

ORIGINAL ARTICLE

Does patient weight and height correlate with the length and diameter of the semitendinosus graft?

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KEYWORDS

ACL reconstruction;
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Correlation weight;
Height

Abstract

Objective: To describe the correlation between the length and diameter of semitendinosus tendon (ST), and weight, height and age in Hispanic population.

Methods: Prospective study of a consecutive series of 61 patients that underwent anterior cruciate ligament (ACL) reconstruction with hamstrings; 40 (67.2%) males and 21 (32.8%) females. The average age was 28.3±10.2 years (range 17-55). In the operating room, length and diameter of ST folded in four bundles (ST4) were measured. Correlations were calculated using patient weight, height and age, including males and females and separating them by gender.

Results: Mean ST4 diameter: 9.0±1.3 mm. Males ST4 diameter: 9.3±0.8 mm; females ST4 diameter 8.3±0.6 mm (p<0.05). Average ST length: 28.1±3.4 cm. Males mean length 28.5±2.3 cm; females mean length 26.0±2.5 cm (p<0.05). Weight was correlated directly with ST length (c=0.47; p<0.001) and ST4 diameter (c=0.51; p<0.001). Patient height was directly correlated with ST length (c=0.57; p<0.001) and ST4 diameter (c=0.34; p=0.008). There was no correlation between patient age and tendon measurements.

Conclusion: A positive correlation was found between ST length and patient weight and height for the general population. A direct correlation was also observed between ST4 diameter and patient weight and height for the general population.

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PALABRAS CLAVE

Reconstrucción LCA;
Tendón semitendinoso;
Correlación;
Peso;
Talla

¿Existe correlación entre el peso y la talla del paciente con el largo y diámetro del injerto semitendinoso?**Resumen**

Objetivo: Describir correlación entre largo y ancho del tendón semitendinoso (ST) con peso, talla y edad en la población hispana.

Método: Estudio prospectivo de una serie consecutiva de 61 pacientes sometidos a reconstrucción del ligamento cruzado anterior (LCA) con tendones semitendinoso y gracilis; 40 varones (67,2%) y 21 mujeres (32,8%). La edad media fue de $28,3 \pm 10,2$ años (17-55). En pabellón se midieron el largo del ST y el diámetro del ST cuádruple (ST4). Se correlacionaron los hallazgos con peso, talla y edad, agrupando y separando por género, y se documentaron las diferencias entre variables.

Resultados: El diámetro medio del ST4 fue de $9,0 \pm 1,3$ mm, siendo en pacientes masculinos de $9,3 \pm 0,8$ mm y en pacientes de sexo femenino de $8,3 \pm 0,6$ mm ($p < 0,05$). La longitud media del ST fue de $28,1 \pm 3,4$ cm, siendo en pacientes masculinos de $28,5 \pm 2,3$ cm y en pacientes de sexo femenino de $26,0 \pm 2,5$ cm ($p < 0,05$). El peso se correlacionó positivamente con el largo ST (0,47, $p < 0,001$) y el diámetro ST4 (0,51, $p < 0,001$). Asimismo la talla del paciente se correlacionó positivamente con el largo ST (0,57, $p < 0,001$) y diámetro ST4 (0,34, $p = 0,008$). No se encontró correlación significativa entre la edad de los pacientes y las medidas del tendón estudiadas.

Conclusión: En el grupo general de pacientes estudiado existía una correlación positiva entre la longitud del ST con talla y peso del paciente. Asimismo, se objetivaba una correlación positiva entre el diámetro del ST4 con talla y peso del paciente.

