

## A Physiological Approach to a Penile Venous Stripping Surgical Procedure for Patients with Erectile Dysfunction

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### Abstract

**Background:** A refined penile venous stripping has been found effective in treating Erectile Dysfunction (ED) for nearly three decades. It appears more viable chronologically while several modifications have been made. We sought to report on the most advanced method.

**Materials and Methods:** The study included 98 male patients treated from February 2003 to March 2006. All they were diagnosed with ED secondary to Venous Occlusive Dysfunction (VOD) and were refractory to prior medical treatment. Among them 35, 32, and 31 men were allocated to the circumferential, semi-circumferential, and control group respectively. The two treatment groups received penile venous stripping via a circumferential or semi-circumferential approach correspondingly, while the control group received only simple follow-up. After degloving the tissues superficial to Colles' fascia, the confluent channel of the Deep Dorsal Vein (DDV) was identified. It was then clamped 2.0 cm proximal to the retrocoronal sulcus, and thoroughly stripped and ligated proximally and distally using 6-0 nylon sutures with a pull-through maneuver. The Cavernosal Veins (CVs) were managed with the same technique, while the Para-Arterial Veins (PAVs) were only segmentally ligated. A median longitudinal pubic incision was then made to resort the DDV and CVs stripped proximally till the infrapubic angle. Lastly, all wounds were fashioned layer by layer, while penile shaft was being stretched consistently by an assistant.

**Results:** The operative times were  $2.4 \pm 0.2$  and  $3.1 \pm 0.4$  hours respectively for the circumferential and semi-circumferential groups. The follow-up periods ranged 3.2-7.2 years with an average of  $5.4 \pm 1.3$  years. The operative time, postoperative frenulum edema ( $3.2 \pm 1.6$  vs.  $11.9 \pm 2.1$  days) and satisfaction rate of surgical course were significantly different ( $p < 0.01$ ) in favor of the circumferential approaches although no difference was noted in postoperative infection among two different approaches. Differences in erectile function were significant between the treatment groups and the control group in terms of preoperative IIEF-5 ( $9.8 \pm 2.3$  and  $9.6 \pm 2.1$ ) scores compared to postoperative ( $21.6 \pm 2.5$  and  $20.8 \pm 2.7$ ) ones respectively (both  $p < 0.001$ ) although no difference was found between the two surgical approaches. Overall, 51 patients in the treatment groups (51/67; 90.4%) reported significant improvement; whereas some worsening in IIEF-5 scores was noted in the control group during the same period of follow up time.

**Conclusion:** A circumferential along with median longitudinal pubic incision was found to be a viable physiological approach with favorable outcomes and negligible morbidity for treating ED secondary to VOD.

**Keywords:** Cavernosal vein; Erectile dysfunction; Deep dorsal vein; Para-arterial vein; Venous-occlusive dysfunction; Venous stripping

### Introduction

Erectile Dysfunction (ED) is still a critical issue although the introduction of Phosphodiesterase-5 (PED-5) inhibitors in 1998 had shed much light into the field [1]. Subsequently this agent has become the first-line drug in ED management [2,3]. Vascular Dysfunction is believed to be a critical cause of male ED, which may be classified as venogenic, arteriogenic, or mixed. Among these, Venous Occlusive Dysfunction (VOD) is the most prevalent in impotent patients [4,5] and even in those caused by cigarette-smoking which was plausibly to be resulting from an arterial insufficiency [6]. Thus, ED could be most often caused by diseased veins which have been known to be associated with various disease entities in the dependent portion of the upright human body such as hemorrhoids in the rectum [7], varicose veins in the leg [8], and varicocele testis [9]. This belief was further underpinned after the study of the dramatic improvement in inducing a fully rigid erection when penile erection-related veins were being stripped and ligated at the tunical level in cadaveric penises [10]. This finding of the pivotal role of penile veins may challenge the consensus of ED contributors which just enrolls hormonal deficiency, arterial insufficiency, neurotic disorders, and adverse effects from drugs, chronic systemic diseases, psychogenic origins and intracavmosal fibrosis. Should penile venous surgery be commensurately beneficial

for ED patients if it works in both fresh and defrosted cadavers which are immune to be influenced by ED contributors above.

