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**"CAROL DAVILA", BUCURESTI**

**DOCTORAL SCHOOL**

**MEDICINE**

**HIGHLIGHTING BY DISSECTION THE PENILE STRUCTURES IN  
ORDER TO RE-EVALUATE CLASSICAL ANATOMICAL DATA.**

**ABSTRACT OF THE PHD THESIS**

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## **The fundamental problem**

The anatomy of the penis is a fundamental area in the understanding of male sexual function and in the rationale for surgical interventions targeting the male genital tract. However, the detailed structure of the penis has not, in recent decades, benefited from a comprehensive, systematic reassessment that reflects both technological advances and changes in medical and surgical practice.

Classical anatomical literature, although rigorous for the era in which it was written, no longer satisfactorily covers the current needs of penile surgery, which has undergone significant development in recent decades.

Penile augmentation procedures, prosthetic implants, post-traumatic reconstruction or functional penile plastic surgery require a detailed knowledge of the structure of the suspensory ligaments, the exact position and role of the penile septum, and the topographical details of the urethra. In the absence of a systematic updating of this knowledge, the surgical procedure is exposed to an increased risk of complications, ranging from postoperative erectile dysfunction to the injury of critical structures, insufficiently delineated in the classical atlases.

Therefore, the fundamental problem identified is the mismatch between the level of detail of current anatomical knowledge and the precise requirements of modern penile surgery.

In the absence of a solid anatomical basis, adapted to contemporary clinical realities, interventions remain in the realm of the empirical, and medical education continues to be based on outdated information, unsupported by modern dissections or updated functional correlations.

This research aims to bridge this major gap by providing original and clinically and educationally relevant data.

## **Research hypothesis**

Starting from this background, the fundamental hypothesis of the research is that a detailed anatomical re-evaluation of the penis, carried out through systematic dissections and careful morphological analysis, will highlight structures and features insufficiently described or omitted in the literature. Thus, we hypothesise that the penile septum, for example, is a structure with a potential functional role in erectile physiology, but which is not explicitly addressed in current anatomophysiological theories. We also hypothesise that variations in suspensory ligament - both in terms of trajectory and insertion - may significantly influence the outcome of penile lengthening interventions or may constitute critical landmarks to avoid surgical complications.

The hypothesis also includes the idea that the anatomical structures of the penis are not only passive, but may have an active role in the biomechanics of erection and in the maintenance of penile position during sexual intercourse. Validation of these hypotheses would allow the direct integration of the results into current therapeutic protocols and would contribute to updating the knowledge taught in medical education, providing a solid basis for the training of future specialists in surgery, urology and andrology.

## **Research objectives**

1. **Inventory and detailed description of the suspensory ligaments of the penis**, by rigorous anatomical dissection, with emphasis on their origin, course, insertion and relationships with neighbouring structures.
2. **Evaluation of ligament involvement in sexual dynamics and biomechanics of penile support**, particularly in the context of penile lengthening or penile correction surgical procedures.
3. **Dissection of the penile septum and its extensions** for a thorough morphological and functional analysis, with the formulation of hypotheses regarding its contribution to erectile physiology.
4. **Detailed analysis of the topographic regions of the penile urethra**, highlighting relevant loco-regional particularities in the context of urological or andrological interventions.

5. **Establishing critical anatomical landmarks**, unfamiliarity with which can lead to major complications during penile surgery.
6. **Standardised photographic documentation**, useful both in research and in medical education, for the didactic support of the data obtained.

### **Research methodology**

The study is descriptive, with a strong applied component, with the central objective of obtaining detailed, reproducible and clinically relevant anatomical data. The research was carried out in the Anatomy Laboratory of the Faculty of Medicine, using formalised anatomical specimens.

Dissections were performed on penises harvested from male cadavers, either in situ or post-harvest, using fine instrumentation and surgical loupes for precision detailing.

Each structure of interest was approached systematically: layer-by-layer dissections were performed with clear delineation of ligaments, septum, urethra and vessels. Images were documented photographically with high-resolution digital cameras. They were then minimally processed for clarity (without altering the scientific content) and archived for teaching and research purposes.

Data analysis was carried out by correlation with the anatomical literature, with the aim of identifying new or previously insufficiently detailed information. Particular attention was paid to the validation of observations through repeatability, comparison of dissections between specimens and morphological consistency of results. Thus, the methodology used supports the research hypothesis and allows conclusions with direct applicability in current medical and surgical practice.

