

Surgical Management of Peyronie's Disease With Co-Existent Erectile Dysfunction



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ABSTRACT

Introduction: Surgical intervention in Peyronie's disease (PD) should ideally be delayed until the resolution of acute inflammatory phase.

Aim: The objective of this review was to highlight the results of penile prosthesis to correct refractory erectile dysfunction (ED) in patients with PD, and the secondary procedures that may be required to correct the penile curvature.

Methods: A systematic search on PubMed online database using Preferred Reporting Items for Systematic Reviews and Meta-Analyses recommendations was done using the MeSH terms "Peyronie's disease" and "erectile dysfunction."

Main Outcome Measure: Success and satisfaction rates of various procedures.

Results: The search yielded 324 language-specific (English and Spanish language) articles and 58 articles were retained for final review. The following variables were assessed in different studies: number of patients, types of secondary procedure to correct the curvature, satisfaction rates, and follow-up period.

Conclusion: The aim of the surgery in PD should be to achieve a functionally straight penis (<20 degree curvature) with good erection. Patients with refractory ED in PD are candidates for penile prosthesis. Secondary procedures, like manual modeling, plication, plaque incision, or excision grafting, may be required depending on the degree of penile curvature and penile length. In quest for the best graft, TachoSil graft seems to have gained popularity in Europe. **Krishnappa P, Fernandez-Pascual E, Carballido J, et al. Surgical Management of Peyronie's Disease With Co-Existent Erectile Dysfunction. Sex Med 2019;7:361–370.**

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Key Words: Peyronie's Disease; Erectile Dysfunction; Penile Prosthesis; Grafts; Penile Induration

INTRODUCTION

Peyronie's disease (PD) is a connective tissue disorder, characterized by the presence of fibrotic plaque within the tunica albuginea, leading to penile deformity.¹

There have been varying prevalence rates among different countries ranging from 0.6–11%.^{2–4} The prevalence rates could be underestimated due to under-reporting, as most men are hesitant/reluctant to discuss this clinical problem.

The exact etiology of PD is less known. The majority experience disease progression (30–50%) or stabilization (47–67%), and spontaneous resolution of PD (3–13%) in very few.¹

PD has 2 stages: acute and chronic (stable) phases. The acute phase is associated with pain and probable progression of penile curvature, during which no surgical treatment is usually attempted. The chronic (stable) phase usually starts 6–12 months later, which is characterized by stable penile curvature and absence of pain.

Without any intervention, the natural history of PD has been best described by Mulhall et al.⁵ Of the 246 men within 5 months of PD onset, the curvature had improved in 12%, remained stable in 40%, and worsened in 48% at a follow-up of

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18 +/- 7 months. Erectile dysfunction (ED) was present in 20–50% of men with PD from a baseline of 32%.

Penile prosthesis (PP) becomes the standard management in patients with PD and co-existent ED. Additional procedures, such as manual modeling, tunical plication, plaque incision, or excision grafting, may be needed depending on the degree of penile curvature. This review article summarizes the various modalities of management of curvature and ED in patients with PD.

MATERIALS AND METHODS

Our study did not require an ethical board approval because it did not contain human or animal trials.

Search Strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses⁶ recommendations were used to frame the study design and to derive results from this review. A systematic literature search was done in the electronic database PubMed using MeSH terms “Peyronie’s disease” and “erectile dysfunction” to obtain relevant literature on PD. A total of 346 articles were identified.

Inclusion Criteria, Data Extraction, and Analysis

2 authors (P.K. and E.F.P.) scrutinized the titles and abstracts of each citation to select eligible studies. The remaining co-authors were approached if there was a need to clarify any discrepancies between the authors (P.K. and E.F.P.). Only English and Spanish articles, which amounted to a total of 324, were retained and the rest were excluded. The 324 language-specific articles were further scrutinized to meet the following inclusion criteria: (i) articles should have had both PD and co-existent ED; (ii) adequate details about the surgical technique, primary/secondary outcomes, complications, types of grafts and penile prosthesis; and (iii) access to full text of the study.

52 articles fulfilled these criteria. After scrutinizing the reference lists of these 52 articles, 6 more articles from the reference list were included, which amounted to a total of 58 articles for final evaluation. The algorithm for the article selection is shown in Figure 1.

RESULTS

Basic Evaluation

The common presenting symptoms of a patient with PD are pain in the penis, change in the penile curvature, palpable plaque, or ED. The Peyronie’s Disease Questionnaire is validated for use in clinical practice.⁷

The penile curvature with an erection can be documented by a self-photography at home during a natural erection or an intracavernous injection using vasoactive agents. The International

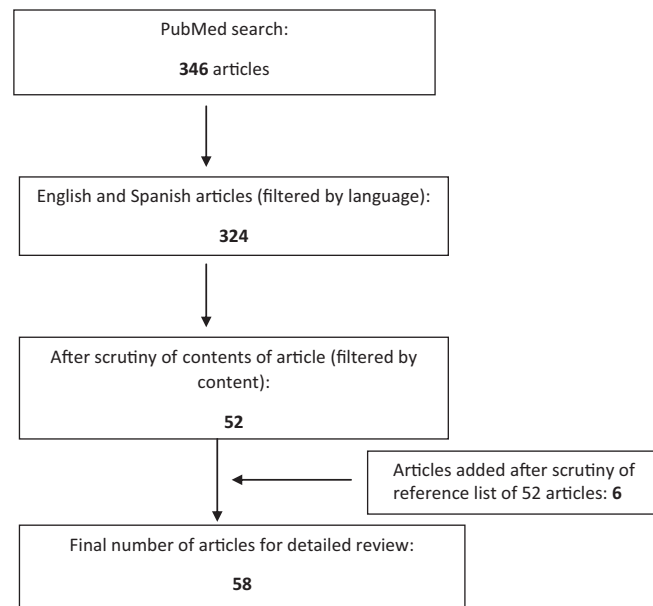


Figure 1. Algorithm for the selection of articles for review.