We consistently applied a refined penile venous stripping technique in a large patient population due to the positive outcomes, minimal complications, and negligible morbidity under local anesthesia on an ambulatory basis over near three decades although it may be above the consensus [11-13]. Despite the new insight in the penile venous anatomy, offensive penile veins in VOD are so complicated that the complete removal of erection veins is technically very challenging [14]. In fact, there may be as many as 125 ligature sites which are appropriate as closest to the tunica as possible. Thereafter surgical approaches must preserve the penile physiology in order to avoid surgical morbidity,

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which in turns can prevent the seemingly ubiquitous postoperative penile edema and shortening. In 1986, we used a transverse infra pubic skin incision and median longitudinal incision of the penile base on 28 and 4 patients, respectively [15,16]. As a result of long-term follow-up, we realized that the latter approach with an inside-out maneuver could be recommended because this type of physiological approach can avoid scarifying the lymphatic vessels, and in turns, postoperative lymphoedema can be avoided although the former approach was initially advised. Later we found that the retro-coronal plexus might be difficult to access in some circumcised men. Either a circumferential or a semi-circumcision approach was then introduced to resolve this problem. However it remains unclear that which approach is preferable? Herein, we will like to report this advanced penile venous stripping method which has provided significant long term results in a great numbers of patients with severe ED who were refractory to conservative measures include medical therapies. These techniques were developed based on extensive clinical experiences reciprocated with anatomy studies [17-25].

## Materials and Methods

### Patient population

In general, patients who had an untreated chronic systemic disease (e.g., diabetes mellitus, chronic liver disease, renal failure, hormonal insufficiency, psychoneurotic disorders, etc) or other obvious etiologies (e.g., prostate surgery, major pelvic surgery, and trauma) were not recommended to undergo cavernosography. Patients who had arterial insufficiency were also excluded from undertaking venous surgery. In this study, patients were included in the cohort if the penis was not covered by the foreskin when erection, and were excluded if they had major penile surgery but circumcision. The final cohort included 98 male patients, aged 23-73 years, from February 2003 to March 2006. All 98 males were diagnosed with ED secondary to VOD upon multidisciplinary investigation and were sexually inadequate and refractory to prior medical treatment which included pharmacological treatment, intracavernosal injection therapy, intraurethral pharmacotherapy and external vacuum therapy. The abridged five-item version of the International Index of Erectile Function (IIEF-5) scoring system was used as our standard questionnaire. A diagnosis of VOD was mainly made basing on dual pharmaco-cavernosography and Doppler ultrasonography. This cavernosographic methodology involves injecting 120 ml of a 30% (diluted from 68%) loversol (Optiray) solution intracavernously via a 19-gauge scale needle firmly affixed to the lateral distal penis. The first set of cavernosograms was taken in order to demonstrate the penile venous anatomy. It was serially performed (Figure 1A-D). The second set was made within 30 minutes following injection of the 20 µg prostaglandin E1 (PGE1) via the same intracavernous route to document VOD if venous channels (Figure 1E and F) were shown during a rigid erection following infusion of the loversol solution and additional 60-120 normal saline if required. The arterial pulsatile function and the response to PGE1 were simultaneously assessed. Doppler ultrasonography of the penis was conducted during a separate visit to rule out arterial insufficiency. Among them 35, 32 and 31 patients were assigned to the circumferential, semi-circumferential, and control group respectively. The two treatment groups received penile stripping via a circumferential approach on those whose foreskin was redundant and an additional circumcision was informed consent or semi-circumferential approach on those whom had no redundant prepuce, while the control group received only simple follow-up. Surgery was conducted under local anesthesia on an ambulatory basis. Neither a Bovie nor a suction apparatus was used. The operative time was recorded from the time of anesthetic injection to the end of skin

suture. Informed consent was obtained in all patients.