## **Study I**

### **Contributions to the study of the penile septum - dissection, anatomical description and functional relevance**

#### **1. Introduction**

The septum of the penis (or pectinate septum, from Latin *pecten*) is a connective structure with a particular morphology, derived from the tunica albuginea of the two corpora cavernosa, with a partly separating, but also integrating role (1) . It is defined by a fenestrated architecture, not being a complete wall, but rather a three-dimensional network of tendinous cords, allowing communication and functional co-operation between the two cavernous components (2-4). Classical anatomical literature treats this formation in a succinct manner, presenting it as a simple separating structure. However, its existence in the context of penile biomechanics and erection raises numerous questions about its dynamic, haemodynamic and mechanical role(3-5).

With this study, we aimed to re-evaluate the anatomical anatomy of the penile septum through systematic dissections and to discuss its functional significance. We also investigated adjacent structures - such as the intercavernous ligaments and connective formations in the glans region - to better understand the anatomical and functional context in which the septum fits.

#### **2. Materials and methods**

The dissections were performed in the Anatomy Department of the "Carol Davila" University of Medicine and Pharmacy in Bucharest, on ten cadavers formolised by femoral injection and subsequent preservation in 9% formalin.

Sagittal and transverse anatomical plans were approached, with detailed identification and description of the penile septum, its relationships with neighbouring structures and its behaviour in the context of penile architecture.

The anatomical parts were photographed and analysed, the images were then digitally edited without altering the scientific content. Data were supplemented with comparative observations from classical and modern literature.

### 3. Results

The septum of the penis was presented as a fenestrated structure, formed by bundles of tendinous chordae organised between the tunicae albugineae of the two corpora cavernosa (3,5,6).

Posteriorly, the septum is compact and continuous, providing complete separation, while anteriorly, it becomes lax, with the appearance of "windows" between the chordae - an architecture similar to the tendinous chordae of the heart (4,6-8).

Of particular interest was the identification of a dense connective mass, triangular in cross-section, located at the base of the septum, which unites the corpora cavernosa and corpus spongiosum. This has been termed **the tendinous centre of the penis**, having a fundamental biomechanical role in the coherence of the penile structure (3).

This formation is traversed by veins with transverse and vertical direction, which allows **trans-septal anastomoses**, contributing to the simultaneous and symmetrical filling of the corpora cavernosa during erection (1,9,10).

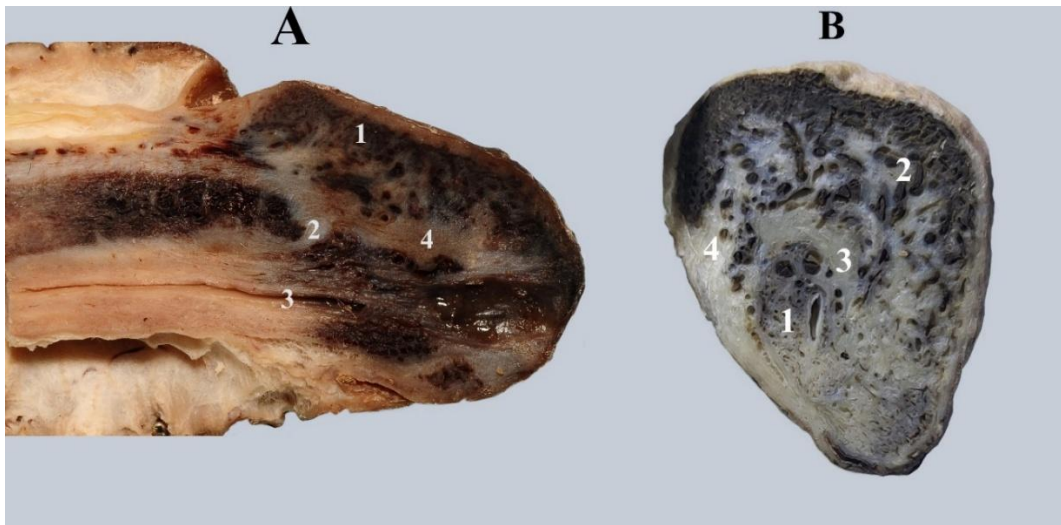
We have evidenced conjunctivo-tendinous pillars ("pillars") starting from the septum and inserting on the albugineae, without relevant biomechanical role due to their small size (3,5-8,11).