Index of Erectile Function (IIEF) score can be used to assess the erectile function, but this is not validated in patients with PD.⁸

Although Doppler ultrasonography is being used traditionally to assess the vascular parameters of ED, its role in documenting plaque details in PD is still evolving. A recent Spanish study⁹ used ultrasound predictive factors, such as absence of septum involvement, absence of calcifications, and plaque measurements, to assess the success of collagenase clostridium histolyticum injection therapy in PD.

Surgery for Combined PD and ED

The initial management of patients with PD and co-existent ED is usually medical therapy. If the penile curvature is not hindering sexual intercourse, then phosphodiesterase type 5 inhibitors (sildenafil, tadalafil, avanafil, verdanafil, and udenafil) form the first line of management, followed by intracavernous injection of vasoactive agents (alprostadil, papaverine, phentolamine, and vasoactive intestinal peptide) either alone or in combination as the second-line treatment.

Vacuum devices are used to reduce penile deformity and ED, and may have a potential role in curvature correction before PP placement in PD.¹⁰

For patients with PD and co-existent ED who do not respond to nonoperative management, the consensus is to proceed with insertion of a PP.¹¹ The International Consultation on Sexual Medicine¹² recommends performing adjunctive straightening maneuvers, such as modeling, plication and corporoplasty, or grafting, during PP insertion in patients with PD and co-existent ED. The European Association of Urology (EAU) guidelines also has a “strong” recommendation for PP implantation in patients with PD with refractory ED, with or without additional procedures.¹

The aim of surgery is to correct penile curvature and ED thereby permitting satisfactory intercourse. The same applies for patients with ventral PD and significant co-existent ED.¹³

Timing of Surgery

Although there are personal differences among urologists about the timing of surgery, the EAU and American Urological Association (AUA) guidelines recommend that surgery be performed after 3 months of stable curvature or after 12 months from the onset of symptoms.^{1,11} A worldwide online survey by Chung et al¹⁴ revealed that a waiting period of 6 months of stable curvature is preferred by most surgeons, although higher-volume surgeons preferred to perform surgery sooner.

There is no single surgical procedure suitable for all cases of PD. A detailed counseling about the surgery and the possibility of additional intra-operative maneuvers has to be explained. The possible risks of loss of penile length, persistent or recurrent curvature, and/or reduced sexual sensation should be discussed with patients. Patient's realistic expectations are crucial for a successful postoperative outcome.¹⁵

PP

PP has been the mainstay of the surgical management of PD with ED, which is not responding to conservative treatment. Levine et al¹² rightly pointed out that the option of PP should be offered at the first visit and not always be reserved as a last option, depending on the co-existent conditions and the patient's goals.

There are differing views about the use of malleable vs inflatable PP in PD. The AUA 2015 guidelines¹¹ mentions the use of the inflatable penile prosthesis (IPP) in PD, but this recommendation is only an "expert opinion."

Comparing the 2 different IPPs, Chung et al¹⁶ noted that mechanical survival was marginally better (91% vs 87%) with AMS 700 CX (Boston Scientific, Marlborough, MA, USA) than Coloplast Titan (Coloplast, Minneapolis, MN, USA) with no statistical significance. Both IPPs provided similar clinical outcomes and patient satisfaction in men with PD and co-existent ED.

A multicentric study¹⁷ involving 166 men evaluated no significant difference in satisfaction and complication rates between the malleable penile prosthesis (MPP) and IPP groups. 136 patients received MPP and the remaining 30 received IPP. 94% of patients with MPP and 83.3% patients with IPP had resolution of their curvature at the end of the operation. Residual curvature was present in 6% of the patients with MPP and 16.7% with IPP with no statistical significance.

Penile Fibrosis in PD

Although the dilatation of the corpora is not cumbersome in the vast majority of cases in PD, one may encounter corporal fibrosis in patients with dense plaques and, thus, becomes a real

surgical challenge. To minimize the complications and improve outcomes, the surgeon should be aware of the several techniques and surgical strategies to manage corporal fibrosis in PD.¹⁸ When dilatation is difficult due to severe corporal fibrosis, surgical dilators, such as the Rossello cavernotomes and Otis urethrotome may be needed.¹⁹

The incidence of corporal fibrosis in PD is variable. 51.2% patients with PD had corporal fibrosis in the 2018 PROPPER study and most patients received the AMS 700 CX cylinder (45.6%) or AMS 700 LGX cylinder (42.8%).²⁰ The study also suggested improvements in depressive symptoms with the majority having good satisfaction rates at 1- and 2-year follow-ups.

