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A comparative study of the spaces between the metacarpal and metatarsal heads

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Summary. The study of the spaces between the metacarpal heads on 23 cadavers, raises the question of the existence of bursae at this level. This is in line with recent studies [1, 4] suggesting that such bursae are present at this level in the foot. Careful dissection and histological studies revealed characteristics compatible with both of the following hypotheses: either the existence of bursae not described until now in anatomy text-books, or spaces limited by a cul-de-sac of the aponeuroses of the hand in the 2nd, 3rd and 4th digits. Tissue analyses that could determine more specifically the nature of the limiting membrane of these spaces, as well as pathological studies demonstrating the occurrence of common anomalies of bursae in these spaces, are required in order to conclude definitively the nature of the spaces between the metacarpal heads. The gross anatomical and histological characteristics of the spaces between the metacarpal and metatarsal heads and of their limiting membranes were compared and found to be analogous in our series.

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Etude comparative des espaces inter-capito-métacarpiens et inter-capito-métatarsiens

Résumé. L'étude des espaces inter-capito-métacarpiens sur 23 sujets frais et conservés soulève la question de l'existence de bourses séreuses à ce niveau, à l'instar des études récentes [1, 4] faites au niveau du pied. Une dissection soigneuse et des études histologiques apparaissent compatibles avec l'une des hypothèses suivantes : la présence soit de bourses séreuses non décrites jusqu'ici dans les ouvrages d'anatomie, soit d'espaces virtuels inter-capito-métacarpiens limités distalement par un cul-de-sac des aponévroses de la main au niveau des 2e, 3e et 4e espaces. Des études histologiques pouvant déterminer de façon plus spécifique la nature de la membrane limitante de ces espaces dans sa partie libre, ainsi que des études pathologiques qui mettraient en évidence les pathologies habituelles des bourses séreuses au niveau de ces espaces, sont nécessaires afin d'affirmer définitivement leur nature. La comparaison entre les espaces inter-capito-métacarpiens et inter-capito-métatarsiens et leurs membranes limitantes a mis en évidence des caractéristiques semblables tant au point de vue anatomique qu'histologique.

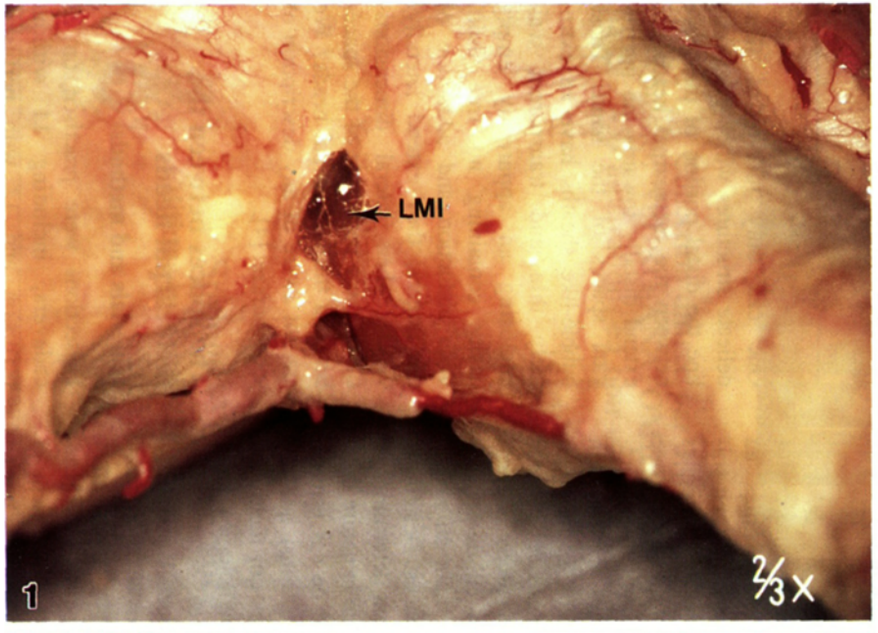
Key words : Hand — Bursae — Metacarpal heads — Metatarsal heads

One can only marvel at thear delicate structures which gracefully line the distal portion of the space between the metacarpal heads and extend distally towards the interdigital spaces of the hand. These bubble-like sheaths have an extremely thin and transparent wall enclosing an apparently empty cavity containing no free fluid. With abduction and adduction of the fingers, they extend laterally, varying their lateral dimensions. Could these be bursae of the spaces between the metacarpal heads? We are not aware of any description of such bursae [4].

