 INITIAL ULTRASTRUCTURAL CHANGES OF THE MENISCI IN THE KNEE JOINT AFTER RUPTURE OF THE COLLATERAL LIGAMENTS - EXPERIMENTAL STUDY

It is known that the dismemberment of the collateral ligaments is one of the most frequent traumas in footballers, skiers and other sportsmen. Our results showed that the first changes in the menisci are occurred in the parameniscal zone. These changes are developed by the 10 day of the operation. Later we observed the changes in the superficial sliding zone of the medial meniscus. We emphasized the fact that these changes begin in the parameniscal zone of the menisci. After the other types of soft tissue traumas in the knee they begin in the superficial sliding zone. After immobilization and regular treatment the results are not always good. The rupture of the collateral ligaments almost always follows to the biomechanical discomfort in the knee and after that, degenerative changes in the menisci begin.

**Keywords:** Degenerative changes, knee joint menisci, collateral ligaments.

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**Introduction**

The purpose of this study is to try to explain the mechanism of releasing the degenerative changes in the knee joint menisci after rupture of the collateral ligaments. It is known that the dismemberment of the collateral ligaments is one of the most frequent traumas in footballers, skiers and other sportsmen (Shoylev, 1998). Even after immobilization and regular treatment the results are not always good. Because of this reason we decided to investigate where, when and how the changes of the knee joint menisci begin really hoping to clarify the reasons and consequences. One of the reasons is the fact that the rupture of the collateral ligaments almost always follows to the biomechanical discomfort in the knee and after that, degenerative changes in the articular cartilage and in the menisci begin (Cameron and Mac, 1973).

Our results showed that the first changes in the menisci are occurred in the parameniscal zone (Vidinov et al., 2005) unlike the injuries as ruptures of cruciate ligaments of the knee (often in the anterior) and lesions of the capture sites of the menisci. Initial changes in these traumas are in SSZ. The reason for this is toposographic anatomical location of the collateral ligaments in relation to the parameniscal zone. In the inner part of the knee the medial collateral ligament is adherent to the medial meniscus (Goldman and Waugh, 1985). Unlike the medial meniscus and the medial collateral ligament there is no connection between the lateral meniscus and the lateral collateral ligament. The tendon of popliteal muscle and a small bursa are situated here. Because of this reason we chose the cutting of a lateral collateral ligament. There is no risk in this procedure for the damage of the lateral meniscus unlike the cutting of the medial collateral ligament where there is a risk of the damage of the medial meniscus.

**Material and methods**

The materials of the investigation were menisci of the knee joint of 15 Wistar rats of both sexes, aged between 3 and 8 months, weighing about 250 g each. The animals were treated under the European Convention working with experimental animals. We used the below mentioned model of cutting of the lateral collateral ligament. It is made a cut
lengthwise side on the right knee skin following the axis of the limb. After the finding of
the lateral collateral ligament the last was cut transversely. We repaired the integrity of the
skin by a suture. Material for investigation was taken 24 hours, 10 and 20 days after the
intervention. The material from left knees was used as a control for comparison. The
fixation was carried out by glutaraldehyde. Light microscopy (hematoxylin-eosin, Van
Gieson, AZAN and Mason), transmission electron microscopy (TEM) and scanning
electron microscopy (SEM) were performed, so we traced out the ultrastructural changes
in each zone of the menisci. It was also examined ultrastructurally for proteoglycan
complexes with Safranin O.

**Results**

Almost immediately there was observed hyperemia, which was seen macroscopically.
Using light microscopy are observed small vessels filled with erythrocytes. The
 ultrastructural examination showed continuous capillaries with blood elements in them
(Figure 1).

**FIGURE 1. PARAMENISCAL ZONE. CAN BE SEEN CONTINUOUS CAPILLARIES
WITH DIFFERENT SIZE, TEM; X - 4000**

There were seen many pinocyte vesicles in the endothelium of the continuous capillaries
(Figure 2).

**FIGURE 2. THERE WERE OBSERVED MANY PINOCYTE VESICLES IN THE ENDOTHELIAL
OF THE CONTINUOUS CAPILLARIES APART FROM BLOOD ELEMENTS, TEM; X - 11500**
Our results showed that there were no changes in superficial zones of the meniscus on the 10th day after the surgery on the light microscopic examination. The scanning microscopic examination also did not reveal significant changes during this period.

