



The influence of hamstring autograft diameter on patient-reported functional scores following anterior cruciate ligament (ACL) reconstruction

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ABSTRACT

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Anterior cruciate ligament (ACL) reconstruction using hamstring tendon autograft is a common procedure in orthopedic surgery to treat ACL rupture. Graft diameter is very important in successfulness of ACL reconstruction. The purpose of this study was to evaluate the influence of hamstring autograft diameter on patient-reported functional scores following ACL reconstruction. The diameter of grafts were collected retrospectively from medical records of the patients who underwent primary ACL reconstruction with hamstring autograft in the Soeradji Tirtonegoro General Hospital, Klaten, Central Java. The patient-reported functional scores data according to the International Knee Documentation Committee (IKDC) score and the Knee Injury and Osteoarthritis Outcome Score (KOOS) were collected by phone call interview from the patients after more than six months post-reconstruction. The comparison between graft diameter and patient-reported functional scores was analyzed by independent t test. A $p < 0.05$ was considered significant. Thirty-two patients who fulfilled the inclusion and exclusion criteria were involved in the study who were divided into two groups with 16 patients in each group i.e. Group 1 with graft diameter ≤ 8 mm and Group 2 with graft diameter > 8 mm. The result showed significant difference in KOOS and IKDC score between the both groups ($p < 0.05$). Patients who underwent ACL reconstruction with graft diameter > 8 mm (Group 2) had higher KOOS and IKDC score compared to graft diameter ≤ 8 mm (Group 1) ($p < 0.05$). In conclusion, ACL reconstruction with increased hamstring autograft diameter > 8 mm associated with better patient-reported functional scores in 6 months follow-up after ACL reconstruction.

ABSTRAK

Rekonstruksi ligament krusiat anterior (LKA) menggunakan autograf tendon hamstring adalah tindakan umum yang dilakukan pada bedah ortopedi untuk penanganan ruptur LKA. Diameter graf merupakan faktor penting dalam keberhasilan rekonstruksi LKA. Penelitian ini bertujuan untuk mengkaji pengaruh diameter autograf hamstring terhadap skor fungsional yang dilaporkan pasien setelah menjalani rekonstruksi LKA. Diameter graf diambil secara retrospektif dari data rekam medik pasien yang menjalani rekonstruksi LKA primer dengan autograf hamstring di RSUP Soeradji Tirtonegoro, Klaten, Jawa Tengah. Skor fungsional yang dilaporkan pasien menurut kriteria *the International Knee Documentation Committee* (IKDC) dan *the Knee Injury and Osteoarthritis Outcome Score* (KOOS) diperoleh melalui wawancara telepon setelah enam bulan menjalani rekonstruksi. Perbandingan antara diameter graf

Keywords:

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dan skor fungsional yang dilaporkan pasien dianalisis dengan uji t independen. Nilai $p < 0,05$ dianggap signifikan. Tiga puluh dua pasien yang memenuhi kriteria inklusi dan eksklusi diikutsertakan dalam penelitian ini yang dibagi menjadi dua kelompok dengan masing-masing kelompok 16 pasien yaitu Kelompok 1 pasien menjalani rekonstruksi LKA dengan diameter hamstring ≤ 8 mm dan Kelompok 2 pasien menjalani rekonstruksi LKA dengan diameter > 8 mm. Hasil penelitian menunjukkan perbedaan signifikan dalam skor KOOS dan IKDC antara kedua kelompok ($p < 0,05$). Pasien yang menjalani rekonstruksi LKA dengan diameter graf > 8 mm (Kelompok 2) mempunyai nilai KOOS dan IKDC lebih tinggi dibandingkan dengan pasien dengan diameter graf ≤ 8 mm (Kelompok 1) ($p < 0,05$). Dapat disimpulkan, rekonstruksi LKA dengan kenaikan diameter autograf hamstring > 8 mm berkaitan dengan skor fungsional yang dilaporkan pasien lebih baik setelah 6 bulan menjalani rekonstruksi LKA.

