

The evolution in the surgical management of Peyronie's disease

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Abstract

Peyronie's disease (PD) is due to a fibrotic alteration of the tunica albuginea of the penis. It is responsible of penile pain, angulation, and possible erectile dysfunction (ED). Despite almost three centuries have passed since the first description of the disease, etiology still remains uncertain. This fact has led to the lack of a truly effective medical therapy and to date the surgical treatment, although not yet standardized, is the only one that offers acceptable outcomes in terms of function and overall patient's satisfaction. Since the beginning of the surgical experience in this field, two different currents of thought have developed: the first, involved the proposal of a number of different plication techniques, applied on the healthy side of the penis, opposite to the sick side, with the sole purpose of correcting the curvature; on the other side, efforts have focused on treating the "focus" of the disease, thus developing the so called "plaque surgery." If with the passing of the decades neither of the two "philosophical" currents has prevailed, this probably depends on the fact that is still not clear which is the lesser of evils: the frequent onset of ED which may follows the plaque surgery or rather the penis shortening that inevitably occurs if any technique of plication has been applied. Our contribution aims to offer an historical retrospective of the surgical treatment of this disease as well as to discuss the latest international guidelines on this topic. The reader will also find some notes about our personal experience in this field.

Keywords

Peyronie's disease, induratio penis plastica, surgical treatment, plication, penis grafting materials, penile prosthesis, soft prosthesis

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Introduction

Peyronie's disease (PD) is an idiopathic, acquired alteration of the penis associated with a history of pain and deviation of the penile shaft that occurs during erection due to the presence of a fibrotic degeneration affecting the tunica albuginea of the corpora cavernosa. The nature and extent of this anatomical alteration, and therefore the severity or complexity of penile deformity, varies widely as well as its association with erectile dysfunction (ED).

Although almost three centuries have passed since the first official description of the disease, the countless treatments that have been proposed over the years have often proved to be a failure, to the test of facts. This is probably due to the forced empiricism of the therapeutic solutions proposed, a consequence in turn of the not yet fully understood etiology of this disease.

Moreover, the spontaneous improvement of the curvature, that sometimes can occur during the natural history of the disease, helped to underestimate its consequences on sexual function.

In this context, the three main studies analyzing the natural history of PD agree on a spontaneous improvement of the curvature in 12%–13% of cases,^{1–3} with the

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pain that marks the initial stages of the disease, self-limiting in a time ranging from 12 to 18 months.³ The purpose of our effort has been to analyze the different surgical options that have been proposed over the past decades, their possible drawbacks, risks, and satisfaction rates.

Historical aspects of surgical management

First reports

The disease was first described in 1743 by Françoise Gigot de La Peyronie (1678–1747), surgeon of French King Louis XIV, in a work called “Some obstacles that prevent the normal ejaculation of semen.” The Author described the case report of a patient with retrograde ejaculation due to urethral stricture. The penis of this patient presented a kind of “rosary beads” (nodules), which ran along the entire dorsal face of the penis and caused it to be dorsally incurved during erection.⁴ To be honest, a long before this “official” description, the disorder was already known: Theodoric of Bologna in the 13th century, Wilhelm from Salierno in 1476, Gabriele Fallopio in 1561, Andreas Vesalius in 1543, Arantius in 1579. . . all of these “erudites” described patients with similar symptoms. Moreover, the Ephemerides (1687) and the rather rough booklet “Venus minsieke gasthuis” (Venus Hospital for the lovesick, 1688), contain short remarks on this condition.

In addition to this, two extensive Dutch contributions were written by Nicolaas Tulp (1641) with a case history, and by the anatomist Fredrik Ruysch who firstly, in 1691, gave an illustration of the penile curvature caused by PD, demonstrated on a cadaver.^{5–12}

Beyond possible historical controversies, today the merit of Françoise Gigot de La Peyronie is still recognized and the disease bears his name; however, other eponyms are still used such as plastic induration of the corpora cavernosa, fibrosclerosis of the penis, fibrous cavernositis, cavernous sclerosis, sclerosis of the cavernous albuginea, or Van Buren’s disease.¹³

While the first attempts of medical therapy go back to Françoise de La Peyronie himself, and consisted in bathing in the holy waters of Barèges (thermal therapy),⁴ the first surgical treatments date back to the 19th century when MacClellan, Regnoli, and Huitfeldt reported the simple excision of the plaque, moreover described as a “disastrous technique” by the Authors themselves, several years later.^{14,15}

In 1903, William Johnson Walsham, the famous surgeon from St Bartholomew’s Hospital in London, suggested an immediate amputation of penis in case of ineffective medical therapy, while Young and Davis, in 1926, proposed the partial excision of the plaque.^{16–18}

Table 1. Historical milestones for Peyronie’s disease surgery.

