The influence of meniscus extrusion and leg alignment on the distribution pattern of subchondral bone density across the knee joint

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【Introduction】The meniscus has a load-distributing function in the knee and serves a protective role for the articular cartilage. However, the relationship between the meniscus and load distribution in living joint is not yet fully understood. Subchondral bone density of the proximal tibia was assessed using CT-osteoabsorptiometry (OAM) [1]. The aim of this study was to investigate the relationship among the meniscal extrusion and leg alignment and the distribution pattern of subchondral bone density of the proximal tibia using the CT-OAM.

【Method】41 patients (41 knees) who scheduled to undergo osteotomy around knee joint for osteoarthritis were enrolled in this study between 2016 and 2022. Inclusion criteria involved patients who have undergone CT and MRI imaging prior to surgery. There were 18 men and 23 women with a mean age of 57 years (range: 39-80 years). High subchondral bone density area (HDA) was defined as the area of the top 30% bone density (Figure 2). The medial ratio was calculated as the ratio of the HDA of the medial compartment to the total HDA of both compartments. Meniscal extrusion was defined as the ratio of the amount of meniscal extrusion to the entire width of the meniscus in the mid coronal plane (Figure 1). A simple linear regression analysis was performed to examine the relationship between the medial ratio and leg alignment parameters and meniscal extrusion. A multivariable regression analysis was conducted using the least squares method for factors showing significant trends, Factors with a VIF (Variance Inflation Factor) of 5 or higher were excluded from the analysis to avoid multicollinearity, The significance level was set at $p = 0.05$. This study was approved by our institutional review board, and all the patients provided informed written consent.

【Results】The results were as follows : HKA, mechanical MPTA, mechanical LDFA were -5.0 ± 6.7°, 83.6 ± 4.3°, and 87.4 ± 2.4°, respectively. Medial and lateral meniscal extrusion ratio were 53.2 ± 25.9% and 27.7 ± 19.4%, respectively. Medial ratio of HDA was 79.5 ± 23.4%. A single linear regression analysis showed that there were significant correlations between the medial ratio of HDA and HKA, mMPTA, mLDFA, and the medial and lateral meniscal extrusion ratio ($p < 0.01$). A multivariable regression analysis revealed that standardized partial regression coefficient of HKA, the

medial and lateral meniscal extrusion ratio were -0.26, 0.34, and -0.49 ($p < 0.05$), respectively. Adjusted R square for this analysis was 0.69 (Table 1). mMPTA was excluded from the analysis because it had a VIF (Variance Inflation Factor) of 5 or higher.

【Discussion】The results of this study suggested that both meniscal dysfunction and leg alignment were factors that influenced the stress distribution on the tibial articular surface, with meniscal dysfunction having a greater impact than leg alignment.

【Clinical relevance】When planning surgery with postoperative load distribution in mind for knee osteotomy, it was considered necessary to pay attention not only to leg alignment but also to meniscal function.

Reference

[1] Müller-Gerbl et al. J Bone Miner Res. 1992

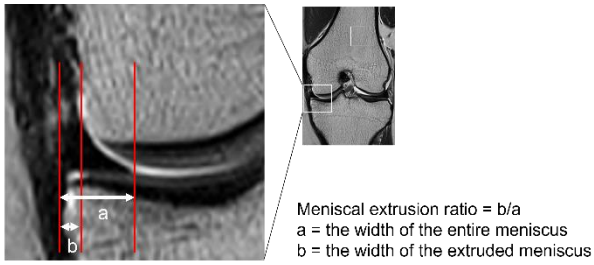

Figure 1. Meniscal extrusion ratio

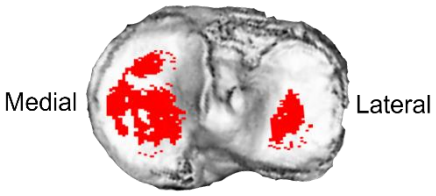

Figure 2. High density area (Red dot)

Table 1. Multivariable regression analysis

	Standardized partial regression coefficient	P value
HKA（°）	−0.26	0.02
mLDFA（°）	0.001	0.96
Medial meniscal extrusion (%)	0.34	<0.001
Lateral meniscal extrusion (%)	−0.49	<0.001