### Anesthesia and penile venous stripping surgery

Acupuncture assisted local anesthesia was performed as previously described. A template of a refined penile venous stripping surgery was referred through the entire procedure (Figure 2). A dorsal semi-circumferential incision (n=32) 1.0 cm proximal to the retrocoronal sulcus with partial degloving of the tissues superficial to Buck's fascia



**Figure 1A:** Dual cavernosography. The first cavernosogram was initially by an anterior-posterior (AP) view while 10 mL 30% loversol (Optiray) solution was injecting. Routinely a second film was similarly taken after another 10 mL solution was infusing for further demonstration of multiple venous channels.



**Figure 1B:** Dual cavernosography. Patient was repositioned to an oblique view followed by taking film while further 15mL solution was consuming. Multiple parallel veins were shown along the penile shaft.



**Figure 1C:** Dual cavernosography. Similar film was undergoing after injection of another 15mL solution.



**Figure 1D:** Dual cavernosography. Thirty minutes after 20µg prostaglandin E1 (test) was injected intracavernously, subsequent film was taken while the penis was erected. The presence of outflow veins documents a veno-occlusive dysfunction (VOD).



**Figure 1E:** Dual cavernosography. Reconfirmation of VOD while the injection proceeded up to 60 mL solution.



**Figure 1F:** Dual cavernosography. An AP view was undertaken in 5 minutes. Note that the opacities of CC attenuated significantly.

or a circumferential incision (n=35) (Figure 3A) followed by a more extensive degloving maneuver being made to access the confluent trunk of the DDV (Figure 3B). The DDV now can be easily identified 2.0 cm proximal to retrocoronal sulcus and enhanced by squeezing the corpora cavernosa. Serving as a guide, it was then thoroughly stripped and ligated with 6-0 nylon sutures with a pull-through maneuver (Figure 3C) via 3-5 openings made on Bucks' fascia at the exits of the emissary veins. The circumflex veins were also ligated at the junction between the corpus cavernosum and the corpus spongiosum along the penile shaft bilaterally. The CVs were managed with the same

technique. A median longitudinal pubic incision (Figure 3D) was then made to relay the stripping of the DDV and CVs (Figure 3E) proximally to the infrapubic angle. It is critical that a segment (Figure 2A, purple cuff) of 1.0 cm of layered tissues proximal to the penopubic fold be spared from dissection, in order to prevent postoperative penile shaft retraction that could result in penile shortening. The darkish-engorged Para-Arterial (PAVs) were ligated only segmentally. Intraoperative cavernosograms (Figure 4) were undertaken in case incomplete removal of the erection-related veins was suspected when reference was made to preoperative cavernosograms. A meticulous surgery could merely be obtained while varied view of cavernosograms were undergone. Lastly, the median longitudinal pubic wound was closed from Colles' fascia, the dermis, and then the skin layers via use of 5.0 chromic sutures. All wounds were fashioned layer by layer, while penile shaft was being stretched consistently. The circumferential wound was closed with a similar technique. A compression dressing, encircling the penile shaft, was then put in place and stretched as much as possible. IIEF and cavernosography were used for follow up for 4.1- 8.2 years as required.