The spaces between the metacarpal heads

Materials and methods

Dissections were practised on 23 cadavers, including 11 without perfusion and 12 with perfusion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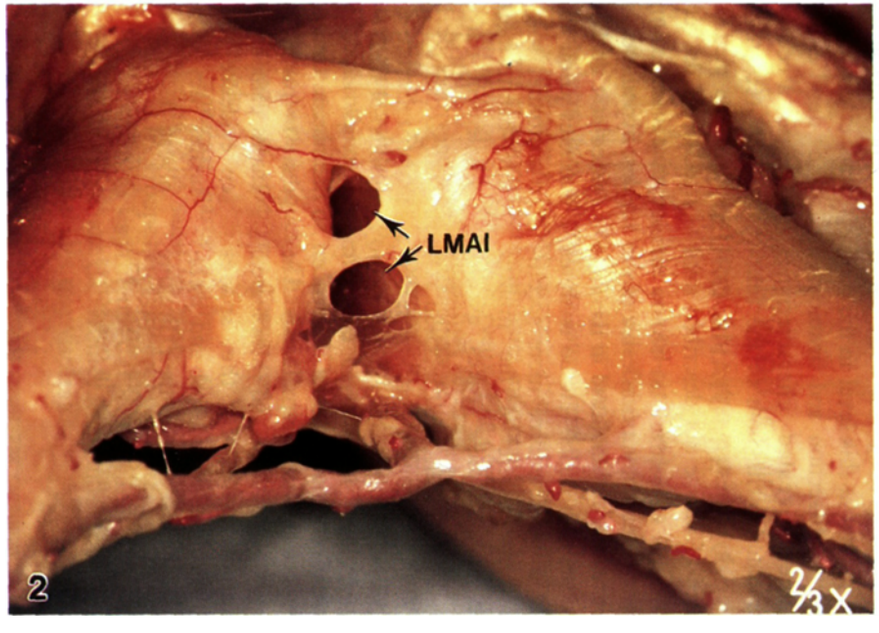
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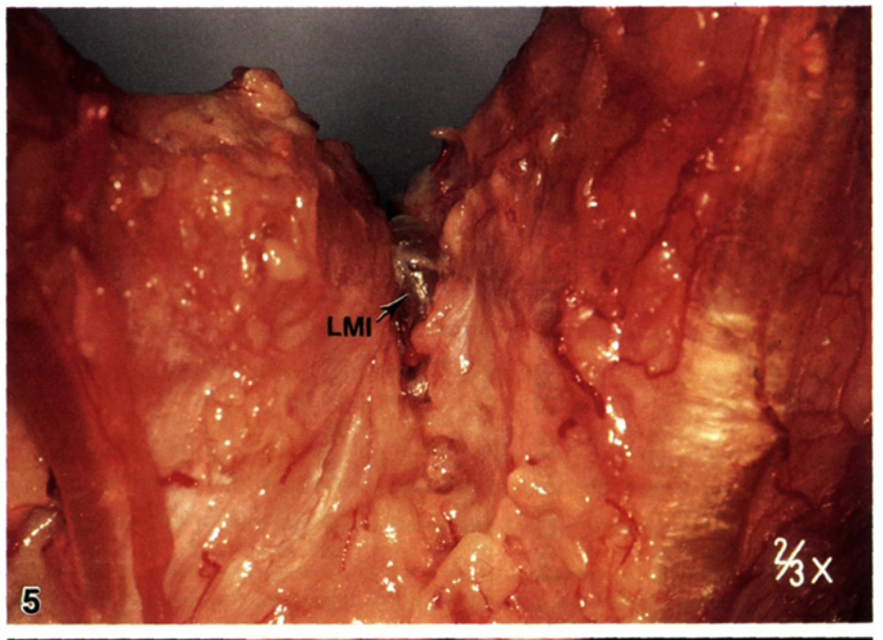
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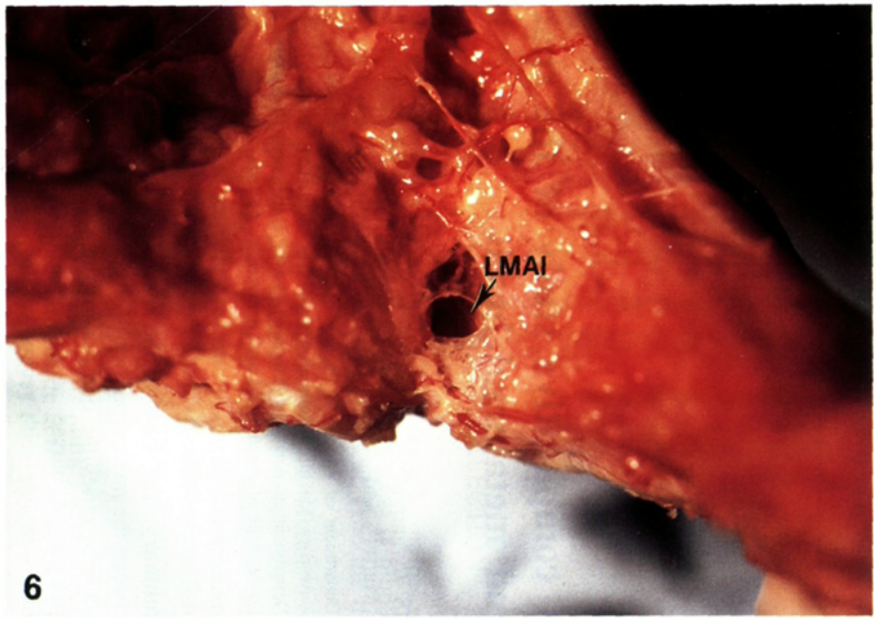
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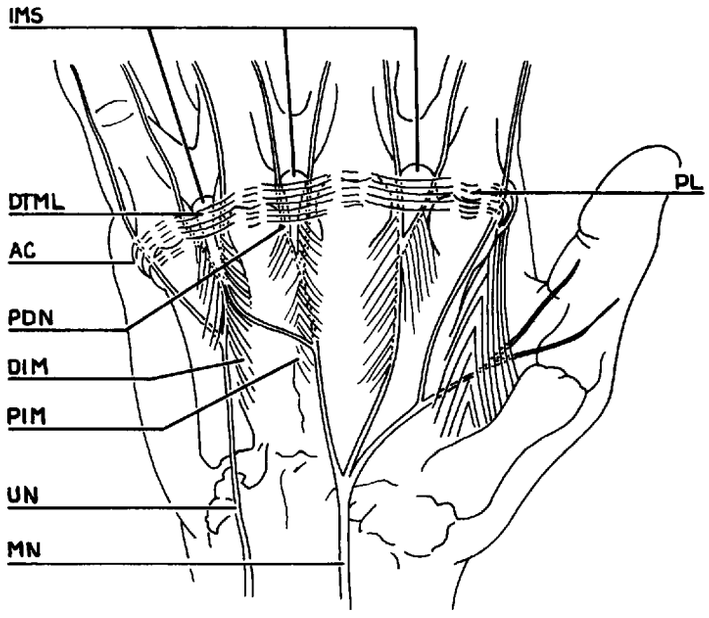


Fig. 3
Diagrammatic illustration of the space between the metacarpal heads. *IMS* Spaces between the metacarpal and metatarsal heads *DTML* deep transverse metacarpal ligament *AC* articular capsule *PDN* palmar digital n. *DIM* dorsal interossei m. *PIM* palmar interossei m. *UN* ulnar n. *MN* median n. *PL* palmar ligament

Illustration de l'espace inter-capito-métacarpien. *IMS* Espaces inter-capito-métacarpiens *DTML* ligament intermétacarpien transverse profond *AC* capsule articulaire *PDN* n. palmaire digital *DIM* m. inter-osseux dorsal *PIM* m. inter-osseux palmaire *UN* n. ulnaire *MN* n. médian *PL* ligament palmaire

fluid containing glycerine, formaldehyde and ethyl alcohol.

