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THE GEOMETRY ESTIMATION OF THE ARTICULATION CARTILAGE SHAPE AND DEFECT DIAGNOSIS USING MAGNETIC RESONANCE IMAGING

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Abstract – MRI of the knee is the most frequently requested MR joint study in musculoskeletal radiology. MRI gives a comprehensive examination of the knee, providing surgeons with information they cannot obtain clinically or invasively. In this paper there is estimated the sensitivity of the articulation cartilage defects imaging using MR. There were examined two animal and two human specimen knees using CT, MRI and coordinate control machine (CCM). The cartilage was artificial destroyed and the defects were measured using MRI and CCM. CT was done to verify bone damage. The outcomes obtained in MRI and CCM are approximately.

Keywords: MRI, CCM, cartilage shape, defect

1. INTRODUCTION

Both computed tomography (CT) and magnetic resonance imaging (MRI) are capable of producing high resolutions scans but the superior soft tissue contrast of MRI and the ability to differentiate different types of tissue based on their signal intensities set it apart. The typical musculoskeletal MRI examination will include three to six sequences obtained in various anatomic planes: Spin Echo (T1, T2, Proton Density), Fast Spin Echo (Proton Density, T2), Gradient Echo (T2, STIR).

The most useful sequences of articulation cartilage are:

1. STIR or fat - saturated Fast Spin Echo- T2- cartilage is dark gray and easily distinguished from joint fluid , making focal defects quite conspicuous. The cartilage is difficult to separate from underlying bone but this distinction is less important than identifying abnormalities of the articulation surface.

2. 3D-T1 Gradient Echo with fat saturation- cartilage is very bright and easily distinguished from subchondral bone and fluid. But because this sequence is quite time consuming and must be added to the standard imaging sequences (unlike a STIR sequence), it is impractical for most uses.

The fibrocartilage in normal appearance is dark on all sequences.

On the Table 1 there are presented musculoskeletal tissues best sequences.

Table 1. Musculosceletal tissues best sequences.

Bone	STIR	Fast T2 with fat saturation	Tl
Cartilage	STIR	Fast T2 with fat saturation	GRE (especially with fat saturation)
Meniscus	GRET2	Tl	Spin Echo Proton Density
Tendons, Ligaments	GRET2	STIR	Fast T2
Muscle	STIR	Tl	Tl

MRI of the knee is the most frequently requested MR joint study in musculoskeletal radiology. MRI gives a comprehensive examination of the knee, providing surgeons with information they cannot obtain clinically or invasively. It has proven to be very accurate with sensitivity in the 90-95% range for menisci and close to 100% for the cruciate ligaments. The sensitivity for cartilage is variable depending on sequence and in more presented papers amount 80-90%. In this paper there is estimated the sensitivity of the articulation cartilage defects imaging using MR.

2. SUBJECT AND METHOD

There were examined three animal and three human knee specimens using CT, MRI and coordinate control machine (CCM). The cartilageof the specimens were artificial destroyed and the defects were measured using MRI and CCM. CT was done to verify bone damage. There were used following MR T1 and T2 sequences for cartilage imaging: DESS, STIR, MEDIC. The first process of the dates transformation consisted in approximations by a curve line of the two - dimensional pictures including the main information about the profile and the edge condition of the defect. The comprehension of the sequences including two-dimensional pictures created a three – dimensional defects (volume of the defects). The specimens were measured twice using CCM: before the damage of the cartilage surface and after it. CCM used in this analysis worked with the scanning head. Outcomes obtained on CCM were counted using Ansys analyzing computed program. After mathematical analysis there was done a visualization of the defect using FEMAP and NE Nastran programs. In this paper there are presented outcomes of the one of the measurement procedures. The outcome of the articulation cartilage defect obtained using MRI procedure was 198 mm^3 and using CCM 212,29 mm^3.

In pictures 1, 2, 3 there are presented a outcomes of measurement using CT, MRI and estimation obtained in MRI. In picture 4, 5 there are presented a visualizations of cartilage defect using FEMAP and NE Nastran programs and the estimation of the defect using Ansys program.

