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CHARLES UNIVERSITY IN PRAGUE,
FACULTY OF PHYSICAL EDUCATION AND SPORT,
DEPARTMENT OF ANATOMY AND BIOMECHANICS

DETECTION OF THICKNESS AND VOLUME CHANGES ON KNEE CARTILAGE IN FEMORAL-TIBIAL JOINT IN DIFFERENT STRESS CONDITIONS WITH MRI

LENKA HORŇÁKOVÁ, DANIEL HADRABA, PAVEL ŠTURSA, KAREL JELEN

SUMMARY

Knee cartilage and meniscus are living tissue, but have limited opportunities for growth and renewal. If they are not loaded for long time, there is a breach of metabolism in the deeper tissues. Many negative changes may be substantially eliminated by periodic various activities. Appropriate load (alternating medium intensity) stimulates the growth of cartilage and muscle and thus prevents them from wasting. When loads are occurring, with elastic deformation of cartilage synovial fluid is extruded from the matrix into the articular capsule slot and the density of the matrix grows. With removing load synovial fluid flows back into the cartilage.

Given the intracharacteristics of the knee (spatial insufficiency) display changes directly inside the meniscus and cartilage is problematic. Detection and modeling of mechanical response of tissue structures to external mechanical loading is possible using non-invasive imaging methods. Fairly accurate representation with wide application in patients provides magnetic resonance imaging (MRI).

MRI use is overwhelmingly performed in supine without burdening the limbs, which can lead to some extent misleading information, even though the unloaded cartilage is exposed to pressure induced by muscle tone. From the point of evaluating changes in knee cartilage to various long-lasting stress following publications are subject to literary critival review. The findings in this paper are obtained mainly on the study of avaliable literature. The authors use to evaluate changes different parameter setting of MRI and thus try to get the most detailed information about the observed structures in various specific types of loads.

Key words: knee, meniscus, cartilage, MRI, load, degeneration

INTRODUCTION

The knee joint is one of the most burdened joints in the body. Its specificity is that it is located below the center of gravity of the body. Therefore it have to face impact of exposure to multiples of body weight during exercise (Bendjaballah, 1997; Bergmann, 1993; Athanasiou, 2009). As indicated by van den Bogert (1999), load forces on the leg joints are 4 to 8 times higher during the run than during walking. When the knee is unloaded contact area in the first place on the meniscus but with a load of 150 kg, meniscus covers only about 59 to 71 % contact surface of the articular capsule, remaining contact is direct (femur oppresses the central part of tibial plateau) (Walker, 1975 in Beaufils, 2010).

Cartilage is composed of 80% water and the remaining mass is largely made up of a solid mass of collagen type II (10–20%) and large proteoglycan (PG) aggregates (5–10%), meniscus has a higher concentration of type I collagen (1–25%) and lower PG content (1–2%) (McNikol, 1980; Kaufman, 1999; Mow, 2004; Athanasiou, 2009). The surface of the cartilage is covered by intra articular fluid, formed in the cells of joint sheaths. Nutrition takes place almost exclusively by diffusion from the synovial fluid which gets into the cartilage through submicroscopic holes alternating pressure and release. Metabolism is relatively intense (especially in younger persons) and extracellular collagen-proteoglycan material (matrix) is relatively well bidirectionally permeable. The flexibility of cartilage is dependent on water content, which is loosely bound in matrix. In the initial phase of the stress the water is fairly rapidly expelled from the matrix, with continuing load the shape of cartilage is almost unchanged, with the load release negatively charged glycosaminoglycans (GAGs) molecules attract water back into the matrix and rehydrates tissue. (Athanasiou, 2009). Viscoelastic response of the meniscus is very low compared with the articular capsule cartilage (McDermott, 2008; Beaufils, 2010), therefore meniscus effectively maintain their volume under load (McDermott, 2008). On elasticity module of meniscus has been found that is only about half the size of the hyaline joing cartilage and permeability was found to be only one-sixth to one-tenth. (Kessler, 2008). Meniscus vascularity declines from full in the fetus after birth gradually. Meniscus adapts to the load gradually with age and vascularised is just one third outside region, its final width is individual, 10 to 30% of total width of the meniscus. Edges are permeated with blood vessels almost entirely (Bartoníček, 2004; Athanasiou, 2009; Beaufils, 2010). Nutrition and removing waste substances inner two-thirds is provided only by diffusion. Increased vascularity of meniscus in younger individuals leads to increased efficiency of regeneration and thus prevent injury. On the contrary increasing age increases the proportion of collagen protein to noncollagen, leading to a reduction of tensile strength (Palastangha, 2008).

