

ESSM Position Statement on Surgical Treatment of Peyronie's Disease



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ABSTRACT

Introduction: Patients with Peyronie's disease may experience significant distress. The choice of treatment depends on a variety of factors, including the stage of the disease, the presence of pain, severity and direction of the curvature, penile length and the quality of erectile function.

Aim: To review the evidence associated with surgical treatment of Peyronie's Disease and provide clinical recommendations on behalf of the European Society for Sexual Medicine. 131 peer-reviewed studies and systematic reviews, which were published from 2009 to 2019 in the English language, were included.

Methods: MEDLINE, Google Scholar and EMBASE were searched for randomized clinical trials, meta-analyses, open-label prospective and retrospective studies.

Main Outcome Measure: The panel provided statements on clinically relevant questions including patient involvement in the decision process, indications for surgery, choice of the approach, and the management of patient expectations. A comparison of the different grafts used in patients who have undergone plaque incision/excision and grafting in order to identify an ideal graft, has been carried out. The prevalence of postoperative complications has been summarized. Levels of evidence were provided according to the Oxford 2011 criteria and Oxford Centre for Evidence-Based Medicine recommendations.

Results: In order to allow shared decision making, a patient preoperative counselling regarding the pros and cons of each intervention is recommended. In particular, adverse effects of surgical treatments should be discussed to set realistic understanding and expectations of surgical outcomes and ultimately improve postoperative satisfaction rates. Surgical treatment should be only offered in the chronic phase of the condition, when the deformity and/or degree of erectile dysfunction, prevent patients from engaging in satisfying sexual interaction, or if the deformity is the cause of severe bother.

Conclusions: Current European Society for Sexual Medicine recommendations cover several aspects of Peyronie's disease treatment. These recommendations aim both to ensure patients and partners have accurate and realistic expectations of their treatment options, as well as to formulate algorithms to guide clinician management

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Key Words: Peyronie's Disease; Induratio Penis Plastica; Acquired Penile Deviation; Penile Length; Penile Graft; Plication; Disappointment; Dissatisfaction; Penile Prosthesis; Penile Reconstruction

INTRODUCTION

Peyronie's disease (PD) (Iduratio Penis Plastica) has been described in literature as early as the 1500s. It is noted in the works of the famous Italian anatomist Gabriel Fallopius, a pioneer in reproductive organs as well as by Andreas Vesalius, a 16th century Dutch Physician and author of one of the most influential books on Human anatomy *De Humani Corporis Fabrica Libri Septem (On the Fabric of the Human Body)*.¹ It was not until 1743, that Francois de la Peyronie, a surgeon of the Court of King Louise XV in France, outlined the disease in detail.²

PD is an acquired connective tissue disorder that is associated with the formation of fibrous/calcified inelastic plaques at the level of the tunica albuginea (TA) of the penis.^{3,4} The exact etiology of PD is unknown. The most accepted hypothesis is that in genetically prone individuals, trauma or repetitive microtrauma to the erect penis causes inflammation, degradation of the elastic fibers and fibrin deposition.⁵⁻⁷ This scarring process may lead to a variety of issues, including penile deformity and erectile dysfunction. Consequently, men with PD may experience significant distress; the extent of which does not necessarily correlate with the degree of curvature nor penile deformity. Psychological concerns regarding self-image, sexual appearance and sexual performance, low self-esteem, anxiety, depression and relationship problems may then further contribute to the psychogenic component of the erectile dysfunction (ED).⁸⁻¹⁰

Recent reports have shown that the prevalence of PD may be as high as 9%, but the true prevalence may be underreported.¹¹ PD is associated with conditions including diabetes, hypertension, hyperlipidemia, ED, smoking and excessive alcohol consumption. It may also be present following local trauma or surgery such radical prostatectomy.¹²⁻¹⁵ The choice of treatment depends on a variety of factors, including the stage of the disease, the presence of pain, severity and direction of the curvature, penile length and the quality of erectile function.¹¹

In the early/acute stage of PD, non-surgical treatments aim to alleviate penile pain and minimise disease progression with stabilization of inflammation, plaque formation and penile deformity.¹⁶ In the late/chronic phase, surgical treatments may be required. These procedures include both penile shortening or penile lengthening types. Surgery aims to correct the curvature whilst maintaining satisfactory penile length and rigidity to enable penetrative sexual activity. Possible risks of surgery

include penile shortening, ED, glans hypoesthesia, residual or recurrent curvature and palpable or uncomfortable suture knots below the skin.¹¹ To date, penile straightening surgery represents the gold standard for correction of the penile deformity, with subsequent relief of sexual distress.

The aim of this paper is to review the current evidence of surgical treatments for PD and provide official position statements with a series of guiding statements to manage patient's expectations and their clinical issues, on behalf of the European Society for Sexual Medicine (ESSM).

MATERIALS AND METHODS

Panel Identification

The scientific committee of the ESSM after ESSM executive committee (EC) approval, commissioned an expert task force of ESSM members expert of the topic. The final version of the manuscript was approved by EC and ESSM affiliated societies.