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Introduction

Reconstruction surgery of the anterior cruciate ligament (ACL) with semitendinosus tendon (ST) and gracilis tendon (G) autografts is currently one of the most widespread procedures to overcome ACL insufficiency.¹⁻⁴ The advantages of the reconstruction technique using ST and G tendons include less morbidity at the donor site, lower incidence of pain in the anterior knee and better cosmesis, in comparison with other autograft techniques such as the patellar tendon or the quadriceps tendon.^{1,4,5}

In ACL reconstruction with ST and G tendons, different femoral and tibial fixation techniques are used, requiring different anatomical characteristics (length and diameter) of the hamstring grafts to be used. The anatomical characteristics of the ST and G tendons are key considerations when it comes to selecting the type of femoral or tibial fixation to be carried out.^{6,7}

The literature provides us with a dearth of studies reporting the anatomical characteristics of the ST and correlating outcomes with the patient's biotype. These studies have been reported in Caucasian or European populations.⁸⁻¹¹

At present, there are no descriptions in the literature documenting the anatomical characteristics of the ST tendon and correlating them with demographic data in the Hispanic population. Understanding the correlation between a patient's age, weight, and height and the length and diameter of the ST can be useful in order to anticipate the harvesting of a tendon of the proper diameter or length, aiding in the preoperative planning so as to choose other

autograft options or in order to have allografts available at the time of surgery.

The objective of this work was to describe the correlation between the length and width of the ST with age, weight, and height in the Hispanic population pooled and separated by gender.

The hypothesis of the study was that there is a positive correlation between the anatomical characteristics of the ST with patients' age, weight, and height.

Material and method

Over a 17-month period, we prospectively studied a consecutive series of 61 patients who underwent reconstruction of ACL with autograft ST and G tendons, using a single technique to harvest the grafts, performed by two surgeons. In the series, 41 cases were male (67.2%) and 20 were female (32.8%). The mean age at the time of the reconstruction was 28.3 ± 10.2 years (17-55).

All patients' weight in kilogrammes (kg) and height in metres (m) were documented just prior to surgery.

During ACL reconstruction, the technique used to obtain the grafts was the one described by Wolf;¹² at the distal end of the ST and G tendons, a Krackow-type suture was made,¹³ running 3 cm proximally, using Fiber Wire 2 suture (Arthrex®, Naples, FL, USA).

After harvesting the hamstring grafts, the length and diameter of the ST were measured on a side table with an Arthrex® soft tissue graft preparation and calibration board (Naples, FL, USA) with 0.5-mm increments between

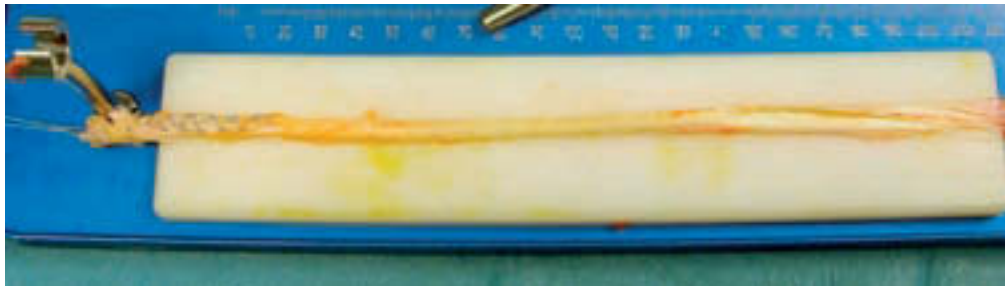


Figure 1 The ST tendon is seen on the graft preparation board with the Krackow-type suture on the distal end. The length is measured in cm.



Figure 2 Measuring the diameter of the ST folded in 4 with the soft tissue graft calibrator.