Morphological defects and subsequent osteoarthritis (OA) in bone as a result of reduction of the cartilage contact surfaces is preceded by degeneration of their matrix (changes in the composition of collagen, proteoglycan loss which can cause reduction of osmotic pressure in cartilage) and changes in water content. This leads to a refinement of the cartilage and the subsequent occurrence of cracks in it. Damage to the matrix, reduction of collagen and GAG content, and increased water content in cartilage and meniscus is the beginning of clinical symptoms and loss of these knee structures (Mankin, 1993; Athanasiou, 2009; Stehling, 2010). With increasing degeneration of the meniscus the water content increases while the content of collagen and GAGs decreases in the same situation (Athanasiou, 2009). Loss of cartilage is usually closely associated with the loss of the meniscus. After partial menisectomy the contact pressure on the knee cartilage increases significantly (Ahmed, 1983). According to the authors Sun, Muerhan (2010), the degree of meniscus degeneration is correlated to the degree of the articular cartilage degeneration. Cartilage loss increases pressure on the bone, resulting in the creation of growths, spurs, and gradually rise to OA.

If the cartilage is not coaded for by a long-term, metabolism in the deeper layers is disrupted and chondrocytes disintegrate. Many negative changes in skeletal – muscle function may be substantially eliminated by periodic various activity (Galloway, 2000). Adequate load (alternating medium intensity) stimulates the growth of cartilage and muscle, and thus prevents them from wasting, which was confirmed in subjects without degenerative changes regularly engaged in running activities. Musculoskeletal system gradually adapts to the load (Shellock, 1991; Hohmann, 2004; Krampla, 2001). As stated by Eckstein (2002), human cartilage can adapt to exercise by increasing GAGs content. Excessive contact stress on the bones and the risk of OA may occur after improper or incorrect manner of performance of physical activity, or excessive loading of joints, which has already developed degenerative changes in cartilage (Krampl, 2001; Schuller, 2006).

Sex differences are also reflected in the cartilages stated Ding (2003) and Eckstein (2006), men have significantly higher amounts of cartilage, which is due to the larger surface of the articular capsule. At the same weight and height of the monitored subjects, difference in the height of cartilage was not significant, however, articular capsule surface is significantly smaller in women (Eckstein, 2006). These authors argue that cartilage thickness decreases after 50 years of age. Cartilage grows slower by girls than boys, and as stated Graeme (2003), with increasing age and height of children the volume of cartilage increases. Research of this author shows that guys performing muscular sports have significantly higher cartilage.

