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Research Article

Hamstrings Graft Harvesting: Where Should be the Incision? Anatomical Landmarks Based on Magnetic Resonance Imaging

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Abstract

Objective: The objective of the present study was to standardize the surgical approach for hamstring graft harvesting, with location of the center of the incision based on anatomical parameters and using data from a selection of magnetic resonance images of the knee.

Method: This study analyzed 40 magnetic resonance images of the knee (20 men and 20 women). The parameters measured were: longitudinal distance from the proximal border of the pes anserinus to the femorotibial joint in the coronal section (PA-JOINT); transverse distance from the lateral border of the pes anserinus to the medial border of the anterior tibial tuberosity in the axial section (PA-ATT); and ratio between the distance from the proximal border of the pes anserinus to the femorotibial joint (PA-JOINT) and the largest transverse width of the tibial plateau (WIDTH PLATEAU).

Results: According to the analysis, the location of the center of the incision was estimated to be 4.0 cm distally to the femorotibial joint (PA-JOINT) and 2.5 cm medially to the anterior tibial tuberosity (PA-ATT). There was a strong intra-observer and regular inter-observer correlation for these measurements.

Conclusion: With the precise determination of the incision center, it is possible to standardize an accurate and reproducible surgical approach for hamstring graft harvesting.

Keywords: Hamstring Graft; Autologous Graft; Surgical Approach; Ligament Reconstruction; Knee Surgery

Introduction

Hamstring tendon graft harvesting has been increasingly used for knee ligament and particularly anterior cruciate ligament reconstruction, as this ligament is one of the most frequently injured in sports, with an estimated number of 300,000 cases per year in the USA [1,2]. Several advantages of this approach have been described in relation to the harvesting of other autologous graft options, such as patellar or quadriceps tendon[3]. They include lower rates of anterior knee pain, avoidance of damage to the extensor mechanism, less donor site morbidity, more versatility during graft preparation and smaller incision size [3,4].

However, the step by step of the surgical technique is inconsistent in the literature as to the location, direction and size of the incision [5,6]. Inadequate surgical approach can cause complications, with significant influence in the clinical and functional outcomes of surgeries that require this procedure of graft harvesting [7]. Such complications involve extensive soft-tissue injury - especially in case of incorrect topographic evaluation of the pes anserinus, surgical wound infections, dysesthesias or neuromas due to iatrogenic injury to the infrapatellar branch of the saphenous nerve, hematoma formation, laceration and decreased strength of the harvested graft, and need for surgical reintervention [3-12].

In order to minimize the incidence of the abovementioned complications, it is necessary to standardize an accurate and effective surgical approach based on well-established anatomical parameters in order to allow the optimization of technical performance, as well as education and training of young knee surgeons [13,14]. This work aims to determine such parameters using data from a selection of magnetic resonance images of the knee to locate the center of the surgical incision and describe the standardized step by step of technique for hamstring graft harvesting.

Patients and Methods

Forty magnetic resonance images of the knee (20 men and 20 women) obtained from the database of patients under outpatient care for knee surgery were analyzed, with a mean age of 35 ± 11.6 years (minimum = 17; maximum = 61). Magnetic resonances of skeletally mature knees with preserved integrity of hamstring tendons and pes anserinus were selected at random. We have not included patients with bone deformities or with a history of previous ligament surgery. Coronal and axial views were analyzed. In each magnetic resonance image, the insertion site of the pes anserinus and other anatomic landmarks were identified, and the following parameters were measured and calculated:

- Longitudinal distance from the proximal border of the pes anserinus insertion to the femorotibial joint in the coronal section (PA-JOINT - figure 1);
- Transverse distance from the lateral border of the pes anserinus insertion to the medial border of the anterior tibial tuberosity in the axial section
- Ratio between the distance from the proximal border of the pes anserinus to the femorotibial joint and the greatest transverse width of the tibial plateau

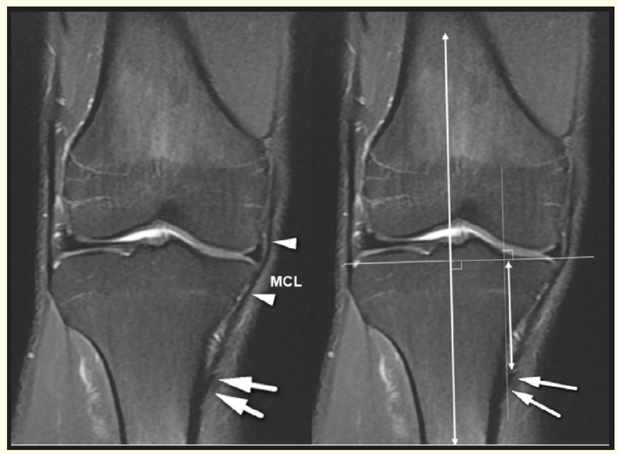

Figure 1: PA-JOINT measurement:

After identification of the pes anserinus in the coronal section, the long axis of the tibial shaft was delineated and the PA-JOINT distance was measured from the proximal border of the pes anserinus to the femorotibial joint parallel to the long axis of the tibia. White arrows are pointing to pes anserinus insertion. MCL and white arrows heads - medial collateral ligament.

