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Nonextruded Grafts Result in Better Cartilage Quality After Lateral Meniscal Allograft Transplantation : Quantitative 3-T MRI T2 Mapping

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Disclosure

- The authors have no financial conflict to disclose.



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Introduction

- This study aimed to investigate **the influence of graft extrusion on the chondroprotective effect of lateral MAT** on knee articular cartilage.
- Previously, **no study** has investigated the effect of graft extrusion on the articular cartilage using **objective quantitative methods**.



Introduction

- **Quantitative MRI T2 mapping** is a sensitive and valid tool that can assess **the characteristics of cartilage tissue** and provide **objective quantitative data**.
- **Increased T2 relaxation times (T2 value)** reflect a decreased concentration of proteoglycans, an increase in water content, and a loss of collagen content and network integrity in the cartilage, thereby indicating inflammation in **cartilage tissues** with **poor biochemical characteristics**.



Methods

- A retrospective, single-center cohort study. (Asan Medical Center)
- 105 patients who underwent isolated lateral MAT by single surgeon (S.I. Bin) between August 2010 and September 2019.

Inclusion criteria

- (1) Underwent subtotal or total lateral meniscectomy.
- (2) ICRS grade ≤ 2 cartilage lesion with or without focal grade 3 or 4 lesion.
- (3) Well-aligned and stable knees.



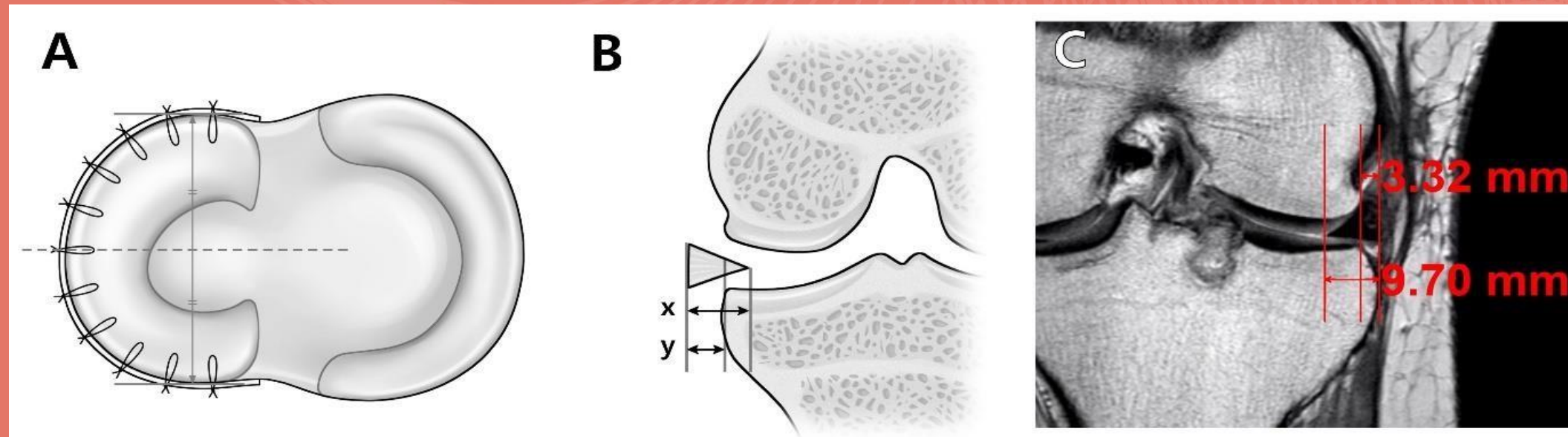
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MRI evaluation of graft subluxation

- Meniscal subluxation was assessed at postoperative 3-month MRI.