Eckstein (2006) states that in evaluating the morphology of cartilage, accuracy errors and reproducibility of the results of MRI depends on factors associated with the images obtaining and their analysis. Author considered differences in joint position during shooting, less critical than projection techniques (eg MRI). One of the great advantages of MRI (over eg. histology) according to author is adherence and layout sections, from which can be obtained 3D parameters characterizing cartilage morphology appropriately. When reporting the amount of cartilage there has to be taken into account that this parameter depends on the cartilage thickness and surface area, and that only under conditions where the surface of cartilage (or transition area cartilage-bone) is constant, the changes in volume or thickness at the time correspond. Eckstein et al. (2005a) states that on the device with 3.0 T field strength (1 mm slice thickness), the accuracy of the cartilage morphology measuring is higher than by the 1.5 T field strength (1.5 mm thick slices) device. When evaluating Eckstein et al. (2006) points out the impracticality of fully-automatic segmentation and the relatively low contrast in some areas of the articular capsule surface, the human eye and semi-automatic segmentation is considered more accurate. For the reliability of noninvasive imaging methods, he indicates that highly reproducible methods are needed to analyze the small changes. In determining the thickness, a relatively large local errors occurs due to differences in the cartilage itself already at shift in the order of 0.5 to 1 mm. Detection of deformations in the femoro-tibial joint is quite difficult, the cartilage is thin, and when taking into account the accuracy error (2–3 %), the resulting values can give quite distorted information, as stated Eckstein (2006). Study of Stone (2004) showed that the measurement of the meniscus through MRI and direct survey of changes in the volume of saline solution after removed meniscus was immersed are linearly dependent, but the volume detection technique using MRI significantly underestimate the actual volume. As the reason author states the inability to accurately distinguish the boundary between the meniscus and synovial part of the knee. This error, as the authors states, could be eliminated by evaluating the results by an experienced orthopedic technician. Regarding accuracy, with repeated measurements no significant differences were found in either one method.

The main objective of the presented publication is to provide information on how is the volume and thickness of knee cartilage and meniscus changing after load in healthy subjects or in subjects with some degree of degenerative changes in these structures and the ways in which are the authors able to identify these changes.

I. Eckstein et al. (2005b) evaluated the deformation of the femoro-tibial knee cartilage after different types of exercises. 10 subjects (18–37 years, 5 men, 5 women). MRI parameters 1.5 T, TR / TE = 17.2 ms / 6.6 ms, slice thickness = 1.5 mm, resolution = = 0.3 × 0.3 mm^2; duration = 7 min. Gain of coronal sections in the initial testing, after 60 min rest and after 30 squats. After a period of 6–12 months were the same volunteers measured after the activity (30 squats on one leg, 2 min static load on a leg at an angle of 15° with a load of 200%, 10 jumps from 40 cm box to 1 foot). Evaluation of volume and thickness after segmentation using 3D reconstruction and transformation of the Euclidean distance. After performing squats, statistically significant reductions in the volume were only on the lateral tibial cartilage. After jumps from 40 cm box to 1 foot, statistically significant changes were in medial and lateral tibial cartilage.

Table 1. Medium values showing the deformation of the cartilage (volume changes) in femoro tibial joint after different types of exercises. The size of deformation was determined by subtracting the volume of cartilage observed prior to the activity from cartilage volume found after activity and expressed precentage. * statistical significance $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. (LFC), the lateral femoral condyle; (LT), lateral tibia; (MFC), medial femoral condyle; (MT), medial tibia. Edited from Eckstein et al. 2005b.

Author ranked a small sample of the population and does not define what are the regular activities of the subjects. Cartilage may behave differently in individuals performing regular exercise, and subjects with a sedentary lifestyle. Rating at 1.5 T device can distort the results compared with use of the 3.0 T device. 1.5 mm thickness of sections is relatively large for accurate determination of the volume change.

	MT	LT	MFC	LFC
Knee bends (2 legs)	+0.1 (4.2)%	–2.8 (4.0)%**	–3.9 (9.4)%	–3.3 (6.1)%
Knee bends (1 leg)	+0.1 (2.4)%	0.0 (2.8)%	–3.2 (8.7)%	–0.1 (4.7)%
Jumps (40 cm height)	–6.1 (3.5)***	–7.2 (4.2)%***	–1.1 (8.3)%	–0.2 (5.2)%
Static exercise	–3.1 (4.5)%*	–2.4 (5.2)%	0.0 (6.6)%	–3.3 (6.2)% *
Values are mean (SD)				
* Borderline significance ($p < 0.1$); ** significant at 5% error level ($p < 0.05$); *** significant at 1% error level ($p < 0.01$)				
LFC, lateral femoral condyle; LT, lateral tibia; MFC, medial femoral condyle; MT, medial tibia.				