Literature Search and Study Eligibility

A MEDLINE, Google Scholar and EMBASE based literature search of original manuscripts published in English between 2009 and 2019 has been carried out using the following key words: "Peyronie's Disease," "induratio penis plastic," "acquired penile deviation," "acquired penile curvature," "penile length," "penile graft," "tunica plication," "patient expectations," "partner expectations," "cosmesis," "disappointment," "dissatisfaction," "penile prosthesis," "penile reconstruction," "comorbidity," "outcome," "satisfaction."

Data Extraction

Studies older than 10 years were included only if considered to be of great value to the topic with respect to the quality of the data. All subsequent articles were cross-referenced to ensure capturing of all relevant papers. Review articles and congenital curvature populations were excluded. Data was catalogued into study type, level of evidence, number of subjects, duration of follow-up, treatment arms and outcomes. Abstracts were reviewed by 5 different authors (D.O., A.R., S.W., G.B., M.F.). If it was not clear from the abstract whether the paper might contain relevant data, the full paper was assessed. Moreover, other studies relevant to the research question were retrieved from the reference lists of selected papers. Included studies were analyzed and summarized

after an interactive peer-review process of the panel. All the data identified during the first analysis were checked in a second wave analysis by 4 of the authors (A.S., R.D., M.P., G.H.). Disagreements were resolved by consensus. All the authors adequately contributed to the analysis of the paper and reviewed the final version of the manuscript.

Review Methods

The panel provided statements on clinically relevant questions including patient's involvement in the decision process, indications for surgery, choice of the most suitable approach and management of patient expectations. A comparison of the different grafts used in patients who have undergone plaque incision and grafting (PIG) or partial plaque excision and grafting (PEG) has been carried out. The rates of postoperative complications with particular focus on sexual outcomes were analyzed. The statements were internally discussed and the level of evidence (LoE) was provided according to the Oxford 2011 Levels of Evidence criteria; moreover, the quality of evidence was graded by applying the Oxford Centre for Evidence-Based Medicine recommendations.¹⁷

PATIENT EXPECTATIONS

Statement #1: The treating clinician should adequately counsel patients before surgery. Benefits as well as side effects and complications of each surgical treatment should be discussed in detail with the patient to set realistic expectations towards surgical outcomes (Good clinical practice).

Statement #2: The treating clinician should thoroughly address psychological, emotional and relationship issues attributable to PD (Level 4, Grade C).

Evidence

One of the main goals of preoperative counselling is setting realistic patient's expectations by providing accurate information about each surgical option, widely discussing pros and cons of each procedure as well as any possible postoperative complication.^{18–24} Without guidance patients may have unrealistic treatment outcome expectations. He must fully understand the progressive and generally irreversible nature of PD and that whilst non-surgical treatment options exists, they may not provide sufficient improvement to their deformities.^{25,26}

Penile shortening due to PD is reported by more than 70% of patients prior to surgery.²⁷ It is therefore paramount that patients are adequately counselled on the nature of the condition and regarding realistic expectations from surgery. Particular counselling points should include that treatments generally may not restore the penis to the pre-morbid dimensions.^{28,29} The patient should be informed regarding the pathophysiology of PD in general, as well as the extent of his condition in his specific case.

Since worsening of the quality of erections is one of the main causes of patient dissatisfaction,³⁰ thorough patient counseling regarding the impact of the disease and each specific treatment option on erectile function is mandatory.^{31–34}

Due to the pain, deformity, loss of length and worsening of the quality of the erections, PD may not only severely impair sexual activity, but it can also affect emotional wellbeing, placing strain on relationships and have resulting broad psychological impact.^{35–37} Up to 48% of patients suffer from depression and this can be directly linked to the onset of PD³⁸ while relationship issues and emotional distress related to this condition can be identified in 54% and 81% of cases respectively.³⁹ PD seems to exert its sexual and psychological effects in 4 domains: physical appearance and self-image, sexual function and performance, PD-related pain and distress and social stigmatization and isolation.^{30,40,41} Investing time in psychological rehabilitation of the patient in the form of thorough counseling is therefore another key factor for overall patient satisfaction.

Remark

Only few studies have specifically evaluated patient expectations regarding surgery for PD. Addressing patient expectations before surgery in order to set realistic expectations towards surgical outcome must be a clinical principle for all physicians involved.

INDICATIONS FOR SURGICAL TREATMENT

General Considerations

Statement #3: Surgical treatment should only be performed in PD patients when the curvature and/or penile deformity and/or inadequate quality of erections do not allow satisfactory sexual intercourse, or when the deformity causes severe bother (Level 3, Grade C).

Statement #4: Surgery should only be performed in patients with stable disease for at least six to twelve months (Level 3, Grade C).

Statement #5: In penile surgery for PD, when adopting a sub-coronal approach, circumcision is not necessary in selected patients with a normal, elastic prepuce (Level 3, Grade C).

Evidence

In patients with PD, a variety of surgical procedures, including tunical plication, plaque incision and grafting/plaque excision and grafting (PIG/PEG) techniques and penile prosthesis (PP) surgery, have been described. The aim of surgery is to improve penile deformities whilst minimizing any adverse outcomes. Surgeons should consider the extent of penile length loss, the degree and nature of the deformity as well as the quality of erections and patient preferences.^{42,43} Surgery for PD should be performed in patients with penile curvature and deformity which prevents satisfactory sexual intercourse, or when the deformity and worsening of the quality of erections is the cause of severe bother.

