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CLINICAL ANATOMICAL STUDY OF THE HAMSTRING TENDONS OF FEMALE CHINESE PATIENTS

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Abstract--- The purpose of this study was to evaluate the number of accessory bands of hamstring tendons of female subjects and find if there is any statistical relationship of the distance of gracilis and semitendinosus tendons from the tendons tibial crest insertion and total tendon length of gracilis and semitendinosus tendons. *Patients and Methods:* ***55 knees of female Chinese patients with ACL deficiency were included. The number of accessory bands and the distance of the most distal band from the tendon's tibial crest insertion were recorded intraoperatively.*** *Results:* ***In our study 38 accessory bands of gracilis tendons and 9 accessory bands of semitendinosus tendons were absent. Patients with shorter, lighter and lower BMI, tended to have less number of accessory bands. Gracilis tendons showed the biggest anatomical variability and none of the gracilis tendons had accessory band 3.*** *Conclusions:* ***We hope our study could make easier in the approach of harvesting of tendons during arthroscopic ACL surgery, mainly in those cases in which the female patients and hamstring tendons are the option of choice. We make sure that accessory bands of hamstring tendon do not originate at a distance of more than 11cm from the tendons tibial crest insertion.***

Key words: Accessory bands; anterior cruciate ligament; ligament reconstruction; hamstrings tendon

I. INTRODUCTION

ACL tears is believed to occur at an annual rate of incidence of thirty-five per 100,000 people of all ages [16] and the most common sports medicine procedures performed in the United States, numbering about 100,000 each year[9] . ACL injury is estimated to occur in 1 in 3000 people in the United States each year [10] and thus more than 100,000 ACL reconstructions are performed annually in the United States [5, 10]. Arthroscopic ACL reconstruction is a widely used technique [6, 20, 26] and the most commonly reconstructed ligament of the knee joint [3, 18]. The length of normal ACL is 3.8 cm (2.5–4.1 cm) and the width is 1 cm (0.7–1.2 cm) [18]. ACL injury is common in adult athletes[23] and can be seen with or without direct contact or in any position, from being flexed to fully extended of the knee [12]. Harvesting of both semitendinosus and gracilis tendons does not cause any clinical functional deficit [6, 13]. The main advantages of arthroscopic anterior cruciate ligament (ACL) reconstruction using a hamstrings tendon graft are its low donor side morbidity and provide strong autograft [1, 4, 6, 8, 11, 19, 21, 22, 24, 25]. As of our clinical experience, hamstring tendon accessory bands are not only highly variable but also present in both gracilis and semitendinosus tendons.

In the literature, there is little information that describes the characteristics of these accessory bands. The previous anatomical studies demonstrate that the formation of these accessory bands is not constant but that there may be variation in number, position or even in histological structure [14, 20]. The premature tendon rupture and failure to obtain adequate tendon length [2, 7, 15] could occur during the harvesting of gracilis and semitendinosus tendons which is an eyeless process involving the introduction of a stripper tendon through a small skin incision.

Having good anatomical knowledge to increase the quality of the ACL reconstruction through decreasing the failure of identification and release all accessory bands during tendon harvest. Thus, the aim of this study was to evaluate the number of accessory bands of hamstring tendons of female subjects and find if there is any statistical relationship of the distance gracilis and semitendinosus tendons from the tendons tibial crest insertion and total tendon length of gracilis and semitendinosus tendons.

II. MATERIALS AND METHODS

After obtaining approval from our university's research ethics committee, 55 Female Chinese patients with ACL deficiency scheduled to undergo arthroscopic anterior cruciate ligament reconstruction surgery using a hamstring tendon autograft between July 2012 and July 2014 were included in this study. The data was collected intra-operatively. The mean age of the patient was 22.22±4.75 years (range 16-35 years).

In all cases, the operation was performed by one surgeon and hamstring tendon was harvested for all cases. The skin incision was given 4-cm below the medial joint line and almost 1-cm medially to the tibial tuberosity. The gracilis and semitendinosus tendons were identified by incising sartorius fascia. The accessory bands of gracilis and semitendinosus tendons were harvested using a blunt dissection technique

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with a curved clamp. A closed blade tendon harvester (Smith and Nephew, USA) was used to obtain a reproducible length of the tendons. All accessory bands were identified and freed from their insertion and the origin. The number of accessory bands and the distance of the most distal band from the tendon's tibial crest insertion were recorded.

III. STATISTICAL ANALYSIS

The average mean, median number and range measurements of the semitendinosus tendons and gracilis tendons of the patients were analyzed. Bivariate correlation coefficients (Pearson r) were calculated to identify relationships among clinical data and intraoperatively measured data. The correlation of outcome variables and the predictor variables were analyze by using simple linear regression analysis. SPSS program version 19.0 (SPSS, Inc, Chicago, Illinois for Windows) was used for statistical analysis. A *P* value of 0.05 was set as the level of significance.

IV. RESULTS

The mean, standard deviation (SD) and range measurements of the patient are shown in Table 1.

