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GASTROCNEMIO-SEMIMEMBRANOSUS BURSA AND ITS RELATION TO THE KNEE JOINT

I. Anatomy and histology

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A swelling in the popliteal region was first described in 1840 by ADAMS, who considered it to be due to enlargement of the bursa lying beneath the medial head of the gastrocnemius muscle. He also reported that the bursa communicated with the knee joint by 'a species of valvular opening', without describing the details further. ADAMS concluded that the condition resulted from arthritis.

The anatomy of enlarged bursae and of their communication with the knee joint was described by GRÜBER (1845, 1869, 1885). He stated that the opening between the joint and the gastrocnemio-semimembranosus bursa consisted of either one or several small round holes.

FOUCHER (1856) presented 11 autopsy cases and 19 patients with popliteal cysts. He favoured the hypothesis that cysts at this site generally consisted in distended bursae, especially the bursa lying beneath the medial head of the gastrocnemius muscle.

BAKER (1877, 1885) described 8 cases of swelling in the popliteal region. He considered that this condition might be due to herniation of the synovial membrane of the knee joint, forming a cyst, caused, in turn, by hydrops resulting from osteoarthritis. Such popliteal cysts have since then been called Baker's cysts.

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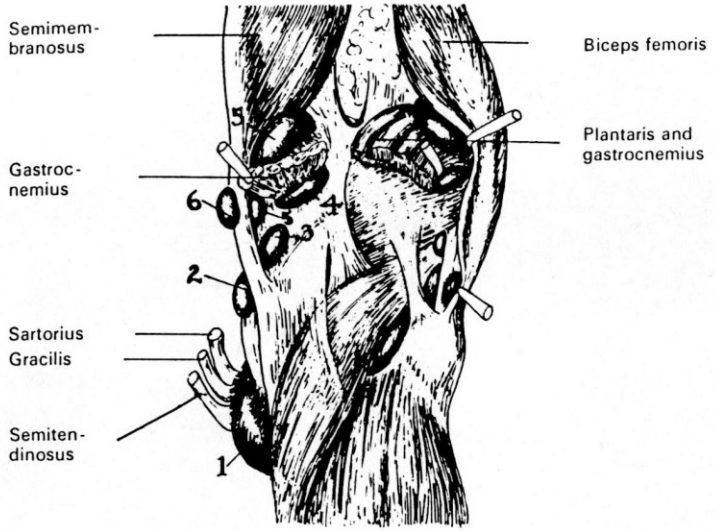


Fig. 1. Six bursae described by WILSON et coll. Bursae 4 and 5 usually communicate with one another and are therefore described as one bursa and called the gastrocnemio-semimenbranosus bursa. (Modified from CALLANDER.)

BAKER also expressed the opinion that distension of a normally occurring bursa could be an underlying mechanism. Several authors have described sporadic cases of popliteal swelling (e.g. CRAVENER 1932, SNODGRASS 1936, HAGGART 1938, 1943). HAGGART considered that in most cases it was due to herniation of the synovial membrane caused by sudden hyperextension of the knee joint and only exceptionally to distension of a bursa.

WILSON et coll. (1938), on the basis of the literature and of their own dissections of 30 autopsy cases, made a summarizing presentation of the postero-medial bursae (Fig. 1).

Bursa No. 4, in the figure, between the medial head of the gastrocnemius and the capsule over the medial condyle of the femur, and bursa No. 5 between the 'superficial surface' of the medial head of the gastrocnemius and the overlying semimembranosus muscle, were described as one single bursa and called the gastrocnemio-semimembranosus bursa.

WILSON et coll. also made microscopic examinations of material from their dissections and conducted clinical investigations of 21 patients but made no direct histologic comparison between material from the joint capsule and the bursa, nor did they compare different age groups. They were of the opinion that there was strong evidence that a cystic swelling at the back of the knee was due to an expansion of the gastrocnemio-semimembranosus bursa and not to herniation of the synovial membrane. Several authors have since discussed this aetiologic problem (KUHN & HEMPHILL 1944, CHILDRESS 1954, BURLESON et coll. 1956, GRISTINA & WILSON 1964, DOPPMAN 1965, FISCHEDICK 1969, PALLARDY et coll. 1969, REINHARDT 1972, WOLFE & COLLOFF 1972, GREPL 1973).

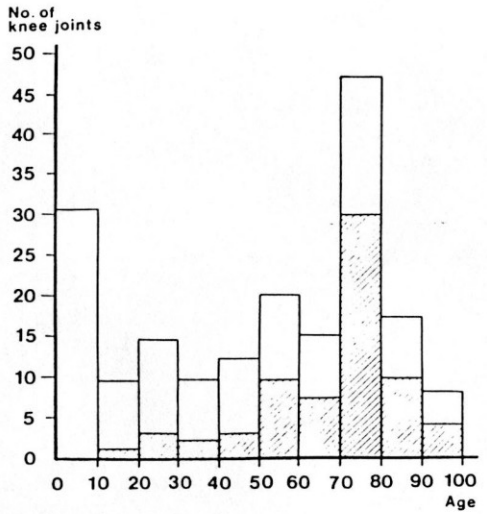


Fig. 2. Radiologic findings in 182 knee joints. Frequency of gastrocnemio-semimembranosus bursa communicating with the knee joint (shaded areas) and without communication (non-shaded areas). 10-year-old patients are included in the 10 to 20 decade, 20-year-olds in the 20 to 30 decade, etc.

