

The suspensory ligament of the penis: an anatomic and radiologic description

A. Hoznek², A. Rahmouni³, C. Abbou², V. Delmas⁴ and M. Colombel¹

¹ Service d'Urologie et de la Chirurgie de la Transplantation, Hôpital E. Herriot, F-69437 Lyon, Cedex, France

² Service d'Urologie, CHU Henri Mondor, F-94010 Créteil cedex, France

³ Service d'Imagerie Médicale, CHU Henri Mondor, F-94010 Créteil cedex, France

⁴ Laboratoire d'Anatomie, UFR Biomédicale des Saints Pères, 45 rue des Saints Pères, F-75006 Paris, France

Summary: The suspensory system of the penis acquires clinical importance in reparative surgery, traumatology and through its role in erection. The aim of this study was to identify the different anatomic structures constituting the suspensory ligament by dissection and by magnetic resonance imaging (MRI). Ten unembalmed male subjects were used for dissection of the region of the base of the penis. Ten volunteer patients underwent MRI of the penis before and after the injection of prostaglandin (PGE1). The suspensory apparatus consisted of separate ligamentous structures: the fundiform ligament, which is lateral, superficial and not adherent to the tunica albuginea of the corpora cavernosa; the suspensory ligament properly so-called, further back, stretching between the pubis and the tunica albuginea of the corpora cavernosa and consisting of two lateral, circumferential, and one median bundles, which circumscribed the dorsal vein of the penis. These structures were identifiable in MRI and their supporting role was evidenced during tests of erection. The sus-

pensory ligament seemed to maintain the base of the penis in front of the pubis and to behave as a major point of support for the mobile portion of the penis during erection.

Le ligament suspenseur du pénis : description anatomique et radiologique

Résumé : L'appareil suspenseur du pénis présente un intérêt clinique en chirurgie réparatrice, en traumatologie, et par son rôle dans l'érection. Le but de cette étude était d'identifier les différentes structures anatomiques constituant le ligament suspenseur par la dissection et par la résonance magnétique nucléaire (IRM). Dix sujets non embaumés ont été utilisés pour la dissection de la région de la base du pénis. Dix patients volontaires ont eu une IRM de la verge avant et après injection de prostaglandine (PGE1). L'appareil suspenseur était composé de structures ligamentaires séparées: le ligament fundiforme, latéral, superficiel et non adhérent à l'albuginée des corps caverneux; le ligament suspenseur proprement dit, plus en arrière, tendu entre le pubis et l'albuginée des corps caverneux et composé de deux faisceaux latéraux, circonferentiels, et d'un faisceau médian, qui circonscrivait la veine dorsale du

pénis. Ces structures étaient identifiables en IRM et leur rôle de soutien a été mis en évidence dans les épreuves d'érection. Le ligament suspenseur semble maintenir la base de la verge en avant du pubis et se comporter comme un point de soutien important pour la partie mobile du pénis en érection.

Key words: Penis — Ligaments — MRI — Erection

In man, the penis is supported in its flaccid state in the prepubic position by a support system: the suspensory lig. of the penis initially, described by Farabeuf, which was the subject of a thesis by Sur-raco [9], and more recently mentioned in a complete account of the physiology and anatomy of erection by Bondil et Wespes [1]. This ligament is firmly tethered to the pubis and is associated with a superficial bundle in front, the fundiform (falci-form) lig., and with a denser and firmer structure behind, the arcuate subpubic lig., which tethers the upper aspect of the hilum of the penis to the lower border of the pubis [1]. The clinical importance of the suspensory lig. of the penis lies in its relations with traumatic lesions or in the performance of a plastic procedure for the purpose of elongation of the penis in

certain disabling cases of shortness of the organ. It is now possible to identify these different structures by means of MRI, which provides precise morphologic data on the anatomy and consistence of the different sheaths of the penis and also allows three-dimensional evaluation of the organ, whether flaccid and at rest [4], or in erection produced by intracavernous injections of prostaglandin [2]. In this study correlating the dissection and radiologic findings, the various anatomic components of the suspensory lig. of the penis were identified and their anatomic bases for MRI are reviewed.