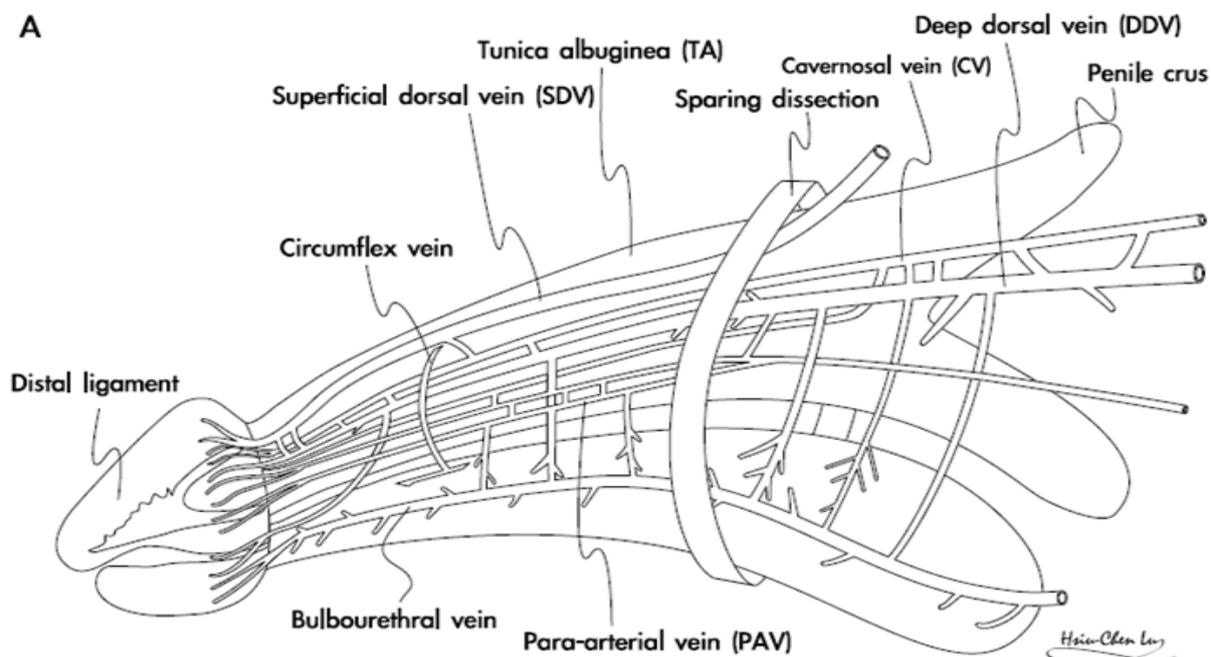
### Statistical analysis

Data with continuous values are reported as the mean  $\pm$  Standard Deviation (SD). Student's t-test and paired t-test were applied for inferential purposes after being logarithmically transformed. It is statistically significant when  $p < 0.05$ .

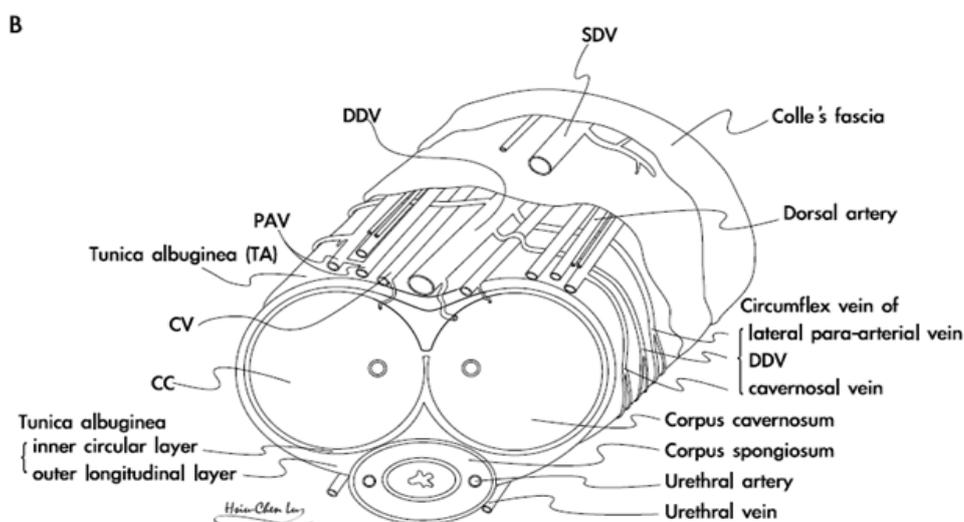
### Results

The data of Doppler sonography of the 98 patients is as following: the cavernosal artery diameter ranged 0.8-1.2 (mean: 1.1) mm with an average of a 49.3% diameter increase after PGE1 stimulation; the Peak Systolic Velocity (PSV) was  $35.0 \pm 4.1$  cm/s, the End Of Diastolic Velocity (EDV) was  $9.6 \pm 1.9$  cm/s, and the Resistance Index (RI) was  $0.71 \pm 0.05$ .