It is a generally accepted standard of care that surgery should only be performed in patients with stable disease for at least 6 months, in order to minimize the risk of subsequent disease progression and recurrence of the curvature.^{31–34} The acute phase of the disease variate between 6 and 18 months, which after the stable disease phase of PD starts.⁴⁴ It is widely accepted

(recommendation strength rating: strong) that surgery should only be performed in case of stable disease for 6 months, which is usually the case after 12 months from the onset of symptoms.⁴⁵

Various surgical approaches can be considered. Kadioglu and colleagues evaluated a large patient cohort of 268 patients whom underwent a variety of surgical procedures. 54 and 144 patients underwent plication or PIG surgery, whereas 70 patients with erectile dysfunction underwent PP implantation.⁴⁶ Both surgical options were successful in terms of penile straightening in both short and long-term follow-up. Authors conclude that penile prosthesis implantation should be preferred for patients with ED and penile deformity.

A complete degloving of the penis is necessary in more complex cases and often for grafting procedures in order to gain full access to the corpora, neurovascular bundle and urethra, which can be achieved with a circumferential subcoronal incision.³⁶ If it is the case, a circumcision is not always mandatory as necrosis, oedema or phimosis requiring a secondary circumcision in patients with a preexistent healthy elastic foreskin occurs as infrequently as 1% of cases, unless in re-do surgery where such issues may occur in up to 50% of cases.^{47,48}

The specific PD surgical approaches will be discussed in the subsequent sections.

Tunical Plication (Shortening Procedures)

Statement #6: Tunical plication can be offered to reduce penile curvature in patients with PD (Level 3, Grade C).

Evidence

Plication procedures straighten the penis by reducing the longer, convex side of the penis, which is not affected by PD and are usually carried out at the point of maximum curvature. Currently the Nesbit technique and its modifications⁴⁹ represents the most commonly used type of shortening procedure in patients with PD.^{50–53} Other techniques include:

- Yachia technique, which relies on the Heineke-Mikulicz principle^{54,55}
- Essed and Schroeder plication (TAP) without tunical excision⁵⁶
- 16-dot or 24-dot technique⁵⁷
- Baskin-Duckett (dual incision and plication) procedure^{35,58–60}

The outcomes of plication procedures are summarized in [Table 1](#). Complete straightening is achieved in 48–100% of with patient satisfaction rates ranging from 58% to 96%.^{48,53,59,61–67}

Remarks

Whilst plication techniques lead to encouraging surgical outcomes and adequate patient satisfaction rates in the vast majority of patients, relevant side effects may also occur. Unfortunately, adequate studies comparing surgical outcomes and patient satisfaction among specific techniques are lacking and the main

limitations for studies of penile plication include their retrospective nature, the low number of patients and the limited follow-up duration.

Grafting Procedures

Statement #7: Grafting techniques can be offered to improve penile curvature and correct penile deformity in selected patients with PD including those with preservation of erectile quality, curvature of more than 60 degrees, ossified plaque, significant waist deformity, or when plication surgery may potentially cause loss of more than 20% of overall penile length (Level 3, Grade C).

Statement #8: The use of Dacron™ and Gore-Tex™ for grafting in penile surgery for PD should be strongly discouraged (Level 3, Grade C).

Evidence

Grafting techniques are characterized by a relaxing incision of the TA of the corpora cavernosa carried out at the point of maximum curvature on the concave side of the penis. The penis is then straightened and the defect of the TA covered with a graft. Although an existing plaque can be either incised or excised, it is commonly accepted to minimize the extent of plaque excision as there is a direct correlation between size of the tunical defect and extent of the worsening of the quality of erection postoperatively.^{31,35,36,51}

The main reason why surgeons opt for PIG/PEG techniques in patients with curvature of more than 60°, is that a plication type procedure may lead to penile shortening. Some authors argue that the shortening has been already caused by PD itself and that plication surgery would therefore not cause further significant shortening.³ PIG/PEG procedures also facilitate correction of more severe indentations and hourglass deformities.

It is mandatory to ascertain the quality of erection prior to offering a PIG/PEG procedure as the erectile quality may deteriorate following surgery. Adequate erections in the postoperative phase may help prevent graft contracture.

Various tunical incision types exist for PIG/PEG. A simple transverse plaque incision at the point of maximal curvature may be sufficient in most cases. Other cases (eg, when associated with an hourglass deformity), may benefit either from a modified “H”-incision or a double-Y incision of the tunica albuginea as the preferred choice.^{68,69} Partially excising a small ellipsoid of the plaque at the maximal curvature point with 2 lateral line extensions is another justified option.^{22,35,70} No TA incision type has proven to be superior over others.⁷¹

A variety of grafts are now available to the reconstructive surgeon, including autologous grafts, allografts, synthetic grafts and xenografts. The distribution of graft materials based on the reviewed evidence is summarized in [Table 2](#). There is ongoing debate regarding the best available graft choice, although the ideal version should be readily available, cheap, resistant to infection, minimize loss of erectile function and contracture and should not

