

## The supra-transverse intermetatarsocapital bursa : a description and its relation to painful syndromes of the forefoot

D Chauveaux, JC Le Huec and D Midy

Laboratoire d'Anatomie, UER II, 146, rue Léo-Saignat, 33076 Bordeaux Cedex, France

**Summary.** Very many painful syndromes of the forefoot remain without a satisfactory explanation; although this region contains quite specific structures, it has suffered from the application of analogies with disorders of the hand. Among these specific components, the presence of the supra-transverse intermetatarsocapital bursa provides an explanation of such clinical entities as the acute syndrome of the second intermetatarsal space and gives fresh impetus to the debate on the etiopathogenesis of Morton's metatarsalgia. On the basis of 25 dissections, the authors studied the region between the metatarsal heads, confirming the presence of these bursae and specifying their site and size and particularly their relations with the common plantar digital nerve at its bifurcation into collateral nerves.

**La bourse intercapito-métatarsienne sus-transversaire : description et intérêt dans la pathologie douloureuse de l'avant-pied**

**Résumé.** Un grand nombre de phénomènes douloureux de l'avant-pied restent mal expliqués, car cette région possédant des structures propres, a longtemps souffert de l'homologie palmo-plantaire qui lui était appliquée. Parmi ces éléments constitutifs spécifiques, la présence de la bourse intercapito-métatarsienne (ICM) sus-transversaire permet d'apporter une explication à des entités cliniques, tel le syndrome aigu du 2<sup>e</sup> espace interméta-

tarsien et de relancer le débat étiopathogénique sur la maladie de Morton. A l'occasion de 25 dissections, les auteurs ont pu étudier l'étage intercapito-métatarsien, objectivant la présence de ces bourses, précisant leur siège, leurs dimensions et surtout, leurs rapports avec le nerf digital plantaire au niveau de sa bifurcation en nerfs collatéraux.

**Key words :** Supra-transverse intermetatarsocapital bursa – Plantar digital nerve – Morton's metatarsalgia – Acute syndrome of the second intermetatarsal space

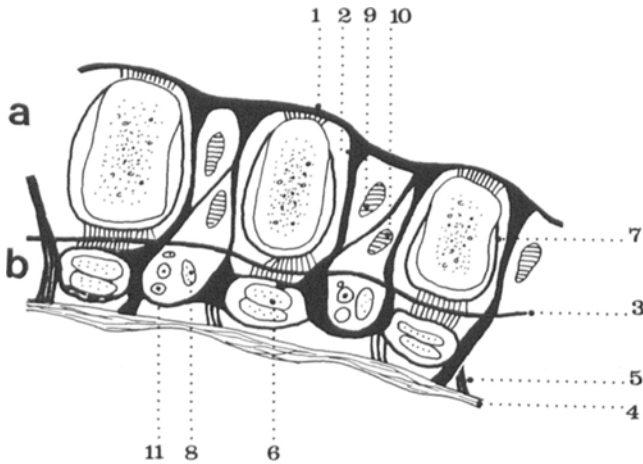
### Anatomic review [3, 8, 9]

The intermetatarsocapital space is the anterior prolongation of the intermetatarsal space and is divided into two levels (Fig. 1) :

*an inferior level, or fibrous channel, bounded below by the superficial transverse intermetatarsal ligament, an expansion of the plantar aponeurosis, above by the deep transverse intermetatarsal ligament, the anterior prolongation of the deep layer of the plantar aponeurosis, laterally by the perforating fibers. It contains the lumbrical muscles and is traversed by the common plantar digital nerve;*

*a superior level, bounded below by the deep transverse intermetatarsal ligament, above by the deep layer of the dorsal aponeurosis and laterally by the perforating fibers.*