Distances were measured using the Horos® image software and the obtained values were registered in an Excel database spreadsheet. Only the study researchers had access to the patients' information and identity. Measurements were taken by three different observers on two separate occasions with an interval of two weeks. The data were processed in the SPSS 11.1 software and submitted to statistical analysis to calculate the intra- and inter-observer confidence intervals. The center of the incision was estimated using the femorotibial joint and the anterior tibial tuberosity as anatomical reference, based on the average PA-ATT and PA-JOINT distances. After determining the location of the center of the incision, a literature review of relevant described techniques and anatomy was made to determine the direction and length of the incision. A step by step standardized technique description was proposed.

Statiscal analyses

The Kolmogorov-Smirnov test was used to evaluate the intrinsic parameters of the sample for normality and distribution. Data were expressed as mean ± standard deviation (SD), and percentages (SPSS Statistical software).

The variables were analyzed descriptively through mean ± SD, minimum and maximum values, and 95% confidence intervals. The study of the difference between the means of two variables was established by the Student's t-test or Mann-Whitney test when normality was rejected. For multivariate analysis, ANOVA with Turkey post-hoc test was used. Correlations were tested using the Pearson or Spearman correlation coefficient. The level of significance used for the tests was 5%.

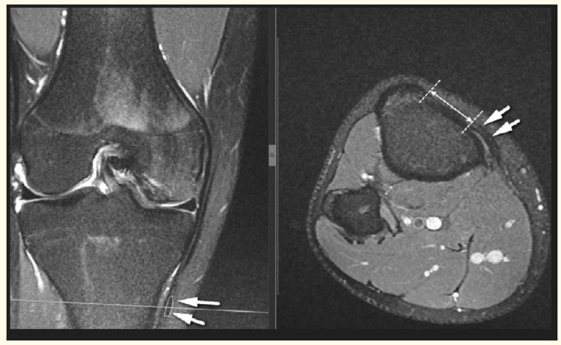

Figure 2: PA-ATT measurement

Using the 3D MPR reconstruction feature of the Horos® software, the pes anserinus was identified in the coronal section and the reference axis was positioned. This reference axis was used to identify the topography of the pes anserinus in the axial sections. The anterior tibial tuberosity (ATT) was then identified in the axial section (edge of the insertion of the patellar ligament), and the distance from the medial border of the ATT to the pes anserinus was calculated. White arrows are pointing to pes anserinus insertion.

Results

There were no significant differences or bias due to age, laterality or gender ($p = 0.481$), as shown in table 1.

Gender	Frequency	Percentage	Laterality	Frequency	Percentage
F	20	50	RIGHT	19	46.3
M	20	50	LEFT	21	51.2
Total	40	100.0	Total	40	100.0

Table 1: Representation of frequency of patients according to gender and laterality.

Distance from the pes anserinus to the femorotibial joint (PA-Joint)

According to the analysis carried out, the location of the center of the pes anserinus (and therefore the center of incision) was estimated to be 4.0 cm distally to the femorotibial joint. The means ± SD of PA-JOINT measurements are shown in figure 3 and the intra- and inter-observer confidence intervals are shown in figure 4.

Figure 3: Mean ± SD of PA-JOINT measurements.

Figure 4: Intra and inter-observer confidence interval for PA-JOINT measurements.

Distance from the pes anserinus to the anterior tibial tuberosity (PA-ATT)

It was estimated that the center of the incision was located 2.5 cm medially to the anterior tibial tuberosity. The means ± SD of PA-ATT measurements are shown in figure 5 and the intra- and inter-observer confidence intervals are shown in figure 6.

Figure 5: Mean ± SD of PA-ATT measurements.

Figure 6: Intra- and inter-observer confidence intervals for PA-ATT measurements.

Ration between the greatest width of the tibial plateau (Width Plateau) and distance from the pes anserinus to the femorotibial joint (Pa-Joint)

According to the analysis, the PA-JOINT distance was estimated to be approximately 50% of the WIDTH PLATEAU distance, that is, the distance from the pes anserinus to the articular line was approximately half the width of the tibial plateau. This data can be an additional anatomical parameter for planning the surgical approach. The means ± SD of the largest width of the tibial plateau (WIDTH PLATEAU) are shown in figure 7. The means ± SD of the PA-JOINT/WIDTH PLATEAU ratios in percentage are shown in figure 8.