The aim of the present investigation was to attempt to clarify whether a cystic formation in the medial popliteal region is due to herniation of the synovial membrane or to distension of a normally occurring gastrocnemio-semimembranosus bursa.

Material. Radiography was performed of 182 knee joints in 100 autopsy cases. The age distribution is given in Fig. 2. In 80 knee joints this examination was followed by dissection and specimens were taken for histologic examination. The autopsy cases were selected randomly, but an attempt was made to include as many age categories as possible. No patients in the material had a known joint disease.

Methods

Radiography. In adults, 20 ml of contrast medium (Urografin 45 %) were injected into the knee joint in the same way as in clinical arthrography. In children the amount of contrast medium varied according to the size of the child. After the injection the knee was flexed and extended 5 to 6 times to allow filling of the gastrocnemio-semimembranosus bursa. On flexion of the knee joint the pressure in the suprapatellar recess increases and any fluid in the joint will then fill the posterior recesses and the

gastrocnemio-semimembranosus bursa in cases where this bursa communicates with the joint (CAUGHEY & BYWATERS 1963, LINDGREN 1977). Films were then exposed in the a.p. and lateral projections.

In 9 cases the gastrocnemio-semimembranosus bursa was exposed and contrast medium injected directly into it.

In 12 knee joints increasing amounts of contrast medium were injected in steps of 20 ml until the joint capsule ruptured. After each injection the knee was flexed several times under fluoroscopy. The total amount of contrast medium injected varied from 40 to 160 ml.

Dissections. Following the roentgenologic examination 80 knee joints were dissected and examined for any communication between the joint and bursa. At all dissections a block specimen was removed, consisting of the posterior joint capsule, the distal part of the semimembranosus muscle and the proximal part of the medial head of the gastrocnemius muscle, and the gastrocnemio-semimembranosus bursa. Adjacent fascia and adipose tissue were included in the block specimen, which was kept in 10 % formalin for subsequent sectioning and light microscopy. Some specimens from the bursa and joint capsule were fixed in glutaraldehyde for scanning electron microscopy (SEM).

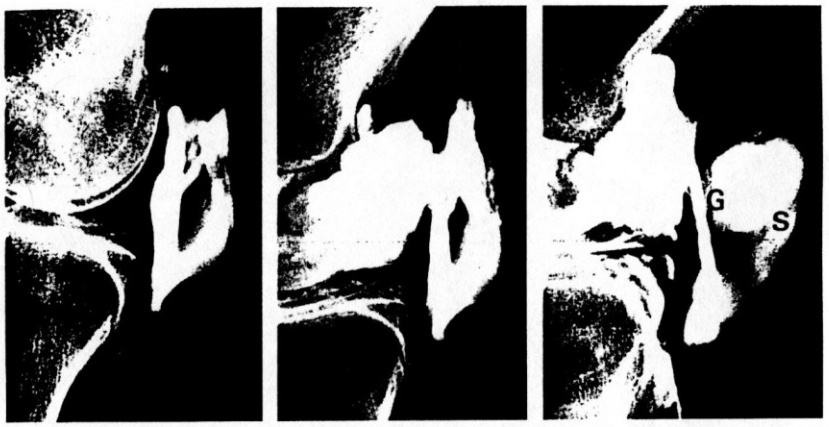
In an attempt to demonstrate how a communication between the joint and the bursa may occur, traction was applied to the joint capsule in 5 excised specimens without opening between the joint and the bursa. The upper part of the capsule, containing the tendon of the medial head of the gastrocnemius, was fixed, and the lower part was extended distally until the capsule ruptured.

Treatment of specimens for histology. Conventional methods of staining and embedding were used, but the embedding procedure was carried out slowly (over a period of 3 days).

The specimens were fixed in 10 % formaldehyde, embedded in paraffin and stained with hematoxylin-eosin and Verlhoeff–van Gieson-stain.

SEM technique: The specimen was fixed for 12 h at 4°C in 2 % vacuum distilled glutaraldehyde in 0.1 M sodium cacodylate buffer containing 0.1 M sucrose (pH 7.2, 510 mOsm), and postfixed in 2 % OsO_4 in collidine buffer (pH 7.2) for 90 min at 22°C. It was rinsed briefly in 0.15 M cacodylate buffer (pH 7.2 at 22°C) between the two fixations. Following postfixation the specimen was dehydrated in a graded series of ethanol (50, 70, 75, 80 %) and then brought through acetone/water (80, 85, 90, 95, 100 %) and critical point dried in liquid carbon dioxide in a Polaron E3000 apparatus (BRUNK et coll. 1975).