Complete dissection of the hand from dorsal and palmar approaches revealed, after spreading the fingers, a cavity between the metacarpal heads of the 2nd, 3rd and 4th spaces, in all subjects. The disposition of the longitudinal and transverse fibers (superficial transverse metacarpal ligament) of the palmar aponeurosis was carefully examined during the dissection. The digital nerves and vessels were preserved. The dorsum of the hand was dissected, with preservation of the dorsal interosseous fascia covering the interossei m.

Passive abduction of the fingers revealed a membrane covering the distal portion of the spaces between the metacarpal heads, with prolongation towards the interdigital spaces, which bulged in accordance with the degree of abduction of the fingers (Fig. 1).

A minute incision of the deep transverse metacarpal ligament inevitably ruptured the fragile wall, opening into a virtually empty cavity. The inner aspect of the limiting wall appeared wet, but no free fluid was observed (Fig. 2).

Results

Appearance

In all specimens, the 2nd, 3rd and 4th spaces between the metacarpal heads presented an oval-shaped cavity of variable dimensions, depending on the degree of spreading of the fingers, occasionally containing honeycomb-like trabeculations.

Contents

The spaces did not contain fluid in any of the cases. However, their lining was unquestionably wet, glistening and slippery.

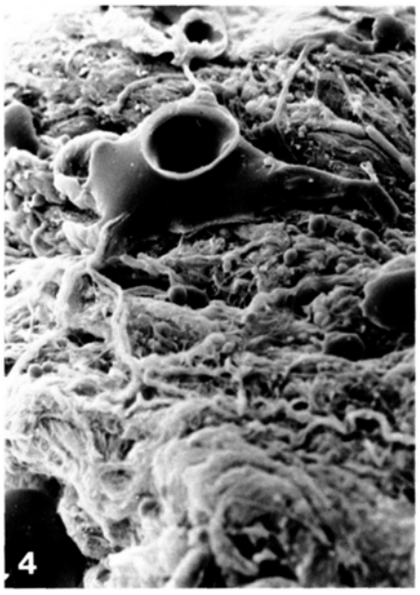
Limits and relationship to the digital n.

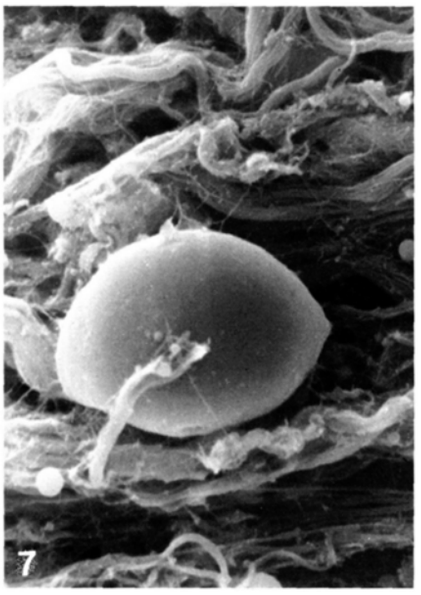
The cavities in the spaces between the metacarpal heads and their membranes present an anterior or palmar surface which is covered by the palmar interosseous fascia and by the deep transverse metacarpal ligament, which is itself considered as a thickening of the palmar interosseous fascia. Posteriorly, the cavity is related to the dorsal interosseous fascia, which covers and is adherent to the dorsal surface of the second to the fifth metacarpals and intervening dorsal interossei.