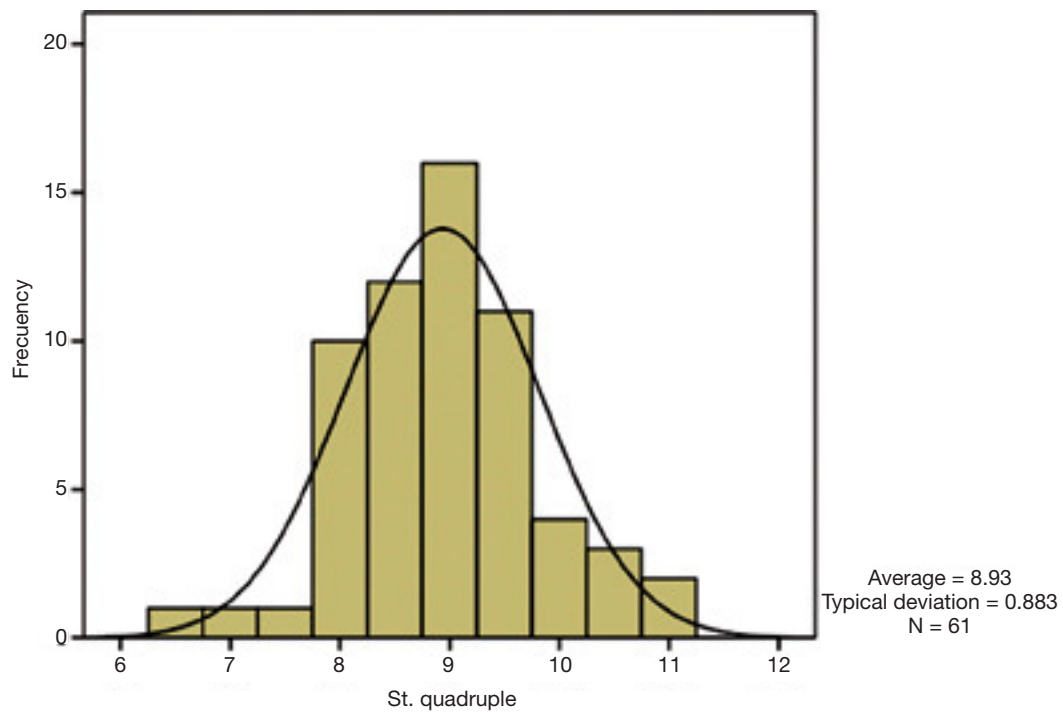


Figure 3 The normal distribution of the diameters of the quadruple ST tendon is shown. A diameter of between 8.0 and 9.5 mm was harvested in most cases.