RESIDUAL CURVATURE CORRECTION AFTER PP

Manual Modeling

Wilson and Delk²¹ first described manual modeling (MM) over the PP in 1994. Although urethral perforation was noted in 4 patients, this maneuver resulted in a straight, rigid erection in 118 patients (86%). This technique of cracking the plaque using the rigid cylinder as a fulcrum initially received a lot of criticism, but, subsequently, the implant surgeons gradually accepted this technique.

Indication for MM

MM is indicated if the residual curvature is >30 degrees after the PP implantation. If <30 degrees, then no further treatment is required, because the repeated cycling of IPP may lead to gradual improvement in penile curvature in the coming months.²²

Technique of MM

Depending on the pre-operative curvature, an additional straightening maneuver is usually needed in 19–42% of patients with PD after cylinder placement.²³ In the recent worldwide online survey, 50% of patients with PD required MM.¹⁴

Procedural Steps of MM after IPP

1. After placing the cylinders, the corporotomy incisions are closed and the IPP is inflated.
2. To protect the pump from high-pressure damage, the tube connecting the pump and the cylinders should be temporarily blocked with rubber-shod mosquito forceps (1 click).
3. Stabilize (hold firmly) the base of the penis to prevent the rupture at the corporotomy site.
4. MM is now performed by bending the IPP in the opposite direction to the curvature for 60–90 seconds.
5. Avoid excessive pressure on the glans penis to prevent urethral erosion by the cylinder tip.
6. The clamped mosquito forceps are then removed to deflate the cylinder.
7. The IPP is again re-inflated at 80% of the maximum capacity to check for straightness and proper positioning of cylinders.
8. If there is persistence of significant curvature, a second attempt of MM can be done for another 90 seconds.
9. MM of more than 2 sessions is not advised.

Although MM can be done on both MPP and IPP, Garaffa et al²³ reported that a 3-piece IPP offered a robust support for MM than an MPP. Adequate straightening with MM was achieved in 89.6% of cases with a 3-piece IPP compared to 53.8% with an MPP in 209 patients with PD and refractory ED.

The results of various studies on MM have been summarized in Table 1.^{16,21,23–28}

PP + Plication

If there is persistence of a 30–40 degree curvature after MM in a patient with adequate penile length and no hour-glass deformity, then plication can be attempted to improve the residual curvature.²⁹ Nesbit's plication involved excising a strip of the plaque containing tunica albuginea and subsequent reapproximation of the tunical edges, whereas the less invasive Essed-Schroeder technique involved plication without any tunical incision.³⁰ The 16/24-dot technique is a modification of Essed-Schroeder plication involving application of 2 (16 dots) or 3 (24 dots) pairs of plications depending on the degree of curvature.³¹

Although a small sample size, Chung et al³² retrospectively reviewed their results of 18 patients who underwent IPP with simultaneous penile plication. Each suture achieving a correction of 8 degrees, median of 4 plication sutures (range 3–6) were placed and an IPP was inserted through the same penoscrotal incision. There was significant improvement in curvature from 39 degrees (range 30–60) to <5 degrees after plication and IPP.

PP + Incision /Excision of Plaque With Grafts

Penile curvatures >60 degrees, ventral curvature, large dorsal plaques, and the presence of residual curvature (>30 degree) following MM and tunical incision are the indications for concomitant use of both IPP and grafts.³³ To prevent cylinder herniation or curvature recurrence due to scar contracture, grafting is usually recommended when the tunical incisional defect is larger than 2 cm.²⁹

There are 3 approaches: i) combined peno-scrotal incision for PP placement and degloving circumcoronal penile incision for plication or grafting; ii) circumcoronal penile degloving incision alone; or iii) penoscrotal incision with the penile inversion technique.

The different grafts have been mentioned in Table 2. Although many grafts have been used for the curvature correction in PD after placement of PP, only few are currently used by the experts and the same has been detailed below.

Dermis Xenograft +PP

Perovic and Djinovic³⁴ observed 95% overall patient satisfaction rate in 98 patients who underwent Intexen LP (AMS, Minneapolis, MN, USA), a lyophilized porcine collagen dermal matrix graft. PP implantation was done along with the Intexen

LP in 37 of 98 patients (38%). Mean penile length gain with PP was 3.2 cm (2–4.5 cm). Infection occurred only in 1 patient with PP.

Sansalone et al,³⁵ in their series of 20 patients, had 18 patients (90%) who were satisfied with the cosmetic and functional result following simultaneous PP insertion and Intexen graft, at an average follow-up of 22 months. 4 patients (20%) had diminished glans sensation and 3 (15%) had residual dorsal curvature of <15 degrees.

Vein Graft + PP

Lue and El-Sakka³⁶ and El-Sakka et al³⁷ first described the venous graft (saphenous vein) technique without PP in 1998. They reported straightening of penis in 96% of patients and overall satisfaction rate of 92%. Montorsi et al³⁸ endorsed using the saphenous vein from the upper thigh region considering the larger diameter of the vein and devoid of saphenous nerves, decreasing improving results and decreasing complications.

Austoni et al³⁹ reported gain in penile length by 1.5 cm with combined vein graft and PP in 114 patients who were available for follow-up. 76 of the 80 patients expressed complete satisfaction on the questionnaire. Using the Virilis PP, Silvani et al⁴⁰ published long-term outcomes of 46 patients with saphenous vein graft and 12 patients with bovine pericardial collagen patch. At 12–36 months follow-up, gain in penile length from 1.2–2.3 cm with complete correction of penile curvature in all the patients were noted, and 75% of patients reported “excellent” penetrative sexual intercourse.

