Original Article • Journal of Southeast Asian Orthopaedics Vol 47 No 2 (2023) 48-53

Journal of Southeast Asian Orthopaedics
ISSN 2821-9848 (Print)
ISSN 2821-9864 (Online)
https://doi.org/10.56929/jseaortho-023-0187 https://jseaortho.org

Short-Term Outcomes of Anterior Cruciate Ligament Reconstruction with Hamstring Tendon Graft: A Randomized Trial Comparing Risk of Injury to the Infrapatellar Branch of Saphenous Nerve in Terms of Knee Hypoesthesia Among Different Oblique Incision Angles

Kraiwut Sooksanit, MD

Department of Orthopedic Surgery, Buriram Hospital, Buriram, Thailand

Purpose: To study the short-term outcomes of anterior cruciate ligament reconstruction (ACLR) with hamstring grafts by comparing the risk of injury to the infrapatellar branch of the saphenous nerve (IPBSN) in terms of the incidence of knee hypoesthesia using 30°, 45°, and 60° oblique incisions.

Methods: We conducted a randomized controlled trial among patients who underwent ACLR with hamstring grafts in our hospital between December 1, 2020 and December 31, 2021. We randomly allocated 111 patients to three groups of 37 patients each, and each group underwent either a 30°, 45°, or 60° oblique incision for hamstring graft harvesting. When incisions were being performed, the age, sex, body mass index, diagnosis, incision length, and operating time were recorded. The incidence and area of knee hypoesthesia were evaluated at 1-, 3-, and 6- month follow-ups.

Results: Demographic and surgical data were similar in all three groups. The incidence of knee hypoesthesia was significantly lower in the 45°-incision group than that in other groups at 1-, 3-, and 6-month follow-ups. At the 6-month follow-up, the incidence was 8.1% in the 45° group, 45.9% in the 30° group, and 35.1% in the 60° group. The area of sensory loss in the 45° group was significantly smaller than that in the other two groups at 3- and 6-month follow-ups.

Conclusions: Performing a 45° oblique incision reduced the risk of the IPBSN injury after ACLR with a hamstring graft more significantly than a 30° or 60° incision. This technique is safe, uncomplicated, and efficacious.

Keywords: anterior cruciate ligament reconstruction (ACLR), infrapatellar branch of saphenous nerve (IPBSN), oblique incision, knee hypoesthesia

Knee hypoesthesia after anterior cruciate ligament reconstruction (ACLR) is a common complication of injury to the infrapatellar branch of the saphenous nerve (IPBSN). The saphenous nerve is the longest branch of the femoral nerve and contains pure sensory fibers. After exiting the adductor canal, it passes behind the sartorius muscle, travels along the anterior of the gracilis tendon on the posteromedial side of the joint, and divides into the infrapatellar and sartorial branches[1]. The infrapatellar branch innervates the skin over the anteromedial aspect of the knee and anteroinferior knee joint

Article history:
Received: February 22, 2023, Revised: April 27, 2023
Accepted: May 10, 2023
Correspondence to: Kraiwut Sooksanit, MD
Department of Orthopedic Surgery, Buriram Hospital, Buriram, Thailand
E-mail: isa_onn2014@outlook.com

capsule[2,3]. In most cadaveric specimens, a branch of the IPBSN was observed to pass between the apex of the patella and the tibial tubercle[4]. Therefore, the nerve is susceptible to injury during knee surgeries, including sensory disturbances, neuropathic pain, and even painful neuroma[3]. The incidence of sensory disturbances after ACLR varies between 14.9%–88%[5-7]. Cohen et al.[8] reported that the overall incidence of patient-reported numbness in ACLR for all graft types was 69.8%. Sanders et al.[9] reported that 52% of hamstring tendon graft recipients experienced knee hypoesthesia.