- 1943—Lowsley: plaque removal and free fat grafting
- 1972—Poutasse: plaque removal without engagement
- 1973—Devine and Horton: plaque removal and dermal graft
- 1979—Pryor and Fitzpatrick: Nesbit technique applied to IPP
- 1982—Lowe: plaque removal and synthetic grafting (Dacron)
- 1993—Lue: plaque incisions and venous graft
- 1994—Wilson: modeling
- 2003—Egydio: application of mathematical formulas for graft
- 2005—Austoni: tutorial surgery

Development of two currents of thought for the surgical treatment of Peyronie’s disease

Modern surgery for PD has its beginnings in the 1940s, where Beach, in his “some observations on PD,” clearly stated that surgical results are conditioned by the skill of the operator who is requested to know the basic concepts of plastic surgery.¹⁹

Since then, two different currents of thought have developed; the first, involved the proposal of a number of different plication techniques of the healthy side of the penis, opposite to the sick side, with the sole purpose of correcting the curvature; on the other side, efforts have focused on treating the “focus” of the disease, thus developing the so called “plaque surgery.”

If with the passing of the decades neither of the two “philosophical” currents has prevailed, this probably depends on the fact that is still not clear which is the lesser of evils: the frequent onset of ED which may follow the plaque surgery or rather the penis shortening that inevitably occurs if any technique of plication has been applied.

Historical milestones for PD surgery are reported in Table 1.

The famous Nesbit’s technique dates back to 1965, and it was originally proposed for the congenital curvatures of the penis; the procedure entails different plications of the corporal albuginea, along the convex (long) side of the penis, followed by the elliptical shaped excisions of the albuginea tissue, with the final transverse suture of the defect.²⁰

This method was then applied for treating patients with PD, with the large data published by John Pryor from London and Alpay Kelami from Berlin.^{21–23}

The opposite technical concept, entailing the idea of acting directly on the disease site, was later introduced by Lowsley and Boyce who proposed the use of a graft of fat to cover the erectile tissue, at the end of plaque excision.¹⁸

With the aim to limit penile shortening, Alpay Kelami experimented the substitution of the excised tunica albuginea with dura mater, in 11 dogs. He reported the epithelization of the grafting surface within the first 3 weeks, and the subsequent transformation of the graft in autologous tissue, with no scarring nor shrinkage.²³

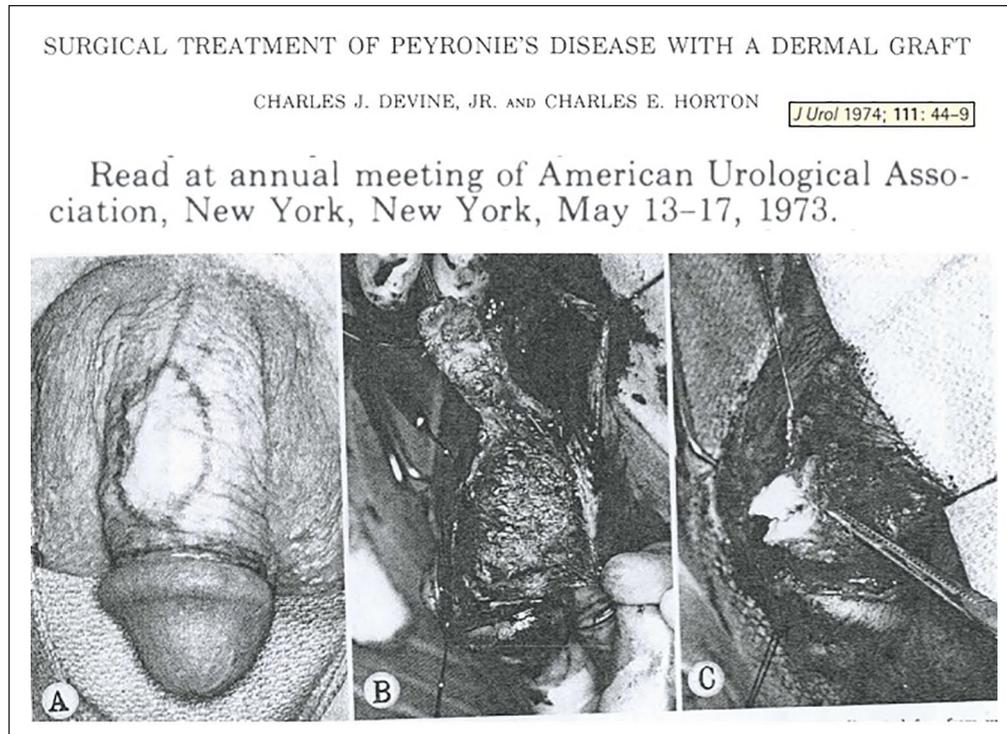


Figure 1. Historical milestones for Peyronie's disease surgery: the original paper published by Devine and Horton in 1974.²⁴

In the same years, Devine and Horton experimented several different grafts, indicating the dermis as the least likely to contract²⁴ (Figure 1). Some years later, in 1979, as a continuation of their studies, the same East Virginia group published a survey of 50 patients operated on with this technique; a rate of 12% ED was reported, which the authors had difficulty recognizing as possible organic consequence of iatrogenic nature. They encountered serious difficulties in the retrospective investigation on the post-operative ED, complained by patients, concluding in favor of a likely psychogenic genesis (one patient regained his sexual health immediately after the divorce, while another one complained impotence only during the penetrative intercourses, but not in case of fellatio).²⁵

Regarding the opposite vein of thought, in 1985 Essed and Schroeder described a modified plication technique,²⁶ faster and easier to be performed, but burdened by significant percentages of recurrences. In general, for all the plication techniques, the use of resorbable sutures increases the risk of recurrence; on the other hand, non-resorbable sutures can entail persistent pain to the patient.