Table 1: Mean Measurements of 55 patients

	Mean ±SD	Median	Range
Age (years)	22.22±4.756	22	16-35
Weight (kg)	57.22±5.262	56	44-70
Height (cm)	158.56±6.324	160	145-170
BMI (Body Mass Index) (kg/m²)	22.822±2.401	22.89	18.08-27.39
Number of Accessory Bands of ST	1.18±0.467	1	1-3
Number of Accessory Bands of GT	1.34±0.393	1	1-2
ST Distance (cm)*	6.22±2.812	4	3-11
GT Distance (cm)*	4.53±1.94	3	3-8
Total Length of ST (cm)	22.055±5.064	17	14-30
Total Length of GT (cm)	21.96±4.639	19	16-29

ST= Semitendinosus Tendon, GT= Gracilis Tendon
*** ST Distance and GT Distance = distance from the tendons tibial crest insertion**

The correlation coefficients are shown in Table 2.
Table 2: Pearson Correlation oefficients for Relationships between Clinical Data and Intraoperative Data.

Age (years)	**Weight (kg)**	**Height (cm)**	**BMI(kg/m²) (Body Mass Index)**
Number of Accessory Bands of Semitendinosus Tendon			
0.130	0.146	0.477*	-0.250
Number of Accessory Bands of Gracilis Tendon			
0.044	0.458*	0.272*	0.156
Semitendinosus Tendon distance from the tendons tibial crest insertion			
0.084	0.312*	0.701*	-0.276*
Gracilis Tendon distance from the tendons tibial crest insertion			
0.028	0.558*	0.391*	0.147
Total Length of Semitendinosus Tendon			
0.134	0.183	0.868*	-0.516*
Total Length of Gracilis Tendon			
0.086	0.269*	0.816*	-0.399*

*** P < .05**

Correlation analysis shows that women with shorter, lighter and lower BMI, tended to have less number of accessory bands and shorter distance of ST and GT from the tendons tibial crest insertion and shorter total tendon length of ST and GT. Thirty-eight GT had no accessory bands, fourteen GT had band 1, three GT had band 2, but no GT has band 3 (Fig.2).

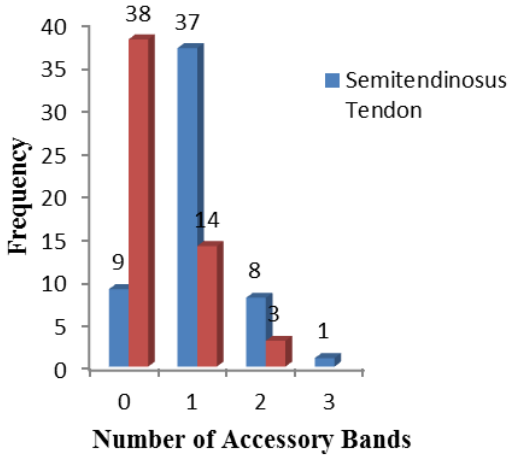

Fig. 2 The number of accessory bands of Semitendinosus and Gracilis Tendons in 55 patients.

Five GT had accessory bands originating at a distance of 6 to 8cm from the tendons tibial crest insertion.The total length of GT range from 16 to 29. Nine semitendinosus tendons had no accessory bands, thirty-seven ST had band 1, fourteen ST had band 2, eight ST had band 3, but only one ST had band. Sixteen ST had accessory bands originating at a distance of 9 to 11cm from the tendons tibial crest insertion (Fig.1).

Fig .1a Gracilis and Semitendinosus tendon with no accessory band

Fig .1b Gracilis and Semitendinosus tendon with accessory band 1

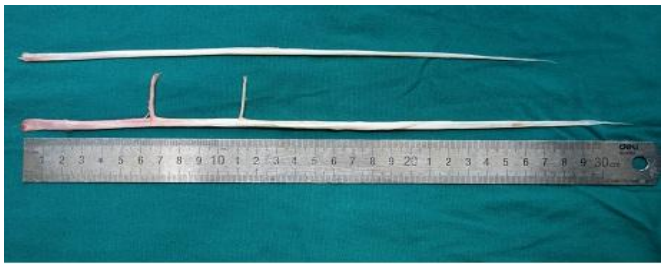

Fig .1c Gracilis tendon with no accessory band and Semitendinosus tendon with band 1

The total length of ST range from 14 to 30. Simple linear regression indicated that height was the best predictors for number of accessory bands of ST while height and weight for number of accessory bands of GT, height, weight and BMI were best predictors for distance of ST while height and weight were for distance of GT from the tendons tibial crest insertion and height and BMI were best predictors for total tendon length of ST while height, weight and BMI were for total length of GT. Simple linear regression analysis are shown in Table 3.