The incidence of postoperative knee hypoesthesia did not differ significantly between the bone-patellar tendon-bone (BPTB) and hamstring tendon autografts[10,11]. However, more severe complications, such as anterior knee pain, kneeling pain, and extensive loss of sensation, were associated with the surgical incisions and techniques used during BPTB graft harvesting[12]. A large surgical incision for the BPTB graft further complicates aesthetic outcomes. Although the severity of numbness reported by patients that underwent ACLR using the allograft technique was significantly lower than that of the other two techniques[8], the risk of graft failure and joint laxity has left allografts controversial[13]. With hamstring tendon autografts, IPBSN injury is common because of the proximity of the tendon to the IPBSN in the pes anserinus. The high variation in IPBSN anatomy makes the nerve more vulnerable, because the position and direction of the incision are important factors in the IPBSN injury[14].

Recently, many studies have confirmed that an oblique incision for hamstring graft harvesting can minimize the risk of the IPBSN injury compared with that in vertical and transverse incisions[15-16]. Henry et al.[15] reported that in cadaveric studies, the risk of IPBSN injury was significantly reduced using an oblique incision (27.6%) as compared with that from vertical (64.7%) and horizontal incisions (50%). To determine the safest angle of oblique incision for ACLR with a hamstring graft, this study proposed 30°, 45°, and 60° oblique incisions and compared the risk of the IPBSN injury to the incidence of knee hypoesthesia among the three groups.

METHODS

This study was approved by the medical ethics committee of our hospital (No. 52, Nov 24, 2020). All patients provided informed consent before the study. Patients who underwent ACLR in our hospital between December 1, 2020 and December 31, 2021 were enrolled in the study according to the following inclusion criteria: age 18–60 years with ACL rupture on physical examination, no history of knee injury or knee surgery on the operated side, and no peripheral neuropathy. Patients with diabetes, morbid obesity (body mass index [BMI] ≥ 40), and multiple ligament injuries were excluded. We randomly allocated 111 patients (104 males and seven females), aged 18–54 years into three groups (37 patients each) by block randomization. All the surgeries were performed by the same surgeon. ACLR was performed using the single-bundle technique with standard arthroscopic instruments. The anterolateral portal was used as the viewing portal, and the anteromedial portal was used as the instrumentation portal. The semitendinosus and gracilis tendons from the operated knee were used as 4-stranded hamstring tendon grafts and fixed to the femur with Endo Button (Smith and Nephew). The tibia was fixed using an absorbable interference screw. The tibial tunnel was drilled under the same incision for graft harvesting, with the guide angle adjusted to 50–55°.

The incision for semitendinosus and gracilis graft harvesting was made with the knee flexed at 90° and the hip externally rotated at 15°. A location along the upper border of the tendon in the pes anserinus area was identified to perform the incision; it was located 3 finger breadths below the knee joint line and 2 fingerbreadths medial to the tibial tubercle. A sterile goniometer was used to measure this angle. The 30°, 45°, and 60° oblique incisions were made in the 30°, 45°, and 60° patient groups, respectively, and extended as required.

Age, sex, BMI, diagnosis, incision length, and operating time were recorded. The occurrence of knee hypoesthesia and the area of sensory loss were evaluated by a well-trained nurse in the outpatient department at the 1-, 3-, and 6-month follow-ups. For the sensory evaluation, the area of skin numbness was marked using a 1-cm^2 transparent measurement grid and measured using the pin-prick sensation. Other complications, such as infection, graft retear, posterior thigh pain, and neuropathic pain, were also assessed during follow-up.

Statistical analyses were performed using SPSS (version 15.0; IBM Corp., Armonk, NY, USA). Data were analyzed using descriptive statistics (means, standard deviations [SDs], and percentages). Categorical variables were compared using the chi-square test, and continuous variables were compared using the Kruskal–Wallis test. P <0.05 was considered to be statistically significant. The sample size was calculated by the N4study program. The estimated incidence of knee hypoesthesia based on literature data was 69.8% (P control = 0.698, P treatment = 0.349, alpha = 0.05, beta = 0.1, N = 37).

