Acta Orthopaedica et Traumatologica Turcica 51 (2017) 100–103

Contents lists available at ScienceDirect

Acta Orthopaedica et Traumatologica Turcica

journal homepage: https://www.elsevier.com/locate/aott

Pain level after ACL reconstruction: A comparative study between free quadriceps tendon and hamstring tendons autografts

Cristian Tudor Buescu [a], Adela Hilda Onutu [b], Dan Osvald Lucaciu [a], Adrian Todor [a, *]

[a] Iuliu Hatieganu University of Medicine and Pharmacy, Department of Orthopedics, Traumatology and Pediatric Orthopedics, Cluj Napoca, Cluj, Romania
[b] Cluj Emercency County Clinical Hospital, Anesthesiology Department of Orthopedics Clinic, Cluj Napoca, Romania

ARTICLE INFO

Article history:
Received 21 February 2016
Received in revised form
12 May 2016
Accepted 2 September 2016
Available online 27 February 2017

Keywords:
ACL reconstruction
Pain
Hamstring tendons
Free quadriceps tendon

ABSTRACT

Objective: The objective of this study was to compare the pain levels and analgesic consumption after single bundle ACL reconstruction with free quadriceps tendon autograft versus hamstring tendon autograft.
Patients and methods: A total of 48 patients scheduled for anatomic single-bundle ACL reconstruction were randomized into two groups: the free quadriceps tendon autograft group (24 patients) and the hamstring tendons autograft group (24 patients). A basic multimodal analgesic postoperative program was used for all patients and rescue analgesia was provided with tramadol, at pain scores over 30 on the Visual Analog Scale. The time to the first rescue analgesic, the number of doses of tramadol and pain scores were recorded. The results within the same group were compared with the Wilcoxon signed test.
Results: Supplementary analgesic drug administration proved significantly higher in the group of subjects with hamstring grafts, with a median (interquartile range) of 1 (1.3) dose, compared to the group of subjects treated with a quadriceps graft, median = 0.5 (0.1.25) ($p = 0.009$). A significantly higher number of subjects with a quadriceps graft did not require any supplementary analgesic drug (50%) as compared with subjects with hamstring graft (13%; Z-statistics = 3.01, $p = 0.002$). The percentage of subjects who required a supplementary analgesic drug was 38% higher in the HT group compared with the FQT group.
Conclusion: The use of the free quadriceps tendon autograft for ACL reconstruction leads to less pain and analgesic consumption in the immediate postoperative period compared with the use of hamstrings autograft.
Level of Evidence: Level I Therapeutic study
© 2017 Turkish Association of Orthopaedics and Traumatology. Publishing services by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

Primary anterior cruciate ligament (ACL) reconstruction is a well-known and researched topic due to its social and economic implications. One of the aspects that still raises controversy is the type of graft used for reconstruction. Lately, the use of the quadriceps tendon as an autograft option is increasing because it has proved to be a versatile graft with low morbidity at the harvest site.[1,2] Still, the most commonly used autografts for ACL reconstruction are the bone-patellar tendon-bone (BPTB) and hamstring tendons (HT). There is some evidence to suggest that BPTB autografts produce more pain than HT autografts both in the immediate postoperative period as well as in the long term.[3] A 10-year follow-up study by Pinczewski et al compared the pain outcomes in patients that received either a BPTB or HT autograft.[4] Harvest site symptoms such as tenderness, irritation, and numbness were significantly more common in the BPTB patients.[3,4] HT autograft is usually recognized to produce the least donor site morbidity, especially compared with the BPTB.[3] As compared to HT and BTB autografts, literature data is limited in terms of the free quadriceps tendon (FQT) graft morbidity and pain following its use for ACL reconstruction in the acute postoperative phase.

The objective of this study was to compare the pain levels and analgesic consumption after single bundle ACL reconstruction with a FQT autograft versus a HT autograft in the immediate postoperative phase.

