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CYSTS OF THE SEMILUNAR CARTILAGE OF THE KNEE

A Light and Electron Microscopic Study

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The semilunar cartilages of the knee of six cases showing various degrees of mucoid degeneration with cyst formation were studied with the light microscope. Three cases were selected for electron microscopic observation which revealed that some of the cystic spaces filled with mucoid material were lined by synovial cells. Masses of mucinous, alcian blue positive material (acid mucopolysaccharides) were observed also among degenerated and intact bundles of collagen. It is concluded that the accumulation of acid mucopolysaccharides in meniscial cysts is at least in part a product of secretion of synovial cells. This observation explains the high incidence of recurrence of meniscial cysts after incomplete surgical excision and supports the concept that it is an active rather than a degenerative process.

Key words: semilunar cartilage; meniscus; meniscial cysts; synovial cell displacement; acid mucopolysaccharides; light and electron microscopic study

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The cause of meniscial cysts is still being debated. The history of trauma is unreliable and in most cases there is absence of a severe trauma so that a chronic, long-standing minor trauma is regarded as significant in the development of meniscial cysts. Patients are usually young adults, more frequently male than female, probably because the former are more often exposed to severe physical activity. The lateral meniscus is more frequently affected than the medial meniscus. An explanation for this is that the medial meniscus is firmly anchored and therefore more exposed to tears, while the lateral meniscus, because of its increased sliding and displacement range, is more protected against lacerations and has a tendency to show degenerative changes. Increased pressure on standing over the lateral meniscus and variable degrees of congenital malformation of the joint surface of the external tibial condyle have been regarded as important contributory factors for the increased incidence of meniscial cysts in the lateral meniscus (Tkachenko & Yuriev 1972). There are two main hypotheses to explain the development of meniscial cysts. While some authors regard the mucoid cystic regeneration of the ground substance with accumulation of acid mucopolysaccharides as the most important factor (Kulman & Szepesi 1970), others claim that the masses of acid mucopolysaccharides derive from the secretions of

synovial cells displaced into the meniscial tissues (Albert & Keller 1953).

METHODS AND RESULTS

The semilunar cartilages of the knee of six cases taken from the departmental files showing various degrees of mucoid cystic degenerative changes were reviewed. The cystic spaces varied greatly in size and contained a mucoid gray-white gelatinous material similar to the contents of ganglia with the slimy character and viscosity of synovial fluid. Four of the cases involved the lateral meniscus, and two the medial meniscus. Three cases showed a distinct synovial-like cell lining in some of the cystic spaces that contained mucoid material. They were selected for electron microscopic study. Only one of the three selected cases gave a history of trauma. He was a 63-year-old male with a cyst in the lateral meniscus of the left knee. Clinically, the patient suffered damage to both cartilages of the knee in an athletic injury more than 15 years previously. He also gave a history of some buckling of his knee for many years. He had had two unsuccessful surgical procedures (15 and 8 years previously) for removal of meniscial cysts of the left lateral semilunar cartilage.

At surgery there was a 5 cm large cystic mass involving the lateral meniscus. On the cut surface it was made up of multiloculated cystic spaces containing gray-white slimy mucoid material (Figure 1). The cysts measured from 0.6 to 3.0 cm in diameter. The walls of the cysts were made up of a gray-white firm tissue and averaged 0.3 cm in thickness.

The meniscial cysts of the two remaining cases were multiloculated and smaller in size measuring up to 2 cm in diameter. They were located in the lateral meniscus of the left knee. The patients were both males, 42 and 45 years old, with no previous surgery or trauma and gave a history of buckling and swelling of the left knee for several years.

Figure 1. Meniscial cyst filled with gelatinous material. It measured 3 cm in diameter.

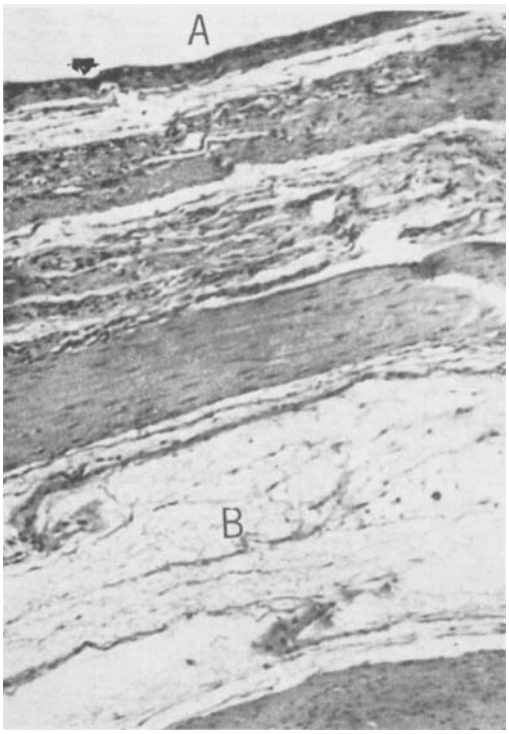

Figure 2. Multiloculated cystic spaces (A, B) filled with a mucinous alcian blue positive substance. One of the cysts (A) is lined by synovial cells (arrow) (Hematoxylin-eosin × 13).