To provide a comprehensive overview, features of the 98 patients are listed in Table 1. The follow-up period was 3.2-7.2 years (average  $5.4 \pm 1.3$ ) years (n=91). The operative time was  $2.4 \pm 0.2$  (n=35) and  $3.1 \pm 0.4$  (n=32) hours for the circumferential and semi-circumferential groups, respectively. The operative time, postoperative frenulum edema ( $3.2 \pm 1.6$  vs. 2.1 days), and patient satisfaction rate (97.1% vs. 71.9% were significantly different ( $p < 0.01$ ) in favor of the circumferential approaches, with no difference found for postoperative infection. Differences in erectile function were significant between the treatment groups and the control, specifically in terms of preoperative IIEF-5 ( $9.8 \pm 2.3$  and  $9.6 \pm 2.1$ ) scores compared to postoperative ( $21.6 \pm 2.5$  and  $20.8 \pm 2.7$ , respectively) scores (both  $p < 0.01$ ) respectively. However, no difference was found between the two treatment groups. Overall, 51 patients in the treatment groups (51/67; 90.4%) reported significant improvement; whereas some worsening in IIEF-5 scores was noted in the control group during the same period of follow up time. The need for a booster injection of local anesthetic (n=67) occurred twice in 23 patients and three times in 2 patients. Intraoperative cavernosography was carried out in 5 patients. Follow-up cavernosograms were conducted in 13 (19.4%) patients, and among whom, 11 (16.4%) males requested confirmation of venous removal because an insufficient responses (Figure 5) was initially reported. 3 patients (4.5%) requested an objective comparison although the surgery was satisfactory.



**Figure 2A:** A template for complete removal of the erection-related veins in a physiology approach in the human penis. Lateral view: The erection-related veins are arrayed surrounding the tunica albuginea of the corpora cavernosa. These include the deep dorsal vein (DDV), cavernosal veins (CV) and para-arterial veins (PAV). The DDV consistently in the median position receives the blood of the emissary veins from the CC and of the circumflex vein from the corpus spongiosum. It is sandwiched in by CVs, although these lie in a deeper position. Bilaterally, each dorsal artery is respectively sandwiched in by its corresponding medial and lateral PAVs. Note that the lateral PAV merges with the medial one proximally. The deeper color of the veins indicates the deeper group of the vasculature. At the penile hilum, communicating veins of DDV and CV are encountered first (purple arrow), denoting the erection veins leaving the CC, and finally (green arrow), signifying the completeness of the venous stripping. A 1.0 cm segment (purple cuff) around the penile base must not be separated in order to prevent the postoperative penile shortening resulting from penile retraction among the layered tissues. The borders of ligatures of venous stumps are marked.



**Figure 2B:** A template for complete removal of the erection-related veins in a physiology approach in the human penis. Cross-section of the mid-portion: The DDV and PAVs are at the same imaginary arc whereas the CVs are ducked at deeper positions with separate perivasculature sheath. Note that the number of the vein is 7 rather than that of the traditionally described 1, although it becomes 4 at the level of penile hilum because a merging takes place in each pair of the nomenclature veins.



**Figure 3A:** Photos of ongoing surgery. A circumferential incision (white arrow) was performed 1.0 cm proximal to retrocoronal sulcus. Note that a median longitudinal pubic incision (black arrowhead).