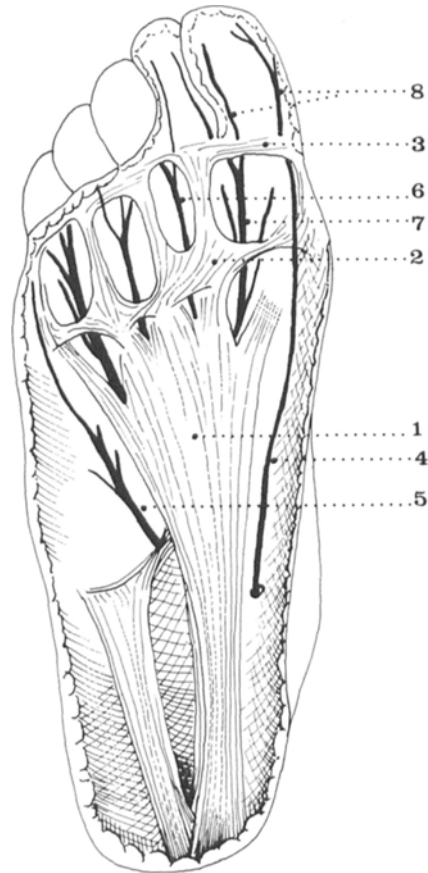
It is in the superior compartment, above the deep transverse intermetatarsal ligament, that a New Zealand



**Fig. 1.**  
The intermetatarsocapital space (after Bouchet and Cuilleret) *a* superior compartment *b* fibrous channel 1 deep dorsal aponeurosis 2 perforating fibers 3 deep transverse intermetatarsal ligament 4 superficial transverse intermetatarsal ligament 5 digital arcades 6 tendons of flexor digitorum longus and brevis 7 joint capsule 8 lumbrical tendon 9 dorsal interosseous muscle 10 plantar interosseous muscle 11 common plantar digital nerve

L'espace intercapitométatarsien (selon Bouchet et Cuilleret) *a* étage supérieur *b* canal fibreux 1 aponévrose dorsale profonde 2 fibres perforantes 3 ligament transverse intermétatarsien profond 4 ligament transverse intermétatarsien superficiel 5 arcades digitales 6 fléchisseur commun des orteils 7 capsule articulaire 8 tendon lombriçal 9 muscle interosseux dorsal 10 muscle interosseux plantaire 11 nerf digital plantaire

author, Bossley (1980), reviving the work of Jones (1946) and Spalteholtz (1941), reported the presence of a bursa situated between the metatarsophalangeal joints. He stated that this overlaps the anterior margin of the deep transverse intermetatarsal ligament in the 2nd and 3rd spaces. It then comes close to the common planter digital nerve, which, at this level, leaves the fibrous channel by passing between the anterior margin of the deep transverse intermetatarsal ligament and the posterior margin of the plantar interdigital ligament (Fig. 2). The classical anatomic treatises do not contain any description of such a structure. Some, however, such as Rouvière quoting Hartmann, Dubois and Leveau (1966), mention without describing the inconstant presence of serous bursae separating the lumbrical tendons from the lateral aspect of the metatarsophalangeal joints, and therefore situated at the level of the fibrous channel. More recently, the presence of bursae between the metatarsal heads has been described by Bonnel (1984) and the Montpellier school.



**Fig. 2**  
Superficial layers of the sole of the foot  
1 superficial plantar aponeurosis 2 superficial transverse intermetatarsal ligament 3 plantar interdigital ligament 4 medial collateral plantar nerve of I 5 lateral collateral plantar nerve of V 6-7 common digital plantar nerves 8 collateral plantar nerves

Plans superficiels de la plante du pied 1 Aponévrose plantaire superficielle 2 Ligament intermétatarsien transverse superficiel 3 Ligament palmant inter-digital 4 Nerf collatéral plantaire interne du I 5 Nerf collatéral plantaire externe du V 6,7 Nerfs digitaux plantaires 8 Nerfs collatéraux plantaires

