Limited Knee Extension Prior to Anatomic Single Bundle Anterior Cruciate Ligament Reconstruction and Prolonged Preoperative Rehabilitation Affect Postoperative Quadriceps Strength

TAKUYA SENGOKU[1], Junsuke Nakase[2], Tomoyuki Kanayama[3], Yoshihiro Ishida[4], YUSUKE YANATORI[1], Yu Arima, Yushin Mizuno
[1]Kanazawa University, [2]Junsuke Nakase, MD Phd, Department of Orthopaedic, [3]Kanazawa University Hospital, [4]Kanazawa-University

INTRODUCTION:
One of the major challenges after anterior cruciate ligament (ACL) reconstruction is the improvement of quadriceps strength. This strengthening is very important because it determines the timing of the start of postoperative running and returns to sports. There have been a lot of reports on the factors contributing to decreased quadriceps strength after ACL reconstruction. Although there are other factors involved, the use of patellar and quadriceps tendons as grafts are considered to significantly impact quadriceps strength. On the other hand, ACL reconstruction using the hamstring tendon of the knee flexor has also failed to meet the criteria for return to sports in some cases. The purpose of this study was to determine the factors that influence the improvement of quadriceps strength after ACL reconstruction using the hamstring tendon graft at 6 months postoperatively. In addition, we examined ways to respond by including items that can be improved, such as preoperative range of motion, waiting period, surgical information, and quadriceps strength at 3 months postoperatively in the study items.
METHODS:
This retrospective study was approved by the Ethics Committee of the hospital. One-hundred-forty-one patients who underwent ACL reconstruction between 2015 to 2022 were included in this study. All patients used hamstring tendon graft, and Tegner activity level scale □ 6. The exclusion criterion was re-injury. The patients were divided into two groups based on the results of isokinetic quadriceps strength (angular velocity 60°) at 6 months postoperatively: the good group with the limb symmetry index (LSI) of more than 90% and the poor group with the LSI of less than 85%. Basic information such as age, gender, and preoperative waiting period were compared between the two groups, as well as other items such as the mechanism of injury and complications, preoperative limited knee extension, gracilis tendon harvest, block injection used for pain management, and quadriceps strength at 3 months postoperatively. Logistic regression analysis was performed on the items that showed statistically significant differences among these items. Furthermore, the cut-off value of LSI for quadriceps strength at 3 months postoperatively required to achieve 90% in LSI at 6 months postoperatively was calculated from the receiver operating characteristic curve.
RESULTS:
The significant differences between the two groups were age, preoperative waiting period, preoperative limited knee extension, the LSI, and body weight ratio of quadriceps strength at 3 months postoperatively. Logistic regression analysis of these items showed that preoperative limited knee extension was the factor most associated with LSI ≥ 90% at 6 months postoperatively (OR: 15.1, 95%CI: 2.57-118.56, $p < 0.01$). The cut-off value at 3 months postoperatively for being classified in the good group at 6 months postoperatively was 72.0% of the LSI.
DISCUSSION AND CONCLUSION:
Preoperative limited knee extension was the strongest factor affecting improvement in quadriceps strength after ACL reconstruction. In addition, the prolonged preoperative waiting period was also a factor influencing muscle strength recovery. Therefore, improving preoperative limited knee extension as early as possible before surgery is important for postoperatively quadriceps strength improvement. The cut-off value of LSI for quadriceps strength at 3 months postoperatively was 72.0%. This result is an important predictor of knee extensor strength at 6 months postoperatively. On the other hand, complications from accelerated rehabilitation should be noted.

	Good group (n=95)	Poor group (n=46)	p-value
Basic information			
Age (years)	25.9 ± 12.4	20.3 ± 8.4	0.02
Sex (male: female)	50:45	21:25	0.48
Height (m)	1.6 ± 0.7	1.6 ± 0.8	0.59
Weight (kg)	63.1 ± 12.2	62.8 ± 11.4	0.70
BMI (kg/m2)	22.9 ± 3.5	22.7 ± 3.0	0.99
Preoperative waiting period (days)	79.3 ± 58.9	59.1 ± 39.3	0.04
Preoperative TAS	8 (6-9)	7 (6-9)	0.06
Status and complications			
Injury status (contact: noncontact)	16:79	10:36	0.49
MCL injury	11 (11.6%)	9 (19.6%)	0.21
Meniscus injury	59 (62.1%)	32 (69.6%)	0.45
Cartilage injury	25 (26.3%)	17 (37.0%)	0.24
Limiting knee extension			
Initial medical examination	46 (48.4%)	27 (58.7%)	0.28
Preoperative	3 (3.2%)	9 (19.6%)	<0.01
Surgical information			
Graft (ST: STG)	48:47	24:22	0.86
Peripheral nerve block (iv-PCA: FNB ACB: cocktail)	23:42:25:5	12:21:7:6	0.25
Muscle strength			
3M LSI (%)	82.3 ± 16.5	60.8 ± 15.1	<0.01
3M BW (N/kg)	1.7 ± 0.5	1.4 ± 0.5	<0.01
6M LSI (%)	105.6 ± 16.5	72.6 ± 11.6	<0.01
6M BW (N/kg)	2.3 ± 0.5	1.7 ± 0.5	<0.01
Occurrence time at 6M knee extensor (msec)	504.8 ± 150.8	535.0 ± 154.7	0.27
Output angle at 6M knee extensor (°)	70.0 ± 7.7	68.7 ± 10.2	0.44
Acceleration time at 6M knee extensor (msec)	35.5 ± 22.9	46.1 ± 42.6	0.10

Factors	Regression coefficient (β)	SE	OR (95% CI)	P value
Age	0.05	0.02	1.05 (1.006-1.10)	0.03
Preoperative waiting period	0.01	0.01	1.01 (1.001-1.02)	0.04
Preoperative limiting knee extension	-1.40	0.48	15.1 (2.57-118.56)	<0.01
3M LSI	-0.09	0.02	0.91 (0.87-0.94)	<0.01
3M BW ratio	0.14	0.57	0.86 (0.27-2.63)	0.80