Original Article

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Measurement of quadriceps strength among patients of Dhulikhel hospital following anterior cruciate ligament reconstruction: A descriptive cross-sectional study

Adhikari U,[1] **Thapa B,**[2] **Shrestha R**[3]

[1]Umesh Adhikari, Lecturer, Kathmandu University School of Medical Sciences, Dhulikhel Hospital, Dhulikhel, Kavrepalanchok, Nepal; [2]Barsha Thapa, Physiotherapist, Dirghayu Guru Hospital, Mitrapark, Kathmandu, Nepal; [3]Rajan Shrestha, Senior Academic and Research Officer, Hospital for Children, Eye, ENT, and Rehabilitation Services, Madhyapur Thimi, Bhaktapur, Nepal.

Abstract

Background: Anterior cruciate ligament is the key structure of the knee joint. Quadriceps weakness in the involved leg is frequently seen in the rehabilitation setting even when an individual returns to their functional activity.

Objectives: To measure the quadriceps strength following an anterior cruciate ligament reconstruction and evaluate the functional activity level.

Methods: An analytical cross-sectional study was conducted among 30 anterior cruciate ligament reconstruction patients visiting physiotherapy outpatient department of Dhulikhel hospital between 2nd May 2019 to 4th May 2020. Non-probability purposive sampling was used for the study. Participants with a history of primary unilateral anterior cruciate ligament reconstruction no less than six months were recruited for the study. Study excluded other lower limb surgeries, anterior cruciate ligament reinjury, multiligament injury, and pregnant women. Quadriceps muscle strength was assessed by using a handheld dynamometer, MicroFET2 and functional activity level with Lysholm scale. Independent sample t-test was done to assess the association between quadriceps strength and different variables.

Results: Quadriceps strength deficit in an involved limb was 17.5% and mean length physiotherapy follow up was 11.7 ± 5.9 days in six months. Quadriceps strength was significantly different between genders. There was no statistical significance between quadriceps strength and body mass index. Higher quadriceps strength had greater levels of function.

Conclusion: Quadriceps strength deficit was found after anterior cruciate ligament reconstruction. Functional activity was affected even after an individual returned to their normal daily activities.

Key words: Anterior cruciate ligament injuries; Anterior cruciate ligament reconstruction; Muscle strength; Rehabilitation.

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Address for correspondence

Mr. Umesh Adhikari
Lecturer, Department of Physiotherapy,
Kathmandu University School of Medical Sciences,
Dhulikhel, Kavrepalanchok, Nepal
E-mail: umeshpt77@gmail.com

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INTRODUCTION

The anterior cruciate ligament is a key structure of the knee joint which resists anterior tibial translation as well as extreme tibial rotation during knee loading.[1] Globally, prevalence rate for anterior cruciate ligament (ACL) injury is more than 200,000 per year.[2] Women have higher incidence for ACL injury compared to men.[3-5] Increased body mass index (BMI) also leads to higher risk of ACL injury.[6] Approximately 250,000 ACL reconstructions are performed every year in the United States.[7]

Quadriceps strength deficit have been widely documented to impact physical function which may contribute to high loading in the knee joint

which eventually leads to the high prevalence of osteoarthritis.[8,9] The quadriceps strength deficits with anterior cruciate ligament injury ranges from 5% to 40% and have been noted even after seven years of surgery.[10] Intensive physiotherapy treatment in rehabilitation setting is provided for five to six months following ACL reconstruction (ACLR).[11] For a better outcome, the focus has to be on time interval and intensive physiotherapy treatment.[12]

Quadriceps muscle strength is an important determinant of physical performance as it plays a vital role in the dynamic stability and the function of the joint.[7,13,14] Present study aims to measure the quadriceps strength after an ACLR.

METHODOLOGY

It was an analytical cross-sectional study conducted among the ACL reconstruction patients visiting Dhulikhel Hospital following six months' time period. There were total of 50 patients with ACL reconstructions in between May 2nd 2019 to 4th May 2020 AD, out of which only 30 met the inclusion criteria. The sampling technique used in this study was non-probability purposive sampling. The study was approved by the Institutional Review Committee of Kathmandu University School of Medical Sciences, Dhulikhel, Nepal (Ref. 151/19). Written informed consent to participate in the study was obtained from all participants.

The participants were screened for the inclusion criteria which included an ability to speak and understand Nepali language and individuals with a history of primary unilateral ACL reconstruction. Participants with no less than six months after ACLR were recruited for the study. Study excluded any other lower limb surgeries other than ACLR, ACL reinjury, multiligament injury, and pregnant women. All the patients with ACL injury underwent hamstring graft for the ACL reconstruction. The aim and procedure of the study to the eligible individuals were explained after screening. There were total of 50 patients who had undergone an ACL reconstruction surgery in between May 2nd 2019 to May 4th 2020 AD. Out of 50, only 30 patients met inclusion criteria.

