

7-1-2013

Clinical measurement of patellar tendon: accuracy and relationship to surgical tendon dimensions.

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Recommended Citation

Zooker, Chad; Pandarinath, Rajeev; Kraeutler, Matthew J; Ciccotti, Michael G; Cohen, Steven B.; and Deluca, Peter F, "Clinical measurement of patellar tendon: accuracy and relationship to surgical tendon dimensions." (2013). *Rothman Institute*. Paper 32.

https://jdc.jefferson.edu/rothman_institute/32

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As submitted to:

The American journal of orthopedics.

And later published as:

**Clinical Measurement of patellar tendon: accuracy and relationship to
surgical tendon dimensions.**

Volume 42, Issue 7, pp. 317-20.

PMID: 24078943

Abstract

Patellar tendon width and length are commonly used for preoperative planning for anterior cruciate ligament (ACL) reconstruction. The purpose of this study was to examine the accuracy of measurements made by palpation through the skin preoperatively and correlate to the actual dimensions of the tendon at surgery. Length of the patellar tendon was measured at full extension and at 90 degrees of flexion and width was measured with the knee in 90 degrees of flexion prior to making incision in 53 patients undergoing ACL reconstruction with patellar tendon autograft. The tendon was then exposed and the width of the tendon was measured with the knee in 90 degrees of flexion. The length of the central third of the patellar tendon was measured after the graft was prepared. Mean patellar tendon length and width at 90 degrees of knee flexion were found to be 39 mm and 32 mm, respectively. No clinical difference was found between the estimated pre-incision and surgical width measurements. However, estimated pre-incision length at flexion and extension were found to be significantly shorter than the

surgical length. Skin measurements can be used to accurately determine patellar tendon width preoperatively, but measurements of length are not as reliable.

Introduction

Patellar tendon width and length are commonly measured in the clinical setting to determine its suitability for grafting for reconstruction of the anterior cruciate ligament (ACL)¹⁻³, posterior cruciate ligament (PCL)⁴⁻⁶, medial patellofemoral ligament (MPFL)⁷, and contralateral patellar tendon⁸. This estimation is an attempt preoperatively to ensure that the graft will have the appropriate width and also be neither too short nor too long.

There are several reasons why the preoperative assessment of patella tendon length and width are necessary when performing ACL reconstruction with bone-patellar tendon-bone (BPTB) autograft. Patellar tendon ruptures following ACL reconstruction with BPTB autograft is a rare complication reported only in a few case reports.⁹⁻¹¹ Having a preoperative evaluation of patella tendon width is important. If the patient's original patellar tendon is too narrow, the remaining portion of the tendon following removal of the central one-third the patient may be at higher risk for rupture upon return to strenuous physical activity.. In addition, evidence of patella alta or baja on preoperative x-ray can be indicators of a patella tendon which may shorter or longer than normal. A patellar tendon that is too long or too short may contribute to graft-tunnel length mismatch.^{12,13} In these settings an alternative graft choice may be indicated for ACL reconstruction.

Previous studies have used magnetic resonance imaging (MRI) to measure patellar tendon length prior to ACL reconstruction for this reason^{14,15}. For those patients with a digital MRI, it is easier and more accurate to perform MRI measurements. However, the accuracy is much lower for non-digital scans rendering it difficult for surgical planning for patients undergoing ACL reconstruction with a patellar tendon autograft. Thus, a quicker, more accessible, and cost-effective method of determining patellar tendon length preoperatively would certainly be valuable to orthopaedic surgeons using patellar tendon autografts.

The purposes of this study were (1) to examine the accuracy of measurements made by palpation through the skin preoperatively and correlate to the actual dimensions of the tendon at the time of surgery and (2) to determine the correlation between patellar tendon length and patient height, weight, and BMI. We hypothesized that (1) there would be a considerable difference between preoperative skin measurements and surgical measurements and (2) there would be no correlation between patellar tendon length and height, weight, or BMI.

Materials and Methods

Approval for this study was obtained from the Institutional Review Board (IRB). We prospectively identified 53 patients undergoing a primary ACL reconstruction with a patellar tendon autograft. Surgery was performed by one of two surgeons () between February 2010 and June 2011. During surgery, prior to making an incision, the width of the patellar tendon was measured with the knee in 90 degrees of flexion (Figure 1A) and the length was measured in full extension (Figure 1B) and at 90 degrees of flexion (Figure 1C). In order to standardize measurements, the distal pole of the patella and proximal edge of the tibial tubercle were used as landmarks. After exposing the patellar tendon, the width was measured with the knee in 90 degrees of flexion (Figure 1D). The actual length of the central third of the tendon was measured on the back table after the graft was prepared (Figure 1E). Tension was placed on the tendon during this measurement.