RESULTS

Demographic and surgical data were comparable among the three groups (Tables 1 and 2). The incidence of knee hypoesthesia was significantly lower in the 45° group than in the other groups at 1-, 3-, and 6-month follow-ups (Table 3). In the first month, eight patients (21.6%) in the 45° group developed knee hypoesthesia, whereas the incidence in the 30° and 60° groups was 51.4% and 37.8%, respectively (P = 0.030). Three months after surgery, two of eight patients in the 45° group who had previously developed knee hypoesthesia recovered from the symptom. Therefore, the incidence significantly decreased to 16.2%, lower than the incidences in the 30° (45.9%) and 60° (37.8%) groups (P = 0.020). In 6 months, only three patients (8.1%) in the 45° group still presented with knee hypoesthesia, whereas the incidences in the 30° and 60° groups were 45.9% and 35.1%, respecttively (P = 0.001) (Table 3). In addition, the area of sensory loss in the 45° group was lower than that in the other two groups throughout the follow-up period. However, the difference was significant at 3- and 6-month follow-ups. Herein, the presence and severity (represented by the area of sensory loss) of knee hypoesthesia in all groups declined within 6 months (Table 3).

No complications, including infection, graft retear, posterior thigh pain, or neuropathic pain, were observed.

Table 1 Demographic data.

Demographic data	**30°**	**45°**	**60°**	***P*-value**
Age, years (mean ± SD)	29.7 ± 10.5	26.0 ± 7.2	27.3 ± 6.9	0.472*
Sex				0.859**
Male (%)	35 (94.6%)	34 (91.9%)	35 (94.6%)	
Female (%)	2 (5.4%)	3 (8.1%)	2 (5.4%)	
BMI (mean ± SD)	23.5 ± 3.7	24.0 ± 2.9	24.4 ± 2.9	0.321*

* Kruskal–Wallis Test ** Chi-square
SD, standard deviation; BMI, body mass index.

Table 2 Surgical data.

Surgical data	**30°**	**45°**	**60°**	***P*-value**
Diagnosis				0.156**
ACL injury (%)	32 (86.5%)	25 (67.6%)	28 (75.7%)	
ACL with meniscus injury (%)	5 (13.5%)	12 (32.4%)	9 (24.3%)	
Incision length (cm) (mean ± SD)	2.97 ± 0.29	3.02 ± 0.33	2.95 ± 0.30	0.325*
Operating time (min) (mean ± SD)	98.3 ± 32.2	87.0 ± 21.0	85.4 ± 29.6	0.264*

* Kruskal–Wallis Test ** Chi-square
ACL, anterior cruciate ligament; SD, standard deviation.

Table 3 Results of surgical incisions by group.

Results		30° N=37	45° N=37	60° N=37	*P*-value
Number of patients with	1 month	19 (51.4%)	8 (21.6%)	14 (37.8%)	0.030**
knee hypoesthesia	3 months	17 (45.9%)	6 (16.2%)	14 (37.8%)	0.020**
(%)	6 months	17 (45.9%)	3 (8.1%)	13 (35.1%)	0.001**
Area of sensory loss	1 month	16.6 ± 26.0	9.0 ± 22.6	14.4 ± 25.8	0.061*
(mean ± SD)	3 months	11.6 ± 19.0	5.8 ± 19.7	10.9 ± 20.8	0.032*
cm^2	6 months	8.6 ± 14.0	3.8 ± 16.5	8.4 ± 17.9	0.003*

* Kruskal–Wallis Test ** Chi-square
SD, standard deviation.

DISCUSSION

The incidence of an IPBSN injury during hamstring tendon harvesting is directly related to the type of surgical incision(17). Recent cadaveric studies have reported that oblique incisions are less likely to damage the IPBSN than vertical and horizontal incisions because they are more parallel to and farther away from the IPBSN(17,18). Horizontal incisions are closely associated with sartorial branch injuries(6,9,19). Henry et al. reported that the incidences of the IPBSN injuries were 64.7%, 50%, and 27.6% for vertical, horizontal, and oblique incisions, respectively. Meanwhile, Pekala et al. reported that the risks of injuries for these groups were 51.4%, 22.4%, and 26%, respectively.