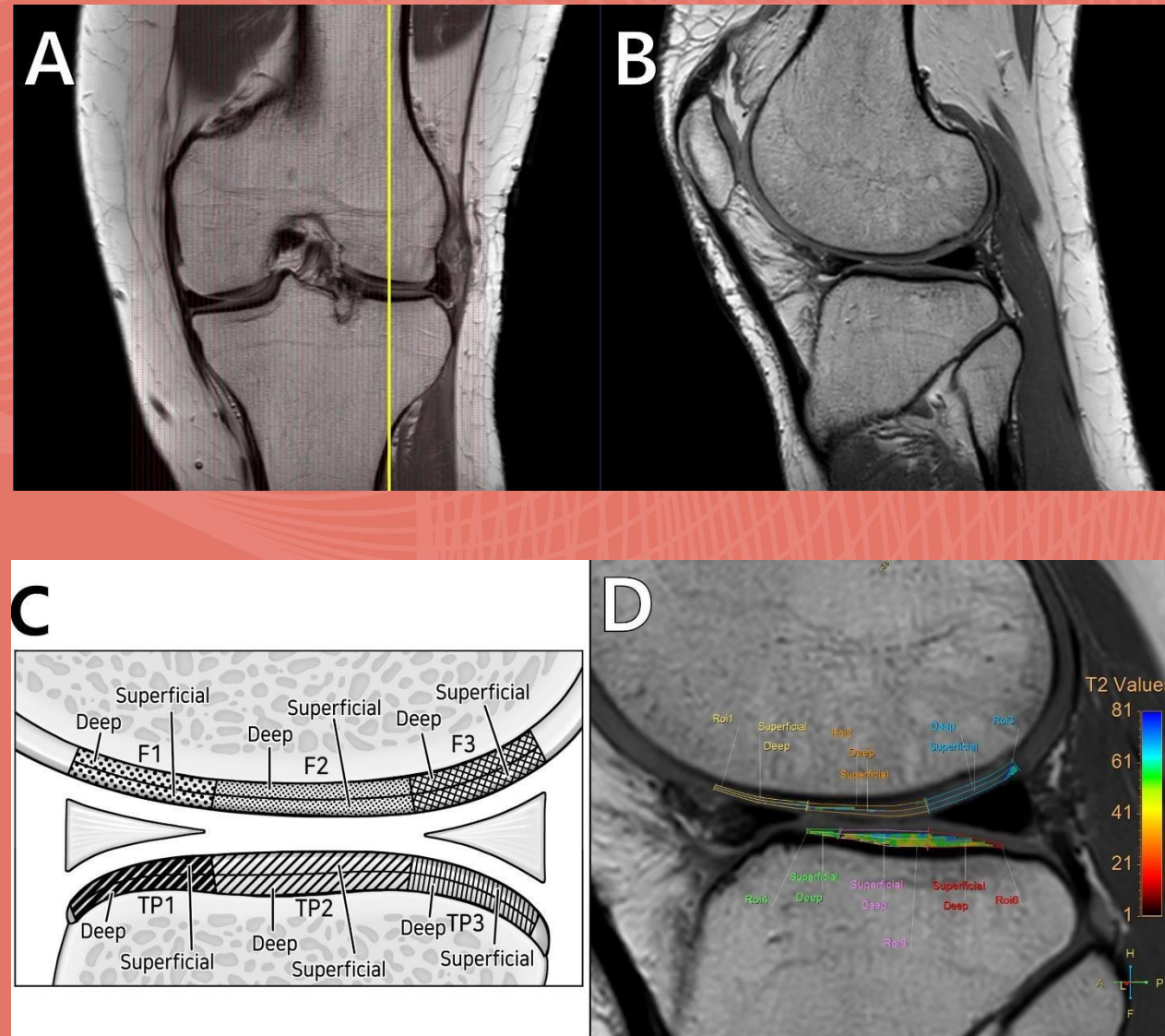
*The absolute value of meniscal subluxation (y)

*The relative percentage of extrusion is (y/x)

*Extruded graft is defined $y > 3\text{mm}$

ROI analysis of T2 mapping

- T2 mapping was conducted on the sagittal image corresponding to the center of the lateral femoral condyle. **(A,B)**
- ROI(Region of Interest) analysis on the articular cartilage, weight-bearing areas of the femoral and tibial plateau articular cartilages were divided into 6 segments (F1, F2, F3, TP1, TP2, and TP3) and were divided into 2 layers of equal thickness (superficial and deep). **(C)**
- T2 maps of the articular cartilage of the knee joint, with a color scale ranging between 1 and 81 ms, were created from the T2 mapping source data ROIs. **(D)**



Result

Changes in **Absolute T2 Values** of Articular Cartilage in the Nonextrusion Group (Graft Extrusion <3 mm)^a