The specimens were mounted on stubs with silver conductive paint and vacuum coated with gold in a Polaron E5000 diode sputtering system run at 30 mA and 1.2 kV for 90 s, giving a gold layer 270 Å in thickness. They were then examined in a Jeol JSM-Sl microscope at 10 kV; the scanning time was 100 seconds.



a b c

Fig. 3. a) Contrast medium injected into a gastrocnemio-semimembranosus bursa not communicating with the knee joint. b) Same case. Injection also into the knee joint. c) A gastrocnemio-semimembranosus bursa communicating with the knee joint. Injection into the joint. The bursa is similar in appearance to that in (a) and (b). S = impression by semimembranosus muscle. G = impression by gastrocnemius muscle.

Results

Radiography

No discrepancies were found between the roentgenologic observations and the findings in the 80 knee joints. Thus at the dissections no communication between the joint and the bursa was found which had not been demonstrated at radiography.

In 5 of the 9 knee joints in which contrast medium was injected directly into the bursa from the posterior aspect, no communication with the joint was present. The appearance of these bursae was radiographically similar to that of the bursae which had been filled from the knee joint through an opening between the joint and the bursa (Fig. 3). The impressions in the bursa are due to the gastrocnemius and semimembranosus muscles (LINDGREN 1977 a). Communications between the joint and the bursa were found in greater frequencies in older age groups (Fig. 2). Thus no opening was found in any child below 10 years of age, whereas one was present in more than half of the adults over 50 years old.

Dissections

The gastrocnemio-semimembranosus bursa was present in all cases and was located between the tendons of the gastrocnemius and semimembranosus muscles; part of it lay anterior to the tendon of the medial head of the gastrocnemius. Anteriorly the bursa was delimited by the posterior surface of the capsule, and the upper part of its wall bordering against the joint was thinner than its other parts; the thinnest part being at the proximal point where the tendon of the medial head of the gastrocnemius

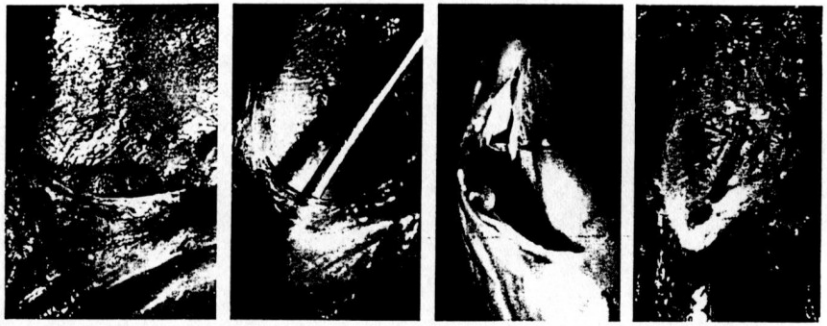


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Fig. 4. a) Medio-posterior part of the joint capsule seen from the knee joint. Slit opening into the gastrocnemio-semimembranosus bursa. b) Probe in the slit. The upper margin of the slit is sharply defined and thin. c) The slit viewed from above. Remnants (→) of thin membranous tissue in the lower part. d) The bursa viewed from behind. Probe (↔) in the bursa demonstrating the thin posterior wall.

left the joint capsule. In 68 of 182 cases a communication was found between the joint and the bursa (Fig. 2). This almost invariably took the form of a transverse slit (Fig. 4 a–c). In the middle and upper parts of the slit the anterior wall was thin and the edge of the opening was sharply defined. The opening was always located posterior to the medial femoral condyle at the site where the tendon of the medial head of the gastrocnemius left the joint capsule. The width of the slit generally varied between 15 and 20 mm, but in a few cases it was narrower—in one case as narrow as 6 mm.

In 35 of 51 dissected specimens a fibrous membrane was found in the middle or lower part of the opening (Figs 4 c, 5, 6 b, c). In 4 cases this membrane was thick and completely bridged the opening (Fig. 5). In the other 31 cases the membrane only partially bridged the opening, and varied in thickness. Similar membranes in the anterior space of the bursa were observed in the same frequency in specimens from cases with no opening between the joint and bursa.

The anterior wall of the bursa was thicker in children than in adults (Fig. 6).

The parts of the wall of the bursa lying adjacent to the gastrocnemius and semimembranosus muscles adhered firmly to the fasciae. The distal and upper parts of the posterior wall of the bursa were not adherent to any muscle and were very thin and macroscopically transparent (Fig. 4 d).

In attempts at traction of the joint capsule in a proximal-distal direction, a slit appeared at the site where the tendon of the medial head of the gastrocnemius left the capsule. This was similar to the slits described. Its upper margin was somewhat frayed, however, and a corresponding irregularity was observed in the posterior part of the joint capsule.

