Influence of preoperative knee instability on graft maturation on MRI 2 years after anterior cruciate ligament reconstruction – with focus on preoperative pivot shift grade-

Hiroaki Fukushima[1], Masahiro Nozaki[1], Jiro Kato[1], Shunta Hanaki[1], Makoto Kobayashi[2], Yusuke Kawanishi[3], Tetsuya Takenaga, Masahito Yoshida, Hideki Murakami[2]
[1]Nagoya City University Department of Orthopedic Surgery, Nagoya, Japan, [2]Nagoya City University Midori Municipal Hospital, Nagoya, Japan, [3] Ogaki Municipal Hospital, Ogaki, Japan
hiro.australia@gmail.com

Disclosures: Hiroaki Fukushima(N), Masahiro Nozaki(N), Jiro Kato(N), Shunta Hanaki(N), Makoto Kobayashi, Yusuke Kawanishi, Tetsuya Takenaga(N), Masahito Yoshida(N), Hideki Murakami(N)

INTRODUCTION: After anterior cruciate ligament (ACL) reconstruction, the graft tendon matures into ligament-like tissue through remodeling. Immature grafts are at high risk of reinjury, and graft maturity is important for postoperative outcomes. Knees with severe preoperative instability have also been reported to have poor outcomes. Signal changes in grafts on magnetic resonance imaging (MRI) expressed by the signal/noise quotient (SNQ) have been widely used to evaluate the maturity of ACL grafts. This study aimed to investigate the relationship between preoperative knee instability and graft maturity on MRI 2 years after ACL reconstruction.

METHODS: A total of 106 patients (48 male, 58 female; mean age 27.2 ± 12.2 years, range 13–60 years) who underwent primary double-bundle ACL reconstruction using autograft hamstring tendon between October 2016 and April 2021 were retrospectively analyzed. 77 patients with preoperative pivot shift grades 0, 1, and 2 were in group L, whereas 29 patients with pivot shift grade 3 were in group H. Group H was divided into subgroup A, which included 17 patients with isolated ACL reconstruction, and subgroup L, which included 12 patients with combined ACL and antero-lateral ligament (ALL) reconstruction. Their knees were evaluated using 1.5-T MRI 2 years after surgery, rates of postoperative residual pivot shift, and patient-reported outcomes. Based on MRI, the signal/noise quotient (SNQ) values were calculated separately for each of the three sections of the anteromedial bundle (AMB) and posterolateral bundle (PLB) of the ACL graft, including the proximal (P), middle (M), and distal (D) sections. (Image A) For statistical analysis of the comparison between groups, Student's t-test, Mann–Whitney *U* test, and chi-squared test were used. Statistical significance was defined as $p < .05$.

RESULTS: The AMB demonstrated significantly lower SNQ values in the group L than in the group H (P, 4.2 ± 4.5 vs 6.8 ± 5.4 [*P* = .015]; M, 6.9 ± 6.3 vs 10.3 ± 8.2 [P = .023]; D, 7.4 ± 6.9 vs 10.6 ± 8.1 [*P* = .044]). The SNQ values were significantly lower in the group L for 1 of the 3 sections of the PLB (P, 8.9 ± 6.7 vs 11.3 ± 9.5 [*P* = .14]; M, 10.7 ± 8.2 vs 13.2 ± 10.1 [P = .18]; D, 8.0 ± 7.2 vs 11.6 ± 10.1 [*P* = .039]). The residual pivot shift rates were 22.8% and 36.4% in groups L and H, respectively (P = .26). No significant differences in KOOS (96.0 ± 5.0 vs 96.4 ± 4.0 [*P* = .74]) and Lysholm score (96.3 ± 6.1 vs 96.0 ± 5.9 [*P* = .86]) were found between the groups. (Table 1) Between subgroup A and L, no significant SNQ difference was found for the all sections of AMB (P, 7.3 ± 6.2 vs 6.1 ± 2.5 [*P* = .56]; M, 12.3 ± 9.8 vs 7.6 ± 4.2 [P = .13]; D, 13.0 ± 9.3 vs 7.3 ± 4.6 [*P* = .060]) and PLB (P, 13.0 ± 11.9 vs 9.0 ± 3.6 [*P* = .27]; M, 14.5 ± 12.1 vs 11.6 ± 6.5 [P = .46]; D, 13.1 ± 11.8 vs 9.5 ± 6.9 [*P* = .35]). The residual pivot shift rates were 41.1% and 16.6% in the group I and L, respectively (P = .54) (Table 2)