II. Kessler et al. (2006) seek to determine volume changes of cartilaginous parts of the knee after extreme dynamic loading as occurs in regularly long-distance runners using MRI (1.5 T). The study of 48 knees of 30 male athletes age 21–65 years without previous knee problems who participated in the testing. The scan protocol was 60 min rest period – 1st measurement - completion of designated trail (5 km, 10 km, 20 km) without prior warm-up – 3 min delay for positioning in the MRI and setting the device – 2nd measurement. Data were coded and transferred to a computer system Octane Duo. Dimensions were determined semi-automatically – cartilage surfaces were marked manually, but limit cartilage – bone was determined automatically with manual correction possibility. The conclusion from these measurements is that after completion of 5, 10 and 20 km there is a reduction of the articular capsule and meniscus cartilage volume, statistically most significant changes are after completion of 5 km run. Volume changes in relation to the traveled distance are statistically significant in all cases. For the next measurement (2008) the same author evaluated hormfull effect of long-distance running (20 km) to the knee joint (20 knees, male athletes 21–28 years). The whole measurement was made identical to the previous measurement and evaluation Kessler, (2006). Statistically significant changes in the cartilage and meniscus were measured immediately after the running, after an hour of rest, however, changes in the structures compared with the initial condition was not statistically significant.

The result is the assessment the tibial cartilage is able to adapt to the loads due to cyclic motion repetitive for a long time. Volume changes on the femur were not observed. After 1 h recovery statistically significant volume changes of the structures were not observed, as confirmed by other studies (Kunz, 2005). In order to show significant changes, it would be necessary to use a more specific measurement technology and obtain a larger population sample. Despite the same parameter settings of MRI equipment as in previous study, volume changes in meniscus and tibial cartilage after running 20 kilometers came differently. However, for all studied

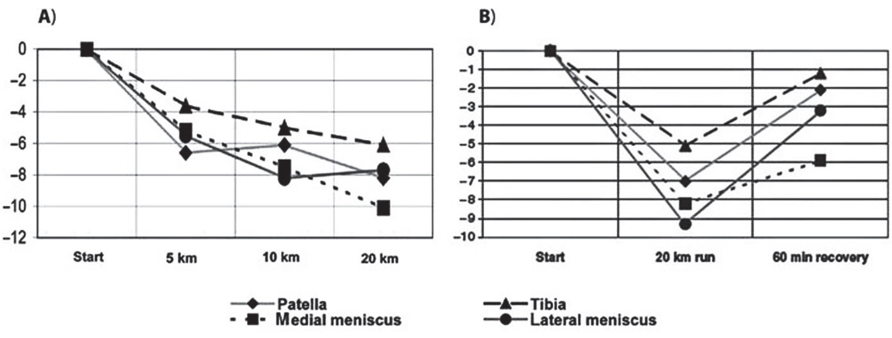

Figure 1A. Percentage volume changes of selected structures of the knee after completion of different periodes of cyclic load. Edited from Kessler et al., 2006.
Figure 1B. Percentage volume changes on the patella, tibia, medial and lateral meniscus measured immediately before and after running 20 kilometers, and after 60 minutes of recovery. Edited from Kessler et al., 2008.

parts of the knee they were statistically significant. Author examines population with a relatively large age variance and he used a device with small force field and large thickness of slices. There is no mention of period during which an individual was captured, when the tissue rehydration occurs. This phenomenon is largely individual, which may distort the results. Resolution is insufficient due to the small volume changes that occur after the load on the meniscus. For individual subjects they are at least about 2%, maximum 12% of average height (5 mm) and width (27 mm) of the meniscus. There is relatively difficult to detect volume changes (assuming that the width of the meniscus will vary at least, most change is at height in the amount of about 0.1 mm to 0.6 mm). When measuring the volume changes of the cartilage (height 1.2 mm to 2 mm) is the detection of volume changes even more difficult. A partial solution is a mathematical approach using software (Matlab, Octane Duo, Amira, etc.), through which acquired images can be processed and more accurately approximate the resulting changes. Regarding studies of the composition of cartilage, or meniscus, not every layer behaves as well (water content, PG, collagen). Mapping techniques have been developed by which it is possible without the presence of contrast material to show different content of water and PG depending on the distance from the cartilage surface.