INTRODUCTION

ACL reconstruction is one of the most studied procedure in the field of orthopedic. ACL reconstruction technique has evolved from open surgery to minimal invasive technique using arthroscopic, and this technique is a standard procedure recently.^{1,2} Hamstring graft is one of the popular graft in Asian population, with semitendinosus and gracilis muscles (ST-G) or only semitendinosus (ST).³ Low donor site morbidity, faster post-operative rehabilitation and similarity in biochemical properties to normal ACL are some advantages compared to bone-patellar-tendon graft.^{3,4}

One of the challenges in ACL reconstruction is harvesting grafts with a diameter of the graft close to the original diameter size of native ACL.⁵ In ACL single bundle reconstruction, a 7 mm diameter is a minimum goal, but variation between 6 to 9 mm is usually encountered.⁶ Some studies suggested, graft diameter below 8 mm and younger patients linked with high revision rates^{7,8} and with lower Knee Injury and Osteoarthritis Outcome Score (KOOS).⁸ A biomechanical study mentioned that increasing graft diameters 1 to 2 mm will significantly lead to better graft strength.⁴

Further study is needed to assess the outcome of the different hamstring graft diameter. This study was conducted to evaluate the influence of hamstring autograft diameter on patient-reported

functional scores following ACL reconstruction. We hypothesized that increased hamstring graft diameter is associated with better patient-reported functional scores after ACL reconstruction.

MATERIALS AND METHODS

Patients

Patients were selected from patients' database in the Soeradji Tirtonegoro General Hospital, Klaten, Central Java in a period of October 2013 to April 2016. Patients who underwent ACL reconstruction with hamstring autograft aged older than 18-years-old were included in this study. Patients younger than 18 years old, patients with multiple ligament injuries, incomplete post-reconstruction physiotherapy program, and incomplete database were excluded from this study.

Procedure of study

Following after selection, the data from patients' medical records include of graft diameter, age, sex and ACL injuries were collected. Patients were divided according to the diameter of the grafts into two groups i.e. Group 1 was patients with graft diameter ≤ 8 mm, and Group 2 was patients with graft diameter > 8 mm. Each patient underwent arthroscopic ACL reconstruction with single-bundle hamstring autograft.

The patient-reported functional

scores data according to the International Knee Documentation Committee (IKDC) score and Knee Injury and Osteoarthritis Outcome Score (KOOS) were collected by contacting each patient based on contact number in the database. The patients were contacted by the participating author and asked about the injured knee and asked to fill the questioner by choosing the most appropriate answer based on what they felt. This study was approved by the Medical and Health Research Ethics Committee, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta. All patients were signed inform consent which showed willing to participate in this study.

Statistical analysis

Data were presented as mean \pm standard deviation (SD). The data of

graft diameter and patient-reported functional scores were compared using independent t-test. A p value <0.05 was considered significant.

RESULTS

Among 32 patients who met the inclusion and exclusion criteria, 27 were male patients (84.4%) and 5 were female patients (15.6%). The mean of patients' age was 31.8 ± 11.5 years (18–59 years old). Eighteen (18) patients had right ACL injury and the rest patients had left injury site. There was no significantly difference between Group 1 and Group 2 in the mean age, gender, and site of injury. Patients' characteristics are shown in TABLE 1. The IKDC score and KOOS of Group 2 were significantly higher compared to those of Group 1 ($p < 0.05$) as shown in TABLE 2.

TABLE 1. Characteristics of patients

Variable	Group 1	Group 2	p
Age (mean \pm SD years)	32.37 \pm 12.37	31.31 \pm 11.04	>0.05
Gender (n)			
• Male	13	14	>0.05
• Female	3	3	
Site of injury (n)			
• Right	6	12	>0.05
• Left	10	4	

Note: Group 1: graft diameter ≤ 8 mm; Group 2: graft diameter > 8 mm

TABLE 2. Functional score (mean \pm SD) based on IKDC and KOOS

Score	Group 1	Group 2	Δ	p	95%CI
IKDC	77.39 \pm 13.26	85.07 \pm 6.51	-7.68	<0.05	70.32-88.54
KOOS	87.84 \pm 6.92	92.45 \pm 3.25	-4.61	<0.05	84..15-94.18

Note: Group 1: graft diameter ≤ 8 mm; Group 2: graft diameter > 8 mm; SD: standard deviation; Δ : mean difference