The concept of "radical surgery"

In the late 1980s, Austoni and Pisani from Milano, introduced the so called "radical surgery" in the treatment of PD, with the publication of an atlas on this topic.²⁷ In order to completely remove the disease and prevent any recurrence, the keypoint of this proposal consisted in further

widening the isolation of the affected tissue, regardless of whether it was dorsal, septal, or circular.

To obtain this outcome, new technical knowledges in advanced penile surgery were gradually reached and popularized, such as the complete isolation of the dorsal neurovascular bundle and the cavernous-glandular disassembly, to be done in case of plaques extending to the corporal tips. The latter technique entailed the contemporary isolation of the dorsal neurovascular bundle and the urethra, so as to ensure trophism and functional recovery of the spongiosa and corpora cavernosa, even in case of plaques which extended all the way up to below the glans (Figure 2). This aggressive attitude was defined by the authors themselves as "extreme surgery," not free from complications, but with satisfactory results in a good number of cases. A great contribution to the technical step of "penile disassembly" was also given by Sava Perovic from Belgrade, whose results were later published on BJU.²⁸

In case of circumferential constriction of the cavernous bodies caused by the disease, the so called "ring plaque" or "hourglass shaped" sclerogenic deformity, the proposed solution involved a circular excision of the fibrotic ring (once completed the isolation of the dorsal neurovascular bundle and the urethra) and its subsequent substitution with a circular shaped dermal graft (Figure 3).

In the very serious cases of calcific plaques involving the intercavernosal septum, the Milan group even reached the point of proposing the radical removal of the septum,

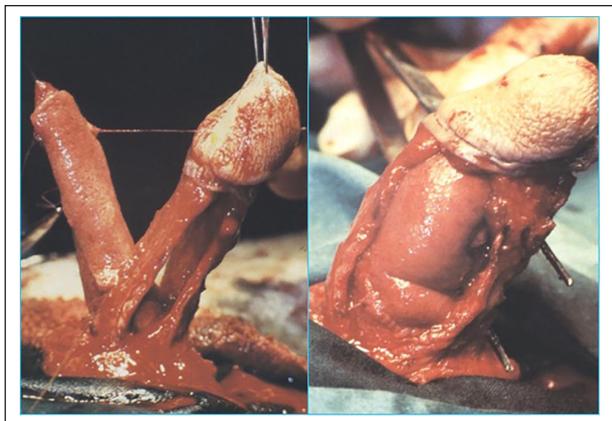


Figure 2. Penile disassembly—Austoni, 80s. The technique was based on the isolation of the dorsal neurovascular bundle and the urethra, so as to ensure trophism and functional recovery of the spongiosa and corpora cavernosa, even after the excision of plaques which extended all the way up to below the glans. This was an extreme surgery, which was not free from complications, but produced satisfactory results in a good number of cases.

with the subsequent need of rotating and approximating the two cavernous bodies.²⁹

The Austoni's experience in this field, started in 1981 and carried out throughout more than a decade, was finally summarized in 1993, at Sentara's international conference on PD (USA), and later on in Barcelona, provoking both emulation and criticism. Out of 619 patients, 537 underwent to plaque excision and dermal graft, whereas 82 penile prosthesis were implanted.

The overall results were noted to be associated with significant rates of complications, such as penile post-operative retraction or bend recurrence (27%) and erectile dysfunction (24%), despite surgery had been performed by highly skilled professionals with more than 10-year of experience in this surgical field.^{29,30}

Reproducing these results was even more difficult for those who approached this surgery with less experience, so that many colleagues, and finally the radical surgery fathers started to put to themselves the question of how to possibly modify indications and technical characteristics of the procedure.

Infact, the qualitative analysis of these complications has led by one side to the search for new grafts (less prone to retractions) and by the other side to a less aggressive surgery.