Other median structures with a potential separating function have also been identified:

- **The posterior intercavernous ligament** ('hilum penileum') - a dense connective mass that connects the roots of the corpora cavernosa to the anterior end of the bulb of the spongiosum (9,12,13,14).
- **Glandular connective formations** - present at the tip of the penis, but without constant morphology, which is why the term "glandular septum" is not anatomically supported (6,12,15).



Sagittal section through the corpus penileum to show the tendinous centre of the penis. 1. Albugined left corpus cavernosum. 2. Veins between corpus spongiosum and corpus cavernosum. 3. Corpus spongiosum with urethra. 4. Tendinous centre of the penis.



A. Sagittal section through the glans penis. 1. Caverns in the gl glans. 2. The apex of the corpora cavernosa and its albuginea. 3. Urethra. 4. Conjunctival fascicles in continuation of the corpus cavernosum albuginea, extending nearly to the tip of the glans. B. Cross section through glans penis distal to the tip of the corpora cavernosa. 1. Urethra surrounded by the corpora cavernosa

spongiosum. 2. Caverns in the glans. 3. Conjunctival mass with predominantly transverse direction. 4. Conjunctival fascicles in continuation of the corpus cavernosum.

#### **4. Discuss**

The data obtained show that the penile septum has an architecture adapted to its dynamic function - it is not a rigid barrier, but a flexible element that supports the elongation, symmetry and haemodynamic coherence of the penis.

The fenestrated aspect of the septum allows elongation of the penis during erection and avoids the formation of curvature or lateral deviation. The right-left venous anastomoses through the chordae tendineae explain how erectile pressure is distributed simultaneously and equally in both corpora cavernosa.

The tendinous centre of the penis, described for the first time in this systematic way, appears as a true anchoring and communication platform between the three cavernous structures - the corpus spongiosum and the two corpora cavernosa. Its biomechanical role is reminiscent of the tendinous centre of the perineum.

The posterior intercavernosal ligament, also described by classical authors as the "penile hilum", should be reconceptualised as the posterior part of the penile septum. It connects the roots of the corpora cavernosa and anchors them to the anterior end of the bulb, helping to stabilise the penis during erection and to control axial tension.

In contrast, the connective masses of the glans do not show consistent consistency or organisation, so the concept of a 'glandular septum' remains controversial and anatomically poorly supported.

#### **5. Limitations of the study**

A weakness of the research lies in the relatively small number of cases and the fact that each cadaver was dissected in a single anatomical plane. This approach provided a clear but partial insight into the three-dimensional architecture of the penile septum.

Further research is needed on a larger sample, with combined sagittal, frontal and transverse

dissections, to confirm and refine the initial observations and to highlight possible interindividual variations of morphological and surgical relevance.

## **6. Conclusions**

The study has provided a detailed analysis of the penile septum, demonstrating that this structure is not a uniform lamina but a complex fascicular network with variations in thickness, orientation and density of connective fibres depending on the penile region analysed.

Additional connective fascicles in hilum and glans, previously unspecified, have been described, with possible implications in reconstructive surgery.

The functional relationship between the septum and the tunica albuginea was clearly evidenced, both together contributing to the rigidisation of the corpora cavernosa during erection.

Important relationships with penile neurovascular structures were also documented, indicating operative risks in aggressive interventions. These observations support the adoption of personalised surgical techniques based on a detailed knowledge of the anatomy of the septum, thus providing a solid foundation for modern penile surgery.

## **7. Personal contributions**

We have revealed for the first time the variable fascicular architecture of the penile septum and described the regional differences in the component connective fibres.

A major contribution lies in the identification of a direct anatomical insertion of the corpora cavernosa on the spongiosal bulb - a structure ignored by the classical anatomical literature, but essential in the planning of surgical separation interventions.

We described additional fascicles in hilum and glans, relevant for the treatment of penile curvatures. The close relationship between the septum and tunica albuginea was functionally analysed, demonstrating that erectile rigidity depends on the interaction of these structures.

The study proposes a new perspective on the septum as an integrative element in erectile biomechanics, not just a separative one.

The article "*Septum of the penis - dissection, anatomical description and functional relevance*"

has been accessed more than 1,360 times, confirming the international interest and practical relevance of the results.