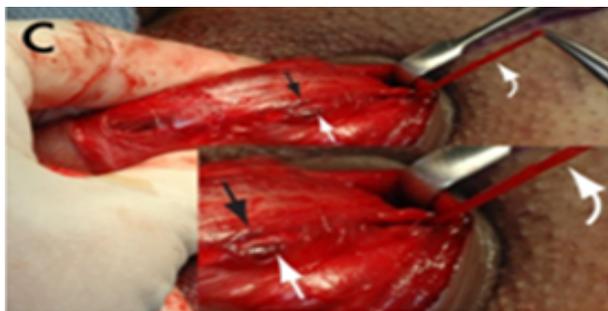
**Figure 3E:** Photos of ongoing surgery. The DDV (cure arrow) and CVs (arrows) were stripped proximally until the infrapubic angle where several venous trunks were consistently encountered.



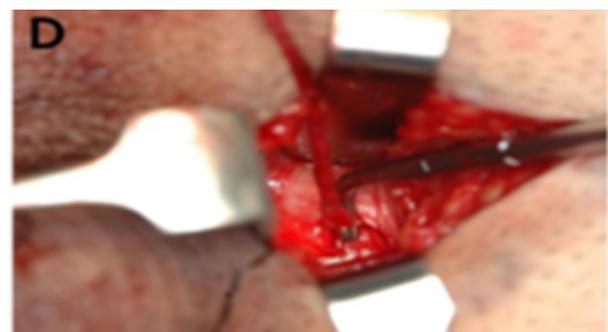
**Figure 3B:** Photos of ongoing surgery. The confluent channel (black arrow) of the deep dorsal vein (DDV) is easily identified 1.5-2.5cm proximal to the retrocoronal sulcus and is enhanced by squeezing the CC.



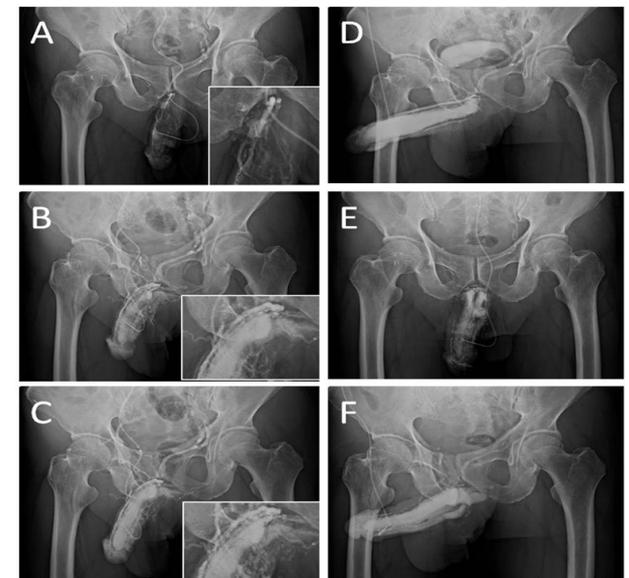
**Figure 3F:** Photos of ongoing surgery. Once the darkish-engorged para-arterial veins (PAVs) were segmentally ligated, both circumferential (white arrow) and median longitudinal pubic wounds were approximated with a 5-0 chromic or 6-0 nylon sutures.



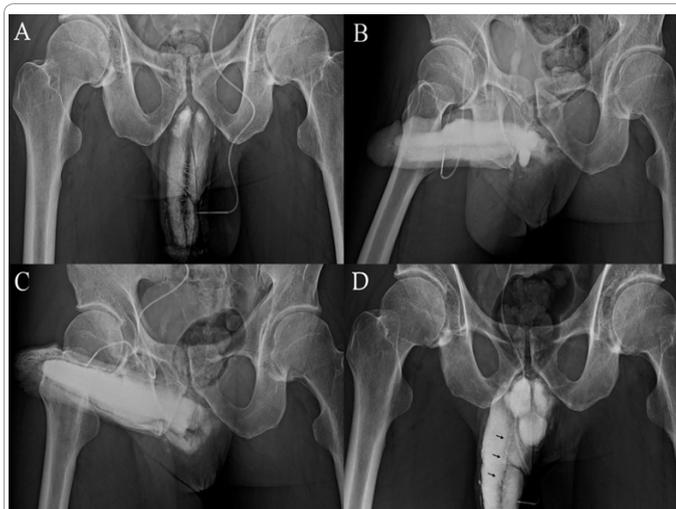
**Figure 3C:** Photos of ongoing surgery. Serving as a guide it (cure arrow, held by a mosquito hemostat) was then thoroughly stripped and ligated with 6-0 nylon sutures using a pull-through maneuver. It was sandwiched by the left (white arrow) and right (black arrow) cavernosal vein (CV).