In this context, Gelbard proposed relaxation incisions of the albuginea at the end of the excision of the plaque in order to optimize the straightening³¹ and Tom Lue proposed the replacement of the dermis graft with the deep dorsal vein, suggesting a minimally invasive isolation of the neurovascular bundle (with the use of loupes).³²

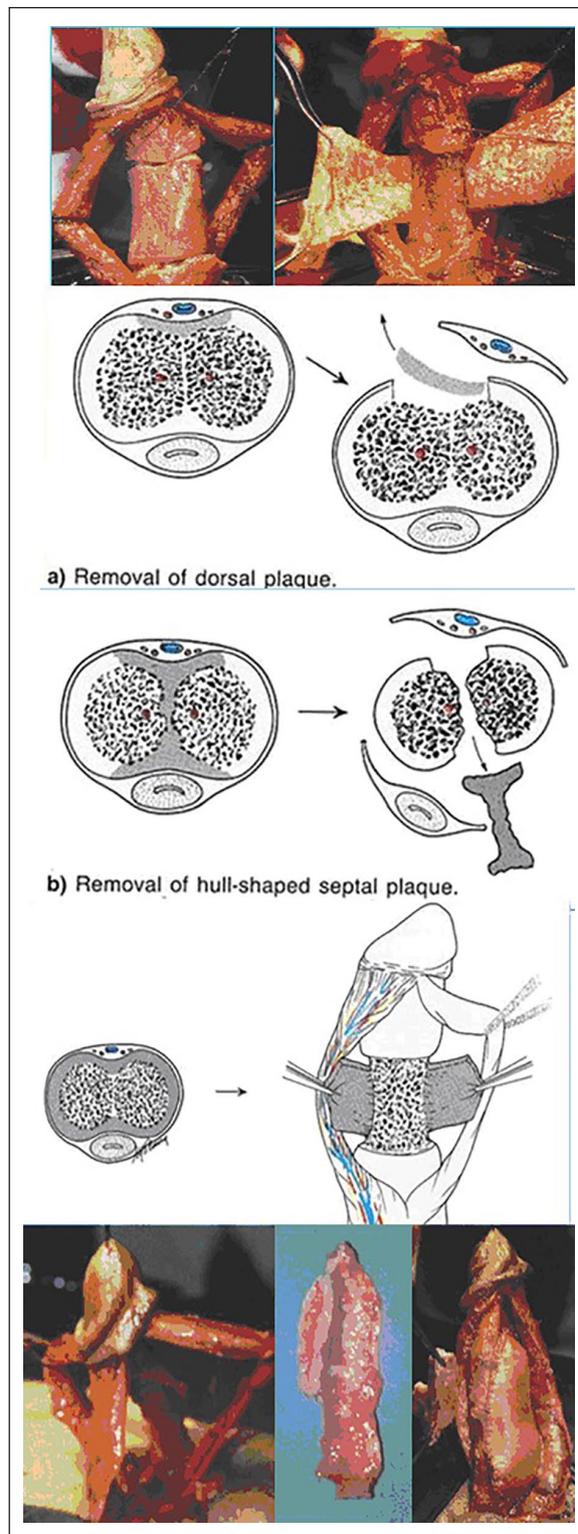


Figure 3. Penile disassembly—Austoni, 80s. In case of circumferential constriction due to the disease, the “ring plaques,” causing the so-called “hourglass” sclerogenic deformity, the proposed solution involved a circular excision of the fibrotic ring (once completed the isolation of both the dorsal neurovascular bundle and the urethra) and its subsequent substitution with a circular shaped dermal graft.

The evolution of plication techniques versus improvement of grafting strategies

In 1990, Yachia proposed an original evolution in the plication techniques, applying the Heineke-Mikulicz principles, consisting in the use of a horizontal suture for closing a longitudinal incision.³³ The Yachia procedure consists of one or more longitudinal incisions of the albuginea tunica on the convex side and its subsequent transverse closure with nonabsorbable stitching material. A 95% of success rate has been reported with a satisfaction rate between 79% and 95%.^{34,35}

On the other side, a real innovative step forward has been proposed in 2003, by Paulo Egydio from San Paulo (Brasil) who introduced some geometric concepts in PD surgery, allowing to planned the albuginea incision according to mathematic considerations.³⁶

In the same decade, continuous efforts were addressed to try to reduce the retraction of the graft and great interest have been pointed toward the postoperative care.

In 2013 Carson and Levine published a comprehensive review on this field, electing penile traction therapies as the gold-standard.³⁷

Traction exercises had to be applied for repeated session, daily, starting at 2–3 weeks post-operatively. In our experience, in case of non-prosthetic surgery, corporal massage and stretching should be performed twice daily, for at least 6 months, starting 2 weeks from operation.

In addition to this, the daily administration of PDE5i drugs was also highly recommended, starting 7–10 days after surgery.³⁷

A possible implant of penile prosthesis in patients with PD, has to be limited to those men who have concomitant ED, or when the extension and severity of the fibrotic disease would make the post-operative ED very likely.

The possible utilization of penile prosthesis implant, at the same time of corporoplasty, as well the so-called remodeling techniques, have been described since the 90s.^{38–40}

In this context, Austoni e Coll., in the first '90, proposed a strategic evolution, so called “functional surgery.” The Authors started from a simple consideration: the main drawback of the so-called “lengthening techniques” come from the fact that, regardless the different kind of material choosed as graft, it will take root during the first post-operative days, so adapting to the size of the flaccid penis: this will lead, ineluctably, to a subsequent resistance to the penis lengthening, at the moment in which the erection will resume.