When increasing amounts of contrast medium were injected into the joint, a rupture occurred in the suprapatellar recess in 10 cases and in the postero-medial recess in one case. In one further case a rupture occurred resulting in a communication with

Fig. 5. Sagittal section through the joint capsule and a bursa. Membranous septum (→) totally bridging the opening. J = knee joint. B = bursa. S = slit.

the bursa. The width of this opening was 5 to 6 mm, compared with a normal width of 15 to 20 mm. It was located at the same place as the slits described. At the site of the opening the posterior part of the capsule was very thin; if the strain in that area had been greater, the slit could easily have widened medio-laterally.

Light microscopy

0–4 years (*6 preparations*). The joint capsule was composed of 3 to 5 layers of intermingled cuboid and elongated synovial cells. The cuboid cells only partly covered the surface. The layer of synovial cells, which was rather thin, formed a nodular outline. Beneath this layer there were several large blood vessels and some loose connective tissue, under which thick strands of connective tissue ran transversely, vertically and even obliquely. The transverse fibres were particularly coarse. The upper posterior part of the capsule was attached to the tendon of the gastrocnemius.

The gastrocnemio-semimembranosus bursa was similarly coated with both elongated and cuboid cells. Up to 5 layers of cells intermingled with collagen connective tissue were observed. Part of the anterior wall of the bursa was attached to strong underlying bundles of connective tissue interlaced with medium-sized blood vessels and tendonous tissue. The surface had a nodular outline. The nearest distance between the joint capsule and the bursa was 3 to 5 mm (Fig. 6 a). No degeneration or any inflammatory reaction was found. Thus, the surface layers of the capsule and the bursa had similar histologic appearances.

5–15 years (*6 preparations*). The joint capsule had become coarser and contained distinct strands of fascia. In the area between the tendon of the gastrocnemius and

