
Five chapters

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Biography

In the early 1970s Geng-Long Hsu worked as an aircraft repair mechanic and concurrently pursued an industrial engineering degree at National Cheng-Kung University; he graduated in 1978, but shortly thereafter shifted his academic and professional
focus to medicine and graduated from the College of Medicine at National Taiwan University in 1985. After completing his urological residency, during which he developed phalldynamic works in the Urology Department and performed penile venous stripping surgery for 101 impotent males, Dr. Hsu attended and completed a research fellowship at the University of California, San Francisco, where he was a research fellow of Prof. Tom F. Lue. That same year (1992) he received the Jean-Paul Ginestie Prize in the 5th World Meeting on Impotence in Milano, Italy for the discovery of the three-dimensional architecture of the tunica albuginea in the human penis.

In 1993, Dr. Hsu was promoted to the first Chair of Urology (and Director of the Microsurgery Potency Reconstruction and Research Center) at Taiwan Adventist Hospital; he held that position until 1997 and then served as vice-superintendent of Po-Jen General Hospital until 2001. From 2001 to 2003, Dr. Hsu was director of microsurgery potency reconstruction at Taipei Medical University Hospital. Afterward, he established his private practice—Hsu’s Andrology—while also serving as a clinical professor at China Medical University. In the latter role, Dr. Hsu had license to pursue unique research topics, and during this time he conducted groundbreaking research and published prize-winning papers. In 2010, for example, Dr. Hsu’s paper “Penile Veins Are the Determining Contributor for Erection: The Hemodynamic Evidence from the Study in Defrosted Human Cadavers” was awarded second prize at the 3rd World Congress on Controversies in Urology (CURy) held in Athens, Greece.

Although Dr. Hsu is officially retired in Taiwan, he is running Hsu’s Andrology to continue his well-developed varied penile reconstructive strategies such as penile vascular surgery (Hsu’s penile vascular surgery, Hsu’s venous stripping), pure local
anesthesia of penile implant (Hsu’s penile prosthesis), penile morphology surgeries (Hsu’s morphology reconstruction, Hsu’s corporoplasty) and even penile enhancement (Hsu’s penile enhancement). Dr. Hsu was proud to receive a USPTO patent for his work in penile venous stripping and is also proud to continue his contributions to the study and treatment of the penis and erectile dysfunction by supplying five chapters to The Reproduction Encyclopedia 2nd edition, which was issued on August 1, 2018. These chapters relate to penile anatomy and erection restoration, and Dr. Hsu earnestly hopes that such expertise and practical knowledge can be disseminated and made available worldwide.

I. Penile structure, Volume I, Page 357-366

ABSTRACT

Though the human penile structure has been in its current form for millennia and has been extensively studied for centuries, its conventional description leaves room for improvement. The human penis consists of two corpora cavernosa and one corpus spongiosum whereby the urethra resides centrally and the glans penis caps distally. Its anatomy clings to the pelvic wall so tenaciously that both sexual activity and urinary passage function perfectly. A dual penile vascular system is indispensable to the corpora cavernosa, which are encompassed by the tunica albuginea’s bi-layered structure, expressed as a 360° inner circular and a 300° outer longitudinal coat, as opposed the single inner circular layer described by conventional textbooks. Similarly, between the Buck’s fascia and the tunica albuginea, the erection-related veins include one deep dorsal, two cavernosal, and four para-arterial
veins. A fibro-skeleton is critical for facilitating erectile rigidity, which is further supported by the distal ligament.

Traditional penile venous anatomy (left): (A) Lateral view: The glans penis is composed exclusively of uniform sinusoids, and
the deep dorsal vein (DDV) is sandwiched in by a pair of dorsal arteries (DA). The 2-to-1 ratio of arteries to veins is identical to the umbilicus vessel. (B) Cross-section of the pendulous portion of the human penis. The tunica albuginea of the corpora cavernosa is consistently described as a single-layered coat with uniform thickness. The median septum is complete. A single DDV and two DAs are present between the tunica albuginea and Buck’s fascia.