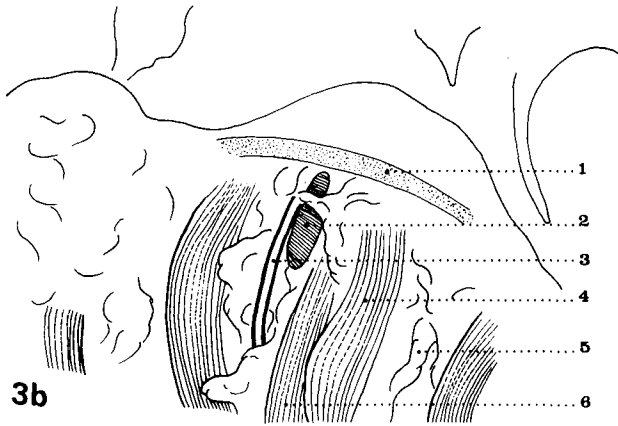
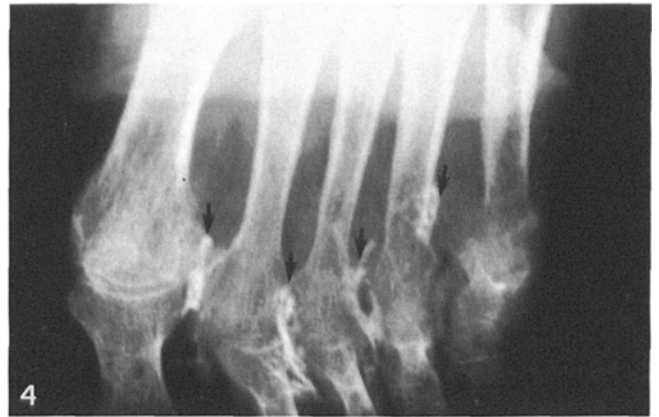
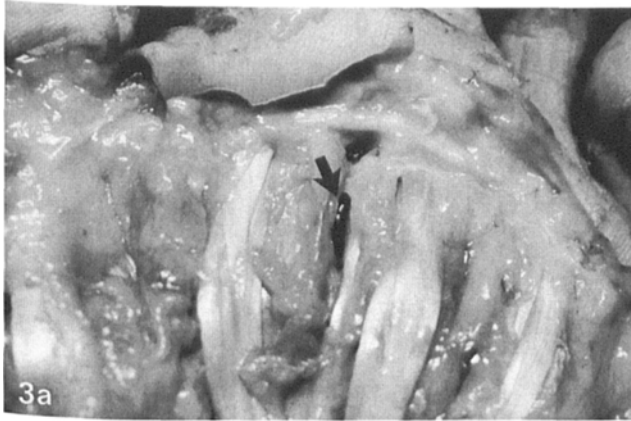
## Present anatomic study

### Material and methods

The study was based on 25 feet of adults, chosen in perfect condition and obtained after traumatic amputation or from fresh cadavers, dissection being performed within 72 hours. A preliminary series had shown that after this interval the fragility of the serous bursae did not allow reliable dissection.

### Method of dissection

An arcuate plantar skin incision was made resembling the classical surgical approach to the metatarsal heads.



**Figs. 3-4**

**3ab** Plantar approach to the bursa (membrane appears transparent) 1 palmar interdigital ligament 2 supra-transverse intermetatarsocapital bursa 3 plantar digital nerve 4 tendon of flexor digitorum brevis 5 cellulo-adipose tissue 6 tendon of flexor digitorum longus 4 Radiograph after opaque injection of bursae (note the metatarsophalangeal overlap at the 2nd and 3rd spaces)

**3ab** Abord de la bourse par voie plantaire (aspect pellucide de la membrane) 1 Ligament palmant interdigital 2 Bourse intercapito-métatarsienne sus-transversaire 3 Nerf digital plantaire 4 Tendon du court fléchisseur commun 5 Tissu cellulo-adipeux 6 Tendon du long fléchisseur commun 4 Radiographie après opacification des bourses. Noter le débordement métatarsophalangien au niveau des 2<sup>e</sup> et 3<sup>e</sup> espaces

The superficial plantar aponeurosis was resected and the tendons of the flexor digitorum brevis and longus identified in their fibrous sheaths. The common plantar digital nerves were dissected as far as the space between the metatarsal heads, where they divide at the anterior margin of the deep transverse metatarsal ligaments. These were divided, as were the fibers of the tendons of origin of the transverse head of the adductor hallucis muscle. The bursa is directly in contact with the dorsal aspect of the transverse ligament and usually bulges out spontaneously, clothed in cellular-adipose tissue (Fig. 3). Contrast injection is difficult in view of the fragility of the bursa. The bursae were measured either by radiography after opacification with dilute angiographic contrast or by microtome section after staining and freezing (Fig. 4).

