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Comparison of semitendinosus tendon length and diameter in sports and non-sports group for ACL reconstruction

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ABSTRACT

Background: Different anthropometric parameters such as weight, height, body mass index, thigh circumference, and thigh length have been extensively studied and their correlation assessed with hamstring graft length and diameter. This study is to analyse the difference of semitendinosus graft characteristics with sports activity of the patient. METHODS: 110 patients undergoing any ligament reconstruction with semitendinosus were included, 55 in sports and 55 in non-sports group. Height, weight, BMI, sports activity were noted pre-operatively. Semitendinosus harvested and graft length and diameter measured. RESULTS: 98 patients completed the study. The mean length of the harvested semitendinosus tendons was 28.45 ± 2.54 cm in non-sports group and 28.06 ± 4.18 cm in sports group. The mean diameter of semitendinosus was 6.29 ± 0.61 mm in non-sports group and 6.35 ± 0.6 mm in sports group. Positive correlation was found between height and graft length. No statistically significant difference between tendon length ($p = 0.994$) and diameter ($p = 0.549$) of sports and non-sports group was found. CONCLUSION: Patient height should be considered for preoperative prediction of tendon length and thickness without any difference in sports or non-sports group. A taller patient has a longer and thicker graft.

1. Introduction

Anterior cruciate ligament(ACL) injury is the most common ligamentous knee injury encountered in athletes.[1] Complete or near complete injuries of ACL are treated with arthroscopic ligament reconstruction and mostly the hamstring graft is used.[2]

Several studies have been done to predict the graft characteristics of an individual pre-operatively. Anthropometric measurements such as weight, height, body mass index, thigh circumference, and thigh length of the patient undergoing surgery were noted and correlation assessed with graft length and diameter. In males, the most reliable predictor of graft length is found to be patient's height.[3,4] This preoperative knowledge is essential for counselling the patient and planning the surgery. To reduce the risk of failure a graft diameter of greater than 8 mm is recommended.[5–7] In cases where a quadrupled semitendinosus (ST) graft is used with suspensory fixation on both ends, a minimum length of 28 cm is advisable to make a graft size of 7 cms as the intra-articular length required is 3 cm and tunnel on femoral and tibial end should accommodate 2 cm of graft each.[8] Sportspersons do rigorous hamstring exercises. We intend to find out whether there is any difference in tendon dimensions of semitendinosus in sportspersons compared to non athletes, so that we can anticipate the graft size on the basis of patient's activity level.

2. Material and Methods

We recruited 110 patients for the study, between January 2020 to March 2020. Informed consent was obtained from all participants and the study was conducted in accordance with all principles of Helsinki Declaration as revised in 2013. Approval for the study was obtained from our Institutional Review Board.

All adult male and female patients with any ligamentous injury of the knee undergoing reconstruction using a hamstring tendon autograft were included in the study. Patients undergoing either primary and revision surgery were included. Children under the age of 18 years and patients operated with grafts other than hamstring were excluded from the study.

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The following data was collected from patients: age, gender, height, weight, level of sporting activity. Patients were then grouped into sports and non-sports category. Only those sports-persons were included who has played at least at the state level and playing sports where hamstrings are known to be utilised well, such as football, basketball, tennis, badminton, cricket and excluding sports where movement is quite less like table tennis. All those patients playing any sports at a lower frequency (less than 3 h a week) were kept in non-sports group. Sports persons playing below state level and non-sports persons playing or exercising more than 3 h a week were excluded from the study. They were not included in any group.

Surgeries were performed by consultants with at least 5 years of experience after residency and performing more than 50 arthroscopic procedures a month, using the same harvesting technique. Using a vertical skin incision starting 1.5 cm medial to tibial tuberosity extending 3 cm distally, ST or gracilis or both tendons were harvested depending on the procedure to be performed.

The ST graft was kept on graft preparation board and muscle tissue and fat was removed. The narrow tailed end of the graft was cut with a knife. Length of the tendon was measured with the help of the markings given over the board. Graft was doubled with a thread in centre and diameter was measured using the measuring device. Diameter was the smallest calibrated hole in which the graft could pass through. Both the measurements were noted.