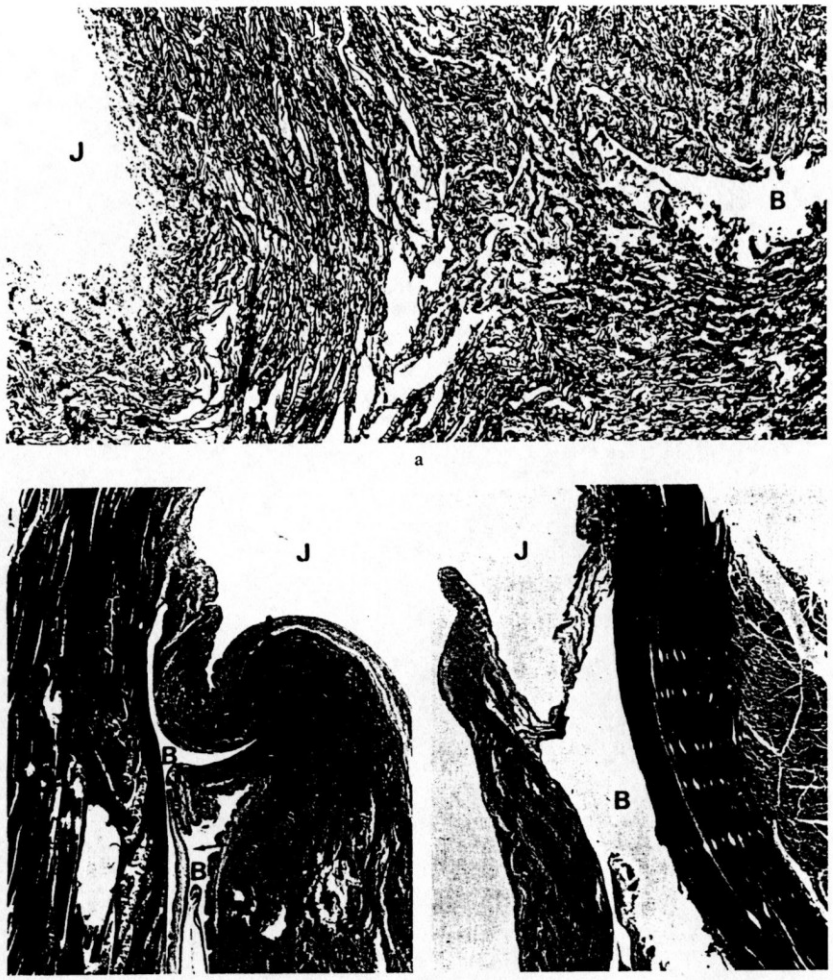

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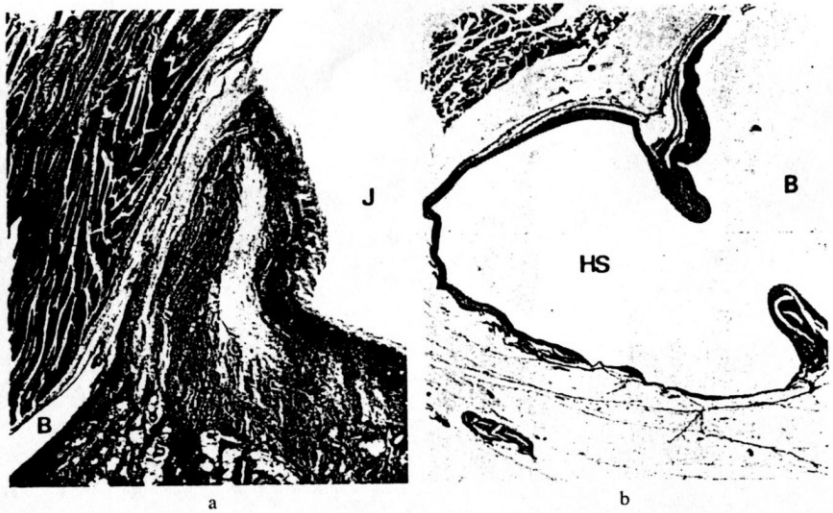
Fig. 6. a) 3-day-old child. Strong fibroelastic tissue between the joint and the bursa. b) 8-year-old child. The synovial membrane is thinner than in the patient in (a). Membranous septum (→). c) 65-year-old adult. Slit with a thin membrane. J = knee joint. B = bursa. Verlhoeff-van Gieson. × 10.

the transverse fibres of the capsular tissue often a loosely woven and slightly oedematous zone (Fig. 7) was present, extending distally towards the tissue of the bursa.

The bursa sometimes contained fibrin-like material and in 2 cases thin septa with spaces in between. In one case the joint capsule had ruptured, giving rise to an opening between the joint and bursa. In this slit-shaped opening a thin membranous



a b

Fig. 7. 8-year-old child. Relatively large distance between the knee joint and the bursa, with a loose oedematous zone (→). Verlhoeff-van Gieson. × 40. b) 70-year-old adult. Herniation of part of the bursa into surrounding fatty tissue. The communication between the bursa and the hernial sac has a softly rounded border. Verlhoeff-van Gieson. × 40. J = knee joint. B = bursa. HS = hernial sac.

tissue which had perforated was found. In the remaining cases the distance between the capsule and bursa was 2 to 3 mm (Fig. 6 b).

16–30 years (*8 preparations*). The joint capsule was composed mainly of elongated and sometimes more cuboid synovial cells, but acellular areas were also found. The capsular tissue was often smooth and slits were observed. In 3 cases membranous septa were present between the capsule and bursa. These membranes were degenerated, with hyaline bodies and in some places calcific deposits.

Degeneration with some acellular areas was also present in the wall of the bursa.

30–50 years (*10 preparations*). In the joint capsule there was usually a marked paucity of cells. In cases without a slit the tissue between the bursa and joint was thin and sometimes loose and oedematous. The wall of the bursa was slightly thickened, with up to 10 layers of cells, and here also there was evidence of diffuse degeneration.

50–90 years (*13 preparations*). In the joint capsule large areas of the synovial membrane were completely smooth, with diffuse degeneration and a paucity of cells. Occasional elongated synovial cells were present. The collagen connective tissue in the capsule was often degenerated, as also was the wall of the bursa, which exhibited a sparsity of cells, hyalinization and fibrinoid degeneration. Degenerated membranes partially bridged the opening. One bursa which communicated with the joint was greatly distended.

In the distal parts of the bursa several sac-like herniations into surrounding adipose tissue were observed (Fig. 7 b). Their openings were fairly narrow, with softly rounded margins.

Scanning electron microscopy

Ten specimens of the joint capsule and bursa from autopsy cases with either a communication between these structures in both knee joints, a communication in one knee joint only, or no communication on either side, were examined. The ages of the patients varied between 30 and 72 years. In all of these cases the findings in the tissue of the capsule and of the bursa were fairly similar, regardless of whether any communication between the joint and the bursa was present or not.

The surface of the capsule, like that of the wall of the bursa, had a wavy appearance and was coated with synovial cells; some areas were smooth. Zones with a honeycombed structure, where the synovial cells only partly covered the underlying bundles of collagen fibres, were found in some cases. These degenerative abnormalities were more marked in older individuals. Fibrin, occasional platelets and sometimes small remnants of contrast medium were also found on the surface.

In cases with a communication between the joint and bursa more evident degeneration was observed, the layer covering the collagen bundles being less complete both in the capsule and in the bursa (Figs 8, 9).

Discussion

The frequency of communication between the gastrocnemio-semimembranosus bursa and the knee joint was greater in the higher age groups (Fig. 2). No discrepancy was found between the radiologic and anatomic findings. That a slit might have occurred during the manipulations at the roentgen examination could have been a possible source of error. However, only in one case was any indication found that this might have happened. In this case the upper margin of the slit was frayed and a corresponding irregularity was found in the posterior wall of the capsule. The changes were similar to those produced when traction was applied experimentally to the joint capsule and resulted in a slit. In all other cases the margin of the slit was sharp and no irregular counterpart in the posterior wall indicated that the opening had occurred post mortem.