**Figure 3D:** Photos of ongoing surgery. A median longitudinal pubic incision was made to carry out the stripping procedures. Note that one deep-seated proximal branch was manipulated with a right angle hemostat.



**Figure 4:** Intraoperative cavernosography. A. Preoperatively an AP view was taken while drainage of multiple venous channel were shown. B. The first oblique view was undergone to demonstrate rapid drainage of veins. C. Then the second oblique view was obtained to show the difficulty of intracorporal fluid retention despite ample injection of solution. D. Thirty minutes after 20µg prostaglandin E1 was injected intracavernously, subsequent film was taken while the presence of drainage veins denoted a veno-occlusive dysfunction (VOD) because the penis was erected. E. During penile venous stripping surgery, an AP view disclosed satisfactory penile venous removal. It was for comparison with that of Panel A. F. In an oblique view, further injection of 20 mL solution resulted in partial erection, which evidenced much improvement of intracorporal fluid retention capability. It was for comparison with that of Panel B.



**Figure 5:** Cavernosography in a 49-year-old man one year postoperative. A. An AP view showed scarce drainage vein despite injection of 10mL solution. B. Similarly in this oblique view, no residual vein was demonstrated. C. Further oblique view disclosed minima drainage vein despite rigid erection occurred when 35mL solution was injected. D. An AP view cavernosogram disclosed a marked vein (arrows). It could be the offensive vein resulting in insufficient surgery.

## Discussion

For over a century, the merit of conducting penile venous surgery to treat ED has not yet been established. In fact, despite many groundbreaking results, using venous surgeries to restore erectile function continued receiving tremendous controversies [26-34]. Clinical guidelines adapted by an American Urological Association (AUA) panel in 1996 following a meta-analysis of literature reports stated that venous surgery was not justified in routine use [35,36]. Most urologists also abandoned this procedure due to lack of sustained functional improvement and post-surgery complications, including the irreversible deformity and permanent numbness of the penis after surgery [37,38]. Although these seemingly unavoidable adverse side effects have discouraged many surgeons from using venous surgery for patients with ED, given the fact that penile venous surgery is exclusively directed at the veins, we came to believe that these complications resulting from fibro skeleton and nerve involvement should be avoidable. This belief prompted us to study the penile anatomy using various methodologies, including dissecting, light, scanning, and transmission electron microscopy and special stains [17,39]. Also, we have performed the penile venous stripping procedures as an outpatient surgery under local anesthesia for a large patient pool since June 1988. With this particular refined penile venous stripping technique, no significant post-surgery long-term complications have been found.

With no venous leakage, the sinusoid of the corpora cavernosa is the ideal milieu in applying the Pascal's law, given that the histology of the tunica albuginea of the corpora cavernosa is virtually the same as the os penis in quadrupeds [40,41]. The law depicts that pressure applied to any part of an enclosed fluid at rest is transmitted undiminished to every portion of the fluid and to the walls of the containing vessel. Interestingly this may ramify that penile erection rigidity has advanced from a rigid body, os penis of a quadriceps, to a hydraulic system, the corpora cavernosa of erect human being, which is similar to the controlling system in an earlier aircraft to modern advanced jet.