Table 1. Outcomes of shortening techniques for Peyronie's disease

Study	Journal	Surgical technique	Study design	Patients number	Mean follow-up	Penile straightness, (%)	Suture-related issues, (%)	Recurrent curvature, (%)	Side effects (%)	Overall satisfaction, (%)
Ralph et al, 1995 ⁵³	Journal of Urology	Nesbit	Retrospective	359	21	94 90	NA	6	Erectile dysfunction: 2 Penile shortening precluding sexual intercourse: 1.7	82 not stated
Rehman et al, 1997 ⁵¹	Journal of Urology	Nesbit modification	Retrospective	32	32	CPC 100 PDPC 73	NA	CPCP 0 PDPC 7.7	Penile shortening: 23.1 Decreased penile sensation: 19.2	CPC 100 PDPC 78
Sassine et al 1994 ⁵²	Urology	Plication	Not stated	55 Congenital 32 PD 23	120 not stated	95	NA	0	Scar perception: 18.2	95% not stated
Geertsen et al 1996 ⁵⁹	British Journal of Urology	Plication	Not stated	28	34	42.9	17.9	Not stated	Pain: 17.9 Persisting curvature: 57.1	54
Savoca et al 2000 ⁶⁴	International Journal of Impotence Research	Nesbit	Not stated	157	72	82.1	1.9	0	Penile shortening affecting sexual intercourse: 1.3 Erectile dysfunction: 12.7	87.9
Chahal et al 2001 ⁶⁶	British Journal of Urology International	Corporal plication	Not stated	69	4.1	Not stated	34	57 mild 14 severe	Significant penile shortening: 55 Numbness of the glans: 32	Not stated
Van der Horst et al 2004 ⁶⁰	British Journal of Urology International	Essed-Schroeder	Retrospective	50 28 PD 22 Congenital	30	100	Not stated	Not stated	Penile shortening: 74% Impairment of penile sensibility: 28 Persisting curvature: 14	78
Lopes et al 2013 ⁵⁵	Urology Annals	Yachia	Retrospective	117	14	94.6	NA	19.6	Glans hyposthesia: 8 Penile shortening concerning sexual intercourse: 2.6	88.4
Rolle et al, 2005 ⁶³	Journal of Urology	modified corporoplasty procedure involving plication suture on the convex aspect of the penis before tunica albuginea resection	Retrospective	50 32 Congenital 18 PD	12 14	100	NA	0	Mild decrease skin sensibility: Congenital 40 PD 60 Penile shortening: 78	94
Friedrich et al, 2000 ¹⁴⁹	British Journal of Urology International	Essed-Schroeder	Retrospective	31 (19 CPC, 12 PDPC)	22	52 48 (residual curvature) Not stated	CPC 3 PDPC 0	CPC 5.3 PDPC 8.3 Not stated	Penile shortening: 19 Pain: 26 Numbness: 6.5 Impaired rigidity: 19	CPC 94.7 PDPC 58.3 81
Gholami et Lue, 2002 ⁵⁷	Journal of Urology	16-dot	Retrospective	132	30	85 93	12	15	Penile shortening affecting sexual activity: 7 Narrowing of the penis: 9 Decrease in penile sensation: 6 Peniel hematoma: 4 Penile pain: 1 Worsening of erectile function: 6	96
Schultheiss et al 2000 ⁶⁷	European Urology	Essed	Retrospective	61 (40 CPC 21PDPC)	40	70 not stated	42.8 32.8	29.5 (22.5 CPC 42.9 PDPC)	Erectile dysfunction: 3.3 Penile shortening: 45.9	NA
Greenfield et al 2006 ⁵⁸	Journal of Urology	Tunica albuginea plication	Not stated	102 (PD (68) chordee (34)	29	99	NA	7 0.9	Penile shortening: PD 7.3, Chordee 2.9 Decreased rigidity: PD 7.3, Chordee 0 Decreased sensation: PD 4.4, Chordee 2.9	PD 98.5 Chordee 100

CDC = Congenital penile curvature; PDPC = Peyronie's disease penile curvature.

Table 2. Distribution of grafting materials

Grafting materials
Autologous grafts
Dermis
Buccal mucosa
Fascia lata
Lingual mucosa
Tunica albuginea
Tunica vaginalis
Vein
Non-autologous grafts (allografts)
Human amniotic membrane
Human dermis
Human dura mater
Human fascia lata
Human pericardium
Non-autologous grafts (xenografts)
Bovine pericardium
Bovine dermis (Xenform)
Equine collagen fleece (Tachosil)
Porcine small intestinal submucosa (SIS)
Porcine dermis
Synthetic Grafts
Dacron
Gore-Tex

promote significant inflammatory reactions.³⁶ No comparative studies comparing graft type and suturing materials with surgical outcomes and patient satisfaction have been published. The relevant prospective and retrospective studies reporting clinical outcomes as well as patient satisfaction of the grafting procedure based on the different graft types are summarized in (Table 4).

Autologous grafts require an additional surgical incision and surgical time.³⁶ Among the autologous grafts, saphenous vein

has shown promising results.^{35,72–76} More recently, oral mucosa graft (buccal or lingual) has been evaluated in a few trials (Table 4 and 5).

Cadaveric fascia lata and pericardium demonstrates encouraging results with complete straightening of the penis and high patient satisfaction rates.^{23,77,78} Dermal grafts are associated with higher rate of long-term failure⁷⁹ (Table 4). Due to considerable risk of infection, inflammatory reactions, contracture, fibrosis and allergic reaction, Dacron and Gore-Tex grafts are no longer used as a grafting material in PD³⁶ Table 3.

