measurements such as weight, gender, activity level cannot be used as definitive predictors for the hamstring graft diameter during harvest but height of the patients can be taken as good predictor in Indian population. However a well-designed study with a larger sample size in Indian population is required to validate the observations of our study.

Conflicts of interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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