Light microscopy

Blocks of tissue for light microscopy were fixed in 10 per cent formalin and stained with hematoxylin-eosin, alcian blue-PAS, Gomori trichrome, Mucicarmine and Gram-Weigert staining for fibrin. The sections revealed a fibrocartilaginous tissue with cystic spaces containing mucinous material intermingled in some areas with fragmented, elongated, dense masses of degenerative collagen. The walls of the cysts were fibrous with occasional cysts showing flattened cell lining. PAS-alcian blue stain showed intraluminal masses of amorphous dense PAS positive material representing degenerated collagen tissue together with lakes of gelatinous alcian blue positive substance (acid mucopolysaccharides) (Figure 2). The Gram-Weigert stain

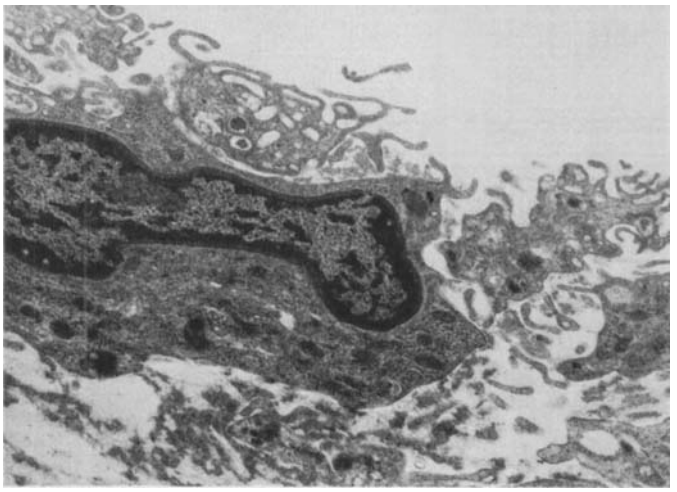

Figure 3. Synovial cells with numerous elongated cytoplasmic processes with vacuoles lined the larger cystic spaces (2 per cent uranyl nitrate and Reynold's lead citrate × 10,300).

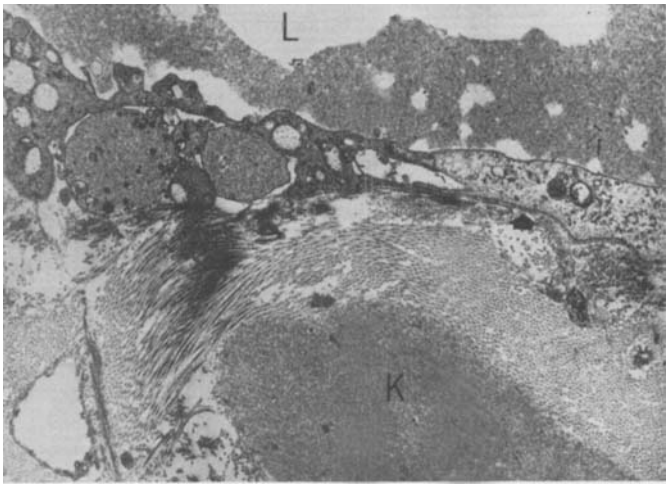

Figure 4. Granular amorphous masses of acid mucopolysaccharides were present in the lumen of the capillary vessels (L) (sectioning artifact) and between bundles of collagen fibers (K). The arrow points to the basement membrane of the capillary vessel (2 per cent uranyl nitrate and Reynold's lead citrate × 6,000).

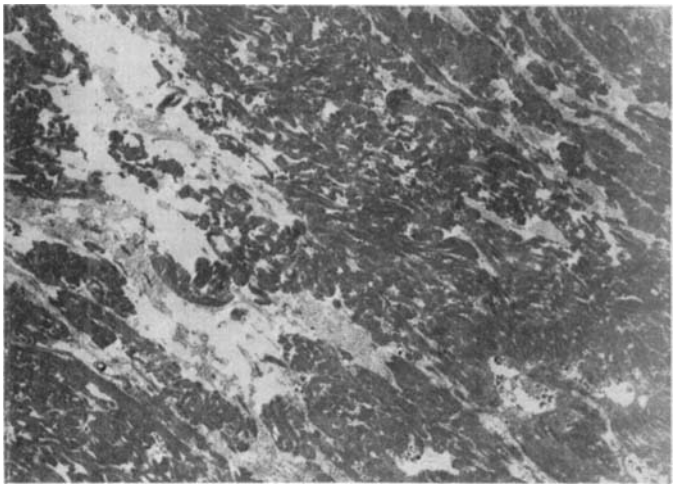

Figure 5. Degenerated bundles of collagen. They were found inside some of the cystic spaces as amorphous strongly PAS positive masses together with lakes of mucin (2 per cent nitrate and Reynold's lead citrate × 4,000).