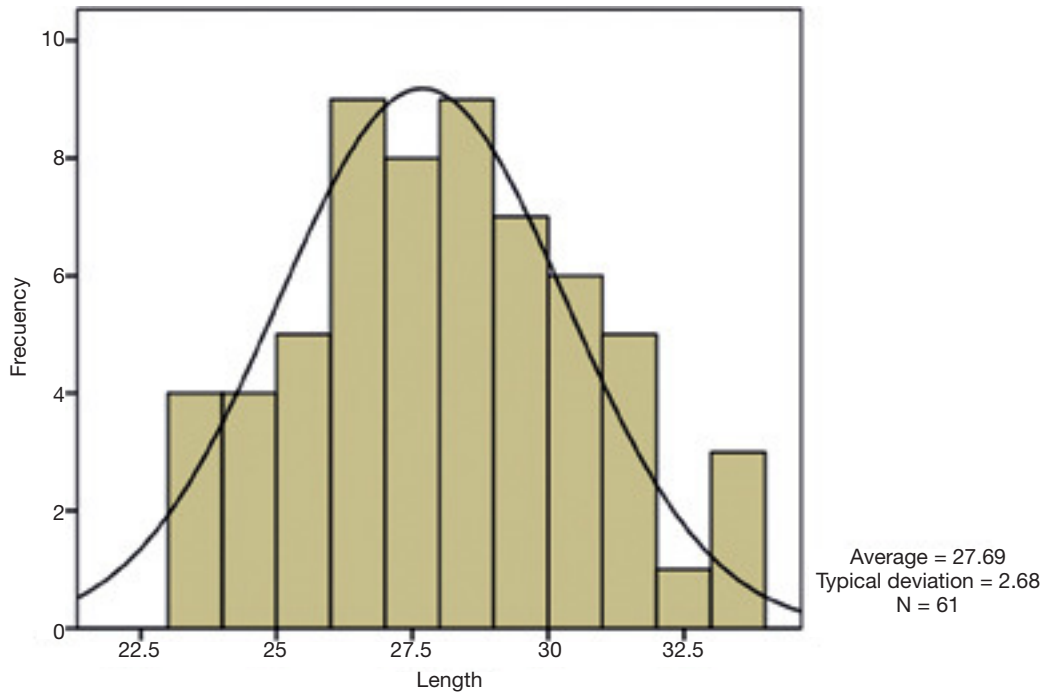


Figure 4 The ST tendon lengths are seen follow a normal distribution. In most cases, the measured length was between 26 and 30.5 cm.

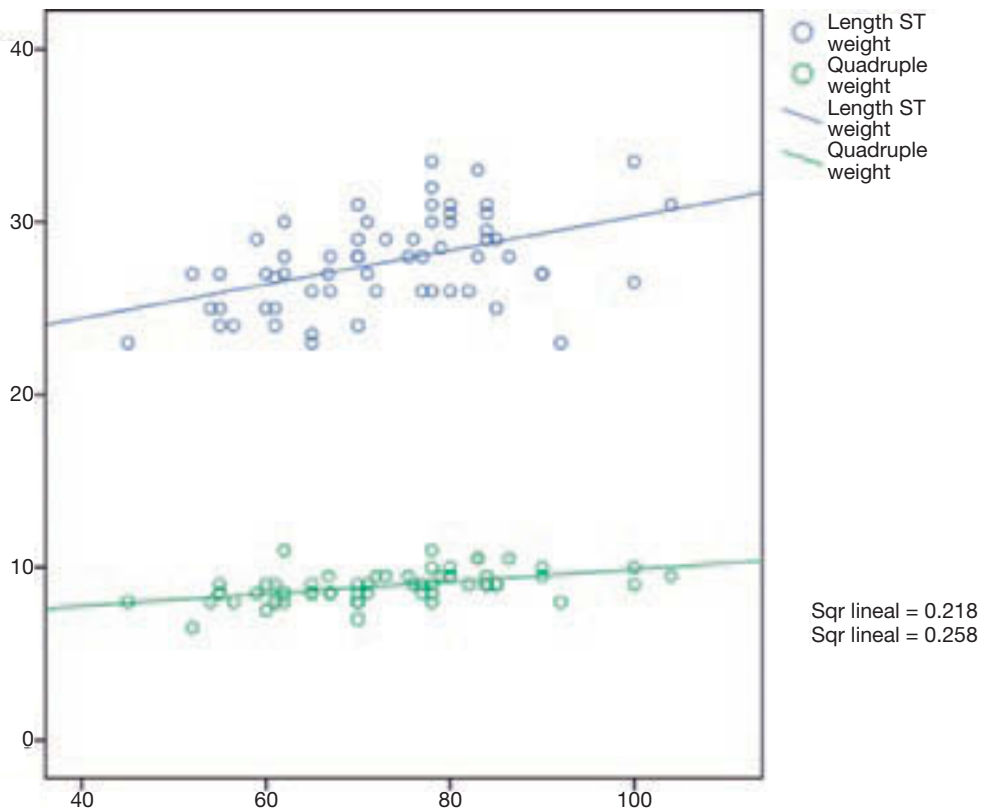


Figure 5 Scatter plots of the values of length and quadruple diameter of the ST tendon correlated with the patient's weight. A positive linear trend is evident in both cases.