* Corresponding author.
E-mail address: adi.todor@yahoo.com (A. Todor).
Peer review under responsibility of Turkish Association of Orthopaedics and Traumatology.

http://dx.doi.org/10.1016/j.aott.2017.02.011
1017-995X/© 2017 Turkish Association of Orthopaedics and Traumatology. Publishing services by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Patients and methods

Patients and randomization

We designed a prospective longitudinal randomized parallel clinical trial, which took place between October 2013 and May 2015 in our department. The study was approved by our University's ethics committee (298/28.07.2014). After signing informed consent for participation in the study 48 patients scheduled for ACL reconstruction were included.

The inclusion criteria were: patients between 16 and 50 years with a documented ACL tear scheduled for arthroscopic reconstruction, willing to participate in the study.

Exclusion criteria were: patients with associated meniscus tears requiring suture repair, associated ligamentous lesions that required surgical management, previous surgeries on the same knee, patients with chronic pain, hepatic impairment, alcoholics, drug abusers, any analgesic use within 14 days of admission as well as those who refused to participate in the study.

The patients were admitted 24 h before the surgery and no analgesics were administered in this period. The 48 patients were randomized in one of the two groups in the morning of the surgery using free randomization software from Sealed Envelope[5] to arthroscopic ACL reconstruction with FQT (n = 24) or HT (n = 24).

Surgical technique

All surgeries were performed by the same surgeon (AT) and the same surgical technique was used except for the graft harvest. We performed arthroscopic anatomic single-bundle ACL reconstruction, placing the tunnels in the center of the footprints both on the femur and on the tibia, using a three portal technique.[6,7] We used extracortical button femoral fixation and bioabsorbable interference screw tibial fixation in every case. The FQT graft was harvested through a 4 cm median longitudinal incision, using a No. 10 blade to establish the depth and a clean cut at the apex of the patella to release the tendon.[8] The HT graft was harvested in the classical manner through a 3 cm antero-medial longitudinal incision taking care not to damage the infrapatellar branch of the saphenous nerve.[9]

All patients received spinal anesthesia and no other peripheral nerve block was associated. Spinal anesthesia was induced in lateral or sitting position with 15–20 mg 0.5% spinal plain bupivacaine, at the L2–L3 intervertebral space, using pencil-point 25–27 G spinal needles.

Postoperative pain evaluation and management

A multimodal analgesic postoperative regimen was started 1 h after completion of surgery and consisted of acetaminophen (Paracetamol, Terapia-Ranbaxy, Cluj-Napoca, Romania) 500 mg per os (po) and ketorolac tromethamina (Ketorol, Dr. Reddy's Lab. (UK) LTD.) 15 mg intravenous (iv) every 8 h, for the first 48 postoperative hours. Rescue analgesia was provided with tramadol (Aliud® Pharma GmbH & Co. KG, Gottlieb-Daimler-Str. 19, D-89150 Laichingen, Germany) 30 mg iv bolus when patients declared pain scores of 30 or more on the Visual Analog Scale (VAS).

Postoperative pain intensity was evaluated using the Visual Analog Scale, ranging from 0 to 100, with 0–30 considered mild pain, 30 to 70 moderate pain and over 70, severe pain.

Time to the first rescue analgesic requirement, the number of doses of tramadol and the pain score were recorded. The postoperative period was split three-way (first 12 h postop, 13–24 h postop, 25–48 h postop). In the first 24 h the pain was recorded with the patients in bed-rest and, in the third period, in-between exercises.

All patients underwent the same hospital stay regime and were discharged on day 3 after surgery. On day 1 after surgery the wounds were inspected and drain removed. All local complications were noted (swelling, redness, numbness or any other local symptoms). All patients were encouraged to ambulate with axillary support with toe touch weight bearing for bathroom privileges only on day one after surgery and as tolerated from day 2 on. All the patients were advised to keep the knee in full extension throughout the day, except for 15 min of passive flexion exercises 3 times a day.

All procedures performed were in accordance with the ethical standards of the institutional and/or National Research Committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Statistical analysis

Parametric data were expressed as mean ± standard deviation (SD) and categorical data as median [interquartile range (IR)].