The technique, whose outcomes were published by Austoni and Colombo in 2005,⁴¹ involves an atraumatic implantation of two prosthetic cylinders of a soft consistency and limited caliber (9–10 mm—named “tutors” from the Authors, Figure 4), followed by a single relaxing incision of the Tunica Albuginea with a single graft to cover the defect.

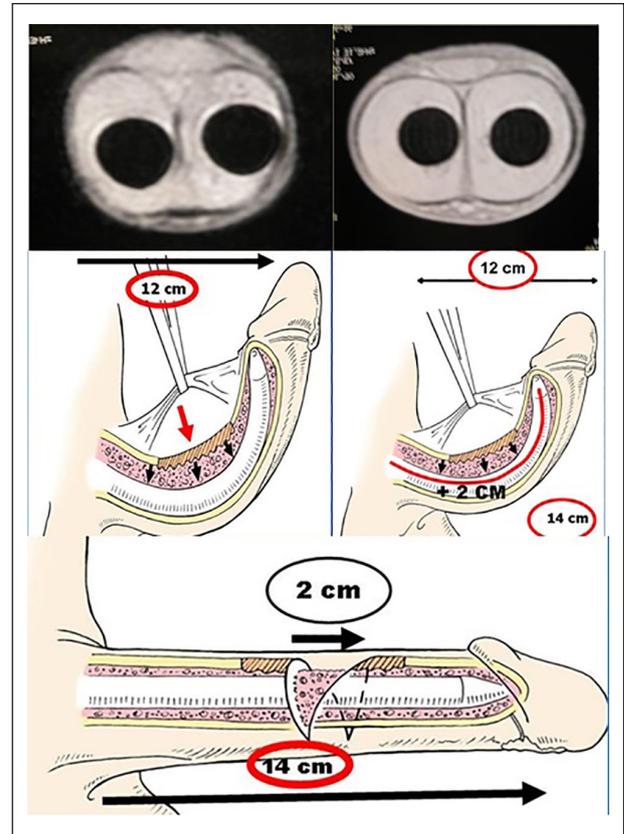


Figure 4. RMN showing \varnothing 10 Fr soft prosthesis Virilis I® (Giant medical, Cremona, Italy) in the corpora cavernosa still allow a sort of “complementary” erection.

Going into the details of the procedure, the first step of the Austoni’s procedure consists of the intracavernous placement of two cylinders of very soft consistency. The length of these “tutors” has to be regulated considering the long side of the cavernous bodies. At this point, the thrust exerted by the “tutors” will help the surgeon to choose the best strategy for the next steps.

As well, the specific characteristics of plaque will have a role in the decision toward the simple incision of the affected tunica albuginea or its excision. In fact, in case of too thick or hard plaque, a complete excision become unavoidable.

The main advantage of this technique is that the graft will successively take root in conditions of forced extension, without any risk of retraction. Obviously, with this technique the importance of the choosen graft decreases.

In the original paper describing a 145 patients cohort, the achieved penile lengthening was of 1.5 cm, in average. Ninety-six percent of patients expressed complete satisfaction, while four reported different degree of glans paresthesia.⁴¹ These outcomes were further confirmed by Zucchi et al. in 2013.⁴²

In the same years, Gholami and Lue introduced a further possible alternative to plications, the so called “16

knot technique” whose main advantage consisted in the absence of tension.⁴³

The authors reported a 96% satisfaction rate and a 93% of straightment rate in 116 patients.

In this series, the shortening rate was 41% and the estimated recurrence rate 15%.

The value of both schools of thought led to the compilation of guidelines by the European Association of Urology (EAU), not earlier than 2012.⁴⁴

Current aspects and future perspectives

More recently, Rolle et al. dedicated their efforts to treat the cases of “end-stage” PD, with severe penile shortening. They introduced a new lengthening surgical procedure based on a combined ventro-dorsal incision of the tunica albuginea, followed by a penile prosthesis implantation, and by a double dorsal-ventral grafting of porcine intestinal submucosa.⁴⁵

An average increase in length 3.2 cm was reported in the first three patients described. This technique was further investigated in 2016, whereas 28 patients were enrolled in a multicentric prospective studies.⁴⁶ Postoperative complications included profuse bleeding requiring a blood transfusion in one patient (3.5%) and PP infection requiring the removal of the device (7%); the mean penile lengthening obtained confirmed previous result while no patient reported recurrence of the curvature.

Additional PD management strategies were developed after the re-proposed infrapubic approach in three-piece inflatable penile prosthesis placement, described by Perito in 2008.⁴⁷ Although this technique has proven to be comparable to the classic penoscrotal incision in terms of patient safety and satisfaction,⁴⁸ an undeniable disadvantage is the impossibility of directly manipulating the fibrotic plaques.