A self-adhesive collage fleece was proposed as grafting alternative. The main advantage was the unnecessary suturing and the significant reduction in operative time.²² This innovative approach proved to be reliable leading to satisfactory outcomes: a complete straightening of the penis in 83% of cases, 8% of patients experienced worsening of erectile function postoperatively and 92% of patients were satisfied with surgical outcome.⁸⁰ Intraoperatively, caution must be paid in order not to overfill the penis during artificial erection, after applying the collagen fleece. However, an artificial erection test, after applying the collagen fleece, of about 70–80% may be sufficient to check for residual curvature. Although many experts recognize the need for a full rigid erection to assess a possible residual curvature. A recent comparative study revealed the reduced operative time with self-adhesive collage fleece over the sub intestinal submucosa (SIS), whilst maintaining comparable outcomes⁸¹ (Table 5). Among the different graft materials, recent evidence highlights collagen fleece graft as a possibility, although long term outcomes regarding functional and anatomical outcome of grafting procedures remains to be proven.

SIS currently represents one of the more commonly used xenografts in PD surgery.^{36,50,30,81–92} Another option is bovine or human pericardium, which has been used for many years with adequate results.^{21,93} Outcomes are summarized in (Table 4–5).

Table 3. Distribution of grafting materials among reviewed studies

Type of graft	Total studies (n)	Total subjects (n)	Mean operative times (min)	Mean follow up (mo)	Mean satisfaction (%)
Small intestine submucosa (SIS)	7	256	136.2	39.6	79.9
Collagen fleece (CF) (TachoSil)	5	438	88.05	26.3	91.5
Pericardium	3	233	NA	17	91.2
Tunica Vaginalis	2	24	79	>12	100
Dermal graft	3	71	>130	60.5	<35
Dermal flap	1	26	NA	95	40.9
Tunica Albuginea	1	33	NA	41	90
Buccal mucosa	1	32	NA	43	85
Lingual mucosa	1	17	130	15	94
Vein	1	30	NA	156	73
Fascia lata	1	9	NA	18	89
Temporal fascia	1	20	120	24	91
Xeniform	1	28	155	31.8	87.5

Table 4. Side to side comparison of surgical outcomes of current grafting techniques

Study	Year	Journal	Study type	Graft type	Patients (n)	Surgical outcomes %:			
						Penile straightening	PO ED	Penile shortening	Overall pat. satisfaction
Rosenhammer et al ⁸¹	2019	Int J Imp Research	Retrospective	SIS and TachoSil	43 and 43	86 and 95	7 and 5	28 and 5	86 and 95
Morgado et al ⁹²	2018	Andrology	Prospective	SIS	32	75	53.8	65.6	87.5
Hatzichristodoulou ⁸⁰	2018	Int J Imp Research	Prospective	TachoSil	12	83.3	8.3	NA	91.7
Sayedahmed et al ⁸²	2017	World J Urol	Prospective	SIS	43	74.4	11.6	27.9	86
Valente et al ⁸⁴	2017	Urology	Prospective	SIS	28	82	36	14.3	82
Caraceni et al	2016	Urology	Prospective	Xenform	28	75	25	NA	87.5
Khawaja et al ¹³⁷	2016	Urology Annals	Prospective	Dermis and temporalis fascia	13 and 20	100	9	NA	91
Cosentino et al ⁸⁷	2016	Int J Imp Research	Retrospective	SIS	44	NA	5	NA	NA
Otero et al ⁹³	2017	Asian J Andrology	Prospective	Pericardium	43	80.5	25	None	85.4
Wimpissinger et al ⁹²	2016	J Sex Med	Pros/Retro	Vein	30	86	36	43	73
Zucchi et al ¹⁰⁵	2015	Urology	Retrospective	Buccal mucosa	32	96	4	NA	85
Hatzichristodoulou et al ²²	2013	Int J Imp Research	Prospective	TachoSil	63	83	NA	NA	NA
Kozacioglu et al ²⁰	2012	Urology	Retrospective	Derm	38	92	34	NA	NA
Da Ros et al ¹⁴¹	2012	IBJU	Retrospective	Tunica albuginea	33	90	24	18	90
Sansalone et al ²¹	2011	Asian J Andrology	Retrospective	Pericardium	157	88	29	None	97
Staerman et al ⁸³	2010	Int J Imp Research	Retrospective	SIS	33	67	11	25	79
Chung et al ⁸⁵	2011	J Sex Med	Retrospective	Dermis, Pericardium and SIS	20,33 and 33	68	67	22	<35
Kadıoğlu et al ⁴⁶	2018	J Sex Med	Retrospektive	Saphenous vein	144	87.5	33.3	N/A	75

Table 5. Follow up after grafting techniques

Technique	Patients	Median follow-up (mo)	Grafting material	Curvature recurrence(%)	Revision surgery (%)
Sansalone et al 2011 ⁸³	157	20	Pericardium	N/A	N/A
Breyer et al 2007 ⁸⁵	19	15	SIS	37	6
Knoll et al 2001 ⁸⁸	12	12	SIS	8.3	8.3
Kovac et al 2007 ⁹⁰	36	22	Dermis	40	N/A
			Tutoplast	0	
			StrataSIS	33.1	
Montorsi et al 2000 ¹⁰⁷	50	32	Vein	6	N/A
Chung et al 2011 ⁸⁶	86	98	Dermis, Pericardium, SIS	50–87	67
Hatzichristodoulou 2016 ¹⁶²	319	47	Collagene Fleece	0	N/A
Kadzıoglu 2018 ⁴⁶	144	51.1	sapheneous vein	16.4	N/A

Overall, complete straightening was obtained in 67–88% of patients with satisfaction rates of 79–87%.