T1rho AND T2 MAPPING

MRI values based on the T1 relaxation times (T1rho) describing the spin-lattice relaxation in the rotating frame are related to energy changes between proton spin and the environment. Changes in extracellular matrix (PG loss) can be viewed through T1rho as less restricted movement of water protons. T1rho relaxation times are more stating about changes in the hyaline cartilage (Rauscher, 2008).

MRI values based on T2 relaxation times mean spin-spin relaxation. They are related to energy changes in proton spins, showing the ability of free protons of water molecules to move and change the energy within the cartilage matrix. T2 relaxation times are sensitive to the interaction between water molecules, the concentration of macromolecules and the structure of the extracellular matrix, especially in the interaction based on the content, orientation and anisotropy of collagen (Fragonas, 1998; Liess, 2002). Damage to the matrix and increase of water content in the degenerating cartilage may increase T2 relaxation times. T1rho correlated significantly with PG content in the cartilage, T2 correlation with a PG is controversial. T2 are more stating about the changes in the meniscus (Rauscher, 2008). T1rho values are about 30 % higher in the cartilage than T2 values and about 20 % higher in the meniscus (Rauscher, 2008). T1rho and T2 allow to distinguish healthy subjects from patients with moderate or higher levels of OA (Rauscher, 2008; Li, 2011). Kaufman (1999) found in vitro that the reduction of T1 values under load is more significant in degenerate cartilage compared with healthy, so it is also in T2 values, which, however, showed even more significant difference by the degenerated cartilage. Degenerate cartilage permeability is higher during the first 5 minutes of load, after this time permeability decreases compared with healthy cartilage.

In subsequent articles authors displays by T1rho and T2 mapping meniscus and cartilaginous matrix and their changes after the load or by degeneration.

III. Moser et al. (2010) made attempt to evaluate changes in knee cartilage. The creation of 4 groups: YM subjects in 45 years running marathons, OM individuals over 45 years running marathons, the YC subjects, including 45 years with a sedentary lifestyle and OC subjects over 45 years with sedentary lifestyle. First measurements were made in the morning, then 30 min run on asphalt and immediately within 10 minutes placed in the device again and measured for the second time. It was used additive device connected directly to the table to eliminate differences in knee position at photography. Quantitative MRI T2 maps were obtained at 3.0 T MRI spectrometer. The resulting resolution was $0{,}33 \times 0{,}33$ mm^2 and total time from the end of running until the end of imaging was 15 minutes. Images were analyzed in the range of gray scale and quantitative T2 maps in color images. For comparison was thickness of the cartilage by observed individuals normalized. For all groups shows a reduction in cartilage thickness after the run, which is statistically significant in young subjects with a sedentary lifestyle and in comparison with active young people are the changes also significant. Comparing older inactive and active subjects brought statisticaly significant reduction of the femoral cartilage.

