Kinematic MRI of knee in wide bore 3T MR system

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Target audience: Musculoskeletal radiologist

Introduction

Menisci were proved to be mobile, allowing movement in either an anterior-posterior direction or in a lateral-medial direction during flexion and extension (1). The protrusion of any part of the meniscus beyond the tibial plateau has been area of interest but kinematic MRI in different knee positions was only available in additional open MR system equipment which has low spatial resolution related to low magnetic field and much motion artifact. The recent development of wide bore 3T MRI raised the expectation of possibility of kinematic MRI with good spatial resolution and an isotropic high-spatial-resolution 3D data without additional MR equipment. The purpose of our study was to evaluate feasibility of kinematic MR imaging in wide bore 3T MRI and to assess position related changes of the meniscus, and medial/lateral tibiofemoral joint in flexion and extension position in asymptomatic volunteers.

Methods

Five knees from five asymptomatic volunteers with no history of knee injury were examined with a 3T wide bore MR system (Discovery 750 W, GE healthare). Sagittal 2D fast spin echo T2 weighted sequences (TR, 4000-5000 ms; TE,70-80 ms, ETL, 14, NEX, 2, slice thickness, 3 mm; field of view (FOV), 150 mm; acquisition matrix, 416 x 288; and bandwidth, 62.5 Hz.) and 3D-FSE-Cube (TR, 1200 ms; TE, 44.1-49.7 ms ETL, 60; slice thickness, 0.6 mm; field of view (FOV), 150 mm; acquisition matrix, 188 x188; and bandwidth, 62.5 Hz. scan time: 8 minutes) were obtained with extension of knee in supine position (extension), and with flexion of knee in lateral decubitus position (flexion) using medium sized phased array coil (Figure 1). The position of menisci regard to the vertical tibial reference lines, medial and lateral joint space, and meniscal flounce were evaluated in extension and flexion position. Statistical analysis was used Wilcoxon Signed Ranks Test.



Figure 1A, 1B) Photographs of extension of knee in supine position. Figure 1C, 1D) Photographs of flexion of knee in lateral decubitus position

Results and Discussion

All images were successfully obtained in extension (175-180 degrees), and flexion (75-95 degrees) position. The positions of the menisci show in table 1. Both anterior horn of medial/lateral meniscus were seen anterior to the tibial reference line (extrusion) in extension but changed into posterior to the tibial reference line (intrusion) in flexion with statistically significance (P = 0.043). The posterior horn of medial was seen anterior to the tibial reference line (intrusion) in extension but changed into posterior to the tibial reference line (intrusion) in extension but changed into posterior to the tibial reference line (intrusion) in extension but changed into posterior to the tibial reference line (extrusion) in flexion with statistically significant positional change. The medial tibiofemoral joint showed contact adjacent cartilage each other in both extension and flexion. The lateral tibiofemoral joint showed contact adjacent cartilage each other in extension but widened in flexion in all cases (100%). The positional changes of meniscus and medial/lateral tibiofemoral joint in our study correspond with prior studies (1, 2). Meniscal flounce was seen in lateral meniscus during flexion in 4/5 cases (80%) and it was not reported in prior study.

Table 1) Distances between the tibial reference lines and the outer edge of the meniscus between different body positions (Meniscal Position)

Location	Medial meniscus						Lateral meniscus					
	Anterior horn		Body		Posterior horn		Anterior horn		Body		Posterior horn	
Position	Ext	Flex	Ext	Flex	Ext	Flex	Ext	Flex	Ext	Flex	Ext	Flex
Mean	+3.27	- 6.76	0.61	-0.13	-4.39	+2.2	+6.24	-9.87	+0.42	+0.04	-7.07	-2.48
St	+0.41	+1.02	+1.4	+0.83	+1.11	+1.29	+1.7	+6.72	+0.92	+0.89	+1.62	+5.37
Min	+2.62	-8.10	0.0	-1.46	-5.66	0.00	+3.81	-14.02.	0	0	-9.10	-6.74
Max	+3.71	-5.87	+3.06	+0.83	-2.78	+3.28	+8.20	+2.07	+2.05	+2	-4.70	+ 5.8
<i>P</i> value	0.043		0.655		0.043		0.043		0.317		0.225	

- Note: Ext, extension of knee with supine position; Flex, flexion of knee in lateral decubitus position; +, extrusion; -, intrusion; St, standard deviation; Min, minimal value; Max, maximum value. Statistically significant results are displayed in bold characters.



Figure 2) MR images of knee extension and flexion Sagittal reconstruction image of 3D-FSE -Cube in knee extension position (2A) shows anterior extrusion of the anterior horn, and posterior intrusion of posterior horn of medial meniscus. Coronal reconstruction image of 3D-FSE-Cube in knee flexion (2B) shows contact adjacent cartilages of medial tibiofemoral joint but widening of lateral tibiofemoral joint. Meniscal flounce of lateral meniscus is seen in sagittal T2 weighted image (2C).

Conclusion: Kinematic MR imaging of knee in wide bore 3T MRI system is feasible. Extrusion of anterior/posterior horn of medial meniscus and anterior horn of lateral meniscus is seen according to position change. Lateral tibiofemoral joint is significantly lax in positional change. Meniscal flounce is seen in lateral meniscus during flexion.

References

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