Remarks

There are insufficient studies comparing surgical outcomes and patient satisfaction for each type of graft. The vast majority of studies regarding PIG/PEG for PD are retrospective, include a low number of patients and have limited follow-up (Table 5).

Penile Prosthesis

Statement #9: Penile prosthesis implantation is reserved for PD patients with refractory ED or distal flaccidity not responding to pharmacologic treatment or those with complex deformities that would otherwise require PIG/PEG procedures (Level 3, Grade C).

Statement #10: Additional procedures including modeling, tunical plication, plaque incision/excision and/or grafting are performed when penile deformity and/or penile curvature persist following penile prosthesis implantation (Level 3, Grade C).

Statement #11: Inflatable prostheses are associated with superior results in terms curvature correction, rigidity, girth restoration and concealability than their semirigid counterpart in patients with PD (Level 4, Grade C)

Evidence

Patients with <30° curvature may be treated with cylinder insertion alone not requiring any additional modeling, plication or grafting. This is because a curvature of less than 30° should usually not interfere with penetrative sexual intercourse and the curve will progressively correct itself.^{33,35} When the curvature exceeds 30° and is not ventral, manual modeling over the implanted inflated cylinders may result in sufficient straightening of the penis. If after 2 attempts of modelling the curvature remains greater than 30°, additional maneuvers should be considered to optimize straightening. Further curvature correction can be achieved either by lengthening the shorter side of the shaft

with relaxing tunical incisions or by shortening the longer side with plications. Since plications induce overall shortening, while relaxing incisions tend to restore part of the length lost due to PD contracture, the latter should be strongly considered as penile length represents one of the main determinants of patient satisfaction after PP implantation.³⁵ Penile prosthesis surgery allows penile straightening and correction of penile deformity in 84–100% of patients, and 79% of patients are satisfied with the surgical outcome in reported series.^{31,94–98} Although further comparative studies are required, the outcomes of penile implant in this context are encouraging. Real or perceived loss of penile length plays a major role in patient satisfaction following surgery; a number of techniques have been described to restore length lost to PD contracture and corporeal fibrosis. The sliding-technique, circumferential grafting and multiple incision techniques (MIST) as well as Egydio's multiple-slit technique (MUST) have been described. Overall, a median penile length gain of 3 cm was found in several series.^{99–102}

Remark

Evidence regarding PP implantation outcomes in PD patients is poor and mainly derived by retrospective studies with small number of patients and limited follow-up.

POSTOPERATIVE COMPLICATIONS

Statement #12: In select cases, complications may be managed successfully with revision surgery, including delayed PP implantation in patients who have developed de novo refractory ED. (Level 4, Grade C)

Evidence

Potential adverse events related to PD surgery include: de novo ED, worsening of preexisting ED, curvature recurrence, glans hypoesthesia, palpable sutures/material and graft bulging. The evidence related to all these aspects will be analyzed in the following sections.

De Novo ED

The mechanism for de novo ED are multifactorial, with the main contributors involving disruption of the veno-occlusive mechanism in the case of PIG/PEG procedures and neurovascular bundle damage during its extensive mobilization. It should be also recognized that psychogenic factors due to the underlying deformities, ED and potentially as a result of circumcision, may also play a role.¹⁰³

Erectile function outcomes are frequently reported using global satisfaction score or non-validated questionnaires (eg, IIEF score, which is not currently validated for PD).^{21,86,104,105} This represents a major limitation of the current outcome literature.

Preoperative artificial erection test can provide more objective information to determine the most appropriate surgical option. Assuming a background of ED, in cases of very poor erectile response to high dose injection, the surgeon may give further consideration towards PP implantation.⁵² Nocturnal penile tumescence tests have also been described as a form of assessment of erectile capacity, although its use in PD populations is less clear.^{106–108} Although standardized values to guide treatment choice are not available, dynamic color duplex doppler ultrasound (CDDU) of the penis should be considered during evaluation prior to surgical interventions for treating PD, among others potentially for medicolegal purposes.¹⁰⁹ Certain comorbidities associated with 1 or more risk factor(s) may prompt further hemodynamic investigation and in selected cases this can be followed by an invasive penile angiographic evaluation. An standardized algorithm for preoperative evaluation has been suggested by Sikka et al,¹⁰⁹ however with the lack of standardized values, its role is yet to be clarified.

The rates of ED are much more frequent following PIG/PEG,^{23,110} compared to plication techniques. The incidence of postoperative ED after grafting procedures is summarized in (Table 4).