The anatomical configuration and histological components of the human penis appear to depend on the specific location gifted with special function [19,39]. For any surgeries, the approach determines the functional outcomes and anatomical integrity. This is particularly true in the penis because it is a reconstructive surgery on an unique structure composed of multiple fascial-sliding layers surrounding the three cylinders of the erectile sinusoids. Although no difference was noted among the two treatment groups (circumferential versus semi-circumferential) in terms of IIEF-5, it were significantly different ( $p < 0.01$ ) in favor of the circumferential approaches on concerning those favorable parameters such as operative time saving, postoperative frenulum edema period reducing and overall surgery satisfaction rate increment. Furthermore recently, circumcision was proven to be beneficial in reducing susceptibility of contracting HIV infection by 60%, although the underlying mechanism has not yet been elucidated [42]. The benefit of the circumferential approach is tremendous, since it not only allows a simultaneous circumcision be performed, but also allows direct accessibility of the offending veins particularly those circumflex veins bilaterally along the entire penile shaft without the expense of scarifying tissues (e.g. lymphatic vessels, arteries, and nerves) and loss of layered structures. Therefore an approach using a circumferential and median longitudinal incision which might be commensurate with the physiology was developed in this study.

It is believed that the sinusoidal tissues in the penis are more vulnerable than other vascular structures for bleeding complications when injured. The unfavorable consequences of extensive fibrosis and deformity commonly encountered following using a Bovie to stop bleeding in a penile surgery led us question whether the use of electrocoagulation for hemostasis in penile surgery was ideal [43]. In fact, it is believed that the best way to prevent bleeding is to keep the stripped venous channels under appropriate tension for optimal closure of the venous lumen. However, if excessive tension was applied or manipulated by instruments, the venous plexus could become too susceptible to avulsion. Applying a Bovie could also compromise the integrity of the sinusoidal tissue in the corpora cavernosa, and damage to the sinusoidal tissues could make it difficult to main their extensibility, which in turns impairs erectile function. Similarly, electrocautery may also damage the extracavernosal tissues and cause fibrosis, which

Group	Patients		IIEF-5		Operation time (hours)	frenulum edema (days)	Satisfaction of surgery course(number/%)	Infection (number)
	No.	Age (years)	Pre-op	Pre-op				
Circumferential	35	45.6 ± 7.8	9.8 ± 2.3	9.8 ± 2.3	2.4 ± 0.2	3.2 ± 1.6	34/97.1	1
semi-circumcision	32	47.3 ± 8.7	9.6 ± 2.1	9.6 ± 2.1	3.1 ± 0.4	11.9 ± 2.1	23/71.9	0
control	31	46.9 ± 8.3	10.0 ± 3.1	10.0 ± 3.1				
Total	98							
p value <sup>a</sup>		NS	NS	NS	NS	<0.001	<0.01	NS

Univariate comparisons were performed using Student's t-test for parameters with continuous values and Chi-square test, Fisher's exact test, and Yate's correction for continuity with discontinuous parameters as necessary.

**Table 1:** Features of 98 patients who underwent venous stripping surgery from 2002 to 2005

result in penile deformity. Furthermore, it is crucial that during wound approximation of Buck's fascia, Colles' fascia, and dermal layers, the glans penis to be applied a consistent stretching force at the 3 and 9 o'clock positions. This is done in order to prevent postoperative penile shortening and loss of the sliding nature of each layer.

The penile shaft is devoid of fatty tissue and is surrounded by well-defined layer fascia and bony-like tunica albuginea, which serves as excellent landmarks for needle placement. With knowledge of the anatomical structure of the fibroskeleton, the technique for local anesthesia can be easily acquired. Since local anesthesia applied in this procedure can last for four hours or longer, most patients do not require a booster injection. In conclusion this advanced method enhances surgery which achieves its treatment purpose at no expense of morbidity. We believe that a circumferential along with median longitudinal pubic incision is a viable physiological approach in penile venous stripping for treating patients with ED secondary to VOD on an outpatient basis.

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