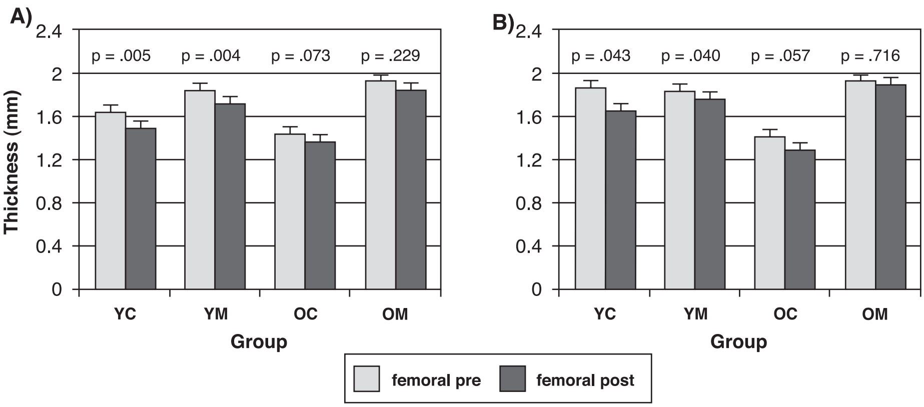

Figure 2. Medium thickness (± standard error of measurement) for A) femoral, B) tibial cartilage before (gray) and after (black) 30 min running workout. P – values show the mutual probability of paired t – test comparing the main measured thickness cartilage before and after exercise. Edited from Moser et al., 2010.

Figure 3. See Colour Appendix.

For T2 mapping decrease in T2 values points to reduction of the water content in the observed cartilage layer. A statistically significant is the thickness reduction of the surface layer in the femoral and tibial cartilage, changes are not so significant in the middle layer and in the deep layer was no evidence of statistically significant changes.

No significant changes were observed in the cartilage T2 values depending on age and activity level. Author came to similar results as in the study of changes in T2 values (2006) after a run, tibial cartilage thinning was observed in 6 of 7 subjects.

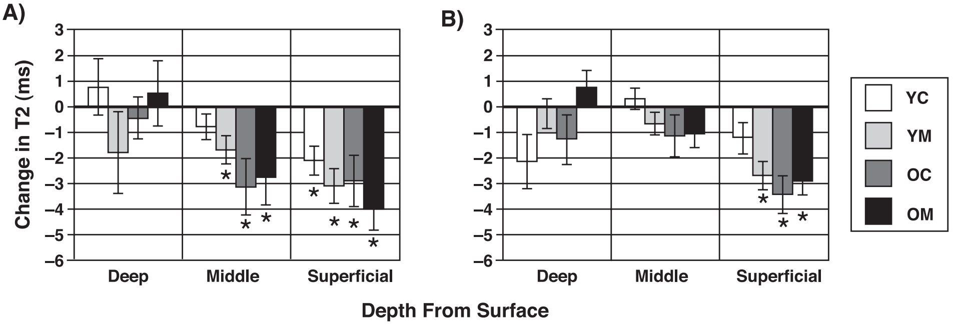

Figure 4. Differences in T2 values in the knee cartilage after 30 min. running A) femur, B) tibia; *changes in T2 values are statistically significant ($p < 0.05$). Edited from Moser et al., 2010.

Figure 5. See Colour Appendix.

A significant reduction in femoral cartilage volume was confirmed. For measurements of the cartilage thickness after running, greater stiffness of the cartilage in elderly persons occurs regardless to activity level. After cyclic loads, such as running, there is a reduction in T2 values, primary near the surface of the cartilage. Disadvantage of this measurement is time needed for re-imaging performed in a lying position without loaded limb, it is quite long for negatively charged GAGs to attract water back into the meniscus matter and rehydrate tissues. The solution to this problem would be to simulate loaded limb by additive device without interfering with magnetic field, which will delay the rehydration factor.

IV. Stehling et. al. (2010) evaluation of changes in T1rho and T2 relaxation times at a meniscus using 3.0T MRI in knees of 13 marathon runners without any previous symptoms and comparison with a group of 10 physically active persons of the same age (around 30 years). Marathon runners were tested three weeks before the race, and 48 to 72 h after the race without any additional race and again after 11 to 14 weeks after the competition. Using semi-quantitative scoring system meniscus and cartilage were evaluated separately. According to thickness cartilage was classified in the groups according to the extent of degeneration and menisci were examined in 6 regions of interest (medial, lateral, front, rear, center), on the of signal intensity basis they were classified into 5 categories depending on the extent of damage. Images were transferred to a SUN / SPARC Workstation and then were created T1rho and T2 maps. Meniscus segmentation was performed using home-made software in interactive IDL language (as in the previous article Moser, 2010). Results: No statistically significant differences between experimental and control group were found. Marathon runners group showed a significant increase in T2 values. After 3 months, a significant reduction in T2 values was confirmed in the same group compared to the state immediately after the marathon. There was no difference in T1rho values between the experimental and control group. When evaluating changes in the experimental group after the contest there was a significant increase in T1RHO values, after three months values remained still high.