Residual or Recurrent Curvature (ReC)

Residual curvature at the conclusion of surgery may be acceptable if of minimal magnitude. If excessive however, it may be considered poor surgical technique and patient dissatisfaction may result. ReC is identified when a surgically straightened penis becomes curved once again, at any point post procedure. This may be due to scarring or progression of PD. Whilst residual curvature and ReC represent separate issues, they are often not distinguished in reported outcomes, with rates following shortening procedures ranging between 0.5% and 55%.^{23,66,111–116} ReC rates following PIG procedures range from 0% to 33%, but these figures may not include patients with mild non-problematic curvatures.^{61,73,83,86,88,114,117–122} Whilst the degree of ReC is usually not severe, uncommonly some patients may experience recurrent curvature as significant as 70° and revision surgery may be necessary in up to 22% of ReC cases.^{88,123–125}

Glans Hypoesthesia

A temporary or permanent reduction in glans sensation is a well-recognized complication of penile straightening surgery and it is universally accepted that neuropraxia plays an important role in this. Infiltration of Peyronie's plaque into the neurovascular bundle structures has also been postulated as a possible cause.¹²⁶ Although most papers assess sensitivity by directly questioning patients, some utilize more objective forms of measurements such as biothesiometry.^{89,127} Glans hypoesthesia has been reported in up to 53% of cases following plication surgery.^{57,66,75,128–133} It is mild in 50%⁶⁶ of cases and up to 29% report a complete resolution over 11–49 months follow up.^{66,128} Approximately 21% of patients report loss of glans sensation following a Nesbit plication.^{61,134} Glans hypoesthesia has been reported in up to 39% of patients who have undergone PIG.^{21,22,61,75,78,79,83,86,89,93,107,109,120–122,124,125,135–141} This complication appears to be transient, with resolution within 12 months from surgery in up to 100% of cases.^{61,109,119,127,135,136,138,140}

Palpable or Uncomfortable Sutures and Graft

Palpable lumps are reported by up to 71%^{57,66,128,131,134} after plication procedures. Following grafting procedures, suture knots/graft material are reported to be palpable in up to 50% of cases^{120,121,142} although they seem to only be painful in 4–6% of patients.¹²¹

Bulge/Ballooning or Indentation Deformities

Although typically as a result of grafting, such deformities may also arise following plication procedures with larger dog-ears causing accentuation of waisting. Overall, they are reported in 9–16.7% according to current evidence.^{57,134} This complication can be noted also after grafting procedures. Ballooning of the grafts has been noted in up to 12.5%. Severe indentation was noted in up to 3% of patients.^{93,118,121,135,143}

Glans Ischemia/Necrosis

Glans necrosis (GN) is defined as ischemia to the glans penis due to compromised blood flow. This complication represents the most feared by surgeons and is a dreadful outcome from the patient's and surgeon's perspectives. Most urologists tend to encounter GN following a sliding technique for penile lengthening.¹⁴⁴ This issue has never been reported after plication procedures, but it must be considered after grafting procedures were it can be found in up to 2.4% of cases.^{93,107} GN may occur even during regular PP implantation.

Typical presentation begins with a dusky glans during the first hours following penile surgery. Anatomically the glans penis is supplied by a rich anastomotic network of end arteries derived from the terminal branches of the dorsal penile artery as well as tributaries from the bulbourethral artery new reference.¹⁴⁴ Glans ischemia is therefore more likely on a background of preexisting

systemic condition. The same predisposition to peripheral vascular disease has been identified as risk factors for this complication. The majority of cases have occurred in patients with diabetes mellitus, smoking, metabolic syndrome, chronic renal failure, end-stage atherosclerosis as well as previous irradiation and implant revision cases.^{145,146}

Interestingly with no evidence of severe arterial insufficiency on performing a preoperative penile duplex in these patients, one could not predict such a complication. Fortunately, although likely under-reported, GN seems to be a rare complication following PD surgery. Wilson et al reported a collective cohort series of 21 patients undergoing PP surgery, combining the clinical experience of 9 high volume PP implanters.¹⁴⁴ This paper provides evidence of IPP-associated GN with practical recommendations on how to identify “high risk” patients. Unfortunately, there is currently no comparable guidelines regarding GN in patients undergoing PD/grafting surgery.

Remark

The lack of prospective randomized controlled trials on the outcome of PD surgery significantly limits the interpretation of data. The vast majority of series in the literature either are retrospective or prospective observational studies. The primary endpoints are frequently based on patient and clinician subjective evaluation. Validated questionnaires are rarely applied. IIEF questionnaire is frequently used, although not validated for PD.