Kerver et al.(3) proposed the concept of a safe area for surgical incisions in relation to the IPBSN anatomy based on a cadaveric study. However, the number of cases in the study was limited, and the variation in nerve location was high. Therefore, safe zones must be used with caution in clinical practice. Zhu et al.(20) designed a modified oblique incision (MOI) within the safe area proposed by Kerver et al. and reported that the incidence of knee hypoesthesia at 1 year with the MOI was lower than that with a standard oblique incision (9.4% vs. 33.3%). Differences were considered statistically significant. The MOI technique moves the surgical incision away from the IPBSN and beyond the hamstring tendon. This may result in technical difficulties in graft harvesting, and put the nerve at risk of a blunt injury during skin traction, subcutaneous dissection, or passage of a tendon-harvesting device. In our study, an oblique incision was made at the pes anserinus using the standard technique. Three angles of oblique incision were studied based on the hypothesis that the angle of the incision affects the distance between the incision and the nerve(15). The incision made with the appropriate angle protected the nerve from injury. Our study demonstrated that the incidence of knee hypoesthesia at 6 months after surgery with an oblique 45° incision was significantly lower (8.1%) than that with 30° and 60° oblique incisions.

Blunt nerve injury has been reported during graft harvesting procedures; however, its occurrence appears to be lower compared to nerve injuries caused by incisions(19). Injury was caused mainly by tendon harvesting devices, and affected the sartorial branch, resulting in a sensory loss in the medial and distal tibial ridges and the anteromedial region of the knee joint. Previous studies have suggested that when the knee is flexed at 90° with the hip externally rotated, the saphenous nerve moves backward and away from the site of the procedure(21). Therefore, this study used this technique to avoid nerve damage during incision and graft harvesting. Additionally, the incision length may be related to the risk of IPBSN injury. A previous cadaveric study found that the distances between various types of incisions and nerves varied from 8.2–8.7 mm.(15), which was a relatively low variance. Therefore, the incision length should be minimized as much as possible without excessive stretching during graft access. In this study, incision lengths in 30°, 45°, and 60° groups were 2.97 ± 0.29, 3.02 ± 0.33, and 2.95 ± 0.30 cm, respecttively. There were no significant differences between the groups. The average length of incision in this study was similar to that of the other study (2.3–3.9 cm)(20).

This study had some limitations. Nerve injury may occur during procedures other than surgical incisions, such as graft harvesting, portal placement, tibial tunnel drilling, skin traction, and subcutaneous dissection(21). These confounding factors could not be controlled during surgery; therefore, to minimize them, the same surgeon performed grafts on all the patients in this study. Another limitation of this study is the method used to assess the extent of sensory loss. Sensory evaluation by pinprick sensation relies on the patient's perception and the intensity of pressure that the assessor applies during the assessment; therefore, it seems unreliable compared with electrophysiological studies. A transparent measurement grid is also not an ideal tool to measure the area of abnormal sensation, as reading and systematic errors during measurements can easily cause data discrepancies. However, this tool was used as it is convenient for use in clinical practice. Relevant to clinical applications of the study, the patients' BMI in the study ranged from 20–26, and therefore this landmark would not be reproducible in patients of extreme size. A surgeon in the outpatient department evaluated function and range of motion, but the outcomes were not analyzed. However, all the patients returned to normal activity within 6 months.

CONCLUSIONS

An oblique 45° incision could lower the risk of an IPBSN injury after ACLR with a hamstring graft compared with that by 30° and 60° incisions, which was evident in both the incidence and area of knee hypoesthesia at 1, 3, and 6 months after surgery. Despite some limitations, this technique is safe, uncomplicated, and effective for clinical application.

