Original Article

Can we use peroneus longus in addition to hamstring tendons for anterior cruciate ligament reconstruction?

Khalilallah Nazem, Mohammadreza Barzegar, Alireza Hosseini[1], Mohammadtaghi Karimi[2]

Department of Orthopedics, [1]General Physician, School of Medicine, [2]Department of Rehabilitation, Isfahan University of Medical Sciences, Isfahan, Iran

Abstract

Background: The aim of this study is to evaluate the possible effects of removing the peroneus longus on the ankle and gait parameters, in order to add insufficient hamstring tendons for anterior cruciate ligament (ACL) reconstruction.

Materials and Methods: In this controlled clinical trial, 375 patients with ACL rupture who underwent ACL reconstruction arthroscopically using hamstring tendons in the orthopedic clinics of Isfahan University of Medical Sciences in 2010 and 2011 were selected. Fifteen patients were included because their hamstring tendon diameter was lower than 8 mm and peroneus longus was added. After 6 months, the patients were followed using "Kistler force plate" to detect 3D kinematics and kinetics of the ankles and spatiotemporal walking parameters.

Results: There was a significant difference between both operated and non-operated ankles in flexion/extension range of motion ($P < 0.05$). There was no significant difference between the moments of both ankles in sagittal and coronal planes ($P > 0.05$), but there was a significant difference between the moments of both ankles in the transverse plane ($P = 0.006$). There was a significant difference in the force of operated and non-operated ankles in all three planes ($P < 0.05$). There was no significant difference in the mean values of spatiotemporal gait parameters between operated and non-operated sides($P > 0.05$).

Conclusion: Removing the peroneus longus tendon has no effect on gait parameters and does not lead to instability of the ankle. So, it can be used as an autogenous graft in orthopedic surgeries.

Key Words: Ankle instability, anterior cruciate ligament reconstruction, peroneus longus tendon

Address for correspondence:
Dr. Mohammadreza Barzegar, Department of Orthopedics, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: m.barzegar62@gmail.com
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INTRODUCTION

Knee is the second greatest weight-bearing joint of the human body. Knee stability mainly belonged to ligamentous and involves cruciate ligaments. Anterior cruciate ligament (ACL) and posterior longitudinal ligament are the most important ones.[1]

ACL has an important role to stabilize knee joint against translational and rotational forces. ACL

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rupture incidence in the general population has been estimated at 1 in 3000. It may lead to knee instability, meniscus tear, and osteoarthritis.[2]

The goal of anatomic reconstruction of the ACL is to regenerate a stable knee that will allow returning to sport and prevent recurrent injury. Multiple graft options exist with their unique advantages and disadvantages and are of two main types: allograft and autograft.[3]

Disadvantages of allograft are their cost and chance of disease transmission. The two main autografts used for ACL reconstruction are bone patellar bone (BPB) and hamstrings. Main disadvantages of BPB are patellar fracture, knee extension, weakness, and donor site problems such as anterior knee pain. Hamstring tendons have greater mechanical strength than the other tendons and lower complications of the donor site.[4,5]

Techniques allowing the hamstring grafts to be doubled or even quadrupled improve the initial tensile strength and increase the cross-sectional diameter of the graft which should be at least 7 mm. Also, hamstring tendons are acceptable sources of ACL reconstruction autograft. We need an additional source of graft for special circumstances that hamstring tendon's thickness is less than 7 mm because of technical errors of removing tendons or even due to normal variations in the diameters of hamstring tendons.[6-8]

It was shown by various researches that PL tendon is a suitable choice for ACL reconstruction because of its length and strength, but we do not know well about the side effects. Previously peroneus longus tendon (PLT) was used as a source of autologous tendon graft, but studies about its side effects are insufficient.[4,6,8-10]

In this research, we added PL tendon to the insufficient hamstring tendons for ACL reconstruction and studied the possible effects on the ankle and gait parameters.

MATERIALS AND METHODS

We undertook a controlled clinical trial in which 375 patients with ACL rupture approved by physical examination and magnetic resonance imaging (MRI) and ligament reconstruction indication underwent ACL reconstruction arthroscopically using hamstring tendons in the orthopedic clinics of Isfahan University of Medical Sciences in 2010 and 2011. Fifteen patients were included because their hamstring tendon's diameter was lower than 7 mm due to technical errors of removing tendons or even normal variations in hamstring tendon's diameter. So, peroneus longus was added. The distal end of remaining PL tendon was sutured to the side of PB tendon.

