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Investigation about the Superficial Sliding Zone and Transitional Sliding Zone in the Knee Joint Menisci

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On the surface of the meniscus facing femur biomechanical forces acting on the sliding. Not coincidentally this part is established in the literature as a Sliding Zone [9]. Concerning the recent investigations [7] this part consisted by two zones as follows: A Superficial Sliding Zone (SSZ) and a Transitional Sliding Zone (TSZ). The SSZ is situated superficially and cover the femoral surface of the meniscus. Medially it adjoins with a Zone of Fusion and lateral is situated a Parameniscal Zone. TSZ is situated under the SSZ. The other zones of the meniscus are as follows: A Superficial Pressure Zone (SPZ); A Transitional Pressure Zone (TPZ); A Central Zone (CZ); A Zone of Fusion (ZF) and. A Parameniscal Zone (PZ). When the meniscus is sectioned transversely these zones are the most visible [10]. The Superficial Pressure Zone covers almost the whole tibial surface of the meniscus, and the Transitional Pressure Zone is located above the SPZ. The CZ is located in the inner part of the meniscus. This zone is surrounded by the PZ, the TSZ and the TPZ. The ZF is situated in the top, most medial part of the meniscus. The PZ is the biggest zone [5] of the meniscus. The PZ is situated in the outer part of the meniscus and it borders on the SSZ, the TSZ, the CZ, the SPZ and the TPZ. Blood vessels are observed in the PZ, but not in the other zones [9].

Key words: knee joint, cartilage, meniscus

Introduction

Concerning the different zones of the meniscus is written much in the last decade. In the present investigation, we studied mainly SSZ and TSZ. These are both areas of the meniscus, where biomechanical forces acting on the sliding. These zones which first began were influenced in degenerative changes in the meniscus of the knee. For this reason we turned attention mainly on these two areas.

Material and Methods

The materials of the investigation were menisci of the knee joint of 15 Wistar rats of both sexes, aged between 60 and 120 days, weighing about 200 g each. The animals were treated under the European Convention working with experimental animals. The fixation was carried out by glutaraldehyde. Permanent histological preparations were obtained after appropriate procedures. They have been colored with HE, Mason, AZAN and Van Guisone. Light microscopy (HE and AZAN), transmission electron microscopy (TEM) and scanning electron microscopy (SEM) were performed, so we traced out the ultrastructural features of the menisci.

Results and Discussion

The Superficial Sliding Zone was situated in the most superficial part of the meniscus which faced to the femur. On light microscopic investigation we observed that SSZ has the appearance of a narrow strip which passes laterally into Parameniscal Zone, passes medially in the zone of fusion and down in the Transitional Sliding Zone (Fig.1).

Scanning electron microscopy showed that the surface topography was defined by elongated cell bodies of layers and bundles of thick collagen fibers located between the cells. (Fig.2).

SSZ consisted of cells that had the character of the fibroblasts. These were elongated cells arranged parallel to the articular surface. They had well-developed granular endoplasmic reticulum and well-defined Golgi complex. Sometimes lysosomes can be seen inside the cells. (Fig.3).

Proteoglycans were distributed evenly in the intercellular matrix and collagen network matrix is type I. The collagen network consisted by collagen fibers that form bundles parallel to the articular surface.

The Transitional Sliding Zone is placed just below described tangential zone. Laterally it was bordered by Parameniscal Zone and medially merged with the Transitional Zone of Pressure (Fig. 4).

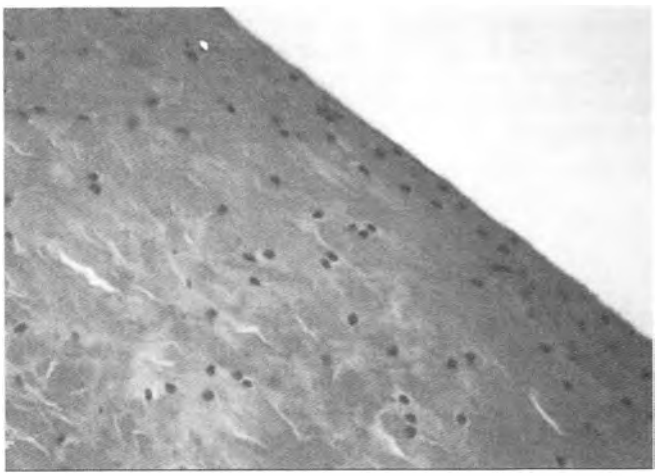

Fig.1. The Superficial Sliding Zone consists of 2 to 4 layers of elongated cells that have a longitudinal axis parallel to the articular cleft. Staining – HE; X – 300