New penile venous anatomy (right): (A’) Lateral view: The glans penis is composed of specific sinusoids and a stout distal ligament (an analog for the os penis in other mammals), for supporting the entire glans. The DDV is consistently in the median position and receives the blood of the emissary veins from the corpora cavernosa and of the circumflex vein from the corpus spongiosum. The DDV is sandwiched between the cavernosal veins (CV), but these lie in a deeper position. Bilaterally, each DA is sandwiched by its corresponding medial and lateral para-arterial veins (PAVs). Note that the lateral PAV merges with the medial vein proximally. The deeper color of the veins indicates the deepest part of the vasculature. (B’) Cross-section of the mid-penis: Note that the number of veins is seven, not one as was traditionally believed, although that number is reduced to four at the level of the penile hilum because each pair of nomenclature veins merges. Erection-related veins are arrayed in an
imaginary arc on the dorsal aspect of the tunica albuginea, which is composed of multiple collagen bundles with a 360° complete inner circular layer and a 300° incomplete outer longitudinal coat. Thus, the penile vascular system still complies with the general anatomical rule that the number of veins exceeds the number of arteries.

References
II. Penile structure: Erections, Volume I, Page 367-375

Abstract

The human penis, when erect, transitions from a spongy-soft to a bony-rigid state, which results from a seamless interplay between various penile structures; in particular, the tunical outer longitudinal layer and intracavernosal pillars are essential structures for erectile rigidity. Once an episodic parasympathetic activity overrides the basal sympathetic tone, erections result from nitric oxide activities (which relax the smooth muscles), increased arterial inflow, sinusoidal trapping, and decreased venous drainage of the corpora cavernosa. Detumescence ensues following smooth muscle contraction mediated by a sympathetic surge such as ejaculation. Tumescence (but not rigidity) occurs in the corpus spongiosum and glans penis, where neither an intracavernosal pillar nor tunical outer longitudinal layer is present.

In humans, penile erections are tied to psychological and physiological phenomena, though the latter ought to be emphasized because an erection is, at its core, merely a hydraulic mechanism.
A comparative study of penile structure was conducted in different species, and the study’s conclusions are detailed herein. (A) In rats, the corpus cavernosum, devoid of the medial septum and intra-cavernosal pillars, is positioned between the deep dorsal vein (arrow) and the urethra (arrowhead) (H & E stain, reduced from 7×). (B) In dogs, a complete septum (arrow) and abundant intracavernosal pillars are obvious. (1×). (C) In male humans, an intracavernosal pillar is not uncommonly encountered (not demonstrated). A septum (arrow) is significant, but incomplete and dorsally fenestrated. Note the clear delineation of the inner circular and outer longitudinal layers of the tunica albuginea. (1×). (D) In rats, a short os penis is positioned between the glans penis and the corpus cavernosum (left panel, 3×). The amount of glanular tissue is scant. The junction between the glans penis and the corpus cavernosum resembles a knee joint and enables a flipping action during mating. The short os penis (right panel, 1×) can be better demonstrated after clearing and alizarin red S staining because only bony tissue can be preserved. (E) In dogs, the os penis (double-headed arrow) is enveloped with a unique glans penis of two compartments (arrowhead and arrow, respectively). As with the rat penis, the corpora cavernosa are not intromitted. However, they are reinforced with abundant intracavernosal pillars and a complete septum. (1×). (F) In male humans, the distal ligament (arrow) within the glans penis is pronounced and should be regarded as a ligamentous structure rather than a mere collection of sinusoids. The distal ligament is an aggregation of the outer longitudinal layer of the tunica albuginea and acts as a buttress of the glans penis (1×).
An illustration of the relationship between sinusoids and emissary veins in the human corpora cavernosa. Left: A cross-section of the human corpora cavernosa. Right: An amplified view of an emissary vein and its supplying sinusoids. Their anatomical relation is like a cluster of grapes, where the emissary veins are regarded as the grape stems and each sinusoid as the fruit.
While erections are fundamentally mechanical, and their durability primarily a matter of venogenic competence, any dysfunction, especially in younger males, is very often ascribed to some psychological factor. Therefore, we questioned how we could differentiate the venogenic factor from the psychogenic contributor. To this end we conducted a hemodynamic study on both fresh and defrosted human male cadavers, a model which would assuredly eliminate the possibility of a psychogenic contributor. Given the fact that we eliminated the influence of hormonal, arterial, neurological, sinusoidal, pharmacological, and psychological factors while the sinusoidal tissue was not viably extensible in cadavers, we believe that our study clearly demonstrates that the human erection is fundamentally a mechanical event contingent upon venous competence.