After 6 months, patients were followed up using "Kistler force plate" to detect 3D kinematics and kinetics of the ankles and spatiotemporal walking parameters. An ethical approval was obtained from the Isfahan University of Medical Sciences ethical committee. Moreover, the subjects were asked to sign a consent form before data collection.

For tracing the movement of the subjects, an array of seven high-speed cameras by Qualysis Company network, USA was used. Participants were asked to walk at a comfortable speed over a level walkway. The ACL was reconstructed with hamstring and PLTs obtained graft. The patients underwent a functional knee orthosis during the 3 months after surgery. The subjects participated in this research 6 months after ACL reconstruction surgery. Moreover, the force applied on the leg was measured by a Kistler force plate. The motions of the markers and the force plate data were recorded by use of Track Manager Software produced by Qualysis Company. The markers were labeled and defined in Track Manager and exported as 3D files. The subjects' lower body anatomy was reconstructed by Visual3D software produced by C Motion Company Nebraska, USA. This program was also used for calculation of the ankle joint angles during walking. Force plate data were also processed with 3D to calculate the resulting moments of the lower limb joints.

Sixteen markers (with 14-mm diameter) were attached to the right and left anterior superior iliac spines (ASIS), right and left posterior superior iliac spines (PSIS), right and left medial and lateral malleolus, right and left medial and lateral sides of the knee joints, and first and fifth metatarsal heads. Moreover, four marker clusters comprising four markers attached on the rhomboid plates were attached to the anteriolateral surfaces of the legs and thighs by use of extensible Velcro straps. The subjects were asked to walk along a level surface to collect five successful trials. The collected data were filtered (Woltring filter with frequency of 10 Hz) and split to gait cycle interval using heel strike data.

The normal distribution of all mentioned parameters was tested using Shapiro–Wilk test. Since the parameters had a normal distribution, the parametric statistical test was used to evaluate the difference between the mean values. Two-sample *t*-test with a significance level at 0.05 was used to compare the gait parameters of operated and non-operated sides.

RESULTS

In this study, we evaluated 15 patients after they underwent the knee operation explained above and compared the operated knee to their intact side. In the evaluation of ankle ROM, we studied flexion/extension, inversion/eversion, and rotation of ankle [Table 1].

In the operated ankle, flexion/extension, inversion/eversion, and rotation of ankle were 24.8° ±4.47°, 18.09° ±8.31°, and 17.29° ±8.72°, respectively. In the intact side, the same parameters were 25.10° ±2.79°, 17.74° ±4.92°, and 14.65° ±7.24°, respectively. There was a significant difference between both ankles in flexion/extension parameter only ($P = 0.005$)

In the evaluation of moment in different planes, we studied sagittal, coronal, and transverse planes of ankle in operated and non-operated sides [Table 2].

In the operated ankle, the moments in sagittal, coronal, and transverse planes were 1.52 ± 0.57, 0.32 ± 0.16, and 0.21 ± 0.14 n/cm, respectively. In the non-operated side, the same planes were 1.27 ± 0.71, 0.22 ± 0.17, and 0.16 ± 0.15 n/cm, respectively. There were no significant differences between both ankles in sagittal and coronal planes ($P > 0.05$), but there was a significant difference between both ankles in the transverse plane ($P = 0.006$).

After operation, we evaluated the operated and non-operated ankles for force in anteroposterior, mediolateral and vertical aspects [Table 2].

In the operated ankle, the maximum and minimum forces in anteroposterior aspect were 0.18 ± 0.02 and 0.12 ± 0.03 N, respectively. In the non-operated side, the same forces were 0.19 ± 0.02 and 0.11 ± 0.04 N, respectively. In the operated ankle, the forces in mediolateral, vertical (first peak), vertical (valley), and vertical (second peak) aspects were 0.07 ± 0.01, 0.86 ± 0.19, 0.70 ± 0.22, and 0.88 ± 0.17 N, respectively. In the non-operated side, the same forces were 0.07 ± 0.02, 0.88 ± 0.21, 0.71 ± 0.22, and 0.92 ± 0.16 N, respectively. There was a significant difference between the operated and non-operated ankles in all force planes ($P < 0.05$).

The mean values of stride length, speed, and cadence were 1.25 ± 0.114 m, 1.031 ± 0.16 m/s, and 8.43 ± 8.8 steps/min, respectively, in the operated sides, compared to 1.26 ± 0.13 m, 1.06 ± 0.21 m/s, and 100.76 ± 10.5 steps/min, respectively, in the contralateral sides. There was no significant difference in the mean values of spatiotemporal gait parameters between operated and non-operated sides ($P > 0.05$).

