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Higher Rate of Patellofemoral Problems After Anterior Cruciate Ligament Reconstruction using Hamstring Autograft

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Abstract

BACKGROUND: Patellofemoral problems are not uncommon among post-anterior cruciate ligament (ACL) reconstruction patients. Hamstring autograft harvesting-related factor is one of the suspected causes. A lack of tibiofemoral internal rotation force due to strength deficit causes the patella tends to shift laterally.

AIM: Peroneus longus tendon has been proposed as an alternative graft source due to its adequate tensile strength and minimal donor site morbidity to the knee biomechanics, including the patellofemoral joint. This tendon does not cross the knee joint and thus does not affect patellofemoral alignment and biomechanics. This study aims to compare patellofemoral problems between hamstring and peroneus longus autograft harvested patients following ACL reconstruction.

MATERIALS AND METHODS: Thirty-one subjects who underwent primary single-bundle ACL reconstruction between September 2018 and September 2019 and met the inclusion criteria were grouped into the hamstring group (n = 16) and peroneus longus group (n = 15). Both groups were evaluated retrospectively. The follow-up assessment was conducted on the phase II rehabilitation program. The assessed variables were pain, crepitus, and the Indonesian-validated Kujala score.

RESULTS: No significant differences in pain and crepitus were found between both groups. There were significant differences in the Kujala score between both groups ($p < 0.001$). The peroneus longus group reported an averagely higher score than the hamstring group.

CONCLUSION: Single bundle ACL reconstruction using peroneus longus tendon autograft produces less patellofemoral symptoms and functional limitation than using hamstring tendon autograft.

Introduction

Anterior cruciate ligament (ACL) injury is one of the most common injuries found in orthopedic sports clinics. The incidence is one in 3000 people each year in the United States, and 100.000–300.000 ACL reconstructions are performed annually [1], [2] ACL reconstruction aims to restore knee stability, allow returning to sports, prevent meniscal tears, and possibly prevent early-onset osteoarthritis of the knee [3]. The technique, graft sources, and devices used in ACL reconstruction have been studied extensively to find the best option for the patient. Nevertheless, one unsolved complication following ACL reconstruction is patellofemoral problems.

Patellofemoral problems, such as patellofemoral pain, have been reported to occur in post ACL reconstruction knee [4], [5], [6], [7]. The highest incidence of patellofemoral pain has been found in ACL reconstruction using bone-patellar tendon-bone (BPTP) autograft, which has been the standard source of graft [8]. Therefore, hamstring tendon autograft has gained popularity as an alternative source of graft. Although some studies reported a significantly lower incidence of patellofemoral pain in ACL reconstructed patients with hamstring tendon autograft than BPTP autograft, it does not necessarily mean that the use of hamstring tendon autograft is spared from patellofemoral pain [5], [9], [10], [11]. Culvenor *et al*. [5] reported that 30% of patients had patellofemoral pain after hamstring tendon ACL reconstruction. Hamstring autograft harvesting-related factor is one of the suspected causes. A lack of a tibiofemoral internal rotation force due to decreased hamstring strength causes the patella to shift laterally and has been proposed to elucidate this problem [12], [13], [14]. However, the exact mechanism behind it is still unclear.

This problem encourages researchers to look for another alternative graft source, and the peroneus longus tendon has been investigated extensively for this purpose. Some studies discovered that the peroneus longus tendon has adequate tensile strength and minimal donor site morbidity to the knee biomechanics, including the patellofemoral joint [15], [16], [17], [18]. The proposed reason is that the peroneus longus tendon does not cross the knee joint so that its harvest does not affect patellofemoral alignment and biomechanics. This study aims to compare the patellofemoral symptoms and functional scores between hamstring and peroneus longus harvested patients following ACL reconstruction.

Materials and Methods

Study design and subject selection

This study is a retrospective cohort study with consecutive sampling. Patients aged 16–45 years old with isolated ACL rupture, underwent primary single-bundle ACL reconstruction either with hamstring tendon or ipsilateral peroneus longus tendon autografts between September 2018 and September 2019 and participated in the phase II rehabilitation program for follow up were eligible for inclusion. The diagnosis of isolated ACL rupture was established based on anamnesis, physical examination, and magnetic resonance imaging of the injured knee. We excluded ACL revision cases, ACL rupture with concomitant injury (multi-ligament injury, cartilage defect, meniscal injury, fracture around the knee), pathologic condition on the lower extremity, and abnormal contralateral knee joint. Accordingly, 31 patients were available for evaluation and divided into two groups (16 hamstring tendon autograft, 15 peroneus longus autograft). Ethical approval was granted by the ethical committee at the designated hospital, and subjects provided written informed consent before participation. This study has been carried out in line with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans [19].