Segment	Preoperative	Postoperative	P Value
F1			
Overall	53.8 ± 19.8	46.8 ± 15.1	.028 ^b
Deep	50.6 ± 19.2	43.5 ± 15.3	.023 ^b
Superficial	56.5 ± 20.4	50.6 ± 15.7	.082
F2			
Overall	58.1 ± 18.8	49.3 ± 16.2	.004 ^b
Deep	54.4 ± 18.4	46.6 ± 16.2	.009 ^b
Superficial	62.4 ± 20.4	52.2 ± 16.8	.002 ^b
F3			
Overall	58.7 ± 19.0	51.3 ± 16.6	.014 ^b
Deep	56.2 ± 18.2	49.9 ± 16.9	.030 ^b
Superficial	61.4 ± 20.3	53.1 ± 16.9	.009 ^b
TP1			
Overall	36.8 ± 13.0	33.3 ± 10.7	.063
Deep	31.8 ± 11.8	29.1 ± 9.9	.123
Superficial	42.4 ± 14.4	38.1 ± 11.6	.033 ^b
TP2			
Overall	35.7 ± 11.5	32.2 ± 9.6	.038 ^b
Deep	30.7 ± 11.4	27.6 ± 9.1	.061
Superficial	40.6 ± 12.6	36.8 ± 10.9	.035 ^b
TP3			
Overall	40.3 ± 13.8	35.0 ± 10.6	.006 ^b
Deep	36.0 ± 13.0	31.5 ± 10.2	.014 ^b
Superficial	44.9 ± 14.6	38.3 ± 11.3	.002 ^b