Laterally we can trace the course of the interossei in the distal third of the spaces. At the level of the metacarpo-phalangeal joints the lateral aspect of each cavity has an important relationship to the colla-

Figs. 1, 2, 5, 6
1 Space between the metacarpal heads, limiting membrane intact *(LMI)* **2** Space between the metacarpal heads, limiting membrane after incision *(LMAI)* **5** Space between the metatarsal heads *(LMI)*, limiting membrane intact **6** Space between the metatarsal heads, limiting membrane after incision *(LMAI)*

1 Espace inter-capito-métacarpien, membrane limtante intacte *(LMI)* **2** Espace inter-capito-métacarpien, Membrane après incision *(LMAI)* **5** Espace inter-capito-métatarsien *(LMI)*, limitante intacte **6** Espace inter-capito-métatarsien, membrane limitant après incision *(LMAI)*





Figs. 4, 7
4 Intermembrane between the metacarpal heads (scanning electron microscopy, magnification 450) **7** Intermembrane between the metatarsal heads (scanning electron microscopy, magnification 2 000)

4 Membrane inter-capitométacarpienne (microscopie électronique à balayage, agrandissement 450) **7** Membrane inter-métatarso-phalangienne (microscopie électronique à balayage, agrandissement 2 000)

teral ligaments of the metacarpo-phalangeal joints and the tendon of the interossei.

Proximally, these cavities merge with the spaces between the interossei at the junction of the middle and distal third of the inter-metacarpal space.

It is only distally that these cavities present a free aspect, as they extend slightly beyond the metacarpo-phalangeal joint; they appear limited by a thin, fragile, transparent sheath, which forms a convex dome at the base of the proximal phalanx.

The deep transverse metacarpal ligament, which consists of a series of 3 fibrous bands that connect the palmar surfaces of the heads of the last 4 metacarpals, is considered to be an important landmark. The spaces between the metacarpal heads are situated behind this ligament (Fig. 3).

Thus, these are spaces of variable width depending on the degree of abduction of the fingers, with limits that are not distinguishable from the neighbouring muscular and aponeurotic structures except distally, almost interdigitally, where they form a delicate cul-de-sac.

One may ask whether this is indeed the serous membrane of a bursa or the mere reflection and reunion of the palmar and dorsal fascia of the hand, along with a thickening of the aponeuroses of the interossei.

The common palmar digital n. originating from the median and ulnar nerves continue to the webs between the fingers, where they divide into the proper digital nerves innervating the adjacent sides of the corresponding fingers.

In general, the division of the common palmar digital n. into the proper palmar digital n. takes place in the proximal part of the intermetacarpal head spaces, anterior to the palmar interosseous fascia. The proper palmar digital n. accompanied by the proper palmar digital vessels, continue to the adjacent sides of the corresponding fingers, and have an important relationship to these spaces, being situated anterior to the deep transverse metacarpal ligament.

Histological structure and clinical importance of the structures

The free portion of the limiting membrane of the spaces between the metacarpal heads was excised for histological examination. The microscopic appearance was found to be compatible with, but not specific for, the presence of bursae (Fig. 4).

A synovial bursa is considered as an area of fusion of different tissue spaces and, as such, does not necessarily have a microscopically complete epithelial wall; its wall is frequently composed of connective tissue, fibers and cells. This explains why the histological examination of membranes of these cavities is compatible with the presence of synovial bursae it also explains the fact that it is not specific.

The spaces of the bursae are flattened and collapsed, containing only small amounts of fluid. However, synovial bursae, when inflamed, infected or injured, are associated with both pain and limitation of active and passive motion. Such pathological conditions involving the bursae between the metacarpal heads as well as compression of the proper palmar digital n. lying anterior to the spaces could explain some painful syndromes of the hand.