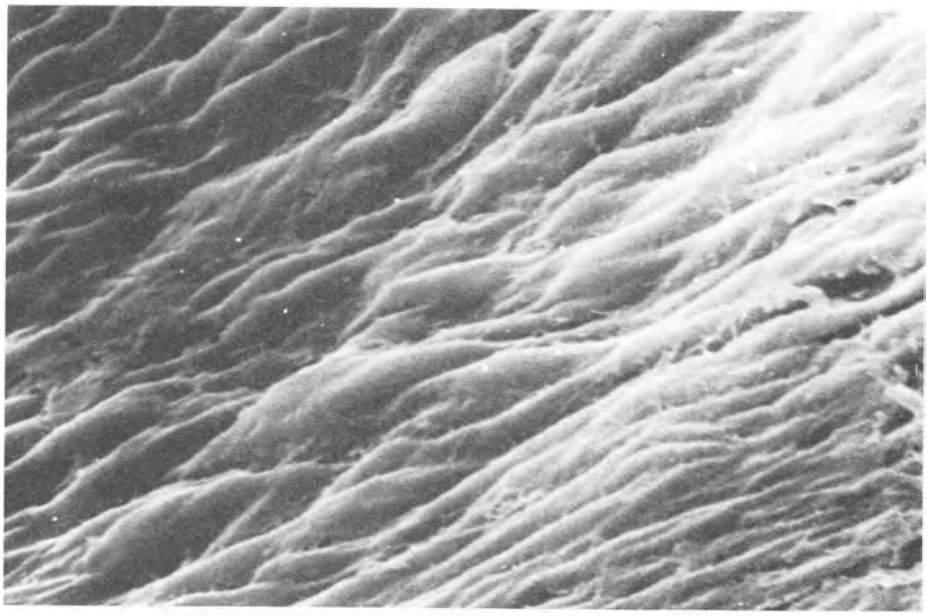

Fig. 2. Scan microscopic investigation on the surface of SSZ. There are seen spindly projections that are arranged in parallel joint space narrowing. SEM; X -4000

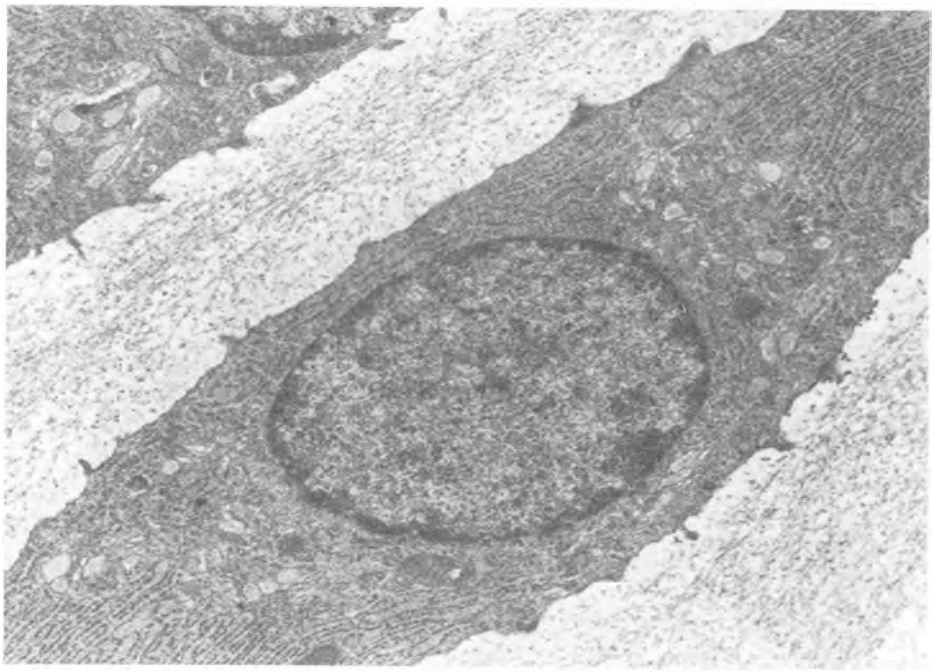

Fig. 3. Fibroblasts of the Superficial Zone of Sliding. It is seen that the cells are spindle shaped, with their longitudinal axis parallel to the articular fissure. There is well-developed granular endoplasmic reticulum. TEM, X - 8000

It was composed of elliptical or oval cells with the character of chondroblasts. Cells are arranged singly or in isogenic groups. These cells had moderate GER, poorly developed Golgi apparatus and sometimes there were glycogen clusters. Intercellular matrix was represented by moderately dense collagen network and proteoglycan complexes. The collagen network was unevenly distributed, as can be seen as bundles type I collagen fibers and irregular fibers of type II (Fig.5).

