Strategies for Penile Prosthesis Placement in Peyronie’s Disease and Corporal Fibrosis

Faysal A. Yafi · Prem sant Sangkum · Ian Ross McCaslin · Wayne J. G. Hellstrom

Abstract  Peyronie’s disease (PD) is a wound healing disorder of the tunica albuginea of the penis. PD is generally categorized into two phases: the early acute inflammatory and late chronic fibrotic. Surgical reconstruction is only recommended during the latter established phase. There are a variety of options when erections are functional. However, when erectile dysfunction is present, the gold standard treatment is the placement of an inflatable penile prosthesis with or without additional straightening procedures. General recommendations include that after implanting and inflating the cylinders, if a clinically significant curvature is present, manual modeling is performed. If a residual curve >30° remains after modeling, then various techniques, including plaque releasing incision, is the next step. Grafting can be considered if tunical defects are >2.0 cm. Causes of corporal fibrosis include complications from an infected implant such as explantation, priapism, penile trauma, and prolonged use of an intracavernosal injection agent. Implant placement in the setting of corporal fibrosis can be technically challenging. Available strategies include incision or excision of the scar, corporotomies with or without grafting, the use of cavernotomes, or other specialized dilators, implant downsizing, and transcorporeal resection.

Keywords  Penile prosthesis · Peyronie’s disease · Degree of curvature · Corporal fibrosis · Erectile dysfunction · Manual modeling

Introduction

Peyronie’s disease (PD) is a wound healing disorder of the tunica albuginea of the penis. Most authorities postulate that repetitive microtrauma or buckling during sexual-related events are causative, but PD can be idiopathic in up to 70% of patients [1]. The initial, or acute, phase can present with penile pain upon erection and intercourse in 15–30% of cases, as well as progressive penile curvature. The pain is self-limited and usually dissipates within a year. The chronic, or quiescent, phase denotes the end of inflammation and stabilization of the penile curvature or abnormality and usually occurs within 12–18 months following onset [2]. Other associated features may include palpable penile plaques, hourglass defects, penile hinging, and penile shortening [1]. Furthermore, there is an association between PD and erectile dysfunction (ED) [1]. Affected patients often have associated psychological distress, which may lead to strained interpersonal relationships and diminished quality of life [3].

The treatment objective for men in the acute phase is directed toward stabilization of the inflammatory process and prevention of penile shortening. Currently, nonsurgical intervention is offered to men in the acute phase (i.e., <12 months in duration) with unstable or progressive deformity, men with established bothersome PD, and those not psychologically ready for surgical correction [2]. Interventions include oral therapy (vitamin E, potassium aminobenzoate, colchicine, tamoxifen, pentoxifylline, and carnitine), intraleseional therapy (verapamil, interferon α2b, and collagenase), extracorporeal shockwave therapy, traction, and vacuum erection devices [4]. Surgical intervention is recommended when the man is unable to engage in satisfactory coitus, has extensive plaque calcification, fails medical treatment, or when the patient requests the most rapid and reliable end-result [2, 4].

The goals of surgical treatment are to correct the penile curvature or deformity, preserve or restore erectile function,
and prevent loss of penile length and girth. The current surgical arsenal available to physicians includes tunical shortening procedures such as the Nesbitt and modified plications, tunical lengthening procedures (plaque incision or partial excision and grafting), and penile prosthesis (PP) implantation for men with concurrent ED [5]. In a long-term follow-up study of non-PP patients with PD, the direction of curvature, surgical approach, graft area, and medical history were not predictive of the development of postoperative ED. Preoperative ED proved to be the only predictive factor in this series [6]. As such, current guidelines recommend penile prosthesis implantation for men who have poor-quality erections and/or do not respond adequately to pharmacological ED therapy [1, 4–9]. Figure 1 summarizes a widely used management

Fig. 1 Algorithm for the management of Peyronie’s disease
algorithm for PD. The aim of this manuscript is to review the current literature on the strategies for penile implant placement in patients with PD and other causes of corporal fibrosis.

Penile Prosthesis and Peyronie’s Disease

In patients with PD and associated ED, placement of a PP may address both conditions and often yields a functional penis, both in terms of erect configuration and rigidity. The approach to placement of a PP in patients with PD resembles that of routine prosthesis placement and occasionally requires straightening. In patients who have a minor curvature or an unstable penis because of indentation or hourglass deformity, a PP alone may be sufficient [10]. In a retrospective analysis of 36 patients, Mulhall et al. reviewed the need for additional straightening techniques based on the degree of angulation [11]. They noted that while no maneuvers were absolutely required for curvatures ≤30°, the need for interventions increased to 12.5% in curvatures 31–45°, to 75% for curvatures 45–60°, and finally 100% for curvatures >60° [11].

While both inflatable and malleable prostheses have been used for the surgical treatment of PD, the latter have fallen out of favor due to higher patient dissatisfaction, higher rates of residual curvature, and less successful straightening [12]. In two series, patient dissatisfaction with malleable prostheses was 35 and 52%, owing to complaints of narrow penile caliber, cold glans, and unnatural erections [13, 14]. As such, it is generally opined that an IPP is the preferred option in patients with PD and ED as its cylinders allow for superior expansion with modeling as well as more effective girth enhancement [15].