### Results

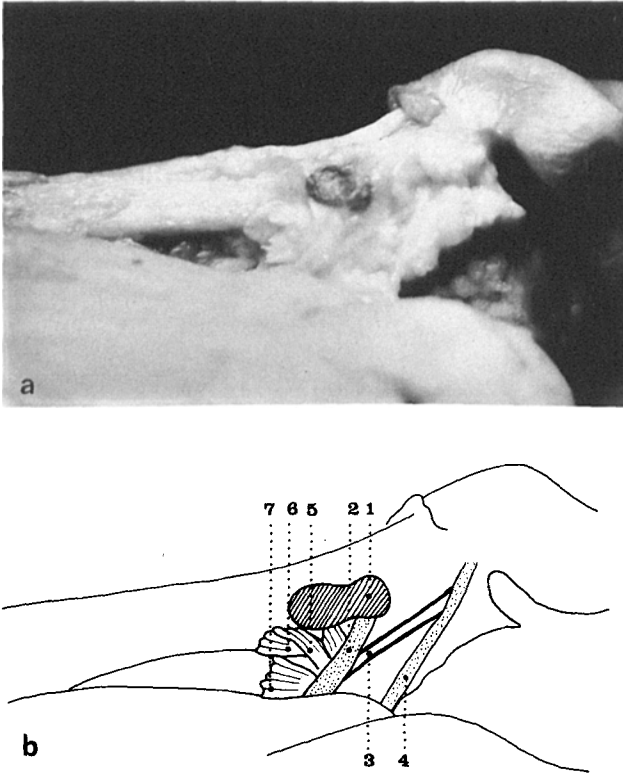
In the 25 dissections we were able to demonstrate the presence of a serous bursa in the 2nd and 3rd spaces in every case, in the 4th space in 21 cases and in the first space in 15.

**Appearance.** The bursa is composed of a pellucid transparent membrane, and is therefore very difficult to isolate from the adipose cellular tissue. It is easily ruptured, especially at its lateral margins where it comes into close contact with the metatarsal heads (Fig. 5).

**Shape.** It is oval or ellipsoidal, with its long axis anteroposterior (sagittal). The shape varies with the degree of metatarsal separation. If lateral pressure is applied it becomes ellipsoidal, elongating in the anteroposterior direction.

**Size.** The dimensions are difficult to assess, even after opacification, especially in the transverse frontal plane. The averages of the measurements found were an anteroposterior length of 2.3 to 3 cm for the 2nd and 3rd spaces and 2 cm for the 1st and 4th spaces; a width of 0.5 to 1 cm in the frontal horizontal plane; and a depth of 1 cm in the frontal vertical plane.

**Site.** It is always situated above the deep transverse intermetatarsal ligament in the dorsal intercapital space, but its site varies in the different spaces. In the 2nd and 3rd spaces, the bursa overlaps in front the anterior part