A possible solution has been described by the Perito’s group in 2018 with the “scratch technique”⁴⁹ which consists in causing a plaque fracture from inside the cavernous body. Any penile curvature greater than 30°, penile hinge or hourglass aspect was addressed by the Author with the scratch technique.

Going into the details of the procedure, the first step consists in inducing an artificial erection to precisely evaluate the entity of penile curvature and the exact location of the plaque.

An 80 mm nasal speculum is introduced inside the cavernous body, then it is opened transversely to fracture the plaque along the *x*-axis. A scalpel blade *N* 12 is then used to incise the plaque internally, along the *z*-axis (longitudinally). The depth of the scratch further disrupts the plaque along the *y*-axis (thickness), completing the internal three-dimensional disruption of the plaque. At the end of the implant, any additionally manoeuvre is not required.

Vacuum therapy is indicated for 6 months post-operatively. In 145 patients, a less than 20° residual curvature was reported postoperatively, further decreased by vacuum

therapy. Even if complications were defined by authors as “negligible,” a 4.1% of infectious manifestations, 2% of prosthesis extrusion, and 25% of severe scrotal hematoma should be mentioned.

Surgical indications

Surgical treatment is indicated only in those patients who are unable to have sexual intercourse any more, for the penile deformity caused by the disease or as consequence of a pre-existent or concomitant erectile dysfunction. For these reasons, it is important to precisely evaluate the patient’s erectile function and verify the exact deformity of the penis, in state of maximal rigidity. Only once these two aspects are clearly established, the surgeon will be in condition to choose the right surgical technique. Surgery should not be considered, if the disease does not entail severe penile deformity and when sexual intercourses are still possible.⁵⁰ Moreover, according to European Association of Urology (EAU) Guidelines, the operation should be performed only after patient’s report of 4–6 months (at least) without pain.⁵¹ Preoperatively, it is of paramount importance to precisely assess the penile length (long and short side) and the degree of the curvature. In case of limited bending, less than 40°, plication procedures could be considered, because the resulting penile shortening should be not so relevant.⁵¹

In case of more acute angle of bending or when complex deformities are present (circumferential reduction, “hour-glass” deformity) the plaque incision/excision with grafting procedures seems to be the best choice.

If a concomitant ED is present, that is not responsive to a medical treatment, in case of mild curvature, a penile prosthesis implantation, per se, can offer satisfactory outcomes.

On the contrary, in case of ED with severe or complex penis deformities, different ancillary techniques can be utilized in association with the prosthesis implant: the simple manual modeling or plaque relaxing incision (with or without grafting) are feasible options, taking into account that in case of residual mild degree of curvature—less than 30°—no further treatment is recommended, as the prosthesis will act, in time, as a sort of inner expander, resulting in complete straightening of the penis after a few months of activation.⁵²

Current technical options for surgical treatment of Peyronies disease

Since the two currents of thought have survived to date, PD surgical techniques are still grossly divided into two groups:

- (1) Shortening procedures, acting on the convex uncontracted side, using an excision or a simple plication of the tunica;

Table 2. Indications for grafting techniques for Peyronie's disease and grafting materials.

Indications:			
- Penile deviation >60°			
- Short penis			
- Hourglass deformity			
- Satisfactory preoperative erectile function			
Autologous grafts	Allografts	Xenografts	Synthetic grafts
Dermis	Cadaveric pericardium	Porcine small intestinal submucosa	Gore-Tex®
Vein grafts	Cadaveric fascia lata	Bovine pericardium	Dacron®
Tunica albuginea	Cadaveric dura matter	Porcine dermis	Collagen fleece (TachoSil®)
Tunica vaginalis	Cadaveric dermis		
Temporalis fascia			
Buccal mucosa			

- (2) Plaque surgery, that works on the concave contracted side, with incisions or excision of the affected tissue, followed or not by a covering graft.

Regardless of the procedure adopted, if patient also presents an impaired erection, a penile prosthesis implant has to be comprised in the procedure.

The choice of the more suitable kind of implant (soft—malleable—inflatable) will be conditioned by the different severity of the dysfunction.

If complex penile deformities are the case, the association of two or more different techniques can be required to provide the expected surgical outcome.

Shortening techniques

Are indicated for men with good erectile capacity, a simple deformation (curvature) of less than 40°, with a penis of sufficient length.

Nesbit technique: The procedure entails the excision of an ellipse of tunica albuginea taken from the convex side of the cavernous body and its closure with a transversal suture. Published data witness satisfactory outcomes with a straightening rate ranging from 79% to 100%. Patient's satisfaction range from 67% to 100%. The post-operative shortening from 17.4% to 100%.^{53,54}

Ralph et al., from London, published results of 16 years experience on 359 patients. The shortening was almost systematic but only six (1.6%) patients reported difficulty penetrating. A minimum of 13 cm in length on the concave side during erection was the requested criterium to benefit from this technique. The hospital readmission rate for suture releases was 13%.⁵⁵

Fontana's modification of Nesbit technique: In 2005 the Turin's group proposed a modification of the Nesbit technique, easy to perform also for unexperienced surgeons, and involving plication suture of the convex aspect of the penis, performed prior that resection of the tunica albuginea has

been initiated. This proposal had the aim to offer the possibility of performing tunica albuginea excision only after the real-time confirmation of the result obtained. In this paper only 6% of operated patients resulted unsatisfied.⁵⁶

Yachia's technique: Consists of one or more longitudinal incisions of the tunica albuginea on the convex side followed by their transverse closures with non absorbable sutures.^{33–35}

Other proposals:

Essed-Schroeder procedure²⁶ is a fast and simple technique, consisting in the realization of introflect sutures on the convex side of the tunica albuginea. This procedure seems to be penalized by significant recurrence rates.