Material and methods

Dissection

Ten male subjects, preserved at 0°C, from middle age to 80 years and not previously operated on in the perineal region, were dissected without preparation or fixation within 48 hours of death. Two subjects were injected with red-colored latex via the abdominal aorta in order to define the topography of the cavernous aa. and their relationship to the suspensory lig. of the penis. The dissections were made layer by layer so as to progressively identify the different components of the lig. A transverse prepubic skin incision, extended in T-shape towards the end of the penis, was made to separate the organ from its cutaneous sheaths. The subcutaneous, fibrous and ligamentous layers demonstrated were listed and then photographed. We also employed a process of artificial erection by injection of the glans with 50 ml of ox gelatin, so as to define the relations of the different components of the suspensory lig. in erection. In each dissection the course of the different ligamentous layers was noted, as well as their relations with the sheaths of the penis and the dorsal nn. and vessels of the penis.

Magnetic resonance imaging

Ten volunteer patients were studied by MRI after having given their informed consent. Of these, 4 had had an injury of the shaft in erection and suffered from a fracture of the corpora cavernosa. The other patients were under investigation in

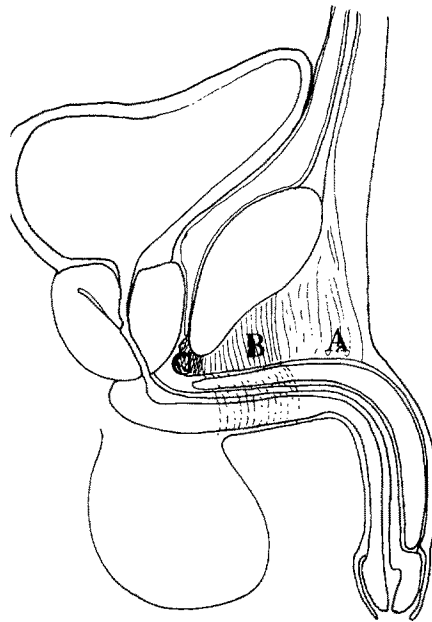


Fig. 1
Diagrammatic sagittal section representing the different distinct parts of the suspensory lig. of the penis. A, fundiform lig.; B, suspensory lig. of penis; C, arcuate subpubic lig.

the department for idiopathic erectile dysfunction without vascular, neurologic or metabolic cause. The different ligamentous structures and integuments of the penis were analysed by MRI in the sagittal and parasagittal planes in order to identify the bundles of the suspensory ligament, and in the transverse planes from the upper border of the pubis to the lowest part of the scrotum.

Histology

Transverse histologic sections of the base of the penis were made to define the relations between the different components of the suspensory ligament, its separate bundles and their attachments to the tunica albuginea of the corpora cavernosa.

Results

The suspensory ligamentous system of the penis

The entirety of the structures constituting the suspensory system of the penis was demonstrated from superficial to deep levels, comprising the fundiform lig., the suspensory lig. of the penis properly so-

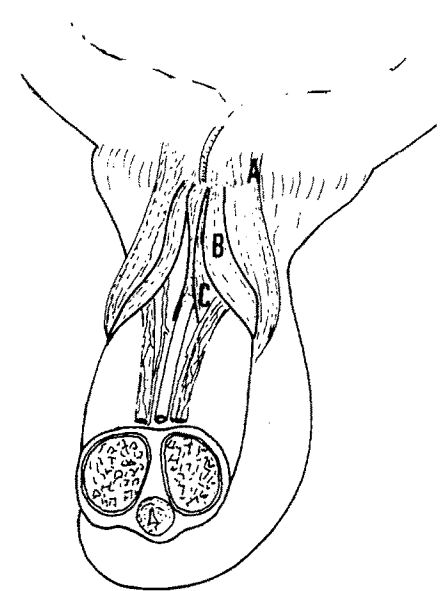


Fig. 2
Diagrammatic anterior view of suspensory apparatus. A, fundiform lig.; B, lateral bundle of suspensory lig.; C, median bundle of suspensory lig.

called, and, more posteriorly, the arcuate subpubic lig. (Fig. 1). These different structures were very lax superficially, but became very firm posteriorly to constitute a very dense layer at the level of the arcuate subpubic lig.