Venous grafts are compatible with cavernosal tissue because of neovascularization. However, there is significant donor wound morbidity and added operative time in graft extraction.

Pericardial Graft + PP

Tutoplast (Coloplast, Minneapolis, MN, USA) is a processed human pericardial graft, which is widely available now, as it is being used in other surgical specialties like ophthalmology and cardiothoracic surgery. In 2000, Hellstrom and Reddy⁴¹ published the use of Tutoplast in 11 patients with PD. PP was simultaneously placed in 3 of 11 patients. Penile curvature resolved in all patients, facilitating normal sexual intercourse at a mean follow-up of 14 months. No postoperative evidence of tissue rejection or infection was noted.

Egydio et al⁴² pioneered the use of bovine pericardial grafts (Braile Biomedica, Sao Paulo, Brazil) and geometric principles of the Egydio technique along with PP in all 105 patients, and noted an overall satisfaction rate of 89.4%. One patient developed wound infection due to the PP, which had to be explanted. 104 patients (99%) were able to have sexual intercourse at a mean follow-up of 18.2 months.

Pericardial grafts have very good traction resistance, adaptability, good host tolerance, and devoid of added donor site morbidity.⁴³

Table 1. Success rates of manual modeling

Author	Year of Publication	No. of patients	Penile prosthesis	Success rates (%)
Wilson and Delk ²¹	1994	138	AMS 700 CX	86
Montague et al ²⁴	1996	34	AMS 700 CX	100
		38	AMS 700 Ultrex	73.6
Usta et al ²⁵	2003	42	AMS 700 CX	93.5
Chaudhary et al ²⁶	2005	28	AMS 700 CX	100
Levine et al ²⁷	2010	90	AMS CX 700, Titan, Ambicor, Alpha I	79
Garaffa et al ²³	2011	129	AMS 700 CX, Titan	84
		80	AMS 600, Genesis	54
Chung et al ¹⁶	2013	138	AMS 700 CX, Titan	92
Yafi et al ²⁸	2016	19	AMS 700 CX, Titan	94.7

Small Intestinal Submucosa Graft + PP

A multicentric study by Rolle et al⁴⁴ reported a 95% patient satisfaction rate in a total of 28 patients who underwent the sliding technique and grafting with concomitant PP. The grafts used were porcine small intestinal submucosa (SIS) Surgisis (Cook Medical, Bloomington, IN, USA), acellular porcine dermal matrix Pelvicol (CR Bard, Covington, GA, USA), or collagen fleece TachoSil (Baxter Healthcare, Deerfield, IL, USA); the majority being SIS in 19 patients (67.8%). The mean gain in penile length was 3.2 cm and none noted recurrence of the curvature.

It is recommended to oversize the SIS graft by 30% compared with the defect to minimize shrinkage and subsequent curvature recurrence.⁴⁵ The SIS graft has been the most commonly used graft due to its easy global availability, comfortable surgical handling, and no significant adverse reactions.⁴⁶

TachoSil + PP

TachoSil (Baxter Healthcare, Deerfield, IL, USA) is a collagen-fleece composed of human fibrinogen and human thrombin coated onto an equine collagen sponge.⁴⁷ Although the 2018 EAU guidelines¹ classify TachoSil under synthetic grafts, it would be ideal to consider it as a xenograft as the collagen is of equine origin. It is cost-effective, simple-to-use, and has an added hemostatic effect.

Hatzichristodoulou et al⁴⁸ popularized the TachoSil graft for curvature correction in PD in 2013. In his recent paper in 2018 using the Coloplast Titan Touch IPP and the TachoSil in 15 patients, he observed 80% of the patients having no curvature and the remaining 20% had residual curvature of 10 degrees at follow-up. None had any immediate or long-term complications.⁴⁸

In their recent study, Falcone et al⁴⁹ compared the TachoSil with the porcine SIS graft (Cook Medical, Bloomington, IN, USA) in 60 patients with PD who underwent simultaneous IPP implantation. The TachoSil group required shorter operative time and the cost was less than the SIS, with no other significant difference in clinical outcomes.

Pascual et al's⁵⁰ experience with the TachoSil in 22 patients was found to have good short-term results. The mean post-operative curvature was 11.5 degrees. 5 patients had hematoma, which was managed conservatively. 18 of 22 patients showed good penetrative sexual intercourse with/without phosphodiesterase type 5 inhibitors. Median time to return for sexual activity was 5 weeks.

Although the SIS and TachoSil patches are being used more extensively and with good results currently, there are still no long-term follow-up studies. A 5–10 mm overlap of the tunical defect is sufficient for the TachoSil considering the minimal risk of its contracture unlike the SIS graft. Once commonly used synthetic grafts, such as polytetrafluoroethylene Gore-Tex (Gore, Flagstaff, AZ, USA) and polyethylene terephthalate Dacron (DuPont, Wilmington, DE, USA), have been

Table 2. Types of grafts

Autologous grafts	Dermis
	Vein grafts
	Tunica albuginea
	Tunica vaginalis
	Temporalis fascia
	Buccal mucosa
Allografts	Cadaveric pericardium
	Cadaveric fascia lata
	Cadaveric dura matter
	Cadaveric dermis
Xenografts	Porcine small intestinal submucosa
	Bovine pericardium
	Porcine dermis
	Equine Collagen fleece (TachoSil)
Synthetic grafts	Gore-Tex
	Dacron