2.1. Statistical analysis

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality was rejected then non parametric test was used.

2.2. Statistical tests were applied as follows-

1. Quantitative variables were compared using Independent *t*-test/ Mann-Whitney Test (when the data sets were not normally distributed) between the two groups.
2. Qualitative variables were compared using Chi-Square test.
3. Spearman rank correlation coefficient was used to assess the correlation of weight, height and body mass index with ST diameter and ST length. Partial correlation coefficient was used to assess the correlation of weight with ST diameter and ST length after adjusting for height.

For comparison of sports and non-sports group, patients were categorised in three groups of height, weight and BMI each and then compared.

A p-value of <0.05 was considered statistically significant.

The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

3. Results

110 patients participated in the study, on final compilation 12 patients had incomplete data, hence were excluded from the study leaving a final number of 98 patients. 55 patients were in non-sports group and 43 patients were in sports group. Both groups were matched for height, weight and BMI. The demographic data is presented in Table 1.

There was positive correlation between height and tendon length as well as height and diameter (coefficient of correlation 0.469 and 0.329 respectively). There was no correlation with BMI. There was positive correlation between weight and tendon length as well as weight and diameter (coefficient of correlation 0.237 and 0.281 respectively).

The mean length of the harvested semitendinosus tendons was 28.45 ± 2.54 cm in non-sports group and 28.06 ± 4.18 cm in sports group. The mean diameter of semitendinosus was 6.29 ± 0.61 mm in non-sports group and 6.35 ± 0.6 mm in sports group. Mann-Whitney Test was performed and it was found that there was no statistically significant difference between tendon length ($p = 0.994$) and diameter ($p = 0.549$) of sports and non-sports group. Table 2 presents the findings in brief. 19 out of 55 non-sports group patients and 13 out of 43 sports group patients had tendon lengths less than 28 cm.

4. Discussion

We carried out this study with the intention to find whether playing sports where hamstrings are intensively involved bring about any change in the tendon characteristics, as a small increase in tendon dimensions may avoid harvesting any additional graft for the ligament reconstruction. We could not find any similar study comparing the ST dimensions in athletes and non-athletes. However, the importance of graft diameter was stressed by several researchers. Magnussen et al.[6] reviewed 256 patients retrospectively and found that patients younger than 20 years, who had hamstring graft size less than 8 mm during ACL reconstruction with hamstring autograft, had higher failure rates. However, other factors can also contribute to ACL failure rates, most importantly, sex and sport.

Treme et al.[9] in their prospective study of 50 patients, found that those with height less than 140 cm, weight less than 50 kg, a thigh circumference of less than 37 cm and BMI less than 18 are at high risk of quadrupled hamstring graft diameter <7 mm. In 2016, Asif et al.[10] published a study after evaluating 46 patients undergoing ACL reconstruction with quadrupled hamstring graft and found out that thigh circumference and height were significant predictors of graft diameter. They also gave the equation: Graft diameter (mm) = 0. 079 height (cm) + 0.068 thigh circumference (cm) − 9.031 to appropriately estimated graft diameter. Ramkumar et al.[11] retrospectively analysed 1681 ACL reconstructions with hamstring autograft over a 13-year period. They gave a formula to predict graft size. Expected autograft size (mm) = 2.074 (fixed intercept) - 0.198 (if female) + 0.025 × patient height (cm) + 0.623 × ln(BMI) + 0.523 (if 5-strand graft). They concluded that the risk of graft failure can be foreseen with preoperative assessment of anthropometric factors—most significantly, height. This gives an idea regarding possible augmentation or alternative graft sources. On the contrary, Wernecke et al.[12] in a retrospective series of 786 patients, found that revision risk after hamstring autograft was not reduced by increased hamstring diameter.