DIFFICULT SALVAGE CASES: MANAGEMENT OF RECURRENT DEVIATION FOLLOWING PPLICATION, GRAFTING, OR INTRALESIONAL INJECTION TREATMENTS

Statement #13: None of the straightening procedures currently available has proven superior with regards to preventing curvature recurrence (Level 3, Grade C)

Statement #14: Surgical curvature correction after Collagenase Clostridium Histolyticum (CCH) injection is possible without significant increase in postoperative complications (Level 4, Grade C)

Statement #15: Postoperative rehabilitation programs may reduce the risk of penile curvature recurrence and shortening (Level 4, Grade C)

Statement #16: When necessary, revision surgery should be carried out at least 6 months after the initial procedure to allow for complete healing and stabilization of the deformity and for adequate assessment of postoperative erectile function (Level 4, Grade C)

Statement #17: Penile prosthesis implantation alone or in combination with straightening maneuvers can be considered during revision surgery, in order to minimize further penile length loss or to avoid worsening of erectile function (Level 4, Grade C)

Statement #18: The use of collagen fleece as a graft material following plaque incision can be contemplated in revision surgery (Level 4, Grade C)

Evidence

Among possible complications of plication corporoplasty, ReC is among the more concerning ones. The presence of strong erections postoperatively may potentially weaken or tear the plication sutures on the tunica albuginea. RC that appears at a later stages more likely related to disease progression rather than to surgical failure.¹³⁰ Among plication procedures, the risk of postoperative RC may range from 0% to 19%.^{53,55,57,58,63,65,67,147-153,130} RC is more likely to occur in grafting, compared to plication procedures. The incidence of RC after PIG may range from 50% to 78% of cases.^{22,80,81,154} Among the different graft materials, recent evidence highlight collagen fleece graft as promising, without any cases of RC registered in the follow-up.^{22,80,81,154}

In 2013, the clinical efficacy and safety of CCH injection for PD was confirmed after the conclusion of IMPRESS I and II trials.¹⁵⁵ Despite the efficacy of intralesional CCH for PD, some patients may have persistent penile curvature requiring subsequent straightening procedure. Surgical correction of persistent or residual curvature following CCH injection was recently investigated by Levine et al and Delay et al.^{156,157} The 2 studies included a total of 17 patients with persistent or residual curvature after CCH and all were managed with straightening procedures such as tunical plication, PIG and/or penile prosthesis implantation. The average preoperative penile curvature was 53.8° (range 35°–70°). Postoperatively, all patients but 1 patient reported a functionally straight penis (curvature <20°). There were no reported significant anatomical changes nor complications secondary to prior CCH treatment. Delay et al found more fibrotic tissue in those patients (3/10) whom underwent surgery within 2–3 months from the last CCH injection. No significant differences in postoperative complication rates were recorded when compared to the same surgical procedures in PD patients who had not undergone previous CCH treatment.

Thus with limited evidence available, it appears that previous intralesional CCH injection should not necessarily preclude patients from undergoing subsequent surgical correction of residual curvature; however, it may slightly increase intraoperative difficulty if surgery is offered within the first 3 months from the last CCH injection.¹⁵⁸

In cases of ReC following plication or grafting procedures, no clear recommendations can be provided due to a paucity of available data regarding the decision to perform revision surgery. It is generally agreed that revision surgery should be postponed for at least 6 months to allow for normal healing to occur and to assess whether a new deformity or de-novo ED develops.³⁵ During this period, patients may be advised to perform some version of penile rehabilitation to potentially reduce the progression of any recurrent penile curvature. Penile rehabilitation can include graft

massage and/or penile traction therapy.^{20,159–161} Until a standard protocol for postoperative rehabilitation is established, experts in the field continue to advise their patients based on personal experience and opinion supported by contemporary studies. Similar to PP implantation, after PD grafting surgery, patients are advised to abstain from sexual intercourse and sexual activities for a period of 4–6 weeks.^{21,43,86,162} Postoperative rehabilitation programs may reduce the risk of penile curvature recurrence and shortening.^{3,25,43,70,80,162,163}

In cases of severe ReC, PP implantation may represent a definitive solution; preventing further shortening whilst providing the necessary rigidity for penetrative intercourse.^{164,165}

The modeling maneuver, to manually bend the penis to the opposite side of the curvature with the implant inflated, was described in 1994.¹⁶⁶ The main concern with this technique is the low risk of urethral perforation, described in 4–5% of cases. This complication would lead to abortion of the procedure.^{2,167} The modeling maneuver is not indicated in severe and complex penile deformities and when performed, may not completely straighten the penis.

In select cases characterized by severe penile shortening, tunical incision with or without grafting could be considered in order to optimize postoperative penile length in patients undergoing penile prosthesis implantation.^{168,169} Whilst this is typically addressed via a sub-coronal incision, a non-degloving technique with ventral incision provides for an alternative method for graft and penile prosthesis placement to maintain dartos and skin continuity to the glans penis while still allowing for adequate surgical exposure.¹⁷⁰

When performing an inflatable PP and tunical incision for ReC, a graft is recommended if the tunical defect is greater than 2 cm in order to minimize the risk of cylinder herniation.^{140,171,172} If a malleable prosthesis is implanted, tunical grafting could be avoided provided adequate hemostasis has been achieved.^{97,173}

In the rare event of a tunical aneurysm, revision surgery including excision of the dilated tunical segment and followed by grafting may be considered.¹⁷⁴

CONCLUSIONS

Although surgery represents the gold standard treatment of PD, it remains far from perfect, despite numerous technique modifications, development of various grafts and rehabilitation protocols. The main surgical limitation is that it does not repair the damage produced by PD and may not completely restore the penis to the original dimensions and function. Current literature lacks large volumes of prospective series, hindering our ability to scientifically compare the techniques and their outcomes.

A multinational, multicenter prospective registry of PD surgery procedures may contribute to the evidence-based knowledge on the indications, procedures, and possible complications of PD treatment modalities.

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