Arthroscopic procedure

A single knee surgeon performed all the arthroscopic procedure. The patients lay in a supine position under regional anesthesia, and a tourniquet was applied to the thigh and inflated without elevation and exsanguination. Standard anterolateral and anteromedial portals were used. Diagnostic arthroscopy for ACL rupture was initially performed, followed by graft harvesting of either the ipsilateral peroneus longus or the hamstring tendon (semitendinosus and gracilis tendons). For the peroneus tendon, the skin incision location was marked 2–3 cm above and 1 cm behind the lateral malleolus. The incision was then made through the skin, subcutaneous tissue, and superficial fascia. The peroneus longus and peroneus brevis tendons were located 2–3 cm above the lateral malleolus level. The distal part of the peroneus longus tendon was sutured to the peroneus brevis tendon with end-to-side sutures. The peroneus longus tendon was then stripped proximally with a tendon stripper to about 4–5 cm from the fibular head to prevent peroneal nerve injury.

The intercondylar notch was then cleared of fibrous tissue to ease visualization during the tunnels' preparation, but some remaining ACL fibers were preserved as a reference for tunnel placement. The femoral tunnel and the tibial tunnel were then prepared independently. After drilling the tunnels, we proceeded with the implantation of the tendon with graft fixation on the femoral side with a button (XO Button®, Conmed©, USA) and graft fixation on the tibial side with a bioabsorbable screw (Bioscrew®, Conmed©, USA) after appropriate tensioning with a graft tensioner.

Rehabilitation and follow up assessment

Both groups of patients were treated with the same rehabilitation program that was divided into five phases.

- Phase I (week 1–2): partial weight-bearing and full extension within 14 days
- Phase II (week 3–6): quadriceps and hamstring strengthening
- Phase III (week 6–12): proprioceptive exercise
- Phase IV (week 12–20): early sport activity
- Phase V (week 20–24): return to sport.

The follow-up assessment was conducted on the phase II rehabilitation program to give the surgical wound enough time to recover. The assessment was performed by anamnesis and physical examination for the presence of pain and crepitus. Both pain and crepitus were reported as yes (present) or no (not present). Subsequently, both groups were asked to fill the Indonesian version of the Kujala Anterior Knee Pain Scale or shortly known as the Kujala score, a patient-reported evaluation of patellofemoral pathology based on symptoms and functional limitation, and comprised of 13 questions [20]. The responses were summed to obtain a total score of 0–100, with 100 means no pain or limitation. The Indonesian version of the Kujala score's validity and reliability to assess patellofemoral pain have been reported [21].

Statistical analysis

The comparison of age, weight, height, time from surgery to evaluation, and Kujala score between hamstring and peroneus longus groups were performed using either the Mann-Whitney U test or independent sample t-test, depending on the data distribution. Fisher's exact test was conducted to compare the gender and the presence of pain and crepitus between hamstring and peroneus longus groups. All analysis was executed with IBM SPSS Statistics 25 for Windows. A $p < 0.05$ was accepted as statistically significant.

Results

Of 31 subjects, 21 (68%) are males, and 10 (32%) are females. The characteristics of the subjects are presented in Table 1. Sixteen (52%) subjects had surgery with hamstring tendon autograft and 15 (48%) subjects with peroneus longus tendon autograft. There were no significant differences in age, gender, weight, height, and time from surgery to evaluation between both groups.

Table 1: Characteristics of the study population

Variables	Hamstring group (n = 16)	Peroneus longus group (n = 15)	p-value
Age (years)	23.19 (16–38)	24.20 (16–49)	0.890
Gender	Male: 10 Female: 6	Male: 11 Female: 4	0.704
Weight (kg)	63.81 (47–90)	72.33 (50–97)	0.113
Height (cm)	168.38 (149–185)	168.53 (152–195)	0.751
Time from surgery to follow up (months)	6.72 (2–12)	8.87 (4–12)	0.173

Table 2 Compared the assessment results on pain, crepitus, and Kujala score between hamstring and peroneus longus groups. There were no significant differences in pain ($p = 0.433$) and crepitus ($p = 0.716$) between both groups. However, significant differences in the Kujala score were noted between both groups ($p < 0.001$). The peroneus longus group reported an averagely higher score than the hamstring group.