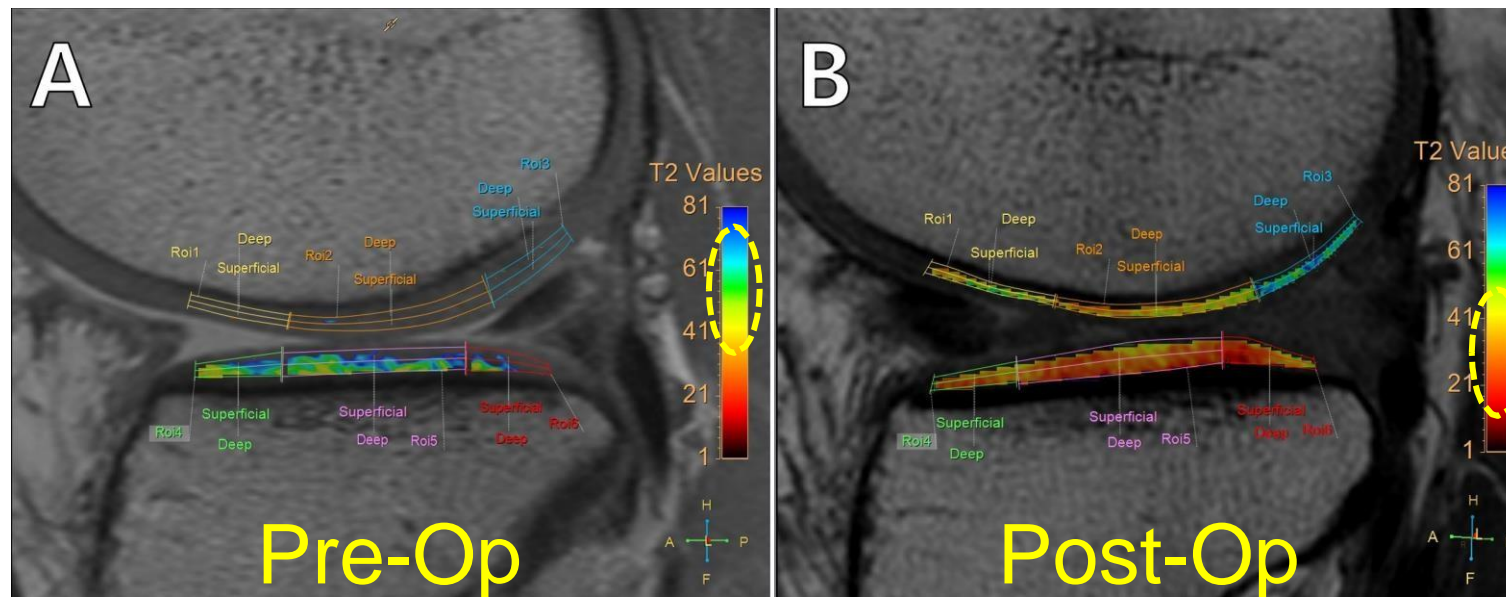
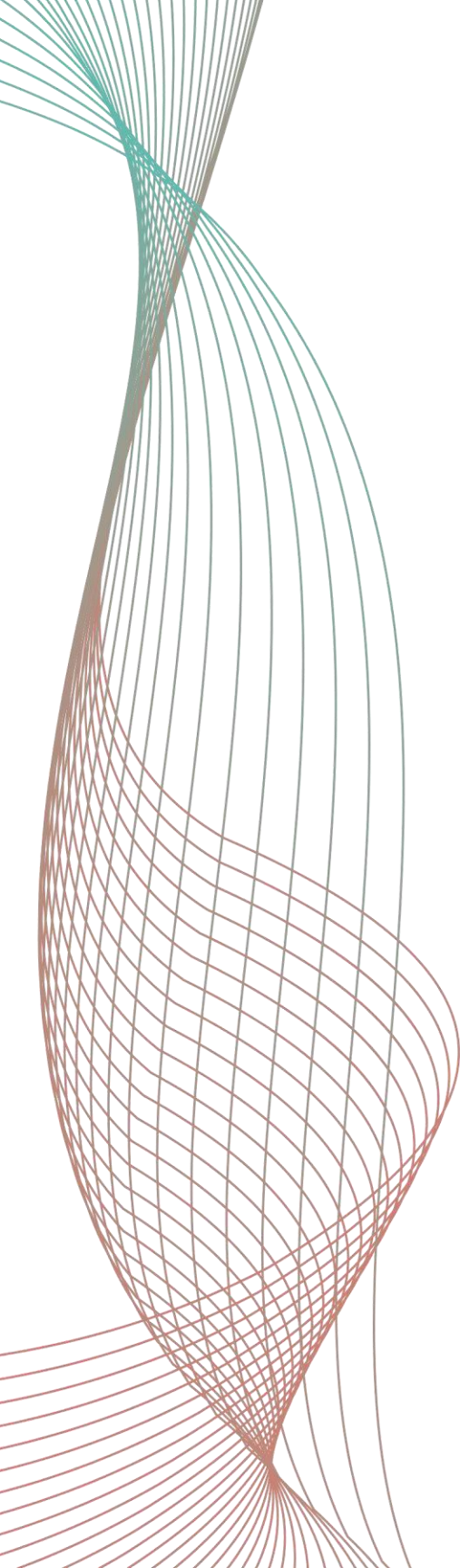
Absolute T2 values were **decreased** in 14 of 18 segments

Changes in **Absolute T2 Values** of Articular Cartilage in the Extrusion Group (Graft Extrusion ≥3 mm)^a