## **STUDY II**

### **Dissection of the male urethra with demonstration of topographic specificity**

#### **1. Introduction**

The male urethra is a complex, musculo-tubular anatomical structure, which passes through several regions - vesical, prostatic, membranous, spongy and glandular - each with morphological and clinical particularities. Detailed understanding of its anatomy is essential in urological pathology, directly affecting diagnosis, treatment and surgical approaches. Our study aims to provide a comprehensive description of the male urethra, highlighting regional topographical features and associated clinical implications (16-23).

#### **2. Materials and methods**

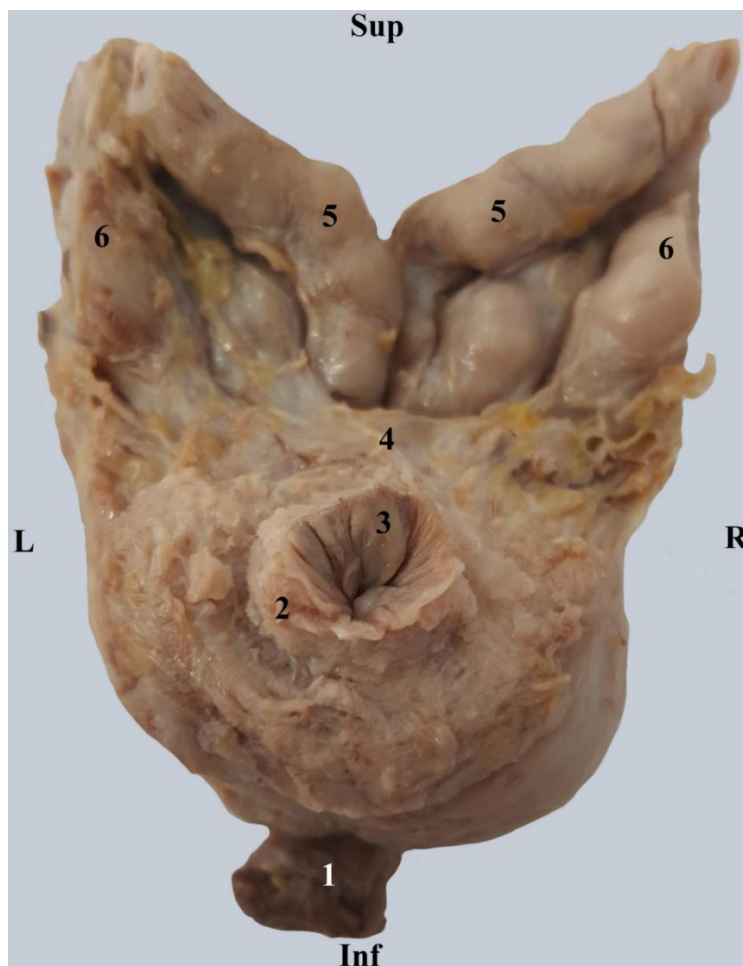
The dissections were performed on ten formalised human cadavers at the Department of Anatomy of UMF "Carol Davila". The urethra was approached stratified, from the bladder neck to the external urethral meatus, all segments were photographically documented: prostatic, membranous, bulbourethral, spongiosal and glandular. Sagittal and transverse sections were used and the bulbourethral glands were dissected separately. Images were digitally processed without alteration of morphological data. The study was ethically approved.

#### **3. Results**

The dissections clearly showed regional demarcation of the urethra.