The fundiform lig. was in fact a lax fibrous layer, arising from a subcutaneous prepubic layer, extending upward, where it was attached by some deep fibers to the linea alba, and extending laterally on either side in the plane of the fasciae of the spermatic cord. Below, the bundles separated and passed on either side of the base of the penis in contact with the tunica albuginea of the right and left corpora cavernosa, but without any connection (Fig. 2). As shown in Fig. 3a and 3b, where the penis is in erection, the fundiform lig. remained independent of the central aspect of the shaft and was therefore not in contact with the tunica albuginea of the corpus spongiosum. At the level of the lower border of the penis the two bundles of the fundiform lig. came together at the midline to form the upper and anterior part of the scrotal septum (Fig. 3c).

More posteriorly, in a very midline plane, there was found the suspensory lig. properly so-called, which was triangular

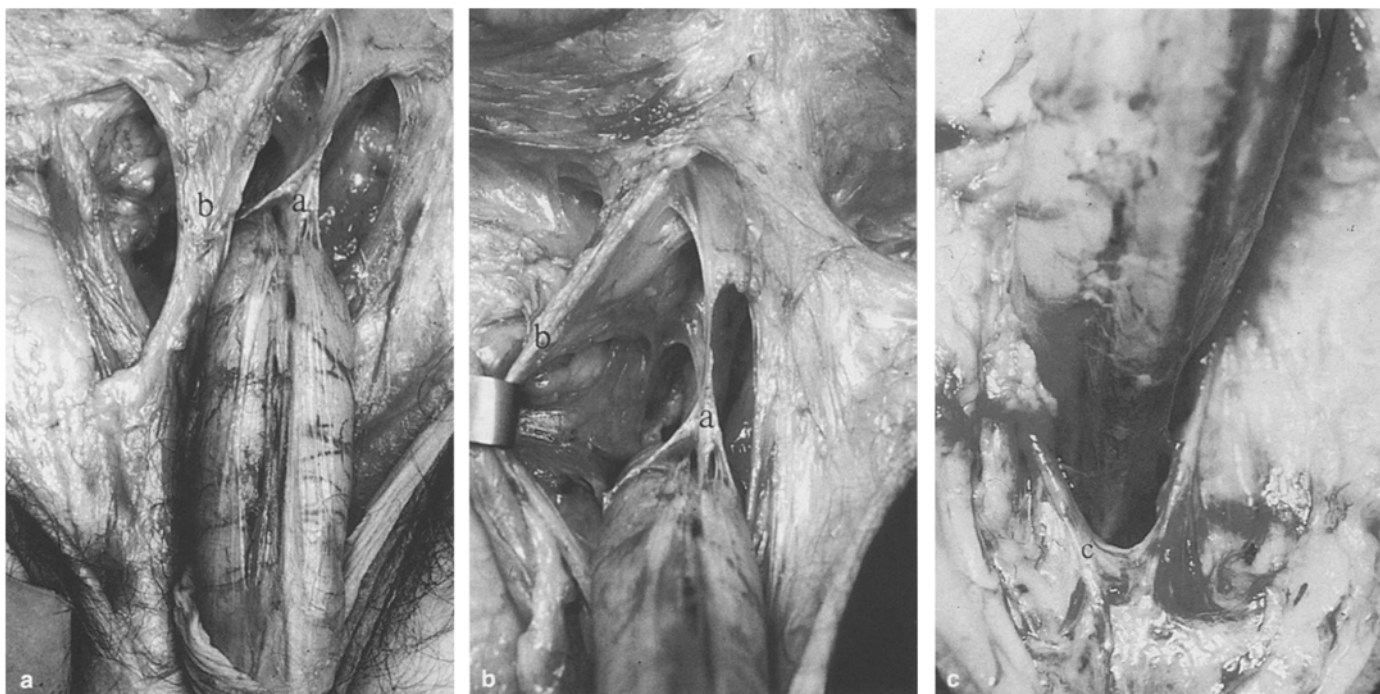


Fig. 3a-c

a Dissection of root of penis; the cutaneous sheath has been removed and the dorsal aspect of the penis is visible with the neurovascular pedicles on either side of the midline. **b** Nearer the base the suspensory lig. with its median (*a*) and lateral bundles and more laterally the fundiform lig. (*b*) which is retracted. **c** The two bundles of the fundiform lig. join at the lower border of the base of the penis (*c*) and are continuous with the scrotal septum

in shape with the apex above and the base below, and which seemed to be attached to the dorsal aspect of the penis. The suspensory lig. was attached by its posterior border to the pubic symphysis. This border measured 37 mm (± 5) on average and was continuous behind and below with the arcuate subpubic lig. It consisted of a median layer of two bundles which terminated at the midline on either side of the dorsal v. of the penis by gaining attachment