The median values and interquartile range are presented for each group. The results within the same group were compared with Wilcoxon signed test. Differences less than 0.05 were considered statistically significant when two groups were compared. Statistical analysis was performed by using R version 2.15.1 software[10] (R Core Team, Vienna, Austria).

Results

48 subjects were included in the study and half of them were treated with a FQT graft and the other half with a HT graft. The majority of subjects included in the study were male patients (M:F = 3.8), the difference between the percentage of male and female being statistically significant ($p < 0.0001$). The mean age of subjects included in the study was 28.35 ± 7.19 years. No significant difference was registered between genders regarding the age (M: 28.82 ± 6.35 years; F: 26.60 ± 9.98 years; $p = 0.391$) or between treatment groups (FQT: 29.21 ± 8.52 years; HT: 27.50 ± 5.62 years; $p = 0.416$). Also, no significant difference was registered regarding the body mass index (BMI) between treatment groups (FQT: 26.27 ± 4.85; HT: 25.68 ± 3.32; $p = 0.6232$).

The median number of the supplementary analgesic drug administration (tramadol, 30 mg/dose) proved significantly higher in the group of subjects with HT, with a median [IR] of 1[1,3] dose, compared to the group of subjects treated with FQT median 0.5 [0,1.25] dose (Z-statistics = −2.61, p-value = 0.009). A significantly higher number of subjects with FQT did not receive any rescue analgesic (50%) compared with patients with HT (13%; Z-statistics = 3.01, p-value = 0.002).

The detailed results of patients who required supplementary analgesia are presented in Table 1.

The percentage of subjects who required supplementary analgesic drugs was 38% higher in the group with HT compared with the group with FQT (Fig. 1).

The pain scores on the visual scale for the patients who required supplementary analgesics were similar between groups (Table 2).

Table 1
Results separated between the postoperative periods with the patients who required supplementary analgesia.

Postoperative interval	FQT (n = 24)		HT (n = 24)	
	n	%	N	%
0–12 h	12	50.00 (29.34; 70.66)	18	75.00 (54.34; 91.49)
13–24 h	5	20.83 (08.51; 41.49)	12	50.00 (29.34; 70.66)
25–48 h	4	16.66 (04.34; 37.33)	9	37.50 (16.84; 58.16)

n = number of patients who required supplementary analgesia.

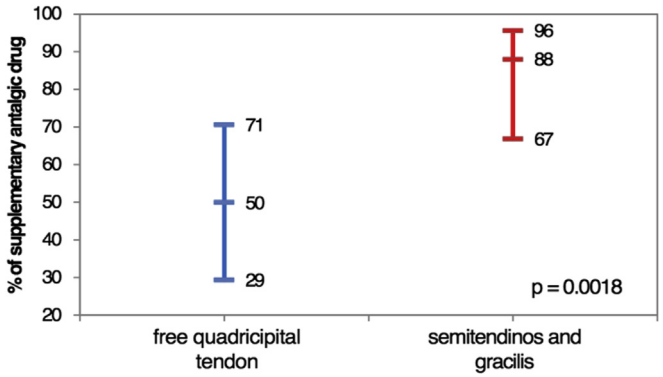

Fig. 1. Percentage and associated 95% confidence interval for receiving supplementary analgesic drug by groups.

Table 2
VAS pain values for patients who requested supplementary analgesia separated between the postoperative periods.

Postoperative interval	FQ (n = 24)		STG (n = 24)	
	n	VAS median (Q1, Q3)	n	VAS median (Q1, Q3)
0–12 h	12	60 (35, 80)	18	50 (40, 62.5)
13–24 h	5	60 (40, 70)	12	47.5 (37.5, 66.25)
25–48 h	4	40 (32.5, 42.5)	9	50 (40, 60)

n = number of patients who required supplementary analgesia.

The mean time from the completion of surgery to the first supplementary analgesic requirement was 8.25 h in the FQT group and 7.85 h in the HT group.

No local complications were noted in any of the two groups during the hospital stay, other than usual tenderness after knee arthroscopy.