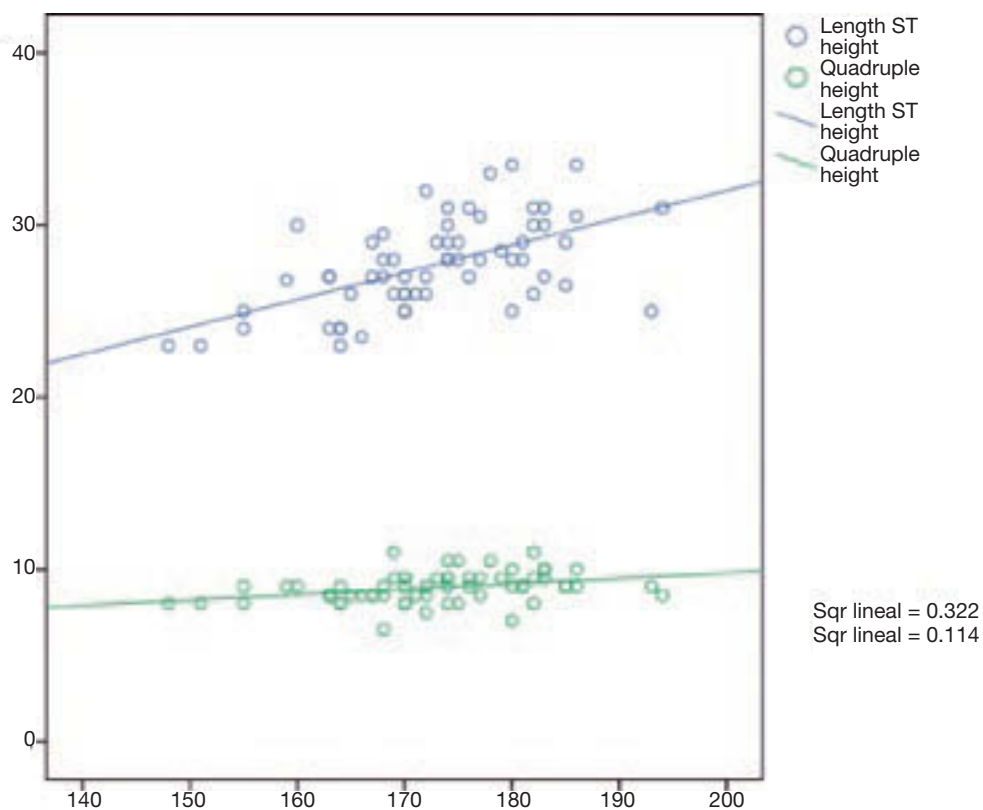


Figure 6 Scatter plots of the values of length and quadruple diameter of the ST tendon correlated with the patient's height. A positive linear trend is evident in both cases.

Table 1 Presents a comparison of the demographic data by gender, calculating the p value on the basis of an analysis of variance (ANOVA)

	Total	Male	Female	p Value
Weight (kg)	73.2±12.6	78.2±10.3	62.8±10.4	< 0.001
Height (m)	1.73±9.5	1.77±7.1	163.7±7.3	< 0.001
Length ST (cm)	28.1±3.4	28.5±2.3	26.0±2.5	< 0.001
Ø ST4 (mm)	9.0±1.3	9.3±0.8	8.3±0.6	< 0.001

Table 2 The Pearson's correlations and their respective p values are summarized for the variables of age, weight, and height, pooled and separated by gender

	All patients		Males		Females	
	Length ST	Ø ST4	Length ST	Ø ST4	Length ST	Ø ST4
Age						
Pearson's correlation	0.01	0.096	0.118	0.179	0.047	0.279
p value	0.909	0.464	0.469	0.238	0.844	0.233
Weight						
Pearson's correlation	0.467	0.505	0.313	0.281	0.21	0.271
p value	< 0.001	< 0.001	0.046	0.075	0.374	0.278
Height						
Pearson's correlation	0.568	0.338	0.335	0.004	0.516	-0.175
p value	< 0.001	0.008	0.032	0.98	0.02	0.46

measuring holes (figs. 1 and 2). The diameter was measured with the ST folded into 4 (ST4) (fig. 2). It was done in this way to facilitate measuring with the graft calibrator available in the operating theatre in all ACL reconstruction surgeries with ST and G tendons.