to the tunica albuginea of the corpora cavernosa. The lateral bundles, initially very close to the median bundles, then separated laterally to reinforce the tunica albuginea of the corpora cavernosa at the base of the penis. The breadth of the ligament measured on average 27 mm (± 8). The ligament skirted the entire circumference of the base of the penis (Fig. 4).

More posteriorly there was a denser layer, represented by the arcuate subpubic lig. This was attached to the lower border of the pubis on a very narrow surface included within the subpubic angle. It terminated by attachment to the tunica albuginea of the corpora cavernosa, also

on a small surface encircling the dorsal v. of the penis, while the vessels and nerves of the penis penetrated the hilum of the penis more laterally and closer to the tunica albuginea of the corpora cavernosa.

MRI analysis

The anatomic structures of the erectile bodies and the penile ligaments are difficult to identify by current techniques; nevertheless, it was possible to demonstrate the different bundles of the suspensory system of the penis, which gave a hyposignal in the T1 sequences. In sagittal and median sections the three ligamentous layers were difficult to identify. In transverse sections, the suspensory lig. was very clearly identifiable throughout its circumference, as were its relations with the tunica albuginea of the corpora cavernosa and the dorsal vessels and nn. of the penis (Fig. 5a, b). However, the definition of the MRI was not adequate to identify the different bundles of the ligament or to measure them or assess their relations with the erectile structures. In erection, MRI showed the relations of the



Fig. 4

Macroscopic section of penis at level of attachment of the suspensory lig. The outer bundle envelops the circumference of the penis and adheres to the tunica albuginea of the corpora cavernosa and spongiosa. The arrow indicates the suspensory lig.