Figure 7: Mean ± SD of WITDH PLATEAU measurements.

Figure 8: Percentage means ± SD of PA-JOINT/WITHD PLATEAU ratios.

Discussion

There are several studies describing different sites and positions for the incision for hamstrings graft harvesting, but there is no consensus on best location. Even the most used books by knee surgeons present divergences in this respect. Pinczewski., *et al*. [5] suggest that an oblique 2-cm-long incision should be made at 1 cm medially and between 1 and 3 cm distally to the ATT. Miller and Frederick., *et al*. [6], on the other hand, suggest an incision of 4 cm anteromedially on the tibia, starting approximately 4 cm distal to the articular line and 3 cm medial to the ATT. According to the data obtained in the present investigation, we suggest that the center of the incision be made 4 cm distally to the femorotibial joint and 2.5 cm medially to the ATT. As for the length of the incision, we adopted 3 cm (1.5 cm proximal and 1.5 cm distal to the center of the incision) as standard, just enough to allow adequate exposure without excessive retraction and damage to the soft tissues.

Another controversy is related to the direction of the incision (vertical, oblique or horizontal). Campos., *et al*. [15] evaluated the preference of surgeons for hamstrings tendon harvesting. They observed that 71.4, 25 and 3.6% of the participants were performing vertical, oblique and horizontal incisions, respectively. Grassi., *et al*. [16]. observed in their meta-analysis a significantly higher risk of injury to the infrapatellar branch of the saphenous nerve with the vertical incision compared to the oblique and horizontal incision. However, there was no influence on the clinical outcome and patient satisfaction. Henry., *et al.* [17] recommended avoiding a vertical incision to prevent nerve injuries and favored making an oblique incision to minimize this complication. In order to avoid injury to the infrapatellar branch in the saphenous nerve, we also suggest making an oblique incision with 45 degrees of inclination.

In studies addressing the surgical approach in question, no scientific evidence or specific recommendations were found about other technical steps that we find to be somewhat important. Therefore, the stages of dissection of subcutaneous tissue, incision of the sartorius fascia, clamping of tendons, identifying adjacent tendon vincula, harvesting, and sectioning of grafts will be described as recommended in the literature most used by knee surgeons [5].

Step by step of the surgical technique

- **Location of the center of the incision:** according to our study, based on the PA-JOINT and PA-ATT mean distances, the center of the incision is located 4.0 cm distally to the femorotibial joint and 2.5 cm medially to the anterior tibial tuberosity.
- **Incision:** in order to avoid injury to the infrapatellar branch of the saphenous nerve[17], a 3-cm-long oblique incision is made at 45 degrees in relation to the joint (1.5 cm proximally and 1.5 cm distally to the center of the incision). The incision should go from proximal and posterior to distal and anterior.
- **Subcutaneous:** the subcutaneous dissection with appropriate cauterization of the interposed vessels is made up to the depth of the sartorius fascia.
- **Incision of the sartorius fascia:** in this plane, palpation of the pes anserinus tendons is feasible over sartorius fascia; thus, an incision is made with a cold blade in the direction of the tendons immediately proximal to them in the sartorius fascia (Figure 10).
- **Clamping of hamstring tendons:** by means of retracting the sartorius fascia with a Langenbeck or Farabeuf retractor, tendons are identified and, by using a Mixter forceps, rotating it from the tibia to the fascia, the gracilis and then the semitendinosus tendons are identified and isolated (Figure 9).
- **Sectioning of tendon vincula:** tendons are pulled with aid of the Mixter forceps, and peritendinous connections (vincula) are sectioned, thus releasing the tendons A closer view of a vincula is depicted in the small box of figure 10.

Figure 9: Retrieving of gracilis tendon by using a small Mixer forceps, after longitudinally opening the sartorius fascia.

Figure 10: Close view of the semitendinosus tendon and its vincula.

- **Tendon harvesting:** Tendons of the gracilis and semitendinosus muscles are then harvested with appropriate length (about 20 cm) by using specific instruments (tendon “strippers”). Proximal muscle detachment of the tendons is performed; distal insertions are sectioned with Mayo scissors or cold blade.

Our study emphasizes a logical step-by-step technique in a standardized fashion based on easily identifiable landmarks and confirmed by magnetic resonance image analyses of distances and references. By doing this, we potentially avoid pitfalls and complications due to inadequate technique of graft harvesting. However, we may still find difficulties in large or obese patients, where landmarks are not promptly recognized. Another limitation of our study is that we did not consider anatomical variation that we may find in this region, although they are not frequent.