Table 2 Summary of a hemodynamic study on 48 valid human male cadavers (for varied purposes) from 2002 to 2013

<table>
<thead>
<tr>
<th>Grouping</th>
<th>Cadaver</th>
<th>Infusion rate or volume</th>
<th>Purpose of study for penile erection-related veins* [Reference]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>5</td>
<td>2002-2003 Normal saline</td>
<td>1050 mL 89 mL the pivotal role in erection [3]</td>
</tr>
</tbody>
</table>
Defrosted 15 2009-2010 10% colloid 28.1 mL/min 7.3 mL/min the principal component in erectile rigidity [9]

Defrosted 7 2010-2012 10% colloid 30.2 mL/min 2.8 mL/min venous drainage of the corpora cavernosa [11]

Defrosted 11 2011-2013 10% colloid role in penile veno-occlusive mechanism [4]

Total 48

*Penile erection-related veins (PERV) include one deep dorsal vein, two cavernosal veins, and two pairs of para-arterial veins.

†The PERV stripping surgery.

References
III. Erection Abnormality, Volume I, Page 382-390

IV. ABSTRACT

Erection abnormalities include both erectile dysfunction and penile dysmorphology. Erectile dysfunction is the inability to attain or maintain rigid erections and may result from hormonal deficiency, arterial insufficiency, neurological disease, pharmacological influence, chronic systemic diseases, psychological disturbance, venogenic incompetence, or cavernosal fibrosis.
Common management strategies of erectile dysfunction include herbal supplements, oral phosphodiesterase 5 (PDE-5) inhibitors, hormone replacement therapy, intracavernous injection therapy, vacuum device aid, vascular intervention surgery, and penile implants. Penile dysmorphology involves congenital or acquired penile deviation and may require surgical intervention if the penile curvature is so severe that it prevents normal coitus.
Schematic illustration of the degree of discrepancy causing penile curvature. A). A formula derived from calculus which is identical to that from geometry. Suppose that the center of a pipe revolves about the Z-axis by radius R as illustrated in the figure. Let S1 and S2 denote the outer and inner surfaces of the pipe, respectively. The difference in area between S1 and S2 is

\[ S1 - S2 = \int_0^\pi 2\pi (R + r \sin \phi) \cdot r d\phi - \int_0^\pi 2\pi (R - r \sin \phi) \cdot r d\phi = 8\pi^2. \]

Consequently, we can determine the difference in area for any degree, \( \theta \), and \( \Delta S \), which is independent of R, but dependent on the pipe radius, \( r \), and \( \theta \), is:

\[ \Delta S = \frac{S1 - S2}{360} \times \theta = \frac{\pi r^2 \theta}{45}. \]

B). The relationship of the tunical incision sector and penile curvature degree.

The incision sector (\( \theta' \)) and the curvature degrees (\( \theta \)) is derived from goniometry. Seven curved penises of human cadavers, with varied deviations of 20, 30, 60, 70, 90, 110 and 150 degrees, respectively, were collected. A 1-0 silk suture was put at the 12 o’clock position to serve as a guide for maintaining the central line. The tunica was cut stepwise along the most curvilinear line until the penile shaft was fully straightened. Subsequently, a curve of continuous parameters was then made with interpolation. The length of the patched veins required, consequently, was \( 2\pi r \theta' / \theta \). Note that a curved penis less than 110 degrees accounts for only approximation. (Reproduction from Hsu, G. L. et al. (2006), *Formulas for determining the dimensions of venous graft required for penile curvature correction*. Int J Androl 29(5), 515-520)
Schematic illustration of penile autologous patched surgery. A.) A retro-coronal circumferential incision is made and the prepuce is de-gloved. The major branch of the deep dorsal vein may be readily identified with a milking manipulation. Making an appropriate opening at the exits of the emissary veins, rather than making a complete opening on Buck’s fascia, is done in order
to perform the pull-through maneuver of the deep dorsal and cavernosal veins. B.) Completing the pull-through maneuver requires the surgeon to make 4-5 openings. The deep dorsal vein is stripped and doubly ligated with each emissary vein. This is preserved for patch material. C.) The hydro-dissection technique is used to facilitate the intact separation, the isolation, and the tag of the neurovascular bundle. D.) An artificial erection is induced, with normal saline via a 21G or 19G scalp needle, in order to determine the location of the depression center, which is feasible for an incision. Using formulas for determining the dimensions of venous graft required for penile curvature correction, E.). An incision is made with a new, sharp surgical scalpel (while the neurovascular bundle is well-protected) until the penis is straightened. F.) The autologous venous grafting is fashioned to the tunical defect with a running suture of 6-0 nylon. It is then enforced at each centimeter. Eventually, an artificial small intestine submucosa is used to cover the patched area to enhance its strength so that it can appropriately withstand intracavernous pressure.