In 6 cases the slit contained a thin membranous septum (Fig. 4 c), which had perforated. Whether the perforation had taken place during the roentgen examination or before death could not be decided with certainty.

These observations may only have marginally affected the results in Fig. 2 and it is therefore considered that the results well reflect the frequencies of communication in vivo between a gastrocnemio-semimembranosus bursa and the knee joint.

The causative mechanism underlying a popliteal or Baker's cyst has long been discussed and various theories have been presented: (1) A herniation of the synovial membrane through a weak area in the posterior part of the joint capsule, (2) rupture of the capsule posteriorly, followed by efflux of fluid into the soft tissues, resulting in a secondary reaction with formation of a membrane and encapsulation of fluid, and (3) rupture of the capsule, giving a communication with the normally occurring

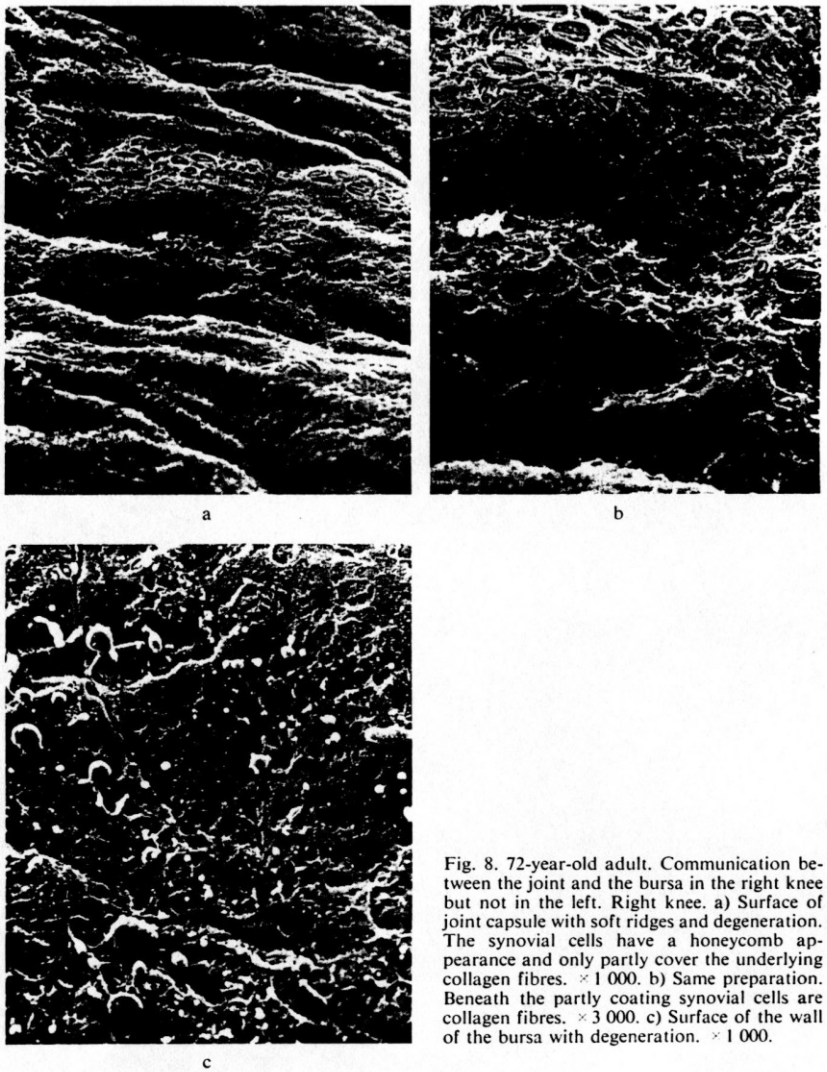
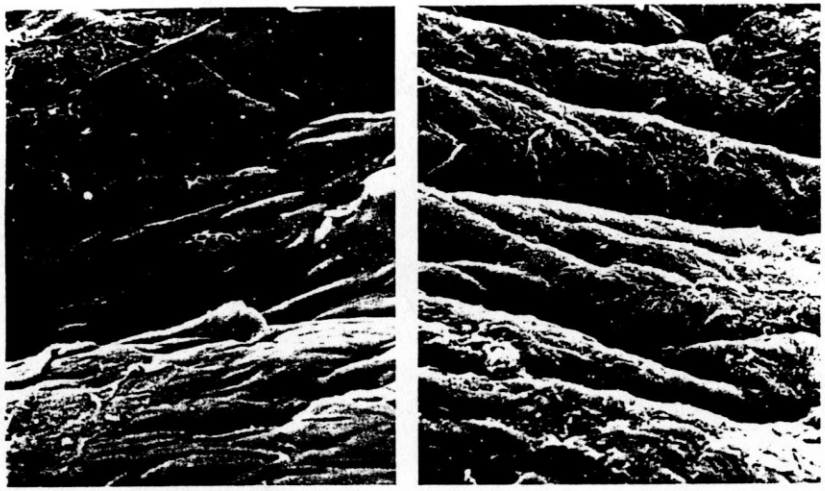