16-knot technique, also known as “plication without tension” has been proposed by Gholami and Lue.⁴³ The authors reported a 96% satisfaction rate and a 93% of straightment rate in 116 patients. In this series, the shortening rate was 41% and the recurrence rate estimated at 15%.

Plaque surgery

Indicated for men with good erectile capacity, affected by complex deformity (“hourglass shape,” tunical profile hinge, etc) or by normal curvature, but greater than 60°. An insufficient penile length can represent other indication for this kind of surgery which entails incision or excision of the plaque and can require the use of grafting procedures to cover the albugineal defect.

Indications for this procedures and available materials for grafting are reported in Table 2.

Synthetic grafting materials like polytetrafluoroethylene (Gore-Tex®/Teflon®, Gore Inc., Flagstaff, AZ, USA) or polyethylene terephthalate (Dacron®, DuPont, Wilmington, DE, USA) were widely used in the past. However, all these materials demonstrated high risk of infection, acute inflammatory response, fibrosis, rejection, contracture due to inelasticity of the material; for all these reasons, these materials are not recommended any more.⁵⁷

At present days, two different kind of grafting materials are used:

- Autologous materials (e.g. saphenous vein, buccal mucosa, others)
- Non-autologous materials (allografts/xenografts)

The use of autologous grafts needs a second incision to perform the tissue harvesting with greater morbidity, prolonged operative time, and related complications possibility. For this reason a growing interest toward the non-autologous grafts has arisen. Many materials have been tested but none allowed to reproduce the biomechanical characteristics of the albuginea.⁵⁸

The perfect material for grafting is still far to come. To date, no single available graft has proven to be the “golden standard” for the tunical substitution.

The requirements for the “ideal” graft for PD reconstructive surgery should include: availability, resistance to infection, lack of contraction, promotes hemostasis, preserve erectile capacity, be cost-effective, and should not prolong operative time.

Grafts can be used in a context of plaque radical excision, partial excision, or simple plaque incision. The total plaque excision is nowadays less used by most of us in favor of the incisions that are considered as mini-invasive. However, in case of advanced disease, with calcified plaque, its complete excision is still mandatory.

Autologous grafts: Several series have reported excellent results with the use of an autologous venous graft in the first 12 months with a 90% satisfaction rate and a 59%–96% restraightening rate.^{59,60} On the other hand, long-term results were disappointing. In this context, Kalsi et al. reported a significant decrease in patient satisfaction after 5 years at the onset of erectile dysfunction (22.5%) or shortening (35%).⁶¹ In addition to this, buccal mucosa has been proposed as easy to perform with a patient satisfaction rate of 85%.⁶²

Synthetic grafts: The graft with synthetic tissues such as Goretex or Dacron has proven its effectiveness in the event of associated penile implantation. However, their inextensibility and their risk of infection must make them prefer synthetic biomaterials such as the submucosa of the pig’s intestine.⁶³ In fact, out of 162 patients with an average follow-up of 38 months, 148 (91%) had a correction of their curvature with 79% of normal erectile function. No shortening, pain, or rejection has been reported.⁶³

Allograft or xenograft materials

To this class belong several patches such as cadaveric or bovine pericardium, engineered dermal graft, porcine small intestinal submucosa (SIS), equine collagen fleece.^{64–66} These acellular matrices allow regenerative ingrowth of native tissues. The main advantage of allograft

tissues is elimination of the need for tissue harvesting. Staerman et al. reported on their experience with SIS grafting following plaque incision a penile straightening achieved in 79% of patients, while 25% of patients experienced penile shortening, and postoperative ED was 11%, with a recurrence of curvature occurred in 33% of patients.⁶⁷

Moreover, TachoSil® has been recently introduced. TachoSil® is a collagen fleece based on equine collagen that contains human fibrinogen and thrombin. Once the TachoSil® gets in contact with fluid like water or blood, it becomes a tissue sealant. Because of these self-adhesive properties, the TachoSil® does not need to be sewn into the tunical defect after plaque incision/partial plaque excision. Thus, operative times are obviously reduced. Of note, the active side of the TachoSil® is marked yellow with riboflavin. Moreover, the TachoSil® has to overlap the edges of the tunical defect at all sides of at least 5–10 mm to attach to the tunica and provide a watertight closure.⁶⁸

Penile prosthesis

Penile implants are intended to give sufficient rigidity to penetration and are indicated in severe forms of PD with organic ED that do not respond to medical treatment. Inflatable penile implants are preferred over semi-rigid implants. The team of Montorsi et al. reported a 52% dissatisfaction rate after using semi-rigid implants.³⁸ On the other hand, the Chaudhary et al. published a 93% satisfaction rate with inflatable implants.⁶⁹ Wilson has described and popularized the “modeling maneuver” consisting of intraoperative manual “fracture” of the plaque performed at the end of the prosthetic implantation. This “trick,” when effective, can avoid the need of corporoplasty, making the operation time notably quicker. Data from the literature show that implants allow good results to be obtained in a very large majority of cases, provided that their indication is appropriate.

Soft penile prosthesis—Austoni technique. The placement of Ø 10 Fr soft prosthesis Virilis I® (Giant medical, Cremona, Italy) in the corpora cavernosa still allow an easier localization of point of traction to be incised and guarantees the maintenance of the graft in condition of extension during the post-operative period, avoiding any risk of retraction. With these devices, a sort of “complementary” erection is still feasible, thanks to the using the residual cavernous tissue which has not been destroyed but only peripherally displaced and greatly spared.⁴¹

Personal experience

To our centre, from 2010 to 2019, 63 patients with PD underwent corporoplasty with plaque incision/excision at single tertiary center, using two different xenografts:

porcine acellular collagen matrix (25 patients—Group 1) and bovine pericardium collagen matrix (38 patients—Group 2).⁷⁰ For long-term evaluation of surgical outcomes multi-disciplinary questionnaires were administered, by phone interview, performed by the same physician. Overall, 53 patients completed the follow up (19 in Group 1 and 34 in Group 2). The following items were considered: correction of penile bending, quality of erection, ability to intercourse, penile shortening, sensitiveness. The overall satisfaction and the impact of the intervention on the sexual activity and quality of life were also investigated. As a result, the two groups were homogeneous in terms of co-morbidity and types of curvature. Ultrasound plaque median size was 27.5 mm (Group 1) and 31 mm (Group 2). Whereas no patient complained significant pre-operative ED, we found significant de novo impotence (overall value <17 of the International Index of Erectile Function—IIEF-5) in 37.7% of patients (p value 0.4). Complete straightening of the penis was obtained in 73.7% (Group 1) and 76.5% (Group 2). Penile shortening occurred in 15 patients in Group 1 (78.9%) and in 27 in Group 2 (79.4%) ($p=0.8$). Four major short-term complications were observed: two infections, one bleeding and ischemia of the glans. Patients' post-operative sexual life was reported as improved in 47.4% of cases in Group 1 and in 47.1% of cases in Group 2, unchanged in 9 patients in Group 1 (47.4%) and in 10 patients in G2 (29.4%), worsened in 1 patient in Group 1 (5.3%) and in 8 patients in G2 (23.5%). In summary, no statistically significant differences were found between porcine acellular collagen matrix and bovine pericardium collagen matrix, in terms of surgical outcomes and overall patients' satisfaction.

In the same period of time, we also surgically treated 48 patients who had a moderate degree of ED associated with PD. These patients underwent corporoplasty according to the Austoni technique. A bovine pericardium collagen matrix graft was most commonly used in 50% of cases, followed by porcine acellular collagen matrix patch or Tachosil used in 29.2% and 10.4% of patients, respectively. The retrospective review of the surgical outcomes testifies to an optimal general satisfaction with almost the whole cohort would repeat the surgery, with an improved or stabilized penetration capacity in 82.3% of the cases.

In 14 men with PD and severe ED, we preferred to implant inflatable penile prostheses with plaque incision followed (11) or not (3) by a covering graft.

Conclusion

Peyronie' disease is a pathology of uncertain etiology. The careful investigation of different domains, such as the preserved ability to have penetrative sexual intercourse, the contemporary presence of ED, the length of the penis, the stability of the disease, is of fundamental clinical importance for a right surgical indication.

To date, a unique “gold standard surgical procedure” is still to be found and the right choice among many different techniques should be specifically tailored, based on the pre-operative aspects of any single patient.

The recently updated European Guidelines can help all of us to grossly orientate in the challenging task of suggesting the right surgical treatment to our patient.

The proposed algorithm has now correctly abandoned the previous rigid correlation between the angle of the penile curvature and the surgical technique to be used, and greater importance was recognized to the holistic approach in the evaluation of each individual patient.

Surgeon experience, kind and degree of penile acquired deformity, as well as patient preference will definitely impact the final surgical outcomes.

Author contributions

Conceptualization: F.C., F.P. Data curation: A.Fi., A.Fr. Formal analysis: A.Fi., M.D. Investigation: F.P., G.G., M.D. Methodology: F.P., F.C. Supervision: F.C. Validation: F.C., A.Fr., G.G. Writing—original draft: F.P. Writing—review and editing: F.P., F.C., A.Fr.

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