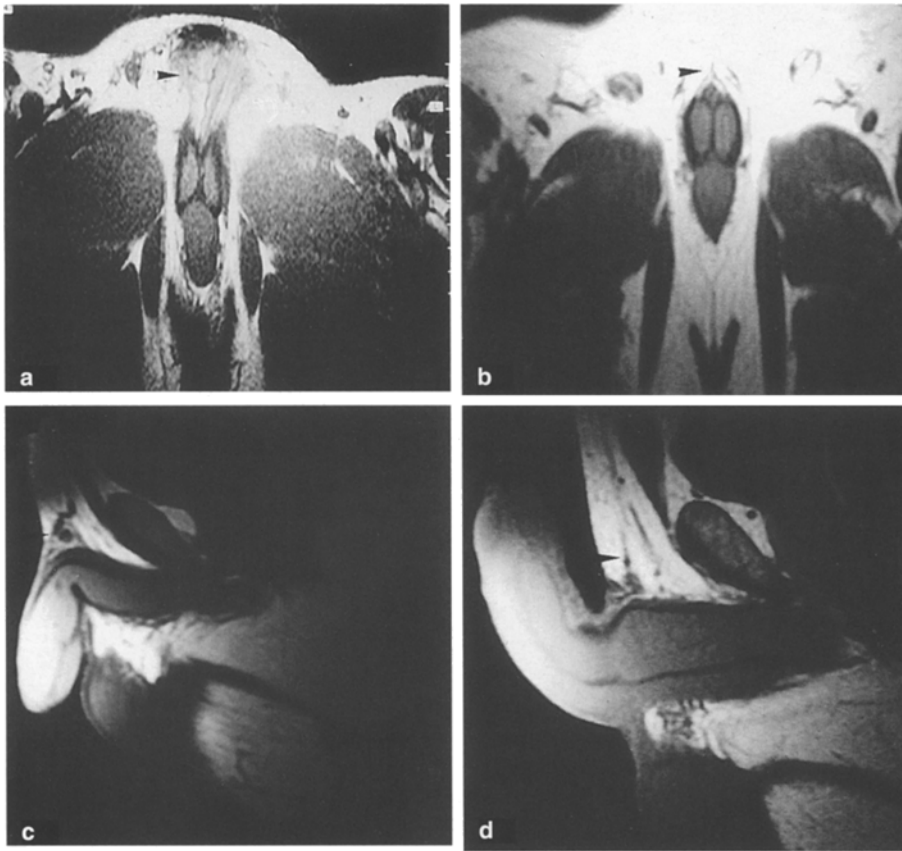


Fig. 5a-d

MRI sections in volunteer subjects. **a** Transverse section at level of base of penis showing the superficial subcutaneous bundles of the fundiform lig. and its extension into the subcutaneous fasciae; **b** At a lower level the suspensory lig. shows its median and lateral bundles; **c** Sagittal section of flaccid penis showing the suspensory lig. which tethers the penis to the pubis and lower part of the abdominal wall; **d** An erection after injection of prostaglandin E1 demonstrates the stability of the suspensory lig.

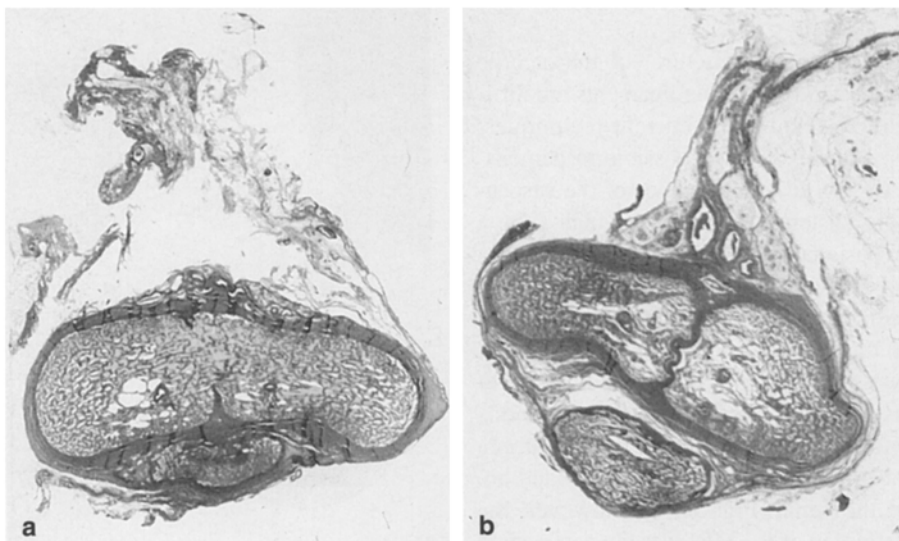


Fig. 6a, b

Histologic preparation of transverse sections of penis at two levels. **a** in front of the attachment of the suspensory lig. and **b** at the level of attachment of the ligament, showing the median (*a*) and lateral (*b*) bundles

corpora cavernosa with the different components of the suspensory apparatus of the penis, Tumescence of the corpora cavernosa was limited at the level of the hilum of the shaft by the lateral part of the suspensory lig. The axis of the erect penis prolonged the line of the ischiopubic rami, but the suspensory system did not seem responsible for maintenance of the axis of the penis, unlike in the flaccid state where the entirety of the erectile bodies was maintained forward by the suspensory lig. (Fig. 5c, d).