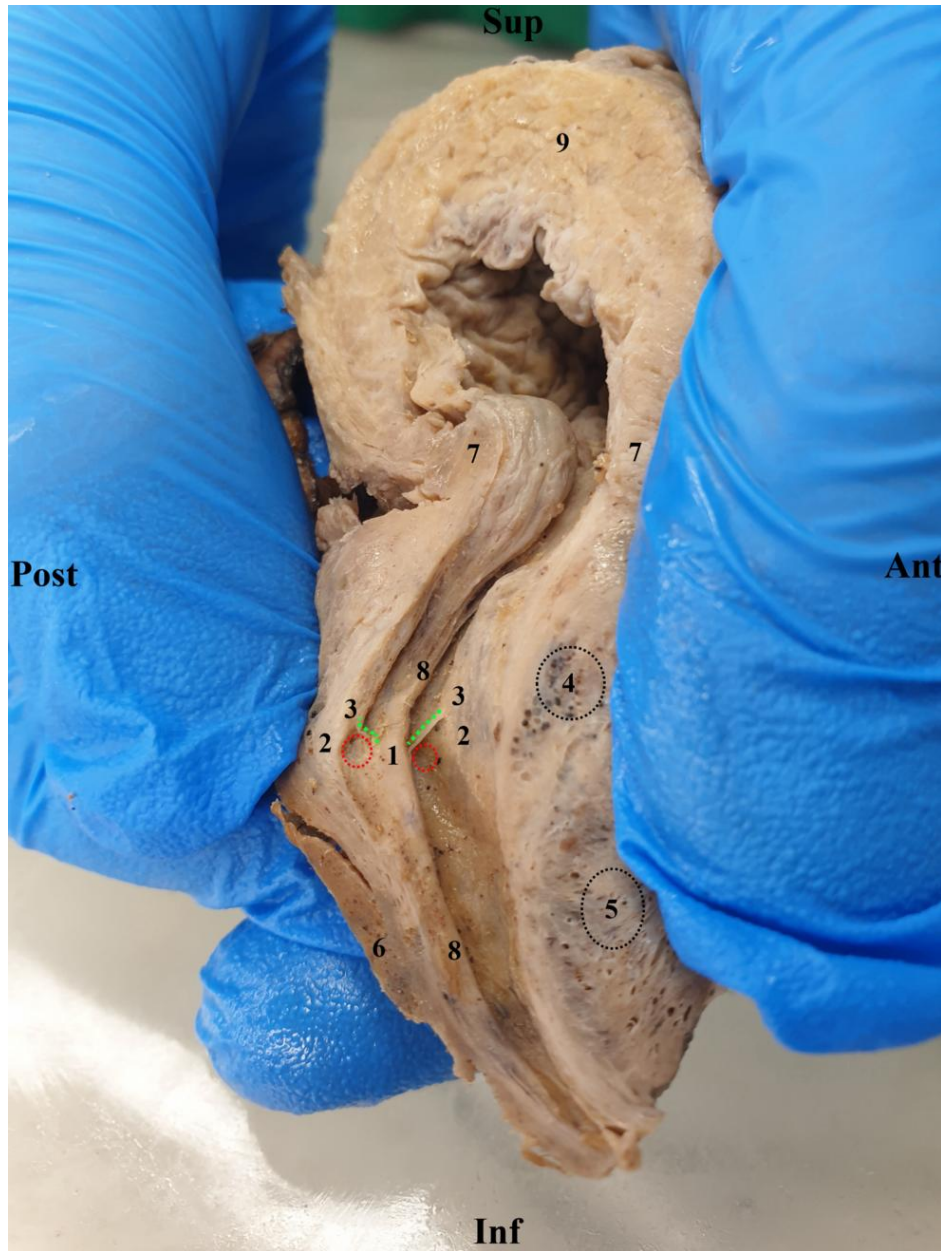
- At the vesico-prostatic level, a supraprostatic segment surrounded by the fibres of the internal sphincter has been demonstrated.

- In the prostatic urethra, the seminal colliculus, prostatic utricle and ejaculatory ducts were clearly exposed, with mucous folds possibly involved in the direction of spermatic flow.
- At the level of the urogenital diaphragm, the bulbourethral glands were identified and dissected, together with their vascular pedicles.
- In the membranous urethra, the striated muscular fibre sheath of the external sphincter was noted.
- The spongy segment showed bulbar sac bottom, urethral lacunae and calibre changes between portions.
- In the glans penis, the fossa navicularis and its mucosal valve (Guérin's valve) were highlighted, with a potential role in catheterisation difficulties.



Superior view of the bladder neck and the base of the prostate.

1 - Membranous urethra; 2 - Vesical sphincter muscle (internal sphincter of the urethra); 3 - Bladder neck; 4 - Transverse band of connective tissue; 5 - Ampullae of the vas deferens; 6 - Seminal vesicles.



Sagittal section through the prostate.

1 - The seminal colliculus (veru montanum); 2 - The orifices of the ejaculatory ducts - red dotted circle; 3 - The membranous fold superior to the orifices of the ejaculatory ducts - green dotted line; 4 - Microcalculus in the prostate glands; 5 - Prostate glands in the lateral lobe; 6 - Posterior lobe; 7 - Bladder sphincter; 8 - Urethral crest; 9 - Urinary bladder.