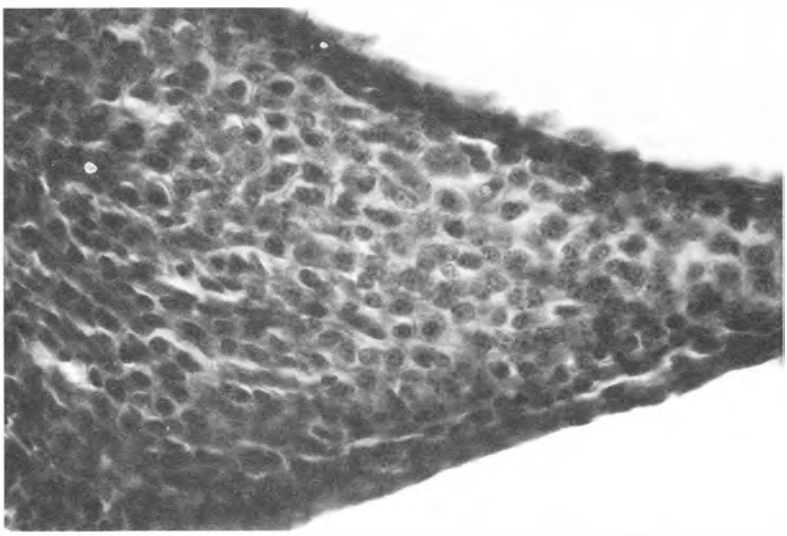

Fig. 4. The Transitional Sliding Zone laterally bordered by PZ and medially merges with the TPZ. Staining - AZAN; X – 200

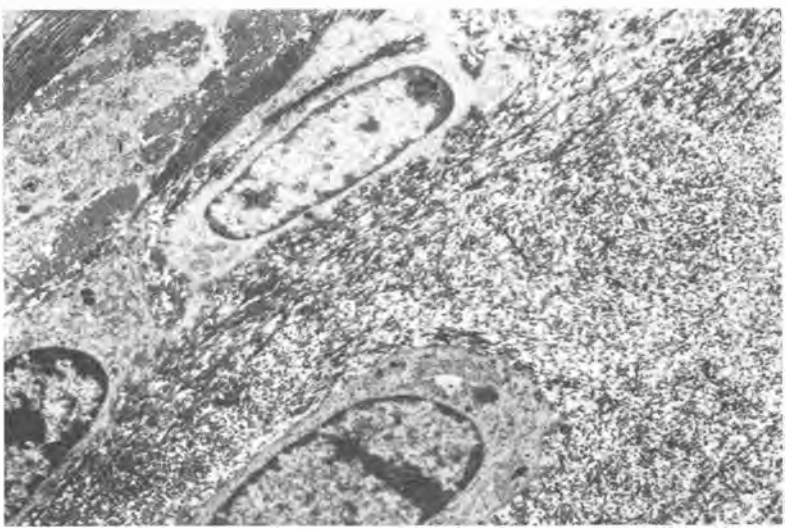

Fig.5. Intercellular matrix of TSZ. There are oval chondroblasts and mixed network collagen type I and type II. TEM, X - 6000

Conclusion

The Superficial Sliding Zone and Transitional Sliding Zone were situated in this part of the meniscus which is in contact with the condyles of the femur. From the biomechanical point of view there are forces acting on the sliding in this area of the meniscus. This determines the structure of these zones. Cells in the Superficial Sliding Zone are fibroblasts, whereas the cells in the Transitional Sliding Zone are chondroblasts. These chondroblasts have signs of active synthesis which is associated with the role of this buffer zone [3, 6]. Thus way it may explain the fact that in the Superficial Sliding Zone collagen is type I, whereas in the Transitional Sliding Zone there are both collagen type I and type II [8]. Proteoglycan complexes are few in SSZ and more in TSZ, but proteoglycans are evenly distributed in both areas [11].

Soft tissue injuries of the knee are more common in younger age. Degenerative changes begin in the knee cartilage after these injuries. The damages of the menisci (more often medial) and ruptures of the cruciate ligaments are most common [12]. Degenerative changes affect not only the cartilage but also menisci [1, 2]. The first degenerative changes in the menisci are observed particularly in SSZ, then in TSZ, whereas the other zones of the meniscus affected by the degenerative process much later [10]. Changes of this type occur in the elderly when no data suffered soft tissue injuries in the knee joint [4].

From all these considerations it can be concluded, that SSZ and TSZ are not only functionally and metabolically most active but these zones have an important role in the development of degenerative processes affecting the knee joint and meniscus in particular.

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