Table 3. Combined grafting and penile prosthesis results

Authors	Year of publication	No. of patients	Penile prosthesis	Graft	Success/satisfaction rates (%)
Austoni et al ³⁹	2004	80	Soft, axially rigid implants	Saphenous vein	95
Pathak et al ⁵⁷	2005	15	IPP	Autologous rectus fascia graft	100
Kadioglu et al ⁵²	2008	20	IPP	Autologous rectus fascia graft	95
Perovic and Djinovic ³⁴	2010	37	Malleable and IPP	Porcine collagen dermal matrix graft (InteXen)	95
Silvani et al ³⁹	2012	58	7 F Virilis II, 7 F Virilis I, 10 F Virilis I, 9.5 F SSDA prosthesis	Saphenous vein graft, bovine pericardial graft	95
Sansalone et al ³⁵	2012	20	AMS 700 CX, Coloplast Titan, AMS Ambicor	InteXen	90
Zucchi et al ⁵⁸	2013	60	Virilis LH axial prostheses (Ø 7 Fr.)	Bovine pericardium (Hydrix)	80
Egydio et al ⁴²	2013	105	AMS 700 CX, AMS Ambicor, Coloplast Titan, AMS 650, Coloplast Genesis	Bovine pericardial graft	95
Rolle et al ⁴⁴	2016	28	AMS Spectra, Coloplast Genesis, AMS 700 CX, Coloplast Titan OTR	Porcine SIS (Surgisis), porcine dermal matrix (Pelvicol), (TachoSil)	95
Fang et al ⁵⁹	2018	7	Coloplast Titan, Genesis	Type of graft not mentioned	86
Hatzichristodoulou ⁴⁸	2018	15	Coloplast Titan	TachoSil	80

AMS = American Medical Systems; IPP = inflatable penile prosthesis; SIS = small intestinal submucosa.

abandoned now because of the risks of infection and eventual contracture.⁵¹

Some of the series where simultaneous PP and grafting were done have been documented in Table 3.^{34,35,40,42,44,52,57–59} There was neither uniformity nor a common criterion in assessing the satisfaction rates in each study. The satisfaction rates have been simply taken from what was mentioned in the studies.

In the recently concluded 2018 worldwide online survey,¹⁴ approximately one-third of Sexual Medicine Society of North America and European Society of Sexual Medicine (ESSM) members preferred allograft pericardium and SIS grafts, whereas 40% of Asia Pacific Society for Sexual Medicine members continued to perform autologous vein graft surgery.

Kadioglu et al⁵² published their results of a group of 150 patients who underwent surgery for PD. Curvature correction was achieved with PP only, MM, plaque incision, and grafting (autologous rectus fascia in the majority), incision of the plaque, and tunical plication in 35%, 30%, 33.3%, 1.6%, and 1.6%, respectively.

Each grafting material has its own advantages and drawbacks in terms of availability, antigenicity, and cost-effectiveness.

The concise algorithm for surgical correction of PD with co-existent ED is explained in Figure 2.

Availability of Grafts for PD and IPP in India and Spain

Depending on the availability and cost constraints, the commonly used grafts for PD in India are SIS, pericardial, and autologous saphenous vein grafts. Biodesign (Cook Medical, Bloomington, IN, USA) is a porcine SIS graft 7 cm × 10 cm dimension 4-layered graft and Syncroscaff (SynkroMax Biotech, Chennai, India) is a decellularized bovine pericardial graft 4 cm × 4 cm/8 cm × 8 cm graft are available in India. Make sure to counsel the patients well prior to using these “porcine” and “bovine” xenografts considering the pre-existing allergies and sensitive religious sentiments in India. Although the saphenous vein graft is autologous, there is always an added morbidity at donor site and the additional operative-anesthetic duration, which will eventually add up to the total surgical expenses. The TachoSil graft, which has recently gained importance in Europe, costs around 250 Euros for a 9.5 cm × 4.8 cm patch in Spain, but is currently unavailable in India.

Boston Scientific (Marlborough, MA, USA) acquired the American Medical Systems (AMS) urology portfolio in 2015 and is the sole distributor of IPP (AMS 700 and AMS Ambicor) in India. In Spain, both Coloplast (Coloplast, Minneapolis, MN, USA) and Boston Scientific (Marlborough, MA, USA) PP are available. The MPP “AMS Spectra” has been currently withheld

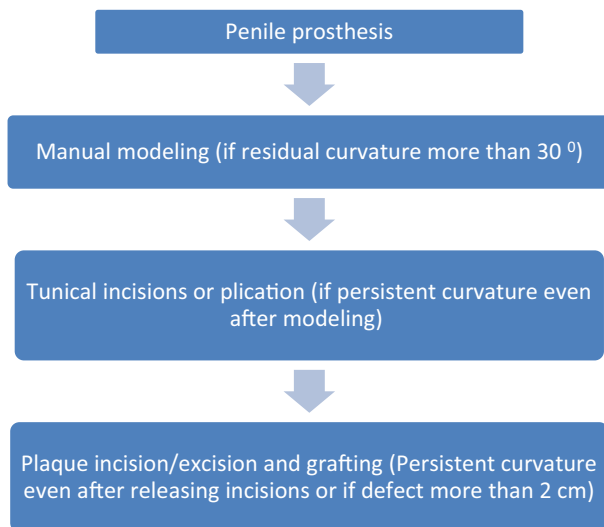


Figure 2. Algorithm for the surgical correction of Peyronie's disease with co-existent erectile dysfunction.

worldwide for the arrival of a newer malleable model “Tactra,” whereas the Coloplast Genesis MPP is available in Spain but not licensed in India.