Pearson's correlation coefficient was used to determine linear dependence of surgical patellar tendon measurements to patient height, weight, and Body Mass Index (BMI). Paired student's t-tests were performed to determine significant differences between clinical and surgical measurements. A p-value less than 0.05 was considered significant.

Results

Mean age at the time of surgery was 19 years (range, 14-42 years). Thirty patients (30/53, 57%) were male. Mean patellar tendon width as measured before excision was 32 mm (range, 25-40 mm). Mean tendon length at full extension and 90 degrees of flexion were 36 mm (range, 26-50 mm) and 39 mm (range, 30-52 mm), respectively ($p < 0.001$).

Mean patellar tendon width and length after excision (surgical measurements) were found to be 33 mm (range, 26-40 mm) and 42 mm (range, 23-61 mm), respectively (Table 1). Surgical width measurements were found to be statistically greater than pre-excision widths ($p = 0.044$), though we do not believe the mean difference ($\Delta = 1.2$ mm) in these measurements is clinically significant. Patellar tendon length at full extension ($p < 0.001$) and 90 degrees of flexion ($p < 0.001$) were found to be significantly shorter than the surgical length.

Between the two surgeons, no significant differences were found in terms of mean tendon width or length, either pre-excision or surgical ($p > 0.05$). Furthermore, there were no significant differences with regard to the absolute differences between pre-excision and surgical width ($p = 0.80$) or length ($p = 0.33$) between surgeons.

Mean patient height, weight, and BMI were 173 cm (range, 158-191 in), 78 kg (range, 51-146 kg), and 25.6 kg/m^2 (range, $19.4\text{-}40.2 \text{ kg/m}^2$), respectively. Surgical patellar tendon width was found to be correlated weakly with patient height ($R^2 = 0.27$), weight ($R^2 = 0.13$), and BMI ($R^2 = 0.030$). Surgical patellar tendon length was also found to be correlated weakly with patient height ($R^2 = 0.066$), weight ($R^2 = 0.089$), and BMI ($R^2 = 0.065$).

Discussion

A quick and cost-effective method of determining patellar tendon length would be valuable for surgeons performing ACL reconstructions with patellar tendon autografts. Previous studies have used MRI^{14,15} and even standard radiographs¹⁶ with successful results. This technique, though precise, is not practical from a logistical or cost perspective. We postulated that a more accessible method such as using a ruler to measure over a patient's skin would be extremely worthwhile.

Measurements of patellar tendon width by palpation through the skin appear to be clinically similar to surgical width measurements. However, length with the knee in flexion or extension can significantly underestimate the surgical length of the tendon. A possible reason for the difference in patellar tendon length when palpated compared to after harvesting is that tibial tubercle bone may emanate or overhang proximally. These are important considerations when planning for procedures utilizing a patellar tendon autograft. Physicians should be familiar with these relationships ahead of time so that preoperative measurements of patellar tendon length are known to be an underestimation of the true tendon length and proper adjustments can be made. Patellar tendon width, while not as important during preoperative measurements, can be accurately assessed by palpation through the skin.

Patient height, weight, and BMI also should not be considered a reliable means of estimating patellar tendon length or width prior to surgery. Two previous studies^{17,18} have also noted poor correlation. Brown et al¹⁷ noted a weak positive association between patient height and patellar tendon length using MRI for tendon measurements. Furthermore, these authors showed no correlation between patellar tendon length and intra-articular ACL length. Yoo et al¹⁸ also used MRI to measure patellar tendon length and found no significant associations between the length and patient height, weight, or BMI. Coefficient of determination (R^2) values for these relationships ranged from 0.015 to

0.061. Goldstein et al¹⁵, however, did show a correlation between patient height, gender, and patellar tendon length using MRI for measurements. However, this study grouped patient height into 4-inch height increments rather than using a single height value for each patient.

Strengths of this study include the use of two experienced surgeons as well as the wide range of body types. The limitations of this study should also be noted. In particular, MRIs were not collected and thus we were unable to compare MRI measurements of patellar tendon length to skin measurements.

Based on the results of this study, patellar tendon width can be accurately determined preoperatively, but measurements of length are not as reliable. Patient height and weight should also not be considered a reliable means of estimating patellar tendon length prior to surgery. We recommend utilizing clinical measurements for tendon width and potentially using MRI measurements when possible for length assessment.

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Figure Legends

1. Patellar tendon measurements. Measurements were made of (A) width preoperatively with the knee in 90 degrees of flexion,(B) length preoperatively in full extension,(C) length preoperatively at 90 degrees of flexion, (D) width perioperatively with the knee in 90 degrees of flexion, and (E) length on the back table after the graft was prepared.

Table Legends

1. Patellar tendon measurements. Provided are the skin measurements for width and length in flexion and extension, as well as surgical measurements of width and length. The last two columns represent differences between skin and surgical measurements. All measurements are in millimeters. *NM = not measured