The spaces between the metatarsal heads

The dissection of the hands was followed by complete dissection of

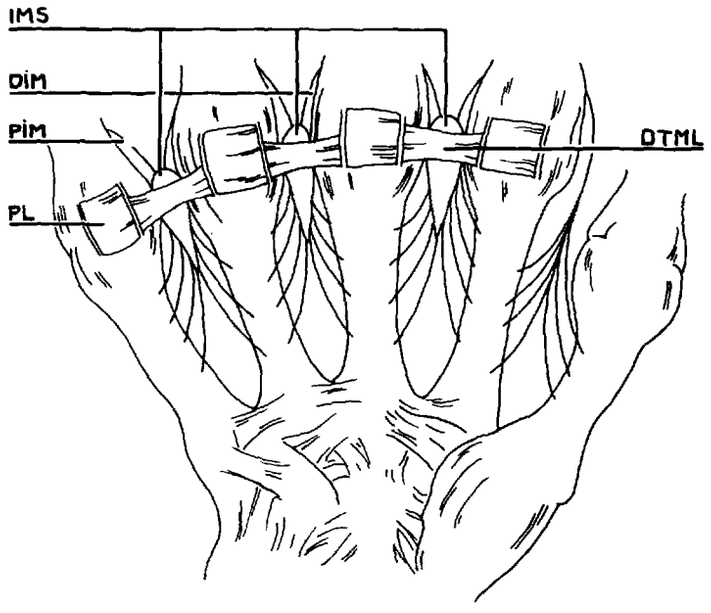


Fig. 8
Diagrammatic illustration of the space between the metatarsal heads. *IMS* spaces between the metacarpal heads *DIM* doral interossei m. *PIM* palmar interossei m. *PL* palmar ligament *DTML* deep transverse metacarpal ligament

Illustration d'espace inter-capito-métatarsien. *IMS* espaces inter-capito-métacarpiens *DIM* m. inter-osseux dorsal *PIM* m. inter-osseux palmaire *PL* ligament palmaire *DTML* ligament intermétacarpien transverse profond

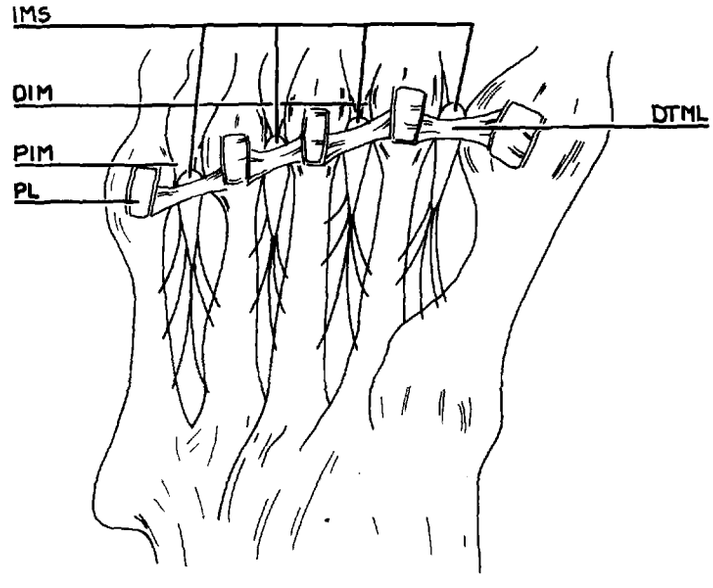


Fig. 9
Diagrammatic illustration of the space between the metacarpal heads. *IMS* Spaces between the metatarsal heads *DIM* dorsal interossei m. *PIM* plantar interossei m. *PL* plantar ligament *DTML* deep transverse metatarsal ligament

Illustration de l'espace inter-capito-métacarpien. *IMS* Espaces inter-capito-métatarsiens *DIM* m. inter-osseux dorsal *PIM* m. inter-osseux plantaire *Pl* ligament plantaire *DTML* ligament intermétatarsien transverse profond

the corresponding regions of the foot in the same 23 human cadavers.

Materials and methods

The dissection of the dorsal and plantar regions of the feet and of their dorsal and plantar aponeuroses was performed, while preserving the digital rami of the nerves, as well as the blood vessels.

