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## GANGLION OF THE WRIST—A STRUCTURE DEVELOPED FROM THE JOINT

*A Histological Study with Serial Sections*

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McEvedy (1962) described the macroscopic structure of the ganglion: The main structure consists of a cyst with pseudopodia. The main cyst is like a rubber balloon with thin spots in the rubber, and these spots are blown out like pseudopodia. Upon careful examination of the main cyst he found "on its deep aspect an attachment to the underlying joint capsule". This "attachment" is not further described; it can be slender or wide, but there is always a connexion to the joint capsule in the case of ganglia of the wrist. Ganglion of the finger may be connected to the tendon sheath, in McEvedy's opinion.

At the connexion with the joint capsule "small capsular cysts could be made out in the substance of the joint capsule". If the main cyst is emptied, the gelatinous content of the capsular cysts will empty into the main cyst. McEvedy could find a luminal connexion between all the cysts with a slender probe, but he did not believe that there was a luminal connexion with the joint cavity.

Earlier authors agree with him, that there is no direct connexion between the cavity in the ganglion and the joint, in spite of the fact that Eller (1746) described the development of the ganglion as a hernia from the joint. The impression one has from McEvedy's description is that the ganglion is like a tree. The roots are placed in the joint capsule. From these rise a pedicle, short or long, slender or wide, more or less right-angled, to the main cyst, which is placed subcutaneously, possibly between tendons. The description by Carp & Stout (1928) and De Orsay (1937) can be interpreted in the same way.

We wished to investigate this theory of the ganglion's anatomy,

particularly the connexion between the ganglion and the joint. The technique used is microscopy of serial sections of ganglia. At the same time we tried to inject contrast in the ganglia and to take X-rays of them. The pictures we obtained were so poorly defined that we found the technique unsuitable.

#### MATERIAL AND METHOD

We studied 18 ganglia of the wrist. The operations were performed under full anaesthesia and with bloodless field. All ganglia were extirpated in a tissue block composed of the main cyst, pedicle, and the connexion between pedicle and joint capsule, and here we removed a "foot-plate" of joint capsule of about 5 mm in diameter. The part of the footplate lined with synovial was marked by sutures. All ganglia were prepared for histology in the normal way. In addition we made serial sections on six ganglia at right angles to the pedicle from the main cyst and including the footplate. The specimen consisted of a piece of tissue 5-7 mm long cut in 10  $\mu$  thick serial sections.

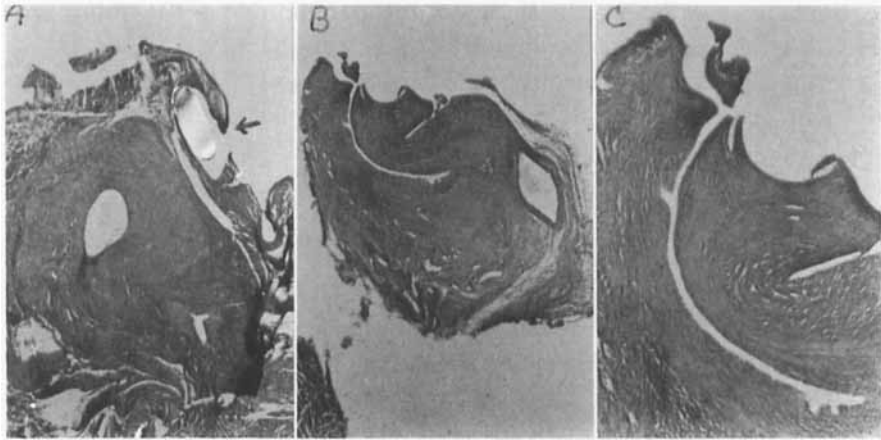
Two of this series were satisfactory, i.e. we had a complete serial section representing all the tissue. Three of the series were partly successful, but were not complete because some of the sections could not be interpreted for various technical reasons. One of the series failed completely because of shrinkage of nearly all the sections, and this was not considered in the material.

#### RESULTS

Histological examination of all serial sections showed the same structure in all the ganglia similar to that described previously (Soren 1966). The ganglion is composed of connective tissue, which is not encapsulated from the surrounding tissue, though nevertheless there is a difference in consistency of the ganglion and the surrounding tissue, which can be seen as a border of the ganglion. The part of the ganglion against this border is composed of fibrotic connective tissue, whereas the central part is composed of cavities with different appearances (Figures 1 A and 3 A).