Figure 6. See Colour Appendix.

Unchanged T1rho values after 3 months may indicate that jogging can affect lasting change in the matrix of the meniscus. Measurement works with relatively small sample and also the age range of studied subjects was too large. Changes were evaluated after unequal time and is not listed, what exactly did individual subjects do before measurements (walk, sleep, etc.).

V. Li et al. (2007) 16 healthy subjects (22–74 years) and 10 patients with OA (37–72 years) were scanned at 3T scanner. Images were transferred to the Sun workstation to determine the volume and cartilage thickness, T1rho and T2 relaxation times. Cartilage was segmented semiautomatically by the home created insoftvare matlab program. Non-parametric ranking test was used to determine the volume, average thickness and T1rho and T2 values between the two groups.

None statistically significant differences in cartilage volume and thickness between the healthy group and patients with OA was shown, it was due to sampling of patients which according to the degree of degeneracy belong in the lower group with OA. Spatial resolution was not sufficient, possible changes would not be captured at these settings. Average T1rho and T2 values were in patients with OA significantly higher.

VI. Rauscher et al. (2008) measured 27 patients with moderate, 10 patients with a high degree of osteoarthritis and 23 healthy subjects using the 3.0 T device. Meniscus boundaries were determined using the home-made Matlab software using semi-automatic technique based on Bezier's curves. After segmentation of the meniscus it was transferred to a 3D binary form with isotopic voxels and T1rho and T2 maps were designed.

Figure 7. See Colour Appendix.

Table 2. T1rho and T2 values of the meniscus measurement in the control group and group of patients with intermediate OA level. Edited from Raucher et al., 2008.

Measurement an Measurementr Area	Control Subjects	Patient with Mild OA	Patuents with Severe OA
T1 (msec)			
Both menisci	14.7 ± 5.5	16.1 ± 6.6	±
Lateral meniscus	14.1 ± 5.6	16.0 ± 6.6	18.7 ± 7.1
Medial meniscus	15.0 ± 5.0±	16.1 ± 6.0	20.7 ± 7.6
T2 (msec)			
Both menisci	11.4 ± 3.9	13.5 ± 4.7	16.6 ± 8.2
Lateral meniscus	10.8 ± 4.1	13.0 ± 4.8	15.9 ± 7.5
Medial meniscus	11.8 ± 3.5	13.9 ± 4.3	18.0 ± 5.3

Note – Data are mean values ± standard deviations.

Figure 8. See Colour Appendix.

T1rho and T2 values in patients with OA were increased compared with the healthy sample and correlated with the degree of OA. Statistically significant were differences in T1rho and T2 values (T2 values more) between formed groups (healthy subjects, medium and high grade OA) in all parts except the media meniscus between control group and patients with medium OA grade. T2 values in both meniscus had the highest diagnostic value, in the medial and lateral meniscus were similar. For T1rho and T2 values were significant differences in patients with moderate OA having meniscus lesion and patients without meniscus lesion.

T1rho and T2 values are elevated with statistical significance in patients with OA compared with healthy subjects. As a result, it can be concluded that in the measurement of the meniscus matrix T2 values can be used to distinguish healthy subjects from those with some degree of OA, T1rho values are usable at hyaline cartilage. Higher correlation is with the measurements in meniscus matrix, but this can not be held for hyaline cartilage.