To obtain a satisfactory view of the dorsal and plantar aponeuroses and of the transverse ligament, a slight abduction of the toes was performed, followed by incision and section of the transverse fibers joining the small pretendinous bands that form the superficial transverse ligament in the region of the metatarsophalangeal articulations. The superficial transverse ligament (interdigital plantar ligament) was then sectioned. This procedure was followed by an approach towards the deep dorsal aponeurosis. The deep dorsal aponeurosis which covers the interosseous muscles and metatarsal bones was dissected as far as the interdigital spaces. The dissection was pursued in the direction of the plantar region, towards the deep plantar aponeurosis and deep transverse metatarsal ligament.

While keeping the toes abducted, observation of the proximal interdigital spaces enabled us to see the slightly rounded anterior part (depending on the degree of abduction of the toes) of a transparent, fragile membrane forming the wall of a bulla which extended to the distal part of the interosseous space. The anterior limit of this bulla slightly exceeded the distal edge of the deep transverse metatarsal ligament while the toes were abducted. However, during the actual process of abduction, there was increased bulging anteriorly, which further exceeded the limits of the above ligament.

The various parts of this membrane were excised and sent for histological examination. Upon the opening of the cavity, its inner aspect exhibited a smooth, damp surface, and it contained no free liquid.

Results

In the specimen studies, oval or elliptical cavities were found in the distal part of the spaces between the metatarsal heads, reaching the proximal portion of the interdigital spaces (Fig. 5). These cavities, of a bulbous aspect, were of varied dimensions (depending on the spread of the toes) and occasionally contained honeycomb type trabeculae. The inner face of these walls had a smooth and slippery appearance (Fig. 6). In no case did the cavities contain fluid which could be measured macroscopically. The limits of these cavities between the metatarsal heads were of varying proportions, differing slightly with the degree of abduction of the toes; other individual variations were also observed.

In general, the walls of the cavities extended slightly beyond the deep transverse ligament, forming a bulge in front, level with the proximal portion of the interdigital spaces.

Thus, these are spaces of variable width depending on the degree of abduction of the toes, with limits that are not distinguishable from the neighbouring muscular and aponeurotic structures except distally, almost interdigitally, where they form a delicate cul-de-sac.

One may ask whether this is indeed the serous membrane of a bursa or the mere reflection and reunion of the plantar and dorsal fascia of the feet, along with a thickening of the aponeuroses of the interossei m. [4].

During our dissection, it was impossible to demonstrate the presence of a cleavage plane between the extremely thin and transparent wall of the bursa and the adjacent structures.

Histological study

Parts of this excised membrane were examined histologically. The results, without being categorical, are compatible with the existence of the wall of a serous bursa. The walls of the cavities are persistently covered with a membrane though inconsistently structured with endothelial cells (Fig. 7). The cavities themselves contain coagulated proteins which are either completely free and take the form of aggregates, or which more or less adhere to the villosities of the membrane itself.

Discussion

In spite of the limited similarity between palm and sole [1, 4], our description of the 2nd, 3rd and 4th spaces in the hand compares with recent descriptions of the corresponding 1st, 2nd, 3rd and 4th spaces between the metatarsal heads [1, 4].

Our data is compatible with the presence of bursae in both the hand and the foot (Figs. 8, 9). However, the absence of previous detailed descriptions particularly in the hand, the difficult isolation of the limiting membrane except in its distal portion, the extreme fragility and transparency of its free portion, a histological structure compatible with but not specific to bursae, and the absence of free fluid in these spaces, preclude an unequivocal demonstration of bursae.

Histological studies to determine more specifically the nature of the limiting membrane of these spaces in their free portion, as well as histo-pathological studies of these spaces showing evidence of the common pathological entities of bursae (e.g. inflammation, thickening of the membrane, increased fluid), are necessary in order to conclude definitively the nature of the spaces between the metacarpal and metatarsal heads. However, our data supports the possibility of the existence of such bursae and demonstrates that the spaces between the metacarpal and metatarsal heads and their limiting membranes are anatomically and histologically analogous.

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