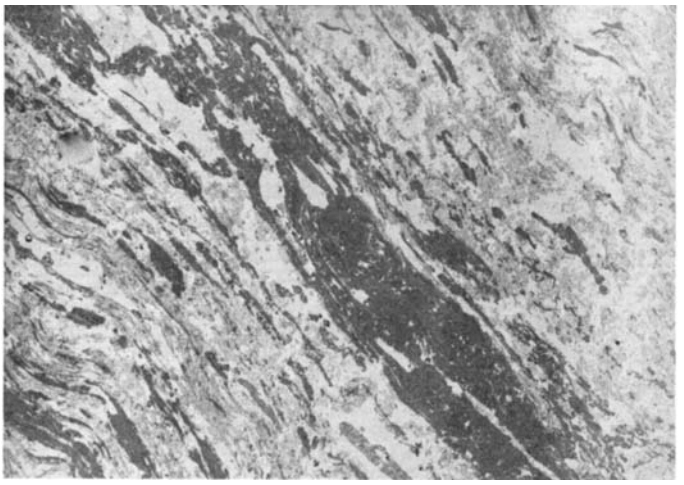

Figure 6. Globular amorphous osmiophilic fibrillary masses without cross striation which probably represent fibrin and degenerated collagen tissue (2 per cent uranyl nitrate and Reynold's lead citrate × 4,000).

showed dark bluish streaks in the cyst contents representing masses of fibrin. Adjacent frozen sections, which were submitted for immunofluorescence studies, showed fluorescent greenish elongated masses in a similar location when treated with anti-human fibrinogen rabbit antibodies and fluorescein isothiocyanate attached to rabbit antiglobulins conjugate.

Electron microscopy

For electron microscopy, multiple small blocks of tissue from different areas were fixed in 3 per cent glutaraldehyde. After postfixation with osmium tetroxide, the specimens were dehydrated and embedded in Araldite. After trimming, the tissue sections were correlated by the adjacent thick-thin section method: 1 μ to 2 μ thick sections were made using a microtome with a diamond knife. They were stained with H&E, alcian blue-PAS and Gram-Weigert stain. Adjacent 60–70 mμ thin sections were stained with 2 per cent uranyl nitrate and Reynold's lead citrate-sodium hydroxide solution. Sections were examined with an electron microscope.

Corresponding to the alcian blue positive areas, the adjacent thin sections showed consistently amorphous, homogenous masses of finely granular material in the lumen of the cystic spaces and between bundles of intact and degenerated collagen. The large cystic spaces were lined by synovial cells characterized mainly by the presence of abundant microvilli (Figure 3). Smaller cystic spaces showed an endothelial cell lining and were undoubtedly capillary vessels (Figure 4). The strongly PAS positive masses of degenerated collagen tissue corresponded in the electron microscope to bundles of dense opaque fibers without distinct periodicity (Figure 5). The streaks of dark blue areas in the Gram-Weigert stain and the greenish fluorescent masses of fibrin material corresponded in the electron micrographs to amorphous globular fibrillary masses (Figure 6). Embedded in the fibrocollagenous matrix were fibroblasts and chondrocytes showing various degrees of degenerative changes with disruption and fragmentation of the smooth and rough endoplasmic reticulum, swelling of the mitochondria and intracytoplasmic vacuolization. Whorled and laminar intracytoplasmic inclusions were present in some of the cells.

DISCUSSION

The origin of meniscial cysts is still in dispute. The theories advanced to date are mainly based in histology findings. Some authors consider chronic infection with hemorrhage as an initiating factor in the formation of the cysts (Jean 1924). Others regard meniscial cysts as the result of degenerative changes of collagen followed by necrosis of cells and accumulations of acid mucopolysaccharides. There are authors (Blanco et al. 1953 and Ollerenshaw 1921) that postulate that meniscial cysts originate from congenital inclusion of synovial rests or from traumatic cleavages of the fibrocartilaginous tissue with subsequent penetration of synovial cells and joint fluid into the meniscus. Other authors believe that the

meniscial cysts represent ganglia that originated as a result of a degenerative process and that the accumulation of acid mucopolysaccharides represents secretory activity of certain connective tissue cells (King 1940) or synovial cells displaced into the fibrocartilaginous tissue (Albert & Keller 1953). The electron microscopic findings in the cases reported here showed evidence of synovial cells lining some of the cysts that contained collections of acid mucopolysaccharides and, therefore, suggested that the accumulation of this substance was the result of secretory activity of the synovial cells in a similar way to synovial fluid. The findings described support the view that meniscial cysts are comparable with ganglion cysts and that the development of meniscial cysts is the result of displacement of synovial cells into the fibrocartilaginous tissue. However, other findings such as the accumulation of acid mucopolysaccharides between intact and degenerated fibrocollagenous fibers without morphologic relationship to synovial cells favor the theory that regards the formation of meniscial cysts as a degenerative process with necrosis of collagen fibers, fibroblasts and chondrocytes and the subsequent accumulation of a large amount of acid mucopolysaccharides that lead to cyst formation. Therefore, two main factors play an important role in the development of meniscial cysts; one is trauma followed by tears or microscopic cleavages through which synovial fluid and synovial cells are pressed into the fibrocartilaginous tissue where they proliferate, secrete large amounts of acid mucopolysaccharides and form cystic spaces, and the other is the degeneration of the collagen tissue with secondary accumulation of masses of acid mucopolysaccharides.

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