#### **4. Discuss**

The study confirms that each urethral segment has a specific conformation and topographic relationship with direct clinical significance. The supraprostatic segment is a key area in obstructive and oncological pathology. The seminal colliculus and the orifices of the ejaculatory ducts are vulnerable during probing, and the bulbourethral glands, although small, may be affected in inflammatory or traumatic pathology. The variability of urethral lacunae and the presence of the navicular fossa valve may influence catheterisation techniques and endoscopic instrumentation.

Dissections confirm the continuity of the external sphincter on the anterior aspect of the prostate, which is relevant to prostate surgery (24-36).

#### **5. Conclusions**

The study provided a detailed morphological analysis of the male urethra, demonstrating the variability of each segment - prostatic, membranous and spongy - and the relevance of these differences in clinical practice.

The preprostatic segment of the urethra, surrounded by the fibres of the internal sphincter, with an essential role in urinary continence, was described for the first time by dissection. We highlighted membranous folds located above the orifices of the ejaculatory ducts, with a possible role in the orientation of the spermatic fluid - formations not specified in the classical literature. The longitudinal and transverse folds of the bulbar urethra, the relationships with the bulbourethral glands and urethral vascular plexus, as well as the differences in calibre and muscle structure between urethral segments confirm the complexity and functional adaptation of the male urethra.

These results support the need for personalised approaches in urethral surgery, based on detailed knowledge of the topographical anatomy and potential individual variations.

## **6. Personal contributions**

We made an original contribution by describing the preprostatic segment and anatomical confirmation of the internal sphincter. We highlighted the superior membranous folds of the seminal colliculus and analysed the structural differences between the urethral segments, with relevance for endoscopic manoeuvres and treatment of strictures.

Another important contribution is the study of the bulbourethral glands and their relationship to the deep transverse perineal muscle - a difficult region to approach dissectionally. We confirmed the inseparability of the spongiosal urethra-spongiosal corpus and the influence of the erectile vascularisation on urethral calibre.

Description of the valve of the navicular fossa and pseudoseptal formations in the glandular urethra complete the morphological picture.

The resulting article, "*Dissection of the Male Urethra Demonstrating Its Topographical Specificity*", published in *Cureus*, has been accessed more than 390 times (views and downloads), including through PubMed Central, reflecting the academic community's interest in the topic and the practical relevance of the study.

## **STUDY III**

### **Suspension of the penis - dissection, anatomical description and outlining the anatomical risks in sectioning the suspensory apparatus**

#### **1. Introduction**

Suspension of the penis is realised by two main ligamentous structures - the fundiform ligament and the suspensory ligament - which contribute to the maintenance of the sagittal position and physiological prepubic curvature of the penis (37). In the context of penile lengthening surgery, these ligaments are frequently severed. However, the literature contains incomplete, inconsistent, or confusing descriptions regarding their detailed structure, fascial relationships, and vascular-nervous relationships. The present study aims to provide an anatomical clarification of these elements, with direct implications for aesthetic and reconstructive penile surgical practice (38-46).

## **2. Materials and methods**

The research was conducted on seven formalised cadavers, preserved according to standard protocols. Dissections were performed in anatomical plans correlated with the operative times of penile augmentation surgery. The origin, insertion, morphology and relationships of the fundiform and suspensory ligaments were identified and analysed in detail. The dissected parts were systematically photographed and the images were scientifically annotated, maintaining the accuracy of the morphological data.