Statistical analysis

We conducted a correlation of our results using Pearson's correlation coefficient for random variables ($-1 < c < 1$), considering $p \leq 0.05$ as significant. The means were compared using ANOVA tables and Mann-Whitney for parametric and non-parametric variables; statistical significance was also determined as $p \leq 0.05$.

The sample size was calculated on the basis of a 95% interval (α error of 5% and 90% power (β error of 10%).

Results

The mean weight of our patients was 73.2 ± 12.6 kg (range: 46-118). The mean height was 1.73 ± 0.09 m (range: 1.48-1.93).

The mean diameter of the ST4 was 9.0 ± 1.3 mm (range: 7-12). The values behaved normally (fig. 3). In male patients, the ST4 diameter was 9.3 ± 0.8 mm and for female patients it was 8.3 ± 0.6 mm. The mean length of the ST was 28.1 ± 3.4 cm (range: 24-36), values that displayed a normal distribution (fig. 4). In male patients, the mean length was 28.5 ± 2.3 cm and in female patients, it was 26.0 ± 2.5 cm (table 1).

In the general group of patients, a positive or direct correlation of 47% was found between the patient's weight and the ST length ($c=0.47$; $p < 0.001$) and 51% between the patient's weight and the diameter of the ST4 ($c=0.51$; $p < 0.001$) (fig. 5). Similarly, the patient's height correlated positively with the length of the ST ($c=0.57$; $p < 0.001$) and the diameter of ST4 ($c=0.34$; $p=0.008$) (fig. 6). When a separate analysis was made by gender, the length of the tendon was documented to correlate directly with weight and height in male patients, whereas in the females, we only found a significant correlation between height and the length of the ST tendon (table 2).

Discussion

The main finding of this study is the direct correlation between the anthropometric measurements and the diameter and length of the semitendinosus tendon harvested. There are recent publications that examine the anatomical characteristics of hamstring tendons and relate the results with various patient characteristics.

Tuman et al.⁸ conducted a retrospective analysis of 106 cases and found a positive correlation between the ST4 diameter and patients' age and height, the latter parameter being the one that correlated to an important degree, particularly in women. These results differ from the ones we present in this study.

Fichler et al.⁹ evaluated the length and surface area of the cross-section of the ST and G tendons in 93 cadavers (43

males and 50 females). A significant relation was found between the length of the femur and the length of the ST only in women. The cause for this difference between genders was not identified.

In the publication by Ma et al.,¹⁰ which included 536 patients, the authors conclude that height and gender are the most relevant predictors of graft diameter and that age does not correlate with the diameter of the tendon, results that are in full agreement with those presented in this paper.

In another retrospective revision of 50 patients published by Treme et al.,¹¹ it was concluded that older women of short stature and young, thin males have a high risk of having a graft with a diameter of less than 7 mm.

The present study supports the finding of studies in other populations,⁹⁻¹¹ that have found that the diameter and length of hamstring grafts are directly related to weight and height and that they are also gender-dependent. This suggests that in female patients, with low body weight or short stature, there is a greater likelihood of harvesting a graft with insufficient diameter or length; in these cases it is important to have alternative autologous grafts or allograft available for augmentation or as the sole source.

One of the limitations of this work is the small number of female patients, which may have conditioned the finding that there were no significant differences between the weight and diameter of the ST4 variables in women.

In conclusion, in the sample studied, there is a positive correlation between the length of the ST and the patient's height and weight. Likewise, there is a positive correlation between the diameter of the ST4 and the patient's height and weight. There was no significant correlation between the age and the ST length and diameter measurements. In female patients, no correlation was found between weight and the diameter or length of the tendon.

Level of evidence

Case series without a control group. Level of evidence IV.

Conflict of Interest

The authors state that they have no conflict of interest.

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