Histologic structure

Histologic examination of transverse sections of the penis demonstrated the relations between the suspensory lig., which extended over the circumference at the root of the shaft, and the tunica albuginea of the corpora cavernosa. As shown in Fig. 6, the collagen fibers of the suspensory lig. were continuous with fibers of the same nature and which constituted the tunical albuginea of the corpora cavernosa. This aspect was particularly accentuated from the pubis to the root of the shaft.

Discussion

The suspensory system of the penis in man was initially described by Farabeuf as a ligament attached to the linea alba at the root of the penis. Subsequently, Suraco in his thesis [9] described the different bundles of the ligament, stressing particularly their suspensory role and the connections of the fundiform lig. with the superficial fibrous structures of the prepubic region, femoral triangle and perineum. The communication of these layers accounts for the complications of serious superficial infections of the perineum, including Fournier's gangrene. The clinical importance currently attributed to the suspensory apparatus of the penis is that it may be involved in pathology of the corpora cavernosa, such as fibrosis of the tunica albuginea or Lapeyronie's disease [7], or in penile trauma because of its relations with the erector apparatus [5, 6]. Lastly, and more recently, its section has been suggested for surgical elongation of the penis in extreme cases of shortness of the shaft in adults

[3]. Investigation of the penis by MRI has become particularly valuable for assessing the pathology of the erector apparatus and of these enveloping layers. It is also possible to study the kinetics of erection after the injection of prostaglandin.

The different structures of the suspensory apparatus of the penis were readily identified by dissection. Contrary to previous accounts, it seemed to us that the fundiform lig. exhibited no connection with the tunica albuginea of the corpora cavernosa and therefore did not seem to have any supporting role except for the scrotum. This ligament, in fact, was the origin of the scrotal septum below and formed an integral part of the very vascularised penile fascia, which was independent of the other penile enveloping layers. On the other hand, the suspensory lig. properly so-called was a fibrous structure, which was very firmly attached to the lower part of the pubis and continuous posteriorly with the arcuate subpubic lig. These two ligaments seemed to form a single fibrous sheet situated at the base of the penis which was circumferential in front and open behind because of the gap created by the corpora cavernosa. Through these pubic attachments and its triangular shape, the suspensory ligament's apparent role is to maintain the flaccid penis towards the front of the pubis and prolong the suprapubic supporting ligamentous structures, ie the

puboprostatic and infrapubic ligaments [8]. Similarly, it may be imagined that the fundiform lig. holds the scrotum forward, helping walking in the vertical position.

In conclusion, MRI allowed identification of the entirety of the structures comprised in the suspensory lig. of the penis. It was clearly shown on sagittal sections that the suspensory apparatus comprised, from before backward, the suspensory lig. and the arcuate sub-pubic lig., and that only these structures were attached to the outer side of the tunica albuginea of the corpora cavernosa. Nevertheless, MRI did not allow precise identification of this ligamentous structure. The role of the suspensory lig. is to fix and support the erector apparatus in anterior position. The suspensory lig., because of its relations with the hilum of the penis, protects the neurovascular structures responsible for sensation and activation of the erector apparatus. Rupture or section of this apparatus exposes the hilum of the penis to repeated neurovascular traumatism during walking, may lead to scrotalisation of the penis by progressive embedding, and finally destabilize the penis in erection and expose it to fracture of the corpora cavernosa during coitus. Investigation of these lesions is possible with MRI, which allows precise identification of the different structures of the suspensory lig.

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