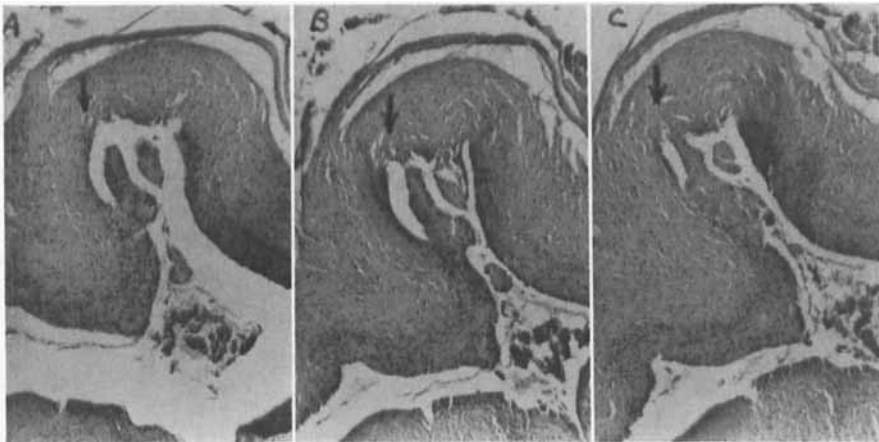
Most frequently there is no real endothelial lining to the lumen, but there are flattened fibroblasts and single star-shaped cells just beside the lumen. In some places, though, the lumen is lined by cells like histiocytes, and they can lie in several rows and look like pseudo-endothelium.

In addition to the large lumina there are innumerable small lumina, which look like capillaries. These small lumina are partly in communication with each other and some of them communicate particularly with the big lumina (Figure 2).



*Figure 1. A. Lumina in articular foot-plate. Note marking suture. Obj.  $\times 4$ . B. One lumen opening on articular surface. Obj.  $\times 4$ . C. Same as B, showing continuity of lining cells. Obj.  $\times 10$ .*

In some places, particularly where the lumen's three-dimensional branches terminate, the connective tissue is transformed to a mucinous form with much ground substance and star-shaped cells. In a few places these reticular anastomosing cells line the lumen. In many places there is fibrinoid degeneration in the walls of the cavities,



*Figure 2. Formation of slit-like lumen in wall of ganglion. Obj.  $\times 10$ . The three pictures are from serial sections with some excluded. A. shows a broad communication between the big lumen and the branch at the arrow. B. shows a narrow communication, and at C. the slit is free from the "mother" lumen.*

especially where they anastomose with each other or with the synovial joint lining. The fibrose connective tissue contains many vessels, mostly arterioles and venules.

The two successful serial sections show cavities with changing shape, diameter and branches which can be followed from the lumen in the main cyst through a pedicle to an opening in the joint capsule and synovial lining to communicate with the joint cavity (Figures 1 B and 1 C).

In one of the partly succesful series a lumen can be followed from the main cyst through the pedicle and down into the footplate. Another lumen beginning in the pedicle descends to communicate with the joint cavity.

In the two other partly succesful series a lumen can be followed from the main cyst through the pedicle and down into the footplate, but there is no communication with the joint cavity. In one of these the lumen in some places is only an irregular fissure in a mucinous connective tissue.

#### DISCUSSION

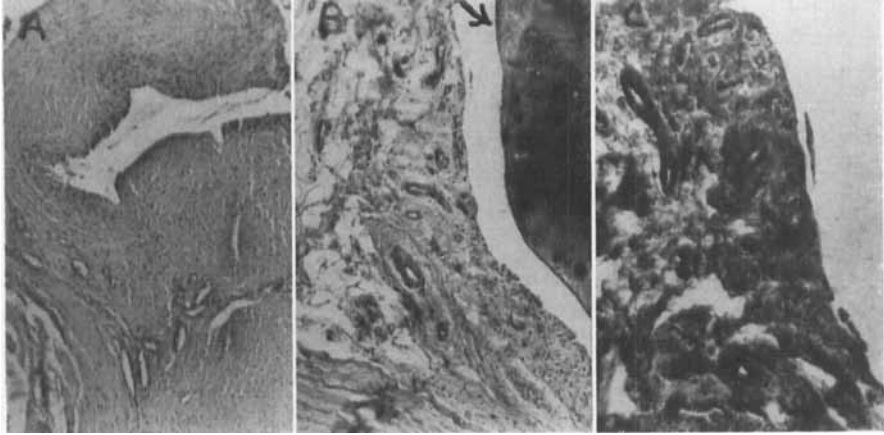
Our investigation has in general confirmed McEvedy's description of ganglia of the wrist. The ganglion is composed of a main cyst continuous in its depth with a pedicle in communication with the joint capsule. We believe that the capsule cysts that McEvedy saw are the same as the lumina we saw in the footplate and which we think are common branches of the lumen of the ganglion.