There were 3 patients who reported nausea, 2 in the HT group and one in the FQT group. One patient from the HT group that reported nausea also experienced vomiting. These symptoms were interpreted as side effects of opioid treatment and responded well to corresponding treatment.

Discussion

The most important finding of this study is that the use of the FQT autograft for SB ACL reconstruction produces less pain than the HT autograft, in the immediate postoperative period, with statistical significance. In our patient group, this resulted in over 30% less drug consumption in the FQT group than in the HT group. Half of the patients in the FQT group did not request any tramadol, their pain level being minor (under 30 mm – VAS). On the other hand, patients who did request supplementary analgesics reported similar pain scores on the visual scale, between groups. Also, the mean time from the completion of surgery to the first requirement of supplementary analgesic drug was similar between the two groups.

The two groups were similar concerning age and gender distribution, and the male/female ratio was similar to other studies.[11]

The less invasive harvest technique for FQT probably helped in obtaining these results, since we had no local complication (significant lesion of the quadricipital pouch, unwanted damage to the quadriceps tendon) and we were able to obtain an average of 8.5 cm of graft length with a 4 cm incision, as other authors did.[12,13]

We chose to compare these two types of autografts because they are both soft tissue without any bone component. Also, we are limiting the use of BPTB grafts due to the fact that studies have shown that using BPTB graft results in higher local morbidity than HT[14,15] and more frequent kneeling pain than the quadriceps tendon with bone block.[16] There is data suggesting that any type of graft is suitable for ACL reconstruction on an outpatient basis with regard to early postoperative pain and morbidity,[17] however no data exists with regard to a FQT graft related morbidity in the immediate postoperative phase. Studies showed that multimodal pain therapy following ACL reconstruction is able to control pain levels and allows one-day surgery protocol for this procedure.[18–21] However, minimizing pain and opioid consumption is very important for the well being, comfort and early recovery of the patient following ACL reconstructive surgery.[22] According to our study, using FQT as a graft choice alone reduces drug consumption and limits the need for additional anesthesia or drug mix, and of course their related secondary effects (nausea, vomiting and excessive sedation).

The postoperative analgesic regime used in this study was developed by the anesthesiologist (AHO) and was tested to be optimal before starting the study.

We are aware that there are some limitations of our study. The pain is difficult to measure and the same level of pain may be reported different by patients and is dependent by many factors. We excluded patients with history of analgesic use within 14 days prior to surgery or history of chronic medication that might influence the study. Also, some bias may exist because the surgeon who performed the local clinical evaluations was aware of the surgical procedure. However, the patient reported pain level recording and rescue analgesia was performed by a study nurse which was blinded to the study protocol.

Even though sample size was low, and no power analysis was performed before the study, a statistical significance was obtained and we believe that the difference observed between the two groups regarding pain level and drug consumption would be respected in larger groups.

In conclusion, the use of the FQT autograft for ACL reconstruction leads to less pain and analgesic consumption in the immediate postoperative period compared with the use of hamstrings autograft.