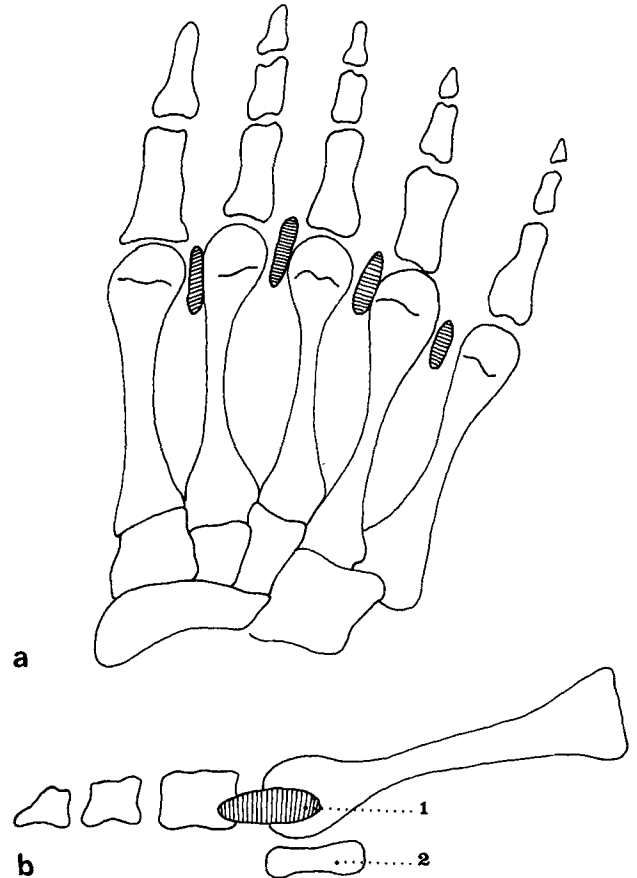


**Fig. 5**  
Sagittal section through the 3rd space 1 serous bursa 2 lumbrical tendon 3 collateral plantar digital nerve 4 palmar interdigital ligament 5 deep transverse intermetatarsal ligament 6 attachment of adductor hallucis muscle 7 common flexor of 3rd toe  
Coupe sagittale passant par le 3<sup>e</sup> espace 1 bourse séreuse 2 tendon du muscle lombriculaire 3 nerf collatéral plantaire 4 ligament palmant interdigital 5 ligament transverse profond intermétatarsien 6 insertion de l'adducteur du gros orteil 7 fléchisseur commun du 3<sup>e</sup> orteil

of the transverse intermetatarsal ligament. It reaches the lateral margin of the base of the proximal phalanx, so that it is intermetatarsophalangeal in extent. In the 4th space, on the other hand, it lies clearly behind the posterior margin of the transverse ligament (by an average of 1 cm in 21 cases) and is therefore purely intermetatarsal. In the first spaces it remains in an intermediate position, but does not go beyond the anterior part of the deep transverse ligament (Fig. 6a, b).

**Histology.** The fine membrane was studied histologically in several cases and the same finding obtained: "After embedding, the very tenuous fragments proved to be entirely composed of fibro-collagenous tissue with some superficial synoviocytic cellular elements."

**Relations.** The bursa is always enclosed in an abundant cellulo-adipose envelope over its entire



**Fig. 6**  
The bursa and its bony relations 1 bursa 2 deep transverse intermetatarsal ligament  
La bourse et ses rapports osseux 1 bourse 2 ligament intermétatarsien transverse profond

periphery except at its inferior aspect opposite the transverse ligament, where the membrane is seen in isolation. This explains the importance of access by the plantar route, as cleavage proves difficult by dorsal and lateral access.

**Inferior relations in the 2nd and 3rd spaces.** The bursa comes into immediate contact with the deep transverse intermetatarsal ligament only in its middle portion. In its *anterior fourth*, it overlaps the anterior margin of the deep transverse ligament while remaining at a distance from the posterior margin of the plantar interdigital ligament. Simple cellulo-adipose tissue separates it from the tendon of the lumbrical muscle, which emerges from the plantar portion of the space between the metatarsal heads and describes a curve with a superior concavity. The collateral nerves (proper digital plantar nerves) remain much further removed (Fig. 7). In its *middle part*, it is directly covered by the deep



**Fig. 7**  
Relation of bursa to digital nerve / common digital plantar nerve and its division 2 intermetatarsocapital bursa

Rapport de la bourse avec le nerf digital / nerf digital et sa division 2 bourse capito-métatarsienne

transverse ligament. The origin of the collateral nerves situated at this level remains at a distance from the bursa. In its *posterior fourth*, the bursa overlaps the deep transverse ligament and communicates directly with the subjacent plantar space. The musculo-tendinous junction of the lumbrical muscle and the common plantar digital nerve are situated much lower in the plantar zone.

*Inferior relations in the 1st and 4th spaces.* The bursa does not overlap the anterior part of the transverse ligament. In the 4th space it does not reach the posterior margin of the deep transverse ligament, more often lying in a purely intermetatarsal position.

*Lateral relations.* The bursa is difficult to free laterally as its wall is often adherent to the capsule of the metatarsophalangeal joint, covered by the perforating fibers. In the 2nd and 3rd spaces, it is in close contact with the capsule throughout its length and sometimes overlaps the side of the proximal phalanx. In the 1st space it is in contact with the metatarsal portion of the articulation, while in the 4th space it is related to the lateral aspect of the metatarsal neck. In 8 cases, opaque injection studies showed communications with the metatarsophalangeal joint in the two middle spaces.

*Dorsal superior relations.* The bursa, enveloped in cellulo-adipose tissue, is subjacent to the musculo-tendinous junction of the plantar interosseous muscles.