Five succesful or partly successful serial sections all show at least one lumen, which can be followed from the main cyst through the pedicle to the footplate. Among these are two complete series with a communication between the lumen in the main cyst and joint cavity by a lumen in the pedicle.

As far as we know, such a communication has only been described in one case before (Pick 1867). Andrén & Eiken (1970), in a series of arthrographies of the wrist, have demonstrated a communication from joint cavity to main cyst in a large number of cases.

In our opinion the operative consequence of this connexion is that main cyst, pedicle, and footplate must be removed if recurrence is to be avoided (Hvid-Hansen 1970).

In addition we think it is risky to use injections of sclerosing fluid in the ganglion as a method of treatment if there is a communication



*Figure 3. Structure of wall of ganglion (A) compared with digital articular capsule (B) and bursal wall from case of bursitis (C). Arrow in (B) shows articular cartilage.*

with the joint, though many of these injections have been performed without complications.

Traditionally there are different opinions about the origin of ganglia. According to Küttner & Hertel (1925), Eller postulated his theory about "ganglion herniosum". His opinion was that the ganglion originated as a pouch of synovial lining from the joint. Carp & Stout (1928) found that ganglia originated by mucinous degeneration of the fibers in the connective tissue around joints and tendons. De Orsay (1937) and Soren (1966) found that it was a myxoid degeneration of collagenous fibers. Soren described a row of degenerative changes which can be seen at the same time in a ganglion in different places.

The first stage is swelling of the collagen fibers with liquation, so that the fibers break away from each other. The second stage is continued liquefaction and the tissue is coloured by basophile dyes.

In the third stage a cavity containing liquid surrounded by condensed connective tissue is formed. The cavity is lined by a row of fibrocytes with endothelial character, and we have confirmed this by our investigation.

Ledderhose (1893) thought the ganglion was a neoplastic formation in fat or connective tissue in the region of joints. In this way a mass of cavities were formed, which he termed a "kystome". Floderus (1915) thought that ganglia came from synovial cells, which in the

foetal development were misplaced beside the real synovial lining. When these cells form synovial fluid, they collect together and form what is termed an "arthron".

Microscopy of ganglia showed that their histological structure was similar to the structure of joint capsule and bursae (Figure 3). Loose connective tissue can form capillary cavities, as is seen in bursae between muscles and over exostoses. When these bursae are formed, they have the same histological structure as joint capsule.

In our opinion, ganglia and joint capsules are analogous structures. We can confirm Soren's findings of degenerative changes in ganglia and we have found the same degenerative changes in bursae.

The finding of parts of the ganglion in the joint capsule suggests that the tissue or origin of ganglia comes from the joint capsule. The cases with established lumen between ganglion and joint indicate a development directly from the joint or at the same time as the joint.

The factors that determine the change from capsule to ganglion remain unknown, however. They may be the primitive cell potential of Floderus, the cell degeneration of Soren, or the influence of some exogenic factor, as with the formation of bursae, but our investigation can throw no light on this problem.

#### SUMMARY

The structure of 18 ganglia of the wrist was examined by ordinary microscopy. In addition serial sections were taken in five ganglia, including the main cyst, pedicle and underlying joint capsule. In this way we have confirmed that the ganglion is composed of a main cyst with a pedicle going from the deep part of the cyst to the underlying joint capsule. We also found that the joint capsule with its synovial lining is involved in the structure of the ganglion. In two of five serial sections a lumen in the pedicle was connecting the main cyst to the joint cavity.

We feel that operative treatment of ganglia should be guided by this anatomy. The main cyst, pedicle and footplate must be removed if recurrence is to be avoided, and in addition there is a potential risk in injecting sclerosing fluids into the main cyst, as they may pass into the joint. The ganglion is a branched, tree-like structure developed in connective tissue, and the microscopic structure resembles the structure of a bursa and is very reminiscent of that of a joint.

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