REFERENCES

1. Henry BM, Tomaszewski KA, Pękala PA, et al. The Variable Emergence of the Infrapatellar Branch of the Saphenous Nerve. J Knee Surg 2017;30:585-93.
2. Kalthur SG, Sumalatha S, Nair N, et al. Anatomic study of infrapatellar branch of saphenous nerve in male cadavers. Ir J Med Sci 2015;184:201-6.
3. Kerver AL, Leliveld MS, den Hartog D, et al. The surgical anatomy of the infrapatellar branch of the saphenous nerve in relation to incisions for anteromedial knee surgery. J Bone Joint Surg Am 2013;95:2119-25.
4. Kartus J, Ejerhed L, Eriksson BI, et al. The localization of the infrapatellar nerves in the anterior knee region with special emphasis on central third patellar tendon harvest: a dissection study on cadaver and amputated specimens. Arthroscopy 1999;15:577-86.
5. Figueroa D, Calvo R, Vaisman A, et al. Injury to the infrapatellar branch of the saphenous nerve in ACL reconstruction with the hamstrings technique: clinical and electrophysiological study. Knee 2008;15:360-3.
6. Papastergiou SG, Voulgaropoulos H, Mikalef P, et al. Injuries to the infrapatellar branch(es) of the saphenous nerve in anterior cruciate ligament reconstruction with four-strand hamstring tendon autograft: vertical versus horizontal incision for harvest. Knee Surg Sports Traumatol Arthrosc 2006;14:789-93.
7. Kjaergaard J, Faunø LZ, Faunø P. Sensibility loss after ACL reconstruction with hamstring graft. Int J Sports Med 2008;29:507-11.
8. Cohen SB, Flato R, Wascher J, et al. Incidence and characterization of hypoesthesia in the distribution of the infrapatellar branch of the saphenous nerve after anterior cruciate ligament reconstruction: A prospective study of patient-reported numbness. J Knee Surg 2018;31:585-90.
9. Sanders B, Rolf R, McClelland W, et al. Prevalence of saphenous nerve injury after autogenous hamstring harvest: an anatomic and clinical study of sartorial branch injury. Arthroscopy 2007;23:956-63.
10. Ejerhed L, Kartus J, Sernert N, et al. Patellar tendon or semitendinosus tendon autografts for anterior cruciate ligament reconstruction? A

prospective randomized study with a two-year follow-up. Am J Sports Med 2003;31:19-25.

11. Lidén M, Ejerhed L, Sernert N, et al. Patellar tendon or semitendinosus tendon autografts for anterior cruciate ligament reconstruction: a prospective, randomized study with a 7-Year follow-up. Am J Sports Med 2007;35:740-8.

12. Zhao L, Lu M, Deng M, et al. Outcome of bone-patellar tendon-bone vs hamstring tendon autograft for anterior cruciate ligament reconstruction: A meta-analysis of randomized controlled trials with a 5-year minimum follow-up. Medicine (Baltimore) 2020;99:e23476.

13. Barrett G, Stokes D, White M. Anterior cruciate ligament reconstruction in patients older than 40 years: allograft versus autograft patellar tendon. Am J Sports Med 2005;33:1505-12.

14. Brown Jr CH, Steiner ME, Carson EW. The use of hamstring tendons for anterior cruciate ligament reconstruction. Technique and results. Clin Sports Med 1993;12:723-56.

15. Henry BM, Tomaszewski KA, Pękala PA, et al. Oblique incisions in hamstring tendon harvesting reduce iatrogenic injuries to the infrapatellar branch of the saphenous nerve. Knee Surg Sports Traumatol Arthrosc 2018;26: 1197-203.

16. Luo H, Yu JK, Ao YF, et al. Relationship between different skin incisions and the injury of the infrapatellar branch of the saphenous nerve during anterior cruciate ligament reconstruction. Chin Med J (Engl) 2007;120:1127-30.

17. Sabat D, Kumar V. Nerve injury during hamstring graft harvest: a prospective comparative study of three different incisions. Knee Surg Sports Traumatol Arthrosc 2013;21: 2089-95.

18. Pękala PA, Tomaszewski KA, Henry BM, et al. Risk of iatrogenic injury to the infrapatellar branch of the saphenous nerve during hamstring tendon harvesting: A meta-analysis. Muscle Nerve 2017;56:930-7.

19. Portland GH, Martin D, Keene G, et al. Injury to the infrapatellar branch of the saphenous nerve in anterior cruciate ligament reconstruction: comparison of horizontal versus vertical harvest site incisions. Arthroscopy 2005;21:281-5.

20. Zhu B, Li X, Lou T. A modified oblique incision in hamstring tendon graft harvesting during ACL reconstruction. J Orthop Surg Res 2021;16: 206.

21. Pagnani MJ, Warner JJ, O'Brien SJ, et al. Anatomic considerations in harvesting the semitendinosus and gracilis tendons and a technique of harvest. Am J Sports Med 1993;21: 565-71.