## **3. Results**

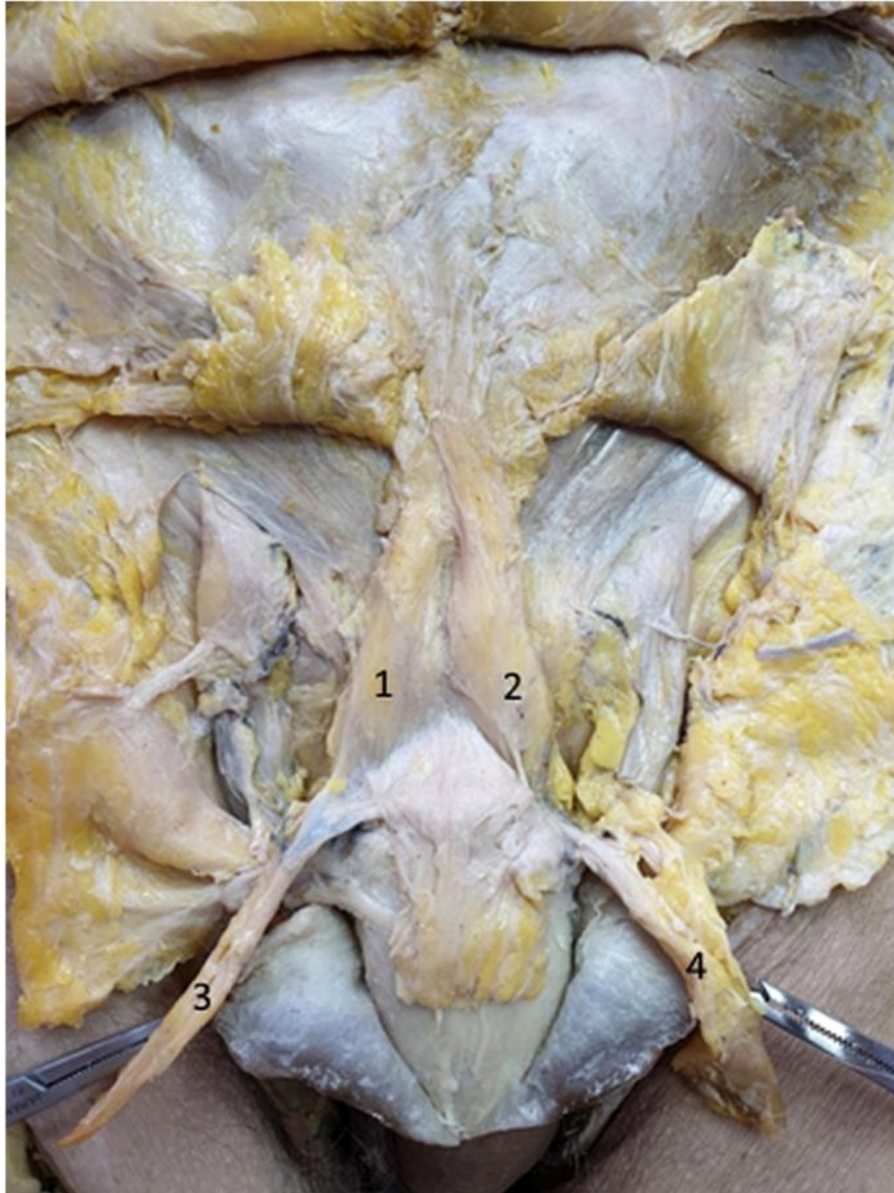
The fundiform ligament has been identified in three main forms:

- single triangular structure, double structure with accessory bundles, undifferentiated fibrous mass.

We noted the frequent presence of external pudendal vessels at the ligament insertion, an aspect with potential surgical impact.

The suspensory ligament was found to be more complex than presented in classical atlases: it contains three distinct fascicles - two lateral and one medial. The medial fascicle continues with the deep fascia of the penis, and is responsible for maintaining the penile shaft on the midline. The lateral ligamentous fibres form a true 'hammock' structure, encircling the penile body and contributing to its prepubic curvature.

All these formations showed individual variations, both in shape and in their relationship to the superficial fascia and the space between the penis and symphysis.



1 - Right fundiform ligament; 2 - Left fundiform ligament; 3,4 - Right and left severed accessory fascicles.

Fundiform ligament with double structure, with accessory fascicles severed and reflected. Note how we have detached the additional ligamentous fascicles which we have folded inferiorly. This leaves the main component of a double-structured fundiform ligament in the foreground.



Components of the suspensory ligament - detail. The pin contains the straight blade of the suspensory ligament.

1 - Medial bundle of the suspensory ligament; 2 - Right lateral bundle of the suspensory ligament; 3 - Penile shaft; 4 - Right bundle of the fundiform ligament; 5 - Left bundle of the fundiform ligament; 6 - Right spermatic funiculus; 7 - Left spermatic funiculus.

#### **4. Discuss**

Our study confirms the importance of these ligamentous structures in penile biomechanics. The morphological variability identified - particularly in the fundiform ligament - highlights the risk of incomplete or asymmetric sectioning in augmentation procedures.