The tool used in this study to measure quadriceps strength was MicroFET2 which is a battery-operated, load cell system with a digital reading of peak force expressed in Newton and shows good intra-rater reliability.[15] The device offers a choice a high or low threshold for the minimal force to start the test.[16] Lysholm scale was used to measure the functional activity level and for the early return to physical function after an ACL reconstruction.[17]

The socio-demographic characteristics of the study population were analysed using descriptive statistics. Frequency count for categorical variables, mean and standard deviation for continuous variables were assessed. Independent sample t-test was done to assess the association between the quadriceps strength and different variables. All the statistical analyses were performed using IBM Statistical Package for Social Sciences (SPSS) Statistics for Windows, version 21 (IBM Corp., Armonk, N.Y., USA). The p-value <0.05 was taken as statistically significant.

RESULTS

Present study included 30 ACL reconstruction patients where half of the participants were male and other half participants were female. The mean age of the participant was 32.2 ± 7.5 years, mean height was 167 ± 17.75 cm and mean BMI was 26.1 ± 3.5 (Table 1).

Patients who had undergone ACL reconstruction required longer period of rehabilitation time to restore strength and function. Here, the mean physiotherapy follow-up was 11.6 ± 5.9 days (Table 2).

Out of 30 ACL reconstruction patients four (12%) of them sustained their injury during sports activities, 25 (85%) were a result of other cause such as accidental slips, falls, or trips. While only one (3%) patient sustained injury due to road traffic accidents (Figure 1). Right knee was more commonly affected (n = 18), than left knee (n = 12) (Table 3). Along with ACL injury, meniscus tear was most frequently associated, 14 (47%) respectively and without meniscus tear it was 16 (53%) respectively. Arthroscopic surgical management was performed in all 30 participants.

Quadriceps strength was significantly lower in an involved leg as compared to the uninvolved leg. The quadriceps strength deficit in the involved leg was 17.5% as compared to uninvolved leg. In male the quadriceps strength was higher by 5.6%. In female the strength was higher by 9.1%. Quadriceps strength was significantly different in between gender: p=0.002 (p<0.05). Mean quadriceps strength in an involved leg was 64.8 ± 20.2 and in uninvolved leg was 78.6 ± 17.1. This study assessed that there was no statistical significance between quadriceps strength and the BMI (Table 4). Patient with higher quadriceps strength score represented with greater levels of function.

Mean Lysholm score was 73 ± 13.2. Among them 30% had poor score, 46.7% had fair score, 6.7% had well, and 16.7% had excellent score.

Table 1: Characteristics of the participants included in the study (N = 30)

Characteristics		n (%)
Gender	Male	15 (50)
	Female	15 (50)
Body mass index (kg/m^2)	Normal	10 (33.3)
	Overweight	14 (46.7)
	Obese	6 (20)
Address	Kavrepalanchok	17 (56.7)
	Kathmandu	6 (20)
	Bhaktapur	4 (13.3)
	Others	3 (10)
Occupation	Recreational activities	9 (30)
	Farmer	8 (26.6)
	Housewife	5 (16.7)
	Students	5 (16.7)
	Businessman	3 (10)

Table 2: The age, height, and body mass index of the participants

Characteristics	Mean ± SD
Age (Years)	32.2 ± 7.5
Height (cm)	167 ± 17.7
Body mass index (kg/m^2)	26.1 ± 3.5
Physiotherapy follows-ups (days)	11.7 ± 5.9

Table 3: Characteristics of the participant with ACLR included in the study

Variables		n (%)
ACLR with or without meniscus tear	ACLR with meniscus tear	14 (46.7)
	ACLR	16 (53.3)
Involved leg	Right leg	18 (60)
	Left leg	12 (40)

Table 4: Association between quadriceps strength with different influencing factor

Characteristics		Strength of involved leg (Mean ± SD)	p-value*
Gender	Male	75.5 ± 17.1	0.002*
	Female	54.1 ± 17.6	
Body mass index	<25	63.5 ± 19.9	
	≥25	65.5 ± 20.8	0.796
Isolated ACL	isolated ACL	74.3 ± 17.2	0.004*
Involved leg	Right	61.2 ± 22.6	0.251
	Left	70.1 ± 15.5	
Lysholm	Lysholm score	73 ± 13.2	0.002*
*Independent sample t-test; significant at 95% Confidence level			