References

1. Slone HS, Romine SE, Premkumar A, Xerogeanes JW. Quadriceps tendon autograft for anterior cruciate ligament reconstruction: a comprehensive review of current literature and systematic review of clinical results. *Arthroscopy*. 2015;31:541–554.
2. DeAngelis JP, Fulkerson JP. Quadriceps tendon–a reliable alternative for reconstruction of the anterior cruciate ligament. *Clin Sports Med*. 2007;26:587–596.
3. Macaulay AA, Perfetti DC, Levine WN. Anterior cruciate ligament graft choices. *Sports Health*. 2012;4:63–68.
4. Pinczewski LA, Lyman J, Salmon LJ, Russell VJ, Roe J, Linklater JA. 10-year comparison of anterior cruciate ligament reconstructions with hamstring tendon and patellar tendon autograft: a controlled, prospective trial. *Am J Sports Med*. 2007;35:564–574.
5. www.sealedenvelope.com +44 20 3176 4242 contact@sealedenvelope.com. Exmouth House, London EC1R 0JH, UK. Accesed 15 October 2013.
6. Araujo PH, van Eck CF, Macalena JA, Fu FH. Advances in the three-portal technique for anatomical single- or double-bundle ACL reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2011;19:1239–1242.
7. Cohen SB, Fu FH. Three-portal technique for anterior cruciate ligament reconstruction: use of a central medial portal. *Arthroscopy*. 2007;23:325.e1–e5.
8. Fulkerson JP, Langeland R. An alternative cruciate reconstruction graft: the central quadriceps tendon. *Arthroscopy*. 1995;11:252–254.
9. Solman Jr CG, Pagnani MJ. Hamstring tendon harvesting. Reviewing anatomic relationships and avoiding pitfalls. *Orthop Clin North Am*. 2003;34:1–8.
10. www.R-project.org R Foundation for Statistical Computing, Vienna, Austria. Accesed 20 September 2014.
11. Schulz AP, Lange V, Gille J, et al. Anterior cruciate ligament reconstruction using bone plug-free quadriceps tendon autograft: intermediate-term clinical outcome after 24–36 months. *Open Access J Sports Med*. 2013;4:243–249.
12. Fink C, Herbort M, Abermann E, Hoser C. Minimally invasive harvest of a quadriceps tendon graft with or without a bone block. *Arthrosc Tech*. 2014;3:e509–e513.

13. Lippe J, Armstrong A, Fulkerson JP. Anatomic guidelines for harvesting a quadriceps free tendon autograft for anterior cruciate ligament reconstruction. *Arthroscopy*. 2012;28:980–984.
14. Xie X, Liu X, Chen Z, Yu Y, Peng S, Li Q. A meta-analysis of bone-patellar tendon-bone autograft versus four-strand hamstring tendon autograft for anterior cruciate ligament reconstruction. *Knee*. 2015;22:100–110.
15. Razi M, Sarzaeem MM, Kazemian GH, Najafi F, Najafi MA. Reconstruction of the anterior cruciate ligament: a comparison between bone-patellar tendon-bone grafts and fourstrand hamstring grafts. *Med J Islam Repub Iran*. 2014;24:134.
16. Lund B, Nielsen T, Faunø P, Christiansen SE, Lind M. Is quadriceps tendon a better graft choice than patellar tendon? A prospective randomized study. *Arthroscopy*. 2014;30:593–598.
17. Baverel L, Demey G, Odri GA, Leroy P, Saffarini M, Dejour D. Do outcomes of outpatient ACL reconstruction vary with graft type? *Orthop Traumatol Surg Res*. 2015;101:803–806.
18. Dahl V, Spreng UJ, Waage M, Raeder JC. Short stay and less pain after ambulatory anterior cruciate ligament (ACL) repair: COX-2 inhibitor versus glucocorticoid versus both combined. *Acta Anaesthesiol Scand*. 2012;56:95–101.
19. Koh IJ, Chang CB, Seo ES, Kim SJ, Seong SC, Kim TK. Pain management by periarticular multimodal drug injection after anterior cruciate ligament reconstruction: a randomized, controlled study. *Arthroscopy*. 2012;28:649–657.
20. Wongswadiwat M, Pathanon P, Sriraj W, Yimyaem PR, Bunthaothuk S. Single injection fascia iliaca block for pain control after arthroscopic anterior cruciate ligament reconstruction: a randomized, controlled trial. *J Med Assoc Thai*. 2012;95:1418–1424.
21. Apostolos K, Georgios K, Omiros C, Christos T. Comparison between ropivacaine 1.5 mg ml(-1) plus fentanyl 2 mg ml(-1) and ropivacaine 1.5 mg ml(-1) plus clonidine 1 mg ml(-1) as analgesic solution after anterior cruciate ligament reconstruction: a randomized clinical trial. *Middle East J Anaesthesiol*. 2011;21:341–345.
22. Secrist ES, Freedman KB, Ciccotti MG, Mazur DW, Hammoud S. Pain management after outpatient anterior cruciate ligament reconstruction: a systematic review of randomized controlled trials. *Am J Sports Med*. 2016 Sep;44(9):2435–2447. http://dx.doi.org/10.1177/0363546515617737. Epub 2015 Dec 18.