No-Graft, No-Plication Penile Curvature Correction

Egydio and Kuehhas⁵³ recently described the Multiple Slit Technique (MUST) for penile length and girth restoration in 138 patients of which 83 patients had PD with co-existent ED. The MUST included multiple tunical incisions without grafts and was combined with PP. Curvature correction was achieved in all cases of PD from a mean pre-operative curvature of 55 degrees. The average IIEF score increased from 22 points at baseline to 66 points at 6-month follow-up. One serious complication of glans necrosis was encountered. The authors concluded MUST to be an effective option but should only be attempted initially by experienced surgeons.⁵³

Platelet Rich Plasma and Platelet Rich Fibrin Matrix Therapy

There are a variety of preparations, delivery modalities, and dosing schedules for platelet rich plasma (PRP) therapy. PRP is prepared by centrifugation of the patient's own blood to remove the white and red blood cells. The plasma obtained is rich in platelets that contain various growth factors, such as platelet-derived growth factor, transforming growth factor- β , insulin-like growth factor-I, and vascular endothelial growth factor.⁵⁴ In the January 2018 issue of the ESSM newsletter, Franco and Garcia-Cruz⁵⁵ highlighted the current status of PRP in ED and the need for proper clinical trials.

A concern with PRP is early washout, a situation potentially avoided by conversion to platelet rich fibrin (PRF) matrix. One of the authors (E.L.G.) is currently working on Vivostat PRF

(Vivostat A/S, Allerød, Denmark) in the surgical treatment of PD. The substance (maximum of 5.3 mL) obtained upon processing of the autologous blood is added over the tunical defect after incising the plaque. This acts as a graft and also plays a hemostatic role. This is an ongoing study, the results of which will soon be published.

Matz et al⁵⁶ noted improvement in IIEF scores by 4.14 points after PRF therapy in 7 patients with ED and/or PD after receiving an average of 2.1 injections.

Although this mode of therapy seems promising, placebo-controlled trials recruiting large numbers with adequate long-term results are required. PRF therapy still needs to be validated and is currently not U.S. Food and Drug Administration approved.

CONCLUSION

Well-informed pre-operative counseling about the realistic outcomes of surgery in PD is mandatory to achieve adequate postoperative satisfaction rates. The goal of the surgery should be to have a “functionally straight” penis (a curvature less than or equal to 20 degrees). Any patient who has a combined PD and refractory ED will need a PP. IPP is most preferred, although there is no good level of evidence to prove that IPP is better than MPP. Secondary procedures, like MM, plication, or graft placement, may be required depending on the degree of curvature and penile length. Grafts are usually preferred when penile curvature is more than 60 degrees. There is no ideal graft available and, hence, the selection of a particular graft depends on the local availability, cost, and surgeon's expertise with the graft. The TachoSil graft is cost-effective, simple-to-use, and seems to be a promising option.