DISCUSSION: In this study, we compared graft maturity and patient-reported outcomes 2 years after ACL reconstruction between patients with preoperative high-grade pivot shift and low-grade pivot shift. The most important finding of this study was that patients with preoperative grade 3 pivot shift had superior graft maturity in all three sections of the AMB and one of the sections of the PLB. There was no significant difference in patient-reported outcomes between the groups; however, to prevent reinjury of ACL grafts and poor clinical outcomes, careful follow-up is needed. The follow-up duration in this study was relatively short, and further investigation is needed. Isolated ACL reconstruction and combined ACL and ALL reconstruction showed no statistically significant difference in graft maturity; however, patients with combined ACL and ALL reconstruction tended to demonstrate lower mean SNQ values of all three sections of both AMB and PLB than those of patients with isolated ACL reconstruction. Thus, the small sample size could not provide enough power for subgroup analysis to detect the potential effect of ALL reconstruction on graft maturity.

SIGNIFICANCE: Compared with patients with preoperative pivot shift grades 0, 1, and 2, grade 3 patients, with or without combined ALL reconstruction, showed lower maturation of ACL grafts on MRI at 2 years postoperatively. To prevent reinjury and poor outcomes, careful follow-up is required in cases of high preoperative instability of ACL-injured knees.

IMAGES AND TABLES:

Image A

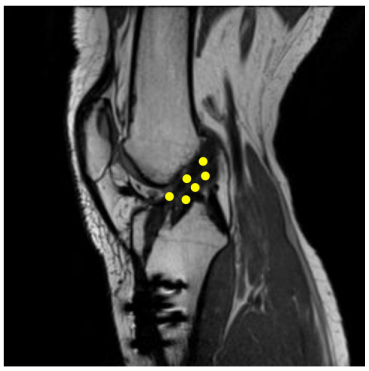

TABLE 1
SNQ values and postoperative outcomes

	Group L	Group H	*P*
Anteromedial bundle			
Proximal	4.2 ± 4.5	6.8 ± 5.4	0.015
Middle	6.9 ± 6.3	10.3 ± 8.2	0.023
Distal	7.4 ± 6.9	10.6 ± 8.1	0.044
Posterolateral bundle			
Proximal	8.9 ± 6.7	11.3 ± 9.5	0.14
Middle	10.7 ± 8.2	13.2 ± 10.1	0.18
Distal	8.0 ± 7.2	11.6 ± 10.1	0.039
KOOS	96.0 ± 5.0	96.4 ± 4.0	0.74
Lysholm score	96.3 ± 6.1	96.0 ± 5.9	0.86
Residual pivot shift rate	22.8%	36.4%	0.26

TABLE 2
SNQ values and postoperative outcomes

	Group A	Group L	*P*
Anteromedial bundle			
Proximal	7.3 ± 6.2	6.1 ± 2.5	0.56
Middle	12.3 ± 9.8	7.6 ± 4.2	0.13
Distal	13.0 ± 9.3	7.3 ± 4.6	0.060
Posterolateral bundle			
Proximal	13.0 ± 11.9	9.0 ± 3.6	0.27
Middle	14.5 ± 12.1	11.6 ± 6.5	0.46
Distal	13.1 ± 11.8	9.5 ± 6.9	0.35
KOOS	96.9 ± 5.3	95.1 ± 6.7	0.48
Lysholm score	96.9 ± 4.1	95.9 ± 4.0	0.57
Residual pivot shift rate	41.1%	16.6%	0.54