Table 1: Mean of ROM in both ankles after operation

Group	Operated ankle	Intact ankle	*P* value
Flexion/extension	24.8±4.47	25.10±2.79	0.005
Inversion/eversion	18.09±8.31	17.74±4.92	0.3
Rotation	17.29±8.72	14.65±7.24	0.9

Values are mean±SD, ROM: Range of motion

Table 2: Mean of force or moment of different plane

Plane	Operated ankle	Non-operated ankle	*P* value
Sagittal	1.52±0.57	1.27±0.71	0.9
Coronal	0.32±0.16	0.22±0.17	0.2
Transverse	0.21±0.14	0.16±0.15	0.006
Anteroposterior (max)	0.18±0.02	0.19±0.02	0.01
Mediolateral	0.07±0.01	0.07±0.02	0.0001
Vertical (first peak)	0.86±0.19	0.88±0.21	0.001
Vertical (second peak)	0.88±0.17	0.92±0.16	0.01

Values are mean±SD

DISCUSSION

Peroneus longus is one of the main evertors of ankle which participates in all three planes. In this study, we observed that ankle force was reduced in all three planes that were predictable regarding the removal of the muscle motor.

Ankle instability is one of the major concerns of removing PL, but there was no increase in the ankle range of motion. We also observed depletion in ROM in sagittal plane in this study, which can be due to compensational activities of the other muscles.

Few studies have examined the strength of the ankle joint musculature following ACL injury or reconstruction. Karanikas *et al*. reported no differences bilaterally in isokinetic ankle plantar flexor strength between 3 and 6 months or 6 and 12 months postoperatively; however, decreased gastrocnemius electromyography activity has been demonstrated during gait in ACL-deficient individuals, as well as during landing following ACL reconstruction, the findings which could be the result of muscle weakness.[11-13]

There are little data concerning the use of the anterior half of the peroneus longus tendon (AHPLT) as an additional autograft. The AHPLT is a suitable graft with respect to its strength, safety, and donor site morbidity.

Kerimoglu *et al*. used full-thickness PLT to reconstruct torn ACL due to the knee joint complications involving patellar and hamstring tendons. Their patients did not report any complaints about the ankle joint dysfunction or any difficulty in sports activities.

However, no clinical pathology was observed in them after harvesting the tendon grafts even if the cases have regularly sport activities walking analyses and study of muscle strength could not be performed to evaluated functional state in ankle.[14]

Kerimoglu *et al*. evaluated the results of ACL reconstruction using a PLT autograft. According to the International Knee Documentation Committee scale, 17 patients (58.6%) were rated as normal or nearly normal and 12 patients (41.4%) as abnormal or severely abnormal. The mean Lysholm score was 83.7 (range 45-100), with excellent or good results obtained in 23 patients (79.3%). Radiographic examination showed mild (n = 10) or moderate (n = 1) degenerative changes in the knee joint. Compared with the normal side, no flexion or extension losses occurred in the affected knees. Stability of the ACL was assessed by the Lachman test, which showed normal findings in 12 patients (41.4%) while 9 patients had 1+, 5 patients had 2+, and 3 patients had 3+ anteroposterior laxities. Pivot-shift test was negative in 13 patients (44.8%); 10 patients had 1+ pivot glide and 6 patients had 2+ pivot shift. Two patients (6.9%) complained of mild to moderate pressure pain, paresthesias, and dysesthesia at the donor site of PLT. No patient experienced ankle joint dysfunction or difficulty in sports activities due to PLT graft transfer.[4]

According to Thomas Study, there were no ankle muscle strength deficits when ACL-injured persons were compared to healthy individuals pre- or postoperatively, though differences existed in quadriceps and hamstring strength preoperatively between ACL-injured and control individuals. The results of this study suggested that improvements in current rehabilitation strategies are necessary to better target lingering quadriceps and hamstring strength deficits.[15]

Increase in ankle moment in transverter plane is the other remarkable change in this study. Movement is obtained by multiplying the force in the length of arm lever. We sutured distal end of PL to the side of PB then both the force and the lever arm has been changed and made predictable changes in movement.

In spite of all the mentioned changes, removing PLT had no effect on the spatiotemporal and gait parameters. It also did not induce instability in the foot wrist.

The spatiotemporal gait parameters did not change in both sides. The walking velocity of the subjects in the operated side decreased slightly, but it did not influence on the walking velocity. Therefore, the symmetry of walking in both sides was nearly the same.

CONCLUSION

This study showed that removing the PLT has no effect on gait parameters or even instability of the ankle. So, it can be used as an autogenous graft in orthopedic surgeries.

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