On the 20th day after the operation were observed changes in the superficial sliding zone of the medial meniscus. In the macroscopic examination was discovered that the surface of the meniscus was more opaque and grayish-pink. In the light microscopic examination was established a thinning of the superficial zone and the presence of roughness on the border strip (Figure 3).


The scanning electron microscopy showed the presence of unevenness, which are result of the revealing the underlying bundles of collagen fibers (Figure 4).

**FIGURE 4. IN THE SCANNING ELECTRON MICROSCOPY WERE FOUND ROUGHNESS WHICH ARE RESULT OF THE REVEALING THE UNDERLYING COLLAGEN FIBERS BUNDLES. FIBROBLASTS ALSO WERE SEEN, SEM; X - 1150**

In the transmission electron microscopy was thinning of the lamina splendens and its mixing with underlying superficial zone. At the same time the chondroblasts of the
superficial zone were with signs of an active synthesis - enlarged granular endoplasmic reticulum and also there was an increase of the concentration of the proteoglycan complexes in the territorial matrix (Figure 5) (Kalniev, 2010).

**Figure 5. Activated chondroblasts were observed in the transmission electron microscopy. There was a development of GER and its cisterns were extended, TEM; X-16100**

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**Summary**

The ruptures of the collateral ligaments of the knee are among the most common injuries, especially in footballers, skiers, handball players and generally at athletes. These injuries are frequent and at common household traumas. Because of this reason they have a great significance in the area of traumatology. It is important to mention that even after immobilization and regular treatment the results are not always good despite of the fact that the injuries of the collateral ligaments have a better prognosis compared to the damages of ACL and PCL. The main reason for this is the occurred biomechanical discomfort in the knee, which follows to restriction of normal motion in the knee. After that the mechanism of the “biological pump” is destroying and then the normal trophic of the intraarticular structures of the knee is disturbing. On the other hand the immobilization leads not only to a disturbing of the mechanism of the “biological pump” (Vidinov, 1998), but also to a disturbance of the active synthesis of the chondroblasts, etc. Because of the fact that PZ is situated topographically closed to the collateral ligaments the initial changes are occurred therein unlike in the other damages namely - in the SSZ of the meniscus. These alterations are expressed in hyperemia, which is manifested in the feeling in the extreme with blood of the continuous capillaries situated here (Vladimirov and Velisarov, 1974) and many pinocyte vesicles in the endothelium. On the 20th day after surgery the changes begin from the surface of the meniscus inside. On the light microscopic examination is seen thinning of the superficial sliding zone and the appearance of unevenness on the border line. In TEM is observed a diminution of lamina splendens and its mixing with SSZ. The chondroblasts of the superficial zones (Kalniev et al., 2008) have signs of an active synthesis. The evidence of this is an enlargement of the cisterns of GER and the enhanced concentration of aggrecan in the territorial matrix. As time further changes in the meniscus are occurred (Hellio et al., 2001). These changes however are more strongly expressed in the medial meniscus (Pagnani et al., 1991) at a molecular level, in comparison with the lateral meniscus (Hellio et al., 2001), which correlates with our findings.
Discussion

As whole injuries of the collateral ligaments have a better prognosis compared to the damages of ACL and PCL. Which is the best option concerning treatment of the ruptures of the collateral ligaments is still the object of discussion. The common opinion is to treat every complete rupture of the collateral ligaments surgically. The best choice is to perform the operation as soon as possible. Most modern opinion includes conservative treatment for complete ruptures of the collateral ligaments.

As far as incomplete rupture is concerned it may be treated conservative by immobilization for about 25-30 days (Shoylev, 1983). Concerning aging ruptures of the collateral ligaments they have to be treated only surgically by using plastic replacement. The question whether above mentioned degenerative changes in the menisci and also in cartilage of the knee may be avoided or may be reduced remains open. If the rupture would be diagnosed on time and if the treatment would be adequate and follows the modern conception concerning these damages, the degenerative changes of the menisci and in the articular cartilage may be diminished to a minimum. Therefore the knowledge about the mechanism of releasing the degenerative changes in the knee joint menisci and cartilage is so important.

References