References
IV.  **Penile Endocrinology, Volume I, Page 376-381**

**ABSTRACT**

The development of the human penis is affected by hormones even in the earliest stages of pregnancy. Early on in embryonic development, both sexes possess equivalent internal structures. These are the mesonephric ducts and paramesonephric ducts. The presence of the SRY gene on the Y chromosome causes the development of the testes in males, and the subsequent release of hormones which cause the paramesonephric ducts to regress. The androgens play different roles in each stage of life: prenatal, infancy, childhood, prepuberty, puberty, adulthood, and late adulthood. Those who sustain divergent hormonal signals may be afflicted with various conditions such as a micropenis, ambiguous exo-genitalia, or penile shrinkage. Some of these conditions can be mitigated through appropriate hormone replacement therapy.

References


V. Penile vascular surgery for erectile dysfunction, Volume IV, Page 427-436

ABSTRACT

The use of penile vascular surgery for treating erectile dysfunction has been studied for more than a century. Although it remains
controversial, penile arterial revascularization surgery is appropriate in young males who have experienced arterial trauma, and in older males with a localized arterial occlusive disease. And while still generally unsupported by the medical community, penile venous stripping has been shown to be beneficial in correcting veno-occlusive dysfunction, with outstanding results. The traditional complications of irreversible penile numbness and deformity have been virtually negated with the introduction of more innovative and technically complex venous ligation techniques.

The table below summarizes the outcome of penile venous stripping methods refined since 1986. 

Friendly reminder: For penile venous stripping, neither electrocautery nor a suction apparatus is required at any point in the procedure. Additionally, there are three prerequisites to performing penile venous stripping:

1. Knowledge of the new penile vascular anatomy
2. Skill in delicate microsurgical techniques, which enables the surgeon to limit all sinusoidal blood within the corpora cavernosa resulting from fixed ligation of each emissary veins closest the outer longitudinal tunica. These techniques can be best honed by practicing microsurgery on small rats.
3. Possession of the essential surgical instruments depicted on USPTO website (under the patent “Physiological approach to penile venous stripping surgical procedure for patients with erectile dysfunction.”)

Table 1. Chronological refinement in penile venous stripping surgery methods since 1986

<table>
<thead>
<tr>
<th>Methods</th>
<th>Patients</th>
<th>Presentation</th>
<th>Follow-up period (years)</th>
<th>Anatomy blueprint [Reference]</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Age (Year)</td>
<td>Time period</td>
<td>Op. time (hours)</td>
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<tr>
<td>Ligation</td>
<td>8</td>
<td>22-58</td>
<td>Jun. 1986 Aug. 1987</td>
<td>0.5-2.0</td>
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<tr>
<td>Stripping</td>
<td>Total</td>
<td>Age Range</td>
<td>Stripping</td>
<td>Total</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
<td>-----------</td>
<td>-----------</td>
<td>-------</td>
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<td>23</td>
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<td>Sep. 1986</td>
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<td>245</td>
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<td>1207</td>
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<td>Aug. 2000</td>
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<td>235</td>
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<td>Jan. 2004</td>
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<td>103</td>
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<td>283</td>
<td>303</td>
<td>20-75</td>
<td>Feb. 2011</td>
<td>2.1</td>
</tr>
</tbody>
</table>

* DDV, CV, PAV, IIEF, IR & SR are abbreviations for the deep dorsal vein, cavernosal veins, para-arterial veins, international index of erectile function, improvement rate, and satisfaction rate, respectively.
Photographs of penile venous stripping surgery. A.) A longitudinal pubic incision was marked and circumcision was performed to access the offending veins. B.) The visibility of the deep dorsal vein (DDV) was enhanced by employing a milking manipulation, mimicking a squeeze applied to a balloon, of the corpora cavernosa. C.) The DDV trunk was freed for 2 cm, firmly held by a pair of hemostats, and cut in the middle. D.) The distal stump served as a guide for stripping and ligating several dozen branches. E.)
Likewise, antegrade stripping was performed in a pull-through maneuver using the proximal stump. F.) A dozen circumflex veins were identified and treated. G.) The superficial dorsal vein was spared to preserve physiological circulation. H.) A longitudinal pubic incision was performed to relay and complete the stripping procedure up to the level of the infra-pubic angle, where several venous trunks are consistently encountered. I.) The wound was fashioned with 5-0 chromic sutures.

References