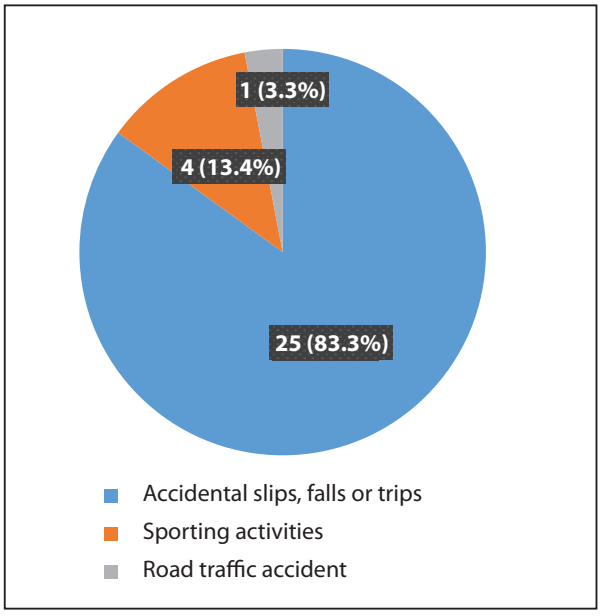

Figure 1: Mechanism of injury

DISCUSSION

The present study shows that the quadriceps muscle strength deficit in the involved limb is 17.56% compared with an uninvolved limb which is similar to the study done by Gobbi et al.[18] However, other studies have shown deficit in knee extensor as 32.6% which ranged from 5% to 40%.[11] This could be due to decrease in the duration of rehabilitation. The mean follow-up for the participants, in the current study was 11.7 ± 5.9 times. The duration period for rehabilitation after postoperative anterior cruciate ligament reconstruction was insufficient as mentioned by Thomas et al. mentioned that for those participants who have been receiving postoperative physiotherapy rehabilitation was on an average of seven months. The current rehabilitation strategy does not fully restore the strength by the time individuals return to their activity level.[11]

A rehabilitation program setting does not alter the quadriceps strength. Beynnon et al. reported that

patients who underwent accelerated rehabilitation experienced a significant improvement in thigh muscle function at three months follow-up ($p < 0.05$) compared with those who participated in non-accelerated rehabilitation but there were no differences between the program seen after this interval time period.[19] The current study shows that the time duration and follow-up period were necessary to restore muscle strength after anterior cruciate ligament reconstruction is.

In the present study, we assessed quadriceps strength at six months after ACLR and compared with an uninvolved limb where we found quadriceps strength deficit of 17.5% on an involved limb. The quadriceps strength deficits have been noted as long as several years after the surgery.[11] Palmier-Smith found that one of the factors demonstrating for quadriceps strength deficits could be neuromuscular dysfunction which is common following ACL injury which can persist even at a time of return to participation.[10] Not only may these reasons for the deficit of muscle strength in the involved leg but also the graft that the surgeon chooses for anterior cruciate ligament reconstruction may influence the result of muscle strength.[20] Research conducted in the department of Orthopaedics, BP Koirala Institute of Health Sciences, Dharan, Nepal chose hamstring (semitendinous and gracilis) autograft from ipsilateral limb found good and predictable outcomes at six months.[21] In the interest of the merits of hamstring graft, in this study also all of the involved participant ACL reconstruction surgery was performed by using the hamstring graft. Studies have also shown that using a hamstring graft results in better muscle strength as compared to the patellar tendon graft.[20]

The current results revealed a significant decrease of the knee extensor muscle strength in males as compared to females after anterior cruciate ligament reconstruction at six months. It was found that the significant changes between gender and those differences could be due to the influence of occupation rather than sex. The possible explanation could be that the most of the participants approximately (8, 26.7%) were involved in farming occupation. Most of the female participants were farmers. Previous researchers concluded that the farmers do a lot of bending and squatting activities and had greater lower extremity muscle power strength.[22] The persistent weakness of quadriceps strength in females using hamstring in the operated leg were not significant.[18] Several studies have concluded that quadriceps strength was not significant between the genders.[18,23] Current study showed that there is no association between BMI and quadriceps strength which resembles several other studies. Some studies also mentioned that athletes with a BMI of less than 25 were more likely to return to their sport activities than those with a BMI of more than 25 ($p = 0.017$).[6] The plausible explanation they had mentioned was that BMI has an inverse relationship with the physical fitness.[6]

The study shows a significant relation between quadriceps strength and functional outcome which was obtained through the Lysholm scale. The Lysholm score in the present study is low when compared to the study conducted at BP Koirala Institute of Health Sciences where Tegner and Lysholm score after ACLR at six-month postoperative was 93 ± 3.94, the maximum follow-up was nine months and minimum was six months.[22] The possible explanation for low Lysholm sore could be due to association of pain, swelling, stiffness, and the weakness of muscle strength. The participants had a persistent pain, swelling, stiffness component even though they returned to their activity of daily which indirectly affect the functional status. Along with such a problem next plausible reason could be fear of movement during ACLR rehabilitation. The study concluded that continuous bodily pain has a significant role to reduce function in the first six months.[24]

CONCLUSION

The present study found that quadriceps strength deficit was present in patient with reconstructed ACL even after their return to their functional activity. Subjects with greater quadriceps strength were more likely to have less knee pain and have better physical activity. There was no association between the quadriceps strength and BMI, while it was in some extent associated with sex and functional level. There may be other possible influencing factors other than quadriceps strength as most of the patients stated fear as one of the factors to reduce functional activity. The authors suggest that awareness of rehabilitation after ACLR is necessary to restore quadriceps muscle strength and better knee outcome. Monitoring quadriceps muscle strength is useful for the better recovery after ACL injury in rehabilitation settings. Current study can be the baseline for the further studies with larger sample to compare and confirm the findings in future.

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