Table 3: Simple Linear regression results for Semitendinosus Tendon and Gracilis Tendon

	Regression Equation	R^2	T	*P*
Number of Accessory Bands of Semitendinosus Tendon (N)				
Age (years)	N=0 .640+0. 017 (years)	0.017	0.953	0.345
Weight (kg)	N=0.032+0. 017(kg)	0.021	1.071	0.289
Height (cm)	N=-6.430+0.047 (cm)	0.227	3.946	0.000
BMI (kg/m²)	N=2.498-0.065 (kg/m²)	0.062	-1.878	0.066
Number of Accessory Bands of Gracilis Tendon (N)				
Age (years)	N=0 .243+0.005 (years)	0.002	.320	0.750
Weight (kg)	N=-2.569+0.051 (kg)	0.210	3.750	0.000
Height (cm)	N=-3.655+0. 025 (cm)	0.074	2.059	0.044
BMI (kg/m²)	N=0.764+0.038(kg/ m²)	0.024	1.147	0.257
Semitendinosus Tendon distance from the tendons tibial crest insertion (N)				
Age (years)	N=3.843+0.061 (years)	0.007	0.613	0.542
Weight (kg)	N=-6.532+0.205 (kg)	0.097	2.389	0.021
Height (cm)	N=-55.655+0.384(cm)	0.492	7.161	0.000
BMI (kg/m²)	N=14.290-0.398 (kg/m²)	0.076	-2.093	0.041
Gracilis Tendon distance from the tendons tibial crest insertion (N)				
Age (years)	N=1.087+0. 014 (years)	0.001	0.207	0.837
Weight (kg)	N=-12.918+0. 250 (kg)	0.311	4.890	0.000
Height (cm)	N=-21.773+0. 146 (cm)	0.153	3.096	0.003
BMI (kg/m²)	N=-1.906-0. 145 (kg/m²)	0.022	1.084	0.283
Total Length of Semitendinosus Tendon				
Age (years)	N=18.883+0.1434 (years)	0.018	0.985	0.329
Weight (kg)	N=11.978+0.176 (kg)	0.033	1.355	0.181
Height (cm)	N=-88.179+0.695 (cm)	0.754	12.734	0.000
BMI (kg/m²)	N=46.900-1.089 (kg/m²)	0.266	-4.388	0.000
Total Length of Gracilis Tendon				
Age(years)	N=20.100+0. 084 (years)	0.007	0.628	0.532
Weight(kg)	N=8.402+0. 237 (kg)	0.072	2.032	0.047
Height (cm)	N=-72.984+0.599 (cm)	0.666	10.290	0.000
BMI (kg/m²)	N=39.539-0.770 (kg/m²)	0.159	-3.165	0.003

V. DISCUSSION

The most important findings of this study were thirty-eight accessory bands of gracilis tendons and nine accessory bands of semitendinosus tendons were absent. Patients with shorter, lighter and lower BMI, tended to have shorter length of ST and GT. For the gracilis tendon there were no accessory bands originating more than 8cm while semitendinosus tendons had accessory bands of 11cm from the tendon's tibial crest attachment. Semitendinosus is a more tendinous[6, 20] and thicker muscle than gracilis. Clinical anatomical differences and unaware of these accessory bands can cause diversion of the tendon harvester into the main tendon resulting in tendon rupture and inadequate tendon graft.

Having good knowledge of the accessory bands of hamstring tendons by the surgeon can increase the likelihood of safe harvesting and decrease pitfalls during arthroscopic ACL reconstruction surgery.

In the literature there is little information which describes the characteristics of the accessory bands of semitendinosus and gracilis tendons. Although many cadaveric studies describe the presence and location of such bands, to our findings no previous study has looked into this subject in vivo which evaluate the charcterstics accessory bands of female subjects. Moreover, our study was solemnly done on Chinese patients only. There may be a high risk of such errors as premature tendon amputation and inadequate graft length during the harvesting of these tendons, due to failure to identify and release all the accessory bands [2, 7, 15].

The differences between the hamstring tendons in terms of number, location, direction and consistency of the bands are related to the muscle function itself [20]. The presence of constant accessory band of semitendinosus is believe to be 77% [17] to 100% [6] of cases originating at a distance of 5–9 cm from the tibial crest[6]. The number of the accessory bands in the gracilis tendons showed great variability. The most common number of accessory bands in the gracilis tendons is two [6].

The findings of our study differ with those of [20], who reported that accessory bands of semitendinosus tendons presents at least one band and but never three bands. This dissimilarity in results may be due to the in vivo intraoperative findings of our study as compared to the cadaveric nature of the speciemens used in that study.

There are some limitations in this study. It must be noted that our study involved only female Chinese patients and subject in vivo not cadaveric studies. This limitation may have caused to the difference found between our study and [20]. Moreover it might be due to the sample difference between different nationalities. To adequately explain the difference requires a bigger sample.

VI. CONCLUSION

The results of this study demonstrate that hamstring tendons show variable numbers of bands. We make sure that accessory bands of ST and GT do not originate at a distance of more than 11cm from the tendons tibial crest insertion. The patients with lower height would have shorter length of ST and GT.

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CONFICT OF INTEREST

We declare no conflict of interest.

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