Conclusion

The analysis of the magnetic resonance images of knees with intact anatomy allowed us to standardize an accurate and reproducible surgical approach for hamstring graft harvesting taking the femorotibial joint and the anterior tibial tuberosity as anatomical references. The statistical analysis determined that the center of the incision is located 4 cm distal to the femorotibial joint and 2.5 cm medial to the anterior tibial tuberosity. We recommend a 3 cm-long-incision with 45 degrees of obliquity.

Another anatomical parameter evaluated in the study is the distance from the pes anserinus distally to the femorotibial joint, which corresponds approximately to half the width of the tibial plateau.

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Bibliography

1. Salmon L., *et al*. “Incidence and risk factors for graft rupture and contralateral rupture after anterior cruciate ligament reconstruction”. *Arthroscopy: The Journal of Arthroscopic and Related Surgery* 21.8 (2005): 948-957.
2. Hewett TE., *et al*. “Current concepts for injury prevention in athletes after anterior cruciate ligament reconstruction”. *American Journal of Sports Medicine* 41.1 (2013): 216-224.
3. Hardy A., *et al*. “Complications following harvesting of patellar tendon or hamstring tendon grafts for anterior cruciate ligament reconstruction: Systematic review of literature”. *Orthopaedics and Traumatology: Surgery and Research* 103.8 (2017): S245-S248.

4. Shelbourne KD., *et al*. "Return to sports and subsequent injury rates after revision anterior cruciate ligament reconstruction with patellar tendon autograft". *The American Journal of Sports Medicine* 42.6 (2014): 1395-1400.
5. Pinczewski L., *et al*. "Sports Knee Rating Systems and Related Statistics. In: Insall and Scott Surgery of the Knee". 6th edition. Elsevier (2018): 396-400.
6. Miller RH and Frederick MA. "Knee Injuries". In: Campbell's Operative Orthopaedics". 12th edition. Elsevier (2012): 2147-2149.
7. Ruffilli A., *et al*. "Saphenous nerve injury during hamstring tendons harvest: Does the incision matter? A systematic review". *Knee Surgery, Sports Traumatology, Arthroscopy* 25.10 (2017): 3140-3145.
8. Alomar AZ., *et al*. "Hamstring autografts are associated with a high rate of contamination in anterior cruciate ligament reconstruction". *Knee Surgery, Sports Traumatology, Arthroscopy* 26.5 (2018): 1357-1361.
9. Murphy MV., *et al*. "Risk Factors for Surgical Site Infections Following Anterior Cruciate Ligament Reconstruction". *Infection Control and Hospital Epidemiology* 37.7 (2016): 827-833.
10. Sipahioglu S., *et al*. "Injury of the infrapatellar branch of the saphenous nerve due to hamstring graft harvest: A prospective comparative study of two different incisions". *Journal of Orthopaedic Surgery* 25.1 (2017).
11. Phegan M., *et al*. "No infections in 1300 anterior cruciate ligament reconstructions with vancomycin pre-soaking of hamstring grafts". *Knee Surgery, Sports Traumatology, Arthroscopy* 24.9 (2016): 2729-2735.
12. Leadbette WB. "Complications and Pitfalls in Reconstruction of Cruciate Ligaments. In: Malek MM, ed". *Knee Surgery: Complication, Pitfalls and Salvage*. Springer US (2000): 14-21.
13. Dujardin D., *et al*. "Muscle recovery after ACL reconstruction with 4-strand semitendinosus graft harvested through either a posterior or anterior incision: A preliminary study". *Orthopaedics and Traumatology: Surgery and Research* 101.5 (2015): 539-542.
14. Lanternier H., *et al*. "Short medial approach harvesting of hamstring tendons". *Orthopaedics and Traumatology: Surgery and Research* 102.2 (2016): 269-272.
15. De Campos GC., *et al*. "Current panorama of anterior cruciate ligament reconstruction surgery in Brazil". *Acta Ortopedica Brasileira* 27.3 (2019): 146-151.
16. Grassi A., *et al*. "Association between incision technique for hamstring tendon harvest in anterior cruciate ligament reconstruction and the risk of injury to the infra-patellar branch of the saphenous nerve: a meta-analysis". *Knee Surgery, Sports Traumatology, Arthroscopy* 26.8 (2018): 2410-2423.
17. Henry BM., *et al*. "Oblique incisions in hamstring tendon harvesting reduce iatrogenic injuries to the infrapatellar branch of the saphenous nerve". *Knee Surgery, Sports Traumatology, Arthroscopy* 26.4 (2018): 1197-1203.