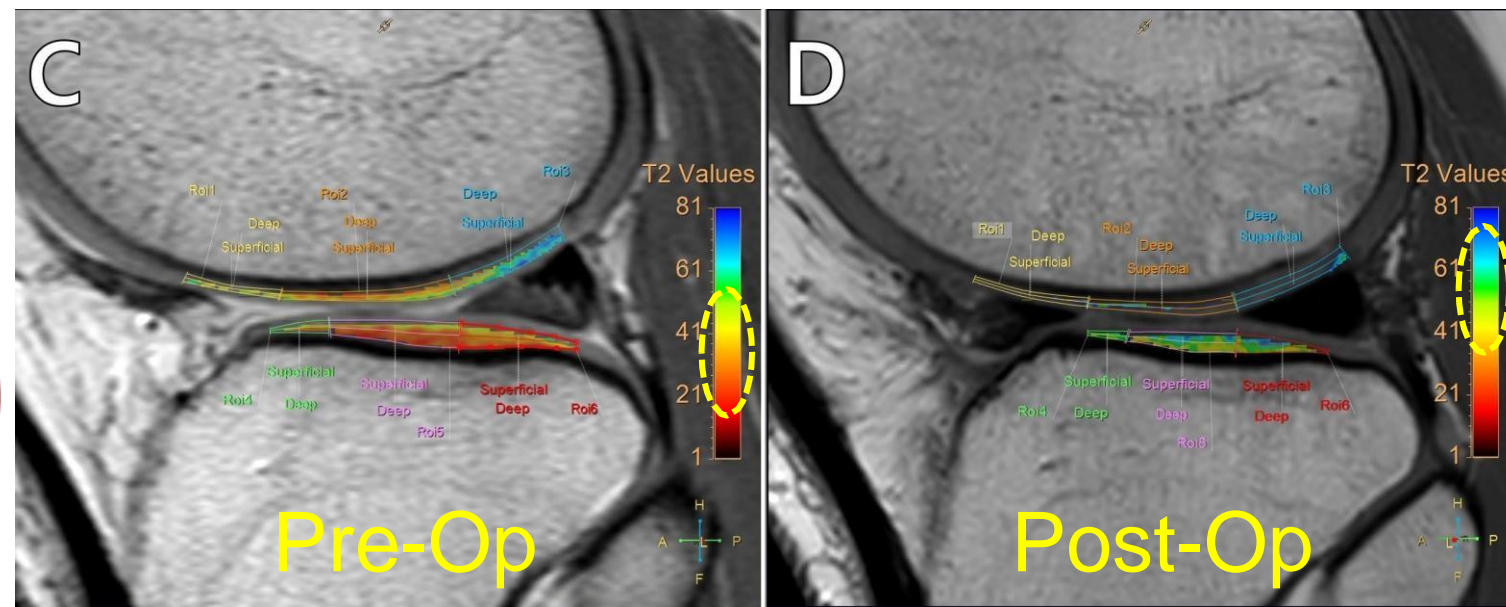
Segment	Preoperative	Postoperative	P Value
F1			
Overall	45.6 ± 5.8	49.5 ± 16.7	.226
Deep	43.4 ± 6.9	45.8 ± 15.6	.430
Superficial	48.1 ± 5.7	52.3 ± 17.3	.197
F2			
Overall	51.2 ± 9.8	52.1 ± 17.0	.788
Deep	47.5 ± 9.7	49.4 ± 15.6	.542
Superficial	55.3 ± 10.2	55.0 ± 19.0	.933
F3			
Overall	52.3 ± 10.8	54.5 ± 21.6	.592
Deep	49.9 ± 11.8	53.6 ± 22.4	.378
Superficial	55.0 ± 11.0	55.6 ± 21.7	.871
TP1			
Overall	33.5 ± 7.6	35.6 ± 14.7	.455
Deep	29.3 ± 6.8	31.6 ± 13.6	.409
Superficial	39.7 ± 10.4	39.7 ± 15.1	.984
TP2			
Overall	30.9 ± 5.9	33.5 ± 11.3	.253
Deep	25.9 ± 6.1	29.1 ± 10.2	.145
Superficial	36.3 ± 6.2	38.1 ± 12.7	.475
TP3			
Overall	36.0 ± 8.8	36.3 ± 14.7	.889
Deep	32.5 ± 10.3	32.9 ± 13.8	.883
Superficial	39.9 ± 9.4	39.5 ± 16.4	.879

No significant change





Improved after LMAT (a non-extruded case)



Deteriorated after LMAT (an extruded case)

Classification of Change in Cartilage Quality

Deteriorated	$A \geq 30\%$
Stationary	$-30\% < A < 30\%$
Improved	$A \leq -30\%$

*Change in Cartilage Quality is measured by relative Changes in T2 Value.

*There is no consensus on T2 values in terms of a normal range or a minimal clinically important difference.



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Result

Degree of **Change in Cartilage Quality** According to the **Relative Change in T2 Values^a**