Fig. 8. 72-year-old adult. Communication between the joint and the bursa in the right knee but not in the left. Right knee. a) Surface of joint capsule with soft ridges and degeneration. The synovial cells have a honeycomb appearance and only partly cover the underlying collagen fibres. × 1 000. b) Same preparation. Beneath the partly coating synovial cells are collagen fibres. × 3 000. c) Surface of the wall of the bursa with degeneration. × 1 000.



a b

Fig. 9. Same case as in Fig. 8. Left knee. a) Surface of joint capsule. Less marked degeneration and the synovial cells almost completely cover the surface. × 1 000. b) Surface of the wall of the bursa. Degeneration only in few areas. × 1 000.

gastrocnemio-semimembranosus bursa. In the presence of joint effusion, fluid may enter the bursa, which will expand and may rupture.

The first two theories are improbable. In the dissected material a cyst located separately from the normally occurring gastrocnemio-semimembranosus bursa was never observed. Neither has such a finding been reported in the literature.

No herniation of synovial membrane through a weak area of the capsule was evident in any of the cases. Neither was any duplication of membranes or mural structures found indicating herniation of the synovial membrane into the normally occurring bursa. Moreover, the wall of the bursa and the wall of the joint capsule had a similar microscopic appearance, regardless of whether an opening was present between the joint and the bursa or not (Figs 8 a, b, 9). Therefore, the present results are in agreement with those of ADAMS, among others, that popliteal cysts occur by the third postulated mechanism.

In the dissections it was noted that when an opening was present between the joint and the bursa this almost invariably had the same appearance, slit-shaped, with a sharply defined, cranially oriented margin (Fig. 4 a–c). Further, the opening was always located at the place where the tendon of the gastrocnemius muscle left the joint capsule. In most cases the slit varied in width between 15 and 20 mm. In cases with slits narrower than 15 mm the margin was thin and it was evident that further widening could have occurred.

In the middle and lower parts of the opening, membranous septa of varying extent

and thickness were found. It seems probable that in some cases these septa may hinder a flow of fluid and may constitute a valve mechanism between the joint and bursa (LINDGREN 1977 b). The gastrocnemio-semimembranosus bursa was found in all dissected cases and in 9 of them contrast medium was injected directly into the bursa from the posterior aspect, whereafter films were exposed in the conventional way. The appearance of this bursa was identical with that of the cavity which filled with contrast medium after injection into the knee joint in cases where a communication was present (Fig. 3).

At light microscopy, the fibrous strands in the joint capsule caudal to the opening ran transversely, while those lying cranial to the opening ran vertically, the latter consisting mainly of tendonous material from the gastrocnemius. With increasing age this capsule became very thin. The capsular wall around the slit area consisted of thicker fibrous tissue. Degeneration of the elongated synovial cells was observed, even at early ages. According to RHODIN (1974) the synovial surface consists of sparse fibroblasts with underlying reticular fibres, thus mesenchymal tissue and not epithelial elements, which also corresponds with the present observations.

Scanning electron microscopy revealed that the surface layers of the joint capsule and the wall of the bursa were similar in structure regardless of whether the joint and bursa communicated or not. The wavy contour of the capsular surface was better preserved in joints that did not communicate with the bursa than in those that did. Correspondingly, general degeneration of the tissues was more marked in cases with an opening between the joint and the bursa. The degeneration in itself increases the probability that such an opening will occur.

An interesting observation was that the synovial cells did not completely cover the underlying collagen bundles either in the joint capsule or in the wall of the bursa. This was particulary evident in cases with marked degeneration and where the bursa and the joint communicated (Figs 8, 9).

Various immediate causes of a communication between the knee joint and the gastrocnemio-semimembranous bursa are possible in vivo.

In young persons with a healthy joint capsule the opening is probably due to forceful extension or hyperextension of the knee joint. The medio-posterior part of the capsule is then stretched over the medial femoral condyle, which may cause a tear in the capsule.

A slit of the same appearance and at the same location as described could be produced by experimental traction of the joint capsule in the cranio-caudal direction. In these cases the upper margin of the slit was somewhat frayed and a corresponding irregularity was found in the posterior wall of the capsule.

HAGGART (1938) noted that in several patients the symptoms followed hyperextension of the knee joint and considered that the popliteal swelling was due to herniation of the synovial membrane into the soft tissues posterior to the joint. However, it is possible that the joint capsule became torn, allowing free passage of fluid from the joint to the gastrocnemio-semimembranosus bursa.