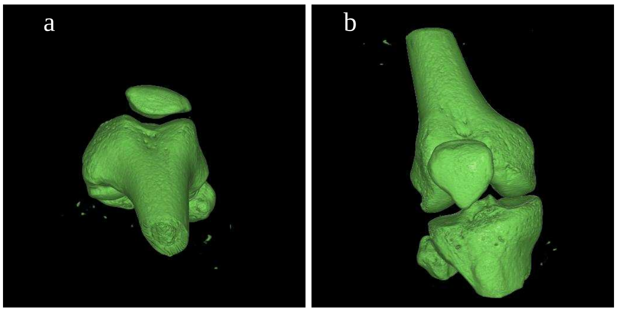

Fig. 1. Human knee specimen in the CT imagine (specimen P.P., No 535/2004, car accident). a – horizontal view , b – vertical view

Fig. 2. Horizontal view of the artificial destroyed human knee specimen in the MR imagine (specimen P.P., No 525)

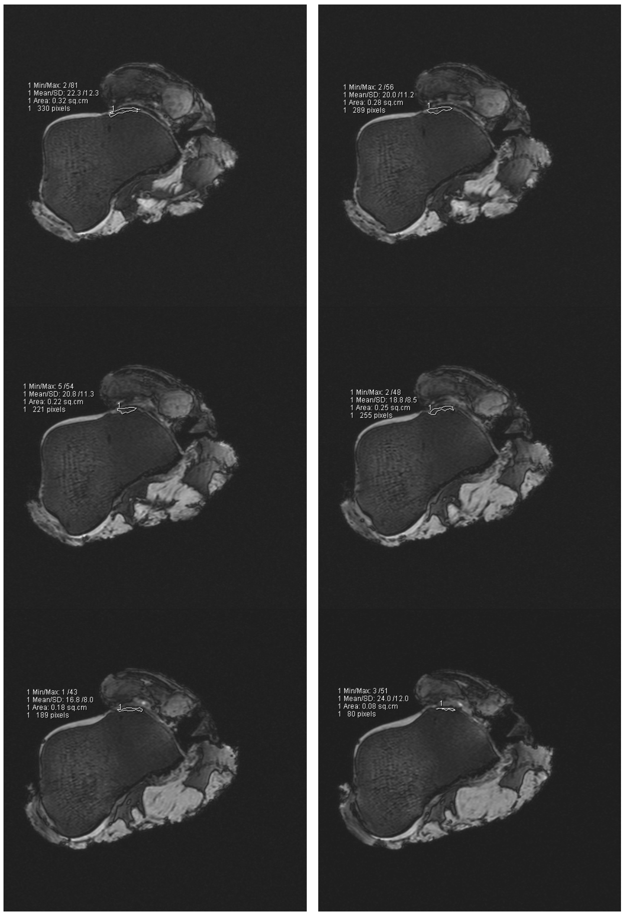

Fig. 3. Horizontal view of the artificial destroyed human knee specimen in the MR imagine (specimen P.P., No 525) with drown line of the cartilage damage

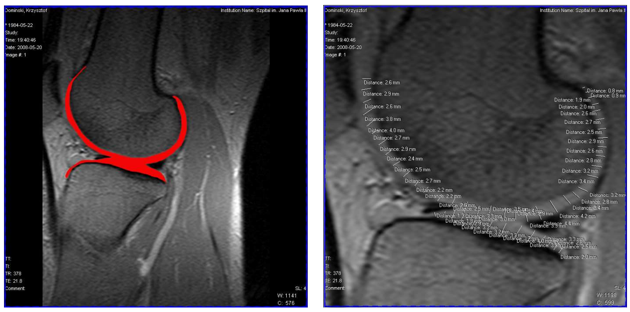

Fig. 4. The geometrical analysis of the knee cartilage

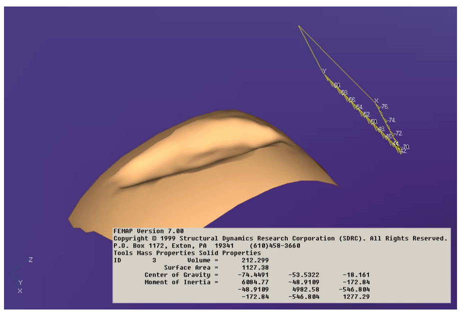

Fig. 5. The mathematical analysis and solid visualization of the cartilage defect

3. CONCLUSIONS

1. MRI is a sufficient method for imaging of cartilage defects.
2. The quality of the shape and volume outcomes depend on the measurement strategy and selection of the best imaging sequences.
3. The described procedure of the MRI application to the computed programs like FEMAP, NE Nastran will be given the possibility for creating of the virtual imaging of the real articulation cartilage defects.
4. The proposed procedure of cartilage defects diagnosis can be used as a modern, non invasion method for preoperative planning of way of treatment.

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