CONCLUSION

The main intention of publication which have been monitoring changes in meniscus and cartilage of the knee was accomplished. In terms of assessing changes in cartilage, we can state the following main results from the literature critical review: authors differ in the results in detecting cartilage thickness and volume changes after a certain load by the MRI. This may be caused by different input settings (field strength, the thickness of slices, resolution, evaluating by one radiologist). There is a significant thinning of the cartilage after load, several authors indicate significant changes in the tibial cartilage and meniscus. Through mapping they were able to prove changes at the surface layer interfaces. A reduction of T2 values after long-term activity occurs in healthy people, a significant increase in T1rho and T2 values immediately after passing the burden occurs in people with some degree of damage, suggesting the possible development of swelling and penetration of water molecules into the matrix. T2 values can be used to distinguish healthy subjects from those with some degree of OA, T1 values are usable at hyaline cartilage.

A review shows controversial results that may be caused by many factors, because the areas of interest of the study are relatively small in relation to the accuracy of MRI imaging. Even small displacements, and a small difference in knee flexion in photography distorts the results. In order to eliminate this factor, it is necessary to use equipment that can providethe most accurate position in the coil for imaging. When the load terminates the tissue rehydration occurs, which is largely individual, it would be appropriate to use a device that is able to simulate load on a limb and prevent the recurrence process of pulling water molecules back into the matrix as much as possible to eliminate this phenomenon. Behavior of cartilage with different age and activity level changes, so the selected sample should be more specified.

This critical review of the literature points to the methods, which could bring even more chances to simulate the real state after load and to predict possible future behavior of cartilage in individuals.

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DETEKOVÁNÍ TLOUŠŤKY A OBJEMOVÝCH ZMĚN KOLENNÍCH CHRUPAVEK VE FEMORO-TIBIALNÍM SKLOUBENÍ V RŮZNÝCH ZÁTĚŽOVÝCH REŽIMECH PROSTŘEDNICTVÍM MRI

LENKA HORŇÁKOVÁ, DANIEL HADRABA, PAVEL ŠTURSA, KAREL JELEN

SOUHRN

Chrupavky a menisky kolenního kloubu jsou živé tkáně, mají však omezené možnosti pro růst a obnovu. Pokud nejsou dlouhodobě zatěžovány, dochází k porušení látkové výměny v hlubších vrstvách. Mnohé negativní změny však mohou být značně eliminovány periodickou nejednostranní aktivitou, přiměřená zátěž (střední střídavá intenzita) stimuluje růst chrupavky a svalů, a tak zabraňuje jejich ochabování. Při zatížení dochází ke pružné deformaci chrupavky, z matrix je vytlačována synoviální tekutina do kloubní štěrbiny, denzita matrix tak roste. Při odlehčení synoviální tekutina proudí zpět do chrupavky.

Vzhledem k intracharakteristikám kolenního kloubu (prostorová nedostatečnost) je zobrazení změn přímo uvnitř menisků a chrupavek problematické. Detekce a modelace mechanické reakce tkáňových struktur na vnější mechanické zatížení je možná pomocí neinvazivních zobrazovacích metod. Poměrně přesné zobrazení s širokým uplatněním u pacientů poskytuje zobrazování magnetickou rezonancí (MRI).

Zobrazování MRI je v drtivé většině prováděno v leže bez jakéhokoliv zatížení končetiny, což může podávat do jisté míry zkreslující informace, i když i nezatížená chrupavka je vystavena tlaku vyvolanému svalovým tonem. Z aspektu vyhodnocování změn na kolenní chrupavce po různě dlouho trvající zátěži jsou podrobeny následující publikace literární rešerši. Autoři využívají na ohodnocení změn různé nastavení parametrů MRI a tak se snaží získat co nejpodrobnější informace o sledovaných strukturách v různých specifických druzích zatížení.

Klíčová slova: koleno, meniskus, chrupavka, MRI, zátěž, degenerace

Lenka Horňáková
lenka.hornakova99@gmail.com