An increasing tendency to hydrops due to arthrosis or other joint changes in older persons may be another factor contributing to a communication between the joint and the bursa. On flexion of the knee the suprapatellar recess is compressed and if an increased amount of fluid is present in the joint this will be forced against the posterior recesses, resulting in a pressure increase (CAUGHEY & BYWATERS 1963, LINDGREN 1977). When the knee is flexed, the posterior part of the joint capsule is not stretched over the femoral condyle as in extension, and the increase in pressure in the posterior part of the joint may lead to a rupture of a thin and degenerated capsule, resulting in a communication with the gastrocnemio-semimembranosus bursa. Such a rupture occurred in the trials in which increasing amounts of contrast medium were injected into the knee joint and the joint was then flexed. If the capsule was already torn but thin bridging membranes were present in the middle and lower parts of the slit (Figs 4 c, 5), these membranes may rupture if the pressure increases in this way. On the other hand, when the knee joint is extended, the pressure in the posterior part of the joint is lower and at the same time the joint capsule is protected against an increase in pressure by being compressed between the femoral condyle and the tendon of the medial head of the gastrocnemius muscle.

Thus, two different mechanisms are conceivable for the occurrence of an opening between the joint and the bursa—one on extension and the other on flexion of the knee joint. Both mechanisms occur more easily with increasing age, due to degeneration and reduced elasticity of the capsule. When such an opening has occurred, in the presence of joint effusion the bursa may expand, especially posterior-downwards and posterior-upwards, where its wall is very thin (Fig. 4 d) and not adherent to any muscular tissue.

Conclusions

A communication between the knee joint and the gastrocnemio-semimembranosus bursa is more frequently found in older individuals.

In cases with a communication between the joint and the bursa the opening was invariably of similar morphologic appearance. It was slit-shaped with a sharp, cranially oriented margin, and was located at the site where the tendon of the medial head of the gastrocnemius muscle leaves the joint capsule.

Degeneration of the joint capsule increases and its elasticity diminishes with age. These conditions facilitate tearing of the posterior part of the capsule on extension or hyperextension of the knee joint, when the capsule is stretched over the medial femoral condyle. With increasing age less and less strain is required for such a tear to occur.

Fluid in the knee joint, the prerequisites of which increase with age, may also play a role, causing a considerable rise in pressure in the dorsal part of the joint on flexion. A communication between the joint and the bursa may then result either from a tear in a degenerated joint capsule or through a rupture of thin membranes in a previously formed slit.

A communication between the knee joint and the gastrocnemio-semimembranosus bursa is thus an acquired condition. If fluid is present in the joint when such an opening occurs, the bursa readily distends to give a cyst-like formation, a so called Baker's cyst.

SUMMARY

The gastrocnemio-semimembranosus bursa and its relation to the knee joint was investigated in an autopsy material. Arthrography, dissection and microscopy were performed. The area between the joint and the bursa is described. The frequency of communicating bursa is higher in older individuals and this is due to degeneration of the joint capsule.

ZUSAMMENFASSUNG

Das Verhältnis zwischen der Bursa gastrocnemii-semimembranosi und dem Kniegelenk wurde an einem Sektionsmaterial untersucht. Arthrographie, Dissektion und mikroskopische Untersuchung wurden ausgeführt. Das Gewebe zwischen dem Gelenk und der Bursa wird beschrieben. Die Frequenz einer kommunizierenden Bursa ist bei Älteren höher und beruht auf der Degeneration der Gelenkkapsel.

RÉSUMÉ

La bourse commune au jumeau interne et au demi-membraneux et ses relations avec l'articulation du genou ont été étudiées sur un matériel d'autopsie. Les auteurs ont fait une arthrographie, une dissection et une étude microscopique. Ils décrivent la région comprise entre l'articulation et la bourse. La communication de la bourse avec l'articulation est plus fréquente chez les individus âgés et ceci est du à la dégénérescence de la capsule articulaire.

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SIMULTANEOUS ARTHROGRAPHY OF THE TALOCRURAL AND TALONAVICULAR JOINTS IN CHILDREN

III. Measurements on normal feet

ÅKE HJELMSTEDT and BO SAHLSTEDT

Abnormalities of the individual small bones in foot deformities in children are difficult to demonstrate roentgenologically because of the incomplete ossification of the foot skeleton. Valuable information on the anatomy of the talus may be obtained, however, by simultaneous arthrography of the talocrural and talonavicular joints (Part II, HJELMSTEDT & SAHLSTEDT 1976).

The degree of bone deformation may only be assessed when the normal variations have been established. Values for certain variables of the talus obtained by arthrography on autopsy material and paediatric patients are now reported.

In determining these normal values it must be considered that certain variables alter with age, i.e. with the size of the talus.

Material

The autopsy material consisted of 32 feet that exhibited no deformity on direct inspection or on dissection. Most of the preparations were obtained from infants in

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