Regarding types of IPPs available for use with PD, a review by Chung et al. compared the outcomes of 138 patients with PD and ED who underwent placement of either an AMS 700 CX (American Medical Systems, Minneapolis, MN, USA) or Titan (Coloplast, Minneapolis, MN, USA) with simultaneous penile modeling [16]. They reported that both IPP types provided similar penile straightening without the need for revision surgery, as well as higher patient satisfaction (86 and 90%, respectively) and improved self-confidence [16]. Furthermore, the overall 5-year mechanical failure rates between AMS 700 CX and Coloplast Titan were not significantly different (91 vs. 87%, p>0.05) [17]. When comparing the various AMS 700 cylinders, Montague et al. observed the AMS 700 CX to be superior to the AMS 700 Uльтrex in PD patients, as it required less corporoplasty maneuvers and caused less postoperative buckling of the IPP device [18]. The Uльтrex is no longer in use. However, it is still preferable to use the AMS 700 CX series over the Uльтrex successor, AMS 700 LGX, if opting for the use of an AMS product.

If the penis is not adequately straightened after cylinder implantation and inflation then manual modeling is performed; the first step of the straightening algorithm is described by Wilson and Delk [15]. Using a penoscrotal approach, the prosthesis is implanted, the corporotomy openings are closed, the cylinders are fully inflated and the penis is bent in the contralateral direction to the curvature. It is recommended to maintain the penis in this position for 90 s [10]. Rubber shods on the pump outlet tubing protect the prosthetic pump valve from high pressures [17]. One reported drawback from this technique is the risk of distal urethral injury in approximately 3% of patients, likely owing to the distal extrusion of the cylinders at the level of the fossa navicularis [15, 19]. To circumvent this complication, one places the bending hand on the shaft rather than the glans penis to avoid downward pressure on the tips of the cylinders. The other hand should be placed on the base of the penis to avoid suture line disruption [17]. Corporotomy rupture during modeling is a common occurrence. For this reason, it is our preference to leave the corporotomies open during the modeling process, covering the opening with our thumb and fingers, and closing the corporotomies afterwards. An alternative technique that involves plication prior to IPP insertion has been recently proposed to avoid the possibility of a urethral injury with modeling [20]. Results in 15 patients revealed complete curvature correction, but shortening was noted in 73%. Another potential adverse outcome from this technique is a greater risk of device malfunction requiring surgical revision, particularly with the AMS 700 CX as compared to the Coloplast Titan’s predecessor, the Mentor Alpha I [21]. These findings were not observed in the aforementioned study by Chung et al. where the overall revision rates were the same with both devices after modeling (only 6%) [16].

In patients who do not achieve satisfactory penile straightening (>30° after two rounds of manual modeling), where there is residual indentation causing the inflated cylinder to buckle or where the surgeon opts against manual modeling for fear of the aforementioned complications, the next steps may include plication, multiple tunical incisions, or, occasionally, excision with or without grafting [10, 12, 17]. Some recommend proceeding with a penoscrotal incision, as it will allow for robust exposure or access to the shaft while circumventing the need for complete penile degloving [10]. Buck’s fascia with neurovascular bundle is elevated, the cylinders are deflated, and the tunical incision is performed. Once the incision has been performed, the cylinders are reinflated and the surgeon can proceed with further modeling. Though no clear guidelines exist, it is generally recommended to use a graft when the tunical defect is larger than 2 cm, for fear of cicatrix formation or cylinder herniation [22]. Although historically employed, synthetic grafts are now being replaced by allografts such as human pericardium (Tutoplast; Tutogen Medical, Clifton, NJ) and small-intestinal submucosa (SIS; Stratasis, Cook Biotech, Spencer, IN) [10]. The use of autologous dermal grafts in conjunction with an IPP should be avoided to minimize contraction and the theoretical risk of bacterial seeding and subsequent prosthesis infection [1].
a series of 90 consecutive patients undergoing IPP placement for PD and drug-refractory ED, Levine et al. reported satisfactory straightening in only 4 % with IPP placement alone. Adequate curve correction was achieved in 79 % with modeling, 4 % with a tunical incision, and 12 % with incision and grafting [9]. The additional straightening maneuvers in this study did not correlate with an increased rate of IPP mechanical failure or infections.

The most common complaint in men who undergo penile prosthesis placement for PD is penile shortening; occurring in up to 50 % of patients [23]. PD by itself is associated with penile shortening, so any additional length loss could have detrimental effects on the patient, his partner, and their relationship. As such, it is imperative that potential loss of penile length be discussed in the preoperative setting with the patient. Wang et al. reviewed the length of penises after intracavernosal injections (ICI) preoperatively and post-IPP insertion for oral drug-refractory ED. The review found 0.83 +/- 0.25, 0.75 +/- 0.20, and 0.74 +/- 0.15 cm decreases in erect penile length at 6 weeks and 6 months and 1 year, respectively, after IPP implantation, when compared with that after ICI (P<0.05) [23]. There was, however, no apparent correlation between loss of length and sexual function, as the Sexual Health Inventory for Men (SHIM) scores at 6 and 12 months were similar between patients who did and did not report shorter penises (P<0.05) [23].