Segment	Total (N = 105)			Nonextrusion (n = 73)			Extrusion (n = 32)			P Value
	Deteriorated	Stationary	Improved	Deteriorated	Stationary	Improved	Deteriorated	Stationary	Improved	
F1										
Overall	17 (16.2)	70 (66.7)	18 (17.1)	10 (13.7)	47 (64.4)	16 (21.9)	7 (21.9)	23 (71.9)	2 (6.3)	.053
Deep	18 (17.1)	67 (63.8)	20 (19.0)	10 (13.7)	46 (63.0)	17 (23.3)	8 (25.0)	21 (65.6)	3 (9.4)	.049 ^b
Superficial	19 (18.1)	68 (64.8)	18 (17.1)	13 (17.8)	44 (60.3)	16 (21.9)	6 (18.8)	24 (75.0)	2 (6.3)	.189
F2										
Overall	12 (11.4)	75 (71.4)	18 (17.1)	6 (8.2)	51 (69.9)	16 (21.9)	6 (18.8)	24 (75.0)	2 (6.3)	.021 ^b
Deep	11 (10.5)	76 (72.4)	18 (17.1)	6 (8.2)	50 (68.5)	17 (23.3)	5 (15.6)	26 (81.3)	1 (3.1)	.013 ^b
Superficial	11 (10.5)	76 (72.4)	18 (17.1)	6 (8.2)	52 (71.2)	15 (20.5)	5 (15.6)	24 (75.0)	3 (9.4)	.094
F3										
Overall	15 (14.3)	71 (67.6)	19 (18.1)	9 (12.3)	48 (65.8)	16 (21.9)	6 (18.8)	23 (71.9)	3 (9.4)	.117
Deep	15 (14.3)	72 (68.6)	18 (17.1)	9 (12.3)	49 (67.1)	15 (20.5)	6 (18.8)	23 (71.9)	3 (9.4)	.140
Superficial	14 (13.3)	72 (68.6)	19 (18.1)	8 (11.0)	49 (67.1)	16 (21.9)	6 (18.8)	23 (71.9)	3 (9.4)	.087
TP1										
Overall	19 (18.1)	70 (66.7)	16 (15.2)	12 (16.4)	47 (64.4)	14 (19.2)	7 (21.9)	23 (71.9)	2 (6.3)	.135
Deep	21 (20.0)	66 (62.9)	18 (17.1)	14 (19.2)	43 (58.9)	16 (21.9)	7 (21.9)	23 (71.9)	2 (6.3)	.157
Superficial	17 (16.2)	64 (61.0)	24 (22.9)	12 (16.4)	46 (63.0)	15 (20.5)	5 (15.6)	18 (56.3)	9 (28.1)	.526
TP2										
Overall	12 (11.4)	78 (74.3)	15 (14.3)	6 (8.2)	53 (72.6)	14 (19.2)	6 (18.8)	25 (78.1)	1 (3.1)	.014 ^b
Deep	15 (14.3)	74 (70.5)	16 (15.2)	9 (12.3)	49 (67.1)	15 (20.5)	6 (18.8)	25 (78.1)	1 (3.1)	.039 ^b
Superficial	15 (14.3)	74 (70.5)	16 (15.2)	9 (12.3)	50 (68.5)	14 (19.2)	6 (18.8)	24 (75.0)	2 (6.3)	.095
TP3										
Overall	14 (13.3)	72 (68.6)	19 (18.1)	8 (11.0)	48 (65.8)	17 (23.3)	6 (18.8)	24 (75.0)	2 (6.3)	.037 ^b
Deep	14 (13.3)	67 (63.8)	24 (22.9)	9 (12.3)	44 (60.3)	20 (27.4)	5 (15.6)	23 (71.9)	4 (12.5)	.150
Superficial	15 (14.3)	69 (65.7)	21 (20.0)	9 (12.3)	45 (61.6)	19 (26.0)	6 (18.8)	24 (75.0)	2 (6.3)	.035 ^b

^aValues are presented as No. (%). F, femoral; TP, tibial plateau.

^bStatistical significance.

The relative change in T2 values revealed significant improvement in the nonextrusion group as compared with the extrusion group in F1(deep), F2(overall/deep), TP2(overall/deep), TP3(overall/superficial).



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Discussion

- An improvement in the biochemical composition of the knee articular cartilage, as judged by quantitative T2 mapping, in the nonextrusion group after lateral MAT at a mean follow-up of 3.2 years, in contrast to extrusion group.
- To overcome the limitation of interpreting the longitudinal change in cartilage T2 value, a classification approach was adopted in this study based on the amount of postoperative change.
- The Lysholm scores yielded no significant difference between the groups, suggesting no correlation between the biocomposition of the cartilage tissue and its clinical function.



Conclusion

- This study shows that the **non-extruded graft** results in **better cartilage properties** of the knee joints **after lateral MAT** as compared with the extruded graft **at midterm follow-up**.



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