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Prospective Correlation of MRI T2 Mapping In ICRS Graded Damaged and Healthy Articular Cartilage Specimens from Hip Arthroscopy Treatment in Patients With FAI

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Summary:
Correlation of arthroscopic and histological findings with pre-operative T2 mapping in patients treated for FAI

Abstract:
INTRODUCTION
There is a paucity of data comparing quantitative MRI T2 mapping with arthroscopic grading and histological analysis in hip joint cartilage. We evaluated ICRS graded damaged and healthy cartilage specimens, taken in-vivo from arthroscopic waste in patients with femoroacetabular impingement (FAI), and compared and correlated arthroscopic and histological findings with preoperative T2 mapping.

METHODS
This prospective study was Institutional Review Board approved. All patients received a pre-operative T2 mapping hip scan at 3.0 T. Forty-four cartilage specimens (22 healthy, 22 damaged) were collected from arthroscopic waste of 22 patients during FAI treatment. The location (using Geographic Zone method), size and ICRS grade were recorded. Cartilage samples were processed using routine methods for H&E and Pico sirius red for collagen orientation. Collagen and GAG were quantified using routine biochemical methods.

For image analysis, manual segmentation of the mapping regions for the specimens based on Geographic Zone location and size recorded during arthroscopy was performed.

Paired comparisons of normal and damaged specimens were completed for the biochemical results. Median (± STD) T2 values were assessed with paired Student's t-tests. Comparisons among defect grades was done using independent testing after collapsing into mild (grade 1 or 2) and severe (grade 3 or 4) defect groups. Associations of variables with T2 mapping were tested.

RESULTS
Cumulative H&E was significantly lower among damaged specimens (median=9) than paired normal specimens (median=11; WSR p=0.027). Damaged specimens also exhibited a lower percent of collagen fibers oriented parallel (median=80% vs median=100%; WSR p=0.046) and a higher percent of collagen fibers oriented randomly

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(median=20% vs median=0%; WSR p=0.008) than normal specimens.

Median T2 values were significantly higher among damaged specimens (55.7 ± 14.9 ms) than normal (49.3 ± 12.3 ms; p = 0.043). This difference was most exaggerated among ICRS mild (grade 1 or 2) defects where damaged specimens (58.1 ± 16.4 ms) were significantly higher than their paired normal specimens (48.7 ± 15.4 ms; p = 0.026). A significant positive correlation was found between T2 values of normal and damaged specimens among the mild defect group (r = 0.722; p = 0.012), but this was not true for the severe defect group (r = 0.087; p = 0.799). Neither median T2 nor STD T2 were significantly monotonically correlated with any biochemical variables.

CONCLUSION

We observed a significant correlation between increasing T2 values and the arthroscopically determined ICRS grade. The associated changes were most exaggerated among mild (grade 1 or 2) defects for which the damaged specimens were significantly higher than paired normal specimens. Damaged specimens with severe defects had significantly lower cumulative H&E than their paired normal counterparts while damaged specimens with mild defects were not statistically significant. Interestingly, T2 values were not significantly correlated, monotonically, with any biochemical variables. This observation may be due to limitations with regard to the close proximity where each specimen was harvested during arthroscopic treatment to treat FAI.

Our findings support the potential of T2 mapping to detect early mild chondral damage where conventional MRI may lack sufficient sensitivity.