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REFERENCES

- Hatzimouratidis K, Eardley I, Giuliano F, et al. EAU Guidelines: Male Sexual Dysfunction [Internet]. Uroweb; Available at: <http://uroweb.org/guideline/male-sexual-dysfunction/>. Accessed September 21, 2018.
- Stuntz M, Perlaky A, des Vignes F, et al. The prevalence of Peyronie's Disease in the United States: A population-based study. *PLoS One* 2016;11e0150157.
- Shiraishi K, Shimabukuro T, Matsuyama H. The prevalence of Peyronie's disease in Japan: A study in men undergoing maintenance hemodialysis and routine health checks. *J Sex Med* 2012;9:2716-2723.
- La Pera G, Pescatori ES, Calabrese M, et al. Peyronie's disease: Prevalence and association with cigarette smoking. A multicenter population-based study in men aged 50-69 years. *Eur Urol* 2001;40:525-530.
- Mulhall JP, Schiff J, Guhring P. An analysis of the natural history of Peyronie's disease. *J Urol* 2006;175:2115-2118 [discussion 2118].
- Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. - PubMed - NCBI [Internet]; Available at: <https://www.ncbi.nlm.nih.gov/pubmed/20171303>. Accessed October 28, 2018.
- Hellstrom WJ, Feldman R, Rosen RC, et al. Bother and distress associated with Peyronie's disease: Validation of the Peyronie's disease questionnaire. *J Urol* 2013;190:627-634.
- Rosen RC, Riley A, Wagner G, et al. The International Index of Erectile Function (IIEF): A multidimensional scale for assessment of erectile dysfunction. *Urology* 1997;49:822-830.
- Pascual EF, Martínez-Salamanca JI, Cerezo E, et al. Ultrasound predictive factors for efficacy and safety of the use of Collagenase Clostridium Histolyticum (CCH) in the treatment of Peyronie's disease (PD): Impact on patient's selection. *Eur Urol Suppl* 2018;17e1310.
- Penile Traction Therapy and Vacuum Erection Devices in Peyronie's Disease. - PubMed - NCBI [Internet]; Available at: <https://www.ncbi.nlm.nih.gov/pubmed/29631979>. Accessed October 28, 2018.
- Nehra A, Alterowitz R, Culkin DJ, et al. Peyronie's disease: AUA Guideline. *J Urol* 2015;194:745-753.
- Levine LA, Becher E, Bella A, et al. Penile prosthesis surgery: Current recommendations from the International Consultation on Sexual Medicine. *J Sex Med* 2016;13:489-518.
- Yafi FA, Hatzichristodoulou G, DeLay KJ, et al. Review of management options for patients with atypical Peyronie's disease. *Sex Med Rev* 2017;5:211-221.
- Chung E, Wang R, Ralph D, et al. A worldwide survey on Peyronie's disease surgical practice patterns among surgeons. *J Sex Med* 2018;15:568-575.
- Peyronie's Disease. Still a Surgical Disease. - PubMed - NCBI [Internet]; Available at: <https://www.ncbi.nlm.nih.gov/pubmed/?term=Peyronie%27s+Disease%3A+Still+a+Surgical+Disease>. Accessed October 28, 2018.
- Chung E, Solomon M, DeYoung L, et al. Comparison between AMS 700™ CX and Coloplast™ Titan inflatable penile prosthesis for Peyronie's disease treatment and remodeling: Clinical outcomes and patient satisfaction. *J Sex Med* 2013;10:2855-2860.
- Habous M, Tealab A, Farag M, et al. Malleable penile implant is an effective therapeutic option in men with Peyronie's disease and erectile dysfunction. *Sex Med* 2018;6:24-29.
- Martínez-Salamanca JI, Mueller A, Moncada I, et al. Penile prosthesis surgery in patients with corporal fibrosis: A state of the art review. *J Sex Med* 2011;8:1880-1889.
- Garaffa G, Kuehhas FE, De Luca F, et al. Long-term results of reconstructive surgery for Peyronie's disease. *Sex Med Rev* 2015;3:113-121.
- Khera M, Bella A, Karpman E, et al. Penile prosthesis implantation in patients with Peyronie's disease: Results of the PROPPER study demonstrates a decrease in patient-reported depression. *J Sex Med* 2018;15:786-788.
- Wilson SK, Delk JR. A new treatment for Peyronie's disease: Modeling the penis over an inflatable penile prosthesis. *J Urol* 1994;152:1121-1123.
- DiBlasio CJ, Kurta JM, Botta S, et al. Peyronie's disease compromises the durability and component-malfunction rates in patients implanted with an inflatable penile prosthesis. *BJU Int* 2010;106:691-694.
- Garaffa G, Minervini A, Christopher NA, et al. The management of residual curvature after penile prosthesis implantation in men with Peyronie's disease. *BJU Int* 2011;108:1152-1156.
- Montague DK, Angermeier KW, Lakin MM, et al. AMS 3-piece inflatable penile prosthesis implantation in men with Peyronie's disease: Comparison of CX and Ultrex cylinders. *J Urol* 1996;156:1633-1635.
- Usta MF, Bivalacqua TJ, Sanabria J, et al. Patient and partner satisfaction and long-term results after surgical treatment for Peyronie's disease. *Urology* 2003;62:105-109.
- Chaudhary M, Sheikh N, Asterling S, et al. Peyronie's disease with erectile dysfunction: Penile modeling over inflatable penile prostheses. *Urology* 2005;65:760-764.
- Levine LA, Benson J, Hoover C. Inflatable penile prosthesis placement in men with Peyronie's disease and drug-resistant