DISCUSSION

Current trends in ACL reconstruction have been toward anatomical reconstruction that restores the native size and location of the ACL insertions and the 2 bundles, the posterolateral (PL) and anteromedial (AM) bundles.⁹ A variety of graft options is available for ACL reconstruction, including autograft and allograft. Common autograft includes the bone–patellar tendon–bone (BPTB), the combination of semitendinosus and gracilis hamstring tendons (HTs), peroneus longus and quadriceps tendon. Allograft options include all of them in addition to tibialis and achilles tendon.^{10,11}

Single-bundle ACL reconstruction with hamstring autograft can use only semitendinosus tendon (ST), or combination with the gracilis tendon.¹² Some studies reported that hamstring autograft can reduce the failure rate after ACL reconstruction¹³ and only the semitendinosus and gracilis auto graft was able to reproduce the native size of the ACL footprint on the femoral side.¹²

One of the challenges in ACL reconstruction using hamstring autograft is to harvest an adequate diameter, close to the size of native ACL.¹⁴ This study conducted to compare the post-operative outcome score using IKDC and KOOS between hamstring tendon autograft with diameter ≤ 8 mm and > 8 mm. This is the first study on evaluation of hamstring tendon autograft in ACL reconstruction in Indonesia.

Some previous studies reported the evaluation of hamstring graft size effect with several outcome variable in ACL reconstruction.¹² Figueroa *et al.*¹⁵ reported that hamstring graft diameter associated with surgery failure, but the exact recommendation of graft diameter is still debatable.¹⁵ Other study evaluated the revision rate on 256 patients underwent primary ACL reconstruction, and concluded that smaller autograft

size (< 8 mm) and younger age are the predictors of graft revision.⁷ Park *et al.*¹⁶ reported that failure rate of ACL reconstruction using graft diameter > 8 mm is significantly different with graft diameter ≤ 8 mm, without revision surgery. Multicenter Orthopedic Outcomes Networks (MOON) Cohort Study reported that none of revision surgery found in graft diameter > 8 mm and 7% revision surgery in graft diameter ≤ 8 mm.⁸ A biomechanical study that tested 6 to 9 mm hamstring allograft suggests that increasing tendon diameters by 1 to 2 mm will significantly lead to better graft strength.⁴ A study demonstrated that four-strand hamstring graft is stiffer and stronger than the original ACL or 10 mm patellar ligament graft,¹³ while other study compared postoperative laximetric measurement between 8 to 10 mm hamstring graft suggested that no benefit to increase the diameter of graft above 10 mm¹⁷ Spragg *et al.*¹⁸ stated that every increasing by 0.5mm increase in graft diameter lead to 0.82 times lower revision surgery. Another study recommended that minimum diameter of the graft was 7mm.¹⁹ The diameter of hamstring tendon autograft was significantly correlated with weight, height, thigh length, leg length, thigh diameter, and gender.²⁰ Male with 180 cm height or more had higher prevalence of 9 mm graft diameter.²⁰ Another study showed that there was no influence on the incidence of graft rupture.²¹

This study found that larger hamstring autograft diameter is associated with better KOOS and IKDC scores. The findings of this study are overall in agreement with a previous study evaluating the relation between graft size and functional scores as an outcome in ACL reconstruction. The graft size < 8 mm is related to higher graft failure and lower KOOS. Park *et al.*¹⁶ stated that graft diameter > 8 mm is associated with better result. Magnitskaya *et al.*²² reported IKDC score

in hamstring graft was significantly higher than Bone-Patellar Tendon Bone (BPTB) graft in 6 months follow-up after ACL reconstruction surgery.

Several previous studies showed that larger hamstring graft size is associated to better outcome. However, more studies are still needed to define the lower and upper limit as an ideal diameter in ACL reconstruction procedures using hamstring autograft.

The subjective measurement tools become the limitation of this study. Several variable scan interfere the patient perspective on the post reconstruction performance of the affected knee. Other limitations include the lack direct contact and physical examination because the participated patients live in different regions in rural areas. We hope that future study will be conducted by using determined rehabilitation protocol to minimize bias and facing the patient in knee score evaluation.

CONCLUSION

Larger hamstring autograft diameter (> 8 mm) is associated with better patient-reported KOOS and IKDC scores 6 months after ACL reconstruction.

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