In an attempt to achieve more precision in terms of graft measurements, Egydio et al. developed a technique to calculate the size of the tunical defect before tunical incision by applying geometrical principles during a full erection, thereby, allowing graft preparation, even at the physician’s office, by induced erection [24]. While the desired benefit derived from this technique is the time saved intraoperatively, it is countered by the complicated nature of these calculations. While using these geometric principles, Egydio et al. reported on a series of 105 men who underwent penile prosthesis implantation with concomitant penile lengthening and girth restoration through circular and longitudinal incisions in the tunica albuginea [25•]. The overall patient satisfaction rate was 89.4 %, but three patients developed graft retraction with residual curves of up to 30° and, in one patient, the prosthesis had to be removed. Interestingly, there was a mean functional penile length gain of 3.6 cm. Patient satisfaction with penile length gain was 95.2 %, and 99 % were able to have satisfactory sexual intercourse [25•]. Another technique that has been described to increase penile length includes the use of a ventrodorsal incision of the tunica albuginea, stretching of the penis, penile prosthesis implantation, and double dorsal-ventral patch grafting using porcine small intestinal submucosa (“the sliding technique”), with an average increase in length of 3.2 cm [26]. In a series of 23 patients with PD, refractory ED, and severe penile shortening, penile lengthening was performed with a circumferential graft and concomitant implantation of an IPP yielding a 2.8-cm average gain of length [27]. For patients and couples who are dissatisfied with penile length postoperatively, Shaer et al. have suggested penile elongation and girth augmentation using various flaps, with variable success rates [28]. The same group also reported on their initial experience with an innovative technique of transcorporeal incision of Peyronie’s plaques with neither mobilization of the neurovascular bundle nor plaque incision and grafting [29•]. While their results are promising, further studies are required to validate its use. Finally, Silvani et al. reported a novel technique using a relaxing albuginal incision and saphenous vein grafting in the presence of a soft axially rigid prosthesis cylinder scaffold [30]. They reported penile elongation from 1.2 to 2.3 cm with complete correction of any penile curvature and adequate sexual function. Table 1 summarizes these studies on penile prosthesis placement in PD patients.

There are other nonoperative techniques reported to preserve penile length as well as erectile function and penile straightening in the postoperative setting. These include regular penile massage with cocoa butter, penile stretching exercises with traction devices, and nightly use of phosphodiesterase inhibitors to promote graft health, with variable results [1, 34, 35•]. More recently, Levine et al. reported their data from a small pilot study using traction therapy before penile prosthesis placement in men with PD and other causes of penile shortening [36]. After 3–4 months of daily traction for an average of 3 h or more per day, 70 % gained some length (up to 1.5 cm) compared to pre-traction. Unfortunately, this process is arduous and requires compliance to the protocol to achieve these positive results.

Penile Prosthesis and Corporal Fibrosis

While IPP placement with PD is usually somewhat complex and difficult, other conditions that cause corporal fibrosis can be similarly challenging. Such conditions include fibrosis after explantation of an infected implant, priapism, penile trauma, and prolonged use of injected vasoactive agents [37•]. Corporal scarring can occur more distally (after priapism) or more proximally (after an infection) and may lead to ED secondary to venous leak [38]. These patients are often best served with a penile implant, as they respond poorly to medical therapy [37•]. Currently used techniques to overcome this surgical challenge have included excision or incision of the scar, corporotomies with or without grafting, the use of specialized dilators such as cavernotomes, implant downsizing and transcorporeal resections [37•].

Traditionally, it has been standard practice to excise fibrotic corporal tissue completely from the healthy tunica albuginea. In a series of 20 salvage PP cases using corporotomies and scar excision with or without grafting, survival was only 50 % [37•]. A review of the literature shows that early and late complication rates are 30 and 50–65 %, respectively [37•].
In an effort to avoid a large corporal excision, others have suggested proceeding with one or more smaller incisions with minimal scar excision and grafting as needed [39]. In this series, their intraoperative and postoperative complication rates were 2.9% with no reported infections. Another described technique is corporal excavation. Here, extended corporotomies are made on the ventral aspect of each corpus cavernosum, and a plane of dissection between the fibrotic corporeal tissue and the inner surface of the tunica albuginea is established. Cylinders are laid into the empty corporeal bed, and the tunica albuginea is closed primarily [40]. In a small series of nine patients, there were no reported intra- or post-op complications, but one prosthesis had to be replaced due to cylinder failure. Finally, Shaeer’s group described a similar technique to their intracorporeal resection of Peyronie’s plaques wherein they resected fibrotic plaques through a 1-cm corporotomy using endoscopic instruments