*Anterior relations.* These are important, since they are with the neurovascular bundle and mainly with the proper digital plantar nerves. Here, too, the relations vary with the site (Fig. 7). In the 2nd and 3rd spaces the relationship is very close; the bursa is frankly metatarsophalangeal in position and the collateral nerves cross the posterior margin of the plantar interdigital ligament

in front, which is the boundary of their forward course. Any increase in size of the bursa will produce compression of the collateral nerves, which are no longer protected by the arc of the lumbrical tendon.

In the 1st space, where the bursa just reaches the joint-line, it is somewhat removed from the nerves; and in the 4th space, where the bursa is purely intermetatarsal, it is quite a distance away.

*Posterior relations.* The posterior border of the bursa is well-defined and separates from the deep plantar aponeurosis in the direction of the interosseous muscles.

## Discussion

The difficulty of demonstrating the existence of these bursae, despite their constancy, is due to their extreme fragility and their relative autonomy in their superior dorsal part. Because of their very specific relations with the deep transverse intermetatarsal ligament, they cannot be confused with other structures such as a serous lumbrical bursa or an expansion of the metatarsophalangeal joint.

We localize them above the deep transverse intermetatarsal ligament in the intermetatarsophalangeal region in the 2nd and 3rd spaces, and in the purely intermetatarsal region in the 1st and 4th spaces. We therefore prefer to call them the intermetatarsocapital bursae, adding the qualification « supra-transverse » to avoid any ambiguity with the existence of a serous lumbrical bursa, classically described but not encountered.

It may be wondered [1, 2] whether the exact role of these bursae is that of shock-absorbing and gliding between the lateral surfaces of the metatarsal heads, or of simple gliding between the lumbrical and interosseous muscles. On the other hand, their pathologic implications are clear enough in view of their close relations with the proper digital plantar nerves, and this especially in the 2nd and 3rd spaces where they are placed very anteriorly. Any increase in size of the bursae will produce compression of the collateral nerves, which will be squeezed behind by the bursae and blocked in front by the posterior aspect of the plantar interdigital ligament.

## Conclusion

The demonstration of these bursae and of their proximity to the plantar digital nerves, especially in the 2nd and 3rd spaces, casts a new light on the complex mechanisms of both the inflammatory and mechanical problems of the forefoot and provides a clue to the etiopathogenesis of two specific classical syndromes : a) the painful syndrome of the 2nd space [4], where inflammation of the bursa may be due to local manifestation of a

rheumatoid process or to a purely mechanical cause, such as overstrain of the 2nd metatarsal produced by a short first ray, b) Morton's metatarsalgia, which is known not to be due to a neuroma but to a compression neuropathy. Its preferential site is due not only to the double origin of the 3rd common plantar digital nerve, but also to possible irritation and compression of the nerve by a bursa inflamed and increased in size, a bursa that is very far forward in this region.

### References

1. Bonnel F (1983) Bourses conjonctives et gaines ostéo-fibreuses tendineuses du pied, le pied en pratique rhumatologique. Masson Paris : 1
2. Bossley CJ, Cairney PC (1980) The intermetatarsophalangeal bursa. Its significance in Morton's metatarsalgia. *J Bone Joint Surg* 62 B : 184
3. Bouchet A, Cuilleret J (1978) Anatomie topographique descriptive et fonctionnelle. Le membre inférieur, 2<sup>e</sup> partie. Simep, Paris
4. Claustre J, Simon L (1982) Syndrome douloureux aigu du 2<sup>e</sup> espace intermétatarsien, troubles congénitaux et statiques du pied, orthèses plantaires. Masson, Paris
5. Dubois JP, Levane JM (1966) Anatomie descriptive du pied humain. Maloine, Paris
6. Jones FW (1946) Structure and fonction as seen in the foot. Baillière, Tindal and Cox, London
7. Mac Minn R, Hutchings R, Logen BM (1982) Foot and ankle anatomy. Wolfe Med Publi Ltd, London
8. Rouviere H (1967) Anatomie tome III (10<sup>e</sup> édition). Masson, Paris
9. Testut A, Latarjet (1928) Traité d'anatomie. G Doin, Paris