Gobbi et al., in 2007 advised using ST alone wherever suited, as it is advantageous over the ST-G combined with respect to the weakness in internal rotation of knee following harvest of both tendons.[13] It has been extensively studied that 28 cm is the minimal ST length required to make a quadrupled 7 cm graft when using suspensory fixation on both ends.[8] At our institute, we use aperture fixation at tibial side needing a longer graft of at least 9 cm (ST is mostly tripled and gracilis doubled). Our findings in regard to positive correlation of graft length with height of the individuals in both sports and non-sports group was similar to previous studies.

There are some limitations in our study. Firstly, as female participants were less in number the comparative data between the two group couldn't be analysed separately for both genders. Secondly, the number of hours each day or week the sportsperson has participated in intensive training has not been taken into account in inclusion criteria for the sports group.

Table 1
Comparison of demographic characteristics between non sports and sports group.

Demographic characteristics	Non sports(n = 55)	Sports(n = 43)	Total	P value	Test performed
Age(years)					
<=20	8 (14.55%)	10 (23.26%)	18 (18.37%)	0.465	Chi square test,1.532
21–30	36 (65.45%)	27 (62.79%)	63 (64.29%)		
>30	11 (20%)	6 (13.95%)	17 (17.35%)		
Mean ± Stdev	26.93 ± 6.16	24.74 ± 4.97	25.97 ± 5.75	.062	*t*-test; 1.891
Median(IQR)	27(22-30)	25(21–29.75)	26(21-30)		
Range	18–48	16–35	16–48		
Gender					
Female	7 (12.73%)	5 (11.63%)	12 (12.24%)	0.869	Chi square test,0.027
Male	48 (87.27%)	38 (88.37%)	86 (87.76%)		
Weight(kg)					
Mean ± Stdev	76.27 ± 12.92	73.07 ± 12.47	74.87 ± 12.76	0.219	*t*-test; 1.237
Median(IQR)	75(70–81.5)	73(65.5–81)	75(67-81)		
Range	49–118	47–100	47–118		
Height(cm)					
Mean ± Stdev	170.23 ± 8.54	171.01 ± 7.39	170.57 ± 8.02	0.633	*t*-test; 0.478
Median(IQR)	170(165–177.5)	170(166.75–175)	170(165-175)		
Range	150–190	150–190	150–190		
Body mass index(kg/m^2)					
Mean ± Stdev	26.3 ± 4.06	24.9 ± 3.59	25.68 ± 3.9	0.072	Mann Whitney test; 932
Median(IQR)	25.06(23.595–27.933)	24.57(22.908–25.928)	24.76(23.157–27.624)		
Range	21.2–42.97	18.67–37.64	18.67–42.97		

Table 2
Comparison of ST diameter(mm) and length(cm) between non sports and sports group.

ST diameter(mm) and length(cm)	Non sports(n = 55)	Sports(n = 43)	Total	P value	Test performed
ST diameter(mm)					
Mean ± Stdev	6.29 ± 0.61	6.35 ± 0.6	6.32 ± 0.61	0.549	Mann Whitney test; 1102
Median(IQR)	6(6-7)	6.5(6-7)	6.5(6-7)		
Range	5–7.5	5–7	5–7.5		
ST length(cm)					
Mean ± Stdev	28.45 ± 2.54	28.06 ± 4.18	28.28 ± 3.35	0.994	Mann Whitney test; 1181.5
Median(IQR)	28(27-30)	29(27-30)	28(27-30)		
Range	21–35	6.5–35	6.5–35		

5. Conclusion

Patient height correlates with ST graft length and diameter irrespective of activity level of lower limbs. It should be considered for preoperative anticipation of tendon length and thickness without any difference in sports or non-sports group. If the patient is short statured, then patient and relatives should be counselled for alternative graft options.

Role of each author

Dr Pallav Mishra - study conception and design, graft harvest and measurement
Dr Ajay-graft harvest and measurement
Dr Ankit Goyal-graft harvest and measurement
Dr Nitin Mehta-graft harvest and measurement
Dr Hitesh Lal-study conception and design
Dr Sanjeev kumar- anthropometric measurements, data collection and writing the manuscript

Declaration of competing interest

There are no conflict of interest to be disclosed by any author.

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