The three-dimensional structure of the suspensory ligament, with fascicles surrounding and stabilising the penis, indicates that its sectioning should be performed with caution, as the median fascicle is in the direct vicinity of the dorsal vascular-nervous bundle. Uncontrolled resection can lead to major complications such as haematoma, nerve injury or penile stability disorders.

In addition, the interligamentous connective tissue, classically described as the Luschka ligament, closes the space between the penis and the symphyseal arch and plays a protective role in preventing intrapelvic blood migration or infection in case of injury.

#### **5. Conclusions**

The study aimed at a thorough anatomical analysis of the penile suspensory apparatus, with a focus on the structure, variability and surgical implications of the suspensory ligaments. It was shown that the suspensory ligament is not a unitary formation, but consists of three components: two lateral laminae and a deep medial lamina, which continues with the deep fascia of the penis and maintains the penile body in median alignment.

The fundiform ligament exhibited significant structural variability, with three main anatomical patterns previously unspecified in the literature. Together, the fundiform and suspensory ligaments contribute to the presymphyseal curvature of the penis, providing stability and facilitating the transmission of pelvic movements.

Dissections have highlighted the potential risks of severing these structures in penile lengthening surgery, with possible negative effects on axial alignment and mechanics of sexual intercourse. Direct relationships with the external pudendal vessels and the dorsal neurovascular bundle of the penile dorsum, injury to which may have significant functional consequences, have also been described.

Confirmation of the existence of the Luschka ligament and connective tissue between the penis and the symphyseal arch completes the morphological picture, highlighting the role of these structures in stabilising the penis and preventing postoperative excessive mobility.

## 6. Personal contributions

We have highlighted for the first time the triple architecture of the suspensory ligament and the structural variability of the fundiform ligament, details essential for planning penile surgery. The study accurately documented the regional vascular-nervous relationships and signalled the risks associated with ligamentolysis, particularly with respect to the external pudendal vessels and the dorsal neurovascular bundle.

An original contribution is the description of the circular arrangement of ligamentous bundles around the penile body, with a role in maintaining the natural curvature - a previously unillustrated detail. We confirmed the presence of the Luschka ligament and its functional role, thus completing our understanding of the anatomical layering between the penis and symphysis. The paper "*Suspension of the penis - dissection, anatomical description and highlighting of anatomical risks in sectioning the suspensory ligaments*", published in the journal *Basic and Clinical Andrology*, had a notable impact: over 6,800 hits, ranking first among the journal's articles in the period analysed. Its international visibility was also confirmed by the presence of the article on the Wikipedia page dedicated to the fundiform ligament, which attests to its scientific, didactic and applied value.

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## LIST OF PUBLICATIONS IN THE PHD THESIS TOPIC

**1.** Serbanoiu Alexandru, **Ion Radu-Tudor**, Filipoiu Florin Mihail, Tulin Adrian, Enyedi Mihaly. Dissection of the Male Urethra Demonstrating Its Topographical Specificity. CUREUS, 2024, 16 (8); ISI - Web of Science indexed article - impact factor 1,2, Q3, chapter II, pages 49-66.

DOI: <https://doi.org/10.7759/cureus.65946>

LINK: <https://www.cureus.com/articles/273570-dissection-of-the-male-urethra-demonstrating-its-topographical-specificity>

**2.** Filipoiu Florin Mihail, **Ion Radu-Tudor**, Filipoiu Zoran Florin, Tulin Adrian, Enciu Octavian, Enyedi Mihaly. Septum of the penis - dissection, anatomical description and functional relevance, Basic and Clinical Andrology, 2024, 34 (19); ISI - Web of Science indexed article - impact factor 2,1 , Q2, chapter I, pages 29-47.

DOI: [10.1186/s12610-024-00235-0](https://doi.org/10.1186/s12610-024-00235-0)

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**3.** Filipoiu Florin Mihail, **Ion Radu-Tudor**, Filipoiu Zoran Florin, Tulin Adrian, Enciu Octavian, Enyedi Mihaly. Suspension of the penis - dissection, anatomical description and highlighting of anatomical risks in sectioning the suspensory ligaments, Basic and Clinical Andrology, 2023, 33 (26); ISI - Web of Science indexed article - impact factor 2,1 , Q2, chapter III, pages 67-89.

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