Table 2: Comparison of the assessment outcome

Variables	Hamstring group (n = 16)	Peroneus longus group (n = 15)	p-value
Pain	Yes: 6 No: 10	Yes: 3 No: 12	0.433
Crepitus	Yes: 9 No: 7	Yes: 10 No: 5	0.716
Kujala score	71.44 (SD 10.89)	93.53 (SD 5.84)	<0.001

Discussion

The use of BPTB autograft for ACL reconstruction has been held accountable for post-surgery patellofemoral complications [10], [22], [23]. Nonetheless, these complications still occurred in patients after ACL reconstruction using hamstring tendon, although the number was not as high as BPTB harvested patients [5], [24]. For this reason, studies have investigated peroneus longus tendon as the alternative graft source for ACL reconstruction.

This study found significant differences in Kujala score between the hamstring and peroneus longus groups favoring the peroneus longus group ($p < 0.001$). The mean Kujala score for the hamstring and peroneus longus groups was 71.44 (SD 10.89) and 93.53 (SD 5.84), respectively. The Kujala score has been proven to be valid and reliable for the diagnosis and screening of patellofemoral disorders [25], [26]. From our result, it can be concluded that the peroneus longus group had fewer patellofemoral symptoms and functional limitations than the hamstring group. Kujala *et al*. [20] reported that a low Kujala score is correlated with increased lateral patellar tilt during quadriceps contraction in 0° knee flexion, and this lateral tilt may be the cause of patellofemoral pain.

To the best of our knowledge, this is the first study that compares the patellofemoral disorders between hamstring and peroneus longus harvested patients with the Kujala score. Therefore, no studies can be used as a direct comparison to our study. Nevertheless, several studies have investigated the knee's functional status in the hamstring and peroneus longus groups using different methods. Rhatomy *et al*. [17] reported that ACL reconstruction using peroneus longus had comparable knee functional score to the hamstring as calculated with the International Knee Documentation Committee (IKDC) Subjective Knee Form, modified Cincinnati score, and Lysholm score. These findings are consistent with the results by Shi *et al*., [18] who found comparable functional scores, evaluated with Tegner-Lysholm Knee Scoring Scale and IKDC, between peroneus longus and hamstring groups. These two studies have a contrasting result with our study in terms of the functional scores. If we set aside the different scoring systems used, the follow-up time and the graft folding may elucidate this contrasting result. Decreased hamstring strength and loss of flexion range of motion (ROM) have been proposed as the cause of patellofemoral pain in hamstring harvested patients [13]. Whereas, rehabilitation post ACL reconstruction has proven to strengthen the hamstring and regain the flexion ROM, thus decreasing the patellofemoral pain [27], [28]. Rhatomy *et al*. [17] evaluated their subjects 1 year after surgery, giving the patients time to complete the rehabilitation and possibly lessen the patellofemoral symptoms. Meanwhile, Shi *et al*. [18] performed the reconstruction using doubled peroneus longus autograft and quadrupled hamstring autograft, instead of single bundled autografts like in our study. In their study, Shi *et al*. [18] reported that doubled peroneus longus and quadrupled hamstring had a comparable tensile strength. Therefore, it may be concluded that a single bundle hamstring graft has a lower tensile strength than a single bundle peroneus longus graft. The lower tensile strength in the hamstring tendon possibly causes patellofemoral problems and thus lower the Kujala score. However, further investigation is needed to confirm this possibility.

Although we found significant differences in the Kujala score, we discovered no significant pain and crepitus differences between both groups. Nevertheless, anamnesis and physical examination were conducted to assess persistent pain and crepitus present at the moment of the examination. Therefore, the results could not represent the presence of pain and crepitus during various activities. Moreover, the Kujala score consists of seven pain-related activities questions, four pain-unrelated questions, and only two questions that evaluated persistent pain.

This study has some limitations. First, the lower incidence of isolated ACL rupture than ACL rupture with concomitant injuries resulted in our study's small sample population. We wanted to make sure that our study has as few biasing factors as possible by excluding other cases besides isolated ACL rupture. Second, since we did not have pre-surgery data of pain, crepitus, and Kujala score, we could not compare it with our post-surgery results. Thus, the possibility of preexisting patellofemoral disorders could not be investigated. Finally, we only conduct one follow-up evaluation of our subjects because the number of rehabilitation participants in our hospital tends to decrease after phase II, resulting in the loss of follow-up. Nonetheless, this is the first study that compares the patellofemoral functional status between hamstring and peroneus longus autografts using the Kujala score. Further investigations with larger sample sizes, more parameters, and longer follow-up will add more knowledge regarding this matter.

Conclusions

Single bundle ACL reconstruction using peroneus longus tendon autograft produces less patellofemoral symptoms and functional limitation than using hamstring tendon autograft.

Ethical Approval

This study has been reviewed and approved by the Medical and Health Research Ethics Committee No: KE/FK/1396/EC/2020.

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