- erectile dysfunction: A single-center study. *J Sex Med* 2010; **7**:3775-3783.
28. Yafi FA, Hatzichristodoulou G, Wang J, et al. Outcomes of surgical management of men with Peyronie's disease with hourglass deformity. *Urology* 2016; **91**:119-123.
 29. Anaissie J, Yafi FA. A review of surgical strategies for penile prosthesis implantation in patients with Peyronie's disease. *Transl Androl Urol* 2016; **5**:342-350.
 30. New surgical treatment for Peyronie's disease - ScienceDirect [Internet]; Available at: <https://www.sciencedirect.com/science/article/pii/S0090429585902857>. Accessed October 28, 2018.
 31. Correction of penile curvature using the 16-dot plication technique: a review of 132 patients. - PubMed - NCBI [Internet]; Available at: <https://www.ncbi.nlm.nih.gov/pubmed/?term=Correction+of+penile+curvature+using+the+16-dot+plication+technique%3A+a+review+of+132+patients>. Accessed October 28, 2018.
 32. Chung PH, Scott JF, Morey AF. High patient satisfaction of inflatable penile prosthesis insertion with synchronous penile plication for erectile dysfunction and Peyronie's disease. *J Sex Med* 2014; **11**:1593-1598.
 33. Grafts for Peyronie's disease: A comprehensive review. - PubMed - NCBI [Internet]; Available at: <https://www.ncbi.nlm.nih.gov/pubmed/29266877>. Accessed October 28, 2018.
 34. Perovic SV, Djinovic RP. Current surgical management of severe Peyronie's disease. *Arch Esp Urol* 2010; **63**:755-770.
 35. Sansalone S, Garaffa G, Djinovic R, et al. Simultaneous penile lengthening and penile prosthesis implantation in patients with Peyronie's disease, refractory erectile dysfunction, and severe penile shortening. *J Sex Med* 2012; **9**:316-321.
 36. Lue TF, El-Sakka AI. Venous patch graft for Peyronie's disease. Part I: Technique. *J Urol* 1998; **160**(6 Pt 1):2047-2049.
 37. El-Sakka AI, Rashwan HM, Lue TF. Venous patch graft for Peyronie's disease. Part II: Outcome analysis. *J Urol* 1998; **160**(6 Pt 1):2050-2053.
 38. Montorsi F, Salonia A, Maga T, et al. Evidence based assessment of long-term results of plaque incision and vein grafting for Peyronie's disease. *J Urol* 2000; **163**:1704-1708.
 39. Austoni E, Colombo F, Romanò AL, et al. Soft prosthesis implant and relaxing albugineal incision with saphenous grafting for surgical therapy of Peyronie's disease: A 5-year experience and long-term follow-up on 145 operated patients. *Eur Urol* 2005; **47**:223-229 [discussion 229].
 40. Silvani M, Pecoraro S, Zucchi A. Corporoplasty for induratio penis plastica with soft axial tutors, single relaxing albugineal incision and safenous grafting. A 3-year follow up. *Arch Ital Urol Androl* 2012; **84**:84-88.
 41. Hellstrom WJ, Reddy S. Application of pericardial graft in the surgical management of Peyronie's disease. *J Urol* 2000; **163**:1445-1447.
 42. Egydio PH, Kuehhas FE, Sansalone S. Penile length and girth restoration in severe Peyronie's disease using circular and longitudinal grafting. *BJU Int* 2013; **111**(4 Pt B):E213-219.
 43. Levine LA, Estrada CR. Human cadaveric pericardial graft for the surgical correction of Peyronie's disease. *J Urol* 2003; **170**(6 Pt 1):2359-2362.
 44. Rolle L, Falcone M, Ceruti C, et al. A prospective multicentric international study on the surgical outcomes and patients' satisfaction rates of the "sliding" technique for end-stage Peyronie's disease with severe shortening of the penis and erectile dysfunction. *BJU Int* 2016; **117**:814-820.
 45. Use of small intestinal submucosa graft for the surgical management of Peyronie's disease. - PubMed - NCBI [Internet]; Available at: <https://www.ncbi.nlm.nih.gov/pubmed/17976656>. Accessed October 28, 2018.
 46. Knoll LD. Use of porcine small intestinal submucosal graft in the surgical management of tunical deficiencies with penile prosthetic surgery. *Urology* 2002; **59**:758-761.
 47. Surgical therapy of Peyronie's disease by partial plaque excision and grafting with collagen fleece: Feasibility study of a new technique. - PubMed - NCBI [Internet]; Available at: <https://www.ncbi.nlm.nih.gov/pubmed/?term=Surgical+therapy+of+Peyronie%27s+disease+by+partial+plaque+excision+and+grafting+with+collagen+fleece%3A+feasibility+study+of+a+new+technique>. Accessed October 28, 2018.
 48. Hatzichristodoulou G. The PICS technique: A novel approach for residual curvature correction during penile prosthesis implantation in patients with severe Peyronie's disease using the collagen fleece TachoSil. *J Sex Med* 2018; **15**:416-421.
 49. Falcone M, Preto M, Ceruti C, et al. A comparative study between 2 different grafts used as patches after plaque incision and inflatable penile prosthesis implantation for end-stage Peyronie's disease. *J Sex Med* 2018; **15**:848-852.
 50. Pascual EF, Portillo LD, Cerezo E, et al. PS-05-016 Initial experience with incision and collagen-fleece grafting in the treatment of Peyronie's disease. *J Sex Med* 2017; **14**:e123.
 51. Contemporary Review of Grafting Techniques for the Surgical Treatment of Peyronie's Disease. - PubMed - NCBI [Internet]; Available at: <https://www.ncbi.nlm.nih.gov/pubmed/28258933>. Accessed October 28, 2018.
 52. Kadioglu A, Sanli O, Akman T, et al. Surgical treatment of Peyronie's disease: A single center experience with 145 patients. *Eur Urol* 2008; **53**:432-439.
 53. Egydio PH, Kuehhas FE. The Multiple-Slit Technique (MUST) for penile length and girth restoration. *J Sex Med* 2018; **15**:261-269.
 54. Growth factor content in PRP and their applicability in medicine. - PubMed - NCBI [Internet]; Available at: <https://www.ncbi.nlm.nih.gov/pubmed/23648195>. Accessed October 28, 2018.
 55. Franco M, Garcia-Cruz E. PRP (platelet enriched plasma) and erectile dysfunction: How far along we are? *ESSM* 2018; **38**:5-6.

56. Matz EL, Pearlman AM, Terlecki RP. Safety and feasibility of platelet rich fibrin matrix injections for treatment of common urologic conditions. *Investig Clin Urol* 2018;59:61-65.
57. Pathak AS, Chang JH, Parekh AR, et al. Use of rectus fascia graft for corporeal reconstruction during placement of penile implant. *Urology* 2005;65:1198-1201.
58. Zucchi A, Silvani M, Pecoraro S. Corporoplasty with small soft axial prostheses (VIRILIS I®) and bovine pericardial graft (HYDRIX®) in Peyronie's disease. *Asian J Androl* 2013;15:275-279.
59. Fang A, Wang R. Nondegloving technique for Peyronie's disease with penile prosthesis implantation and double dorsal-ventral patch graft. *Asian J Androl* 2018;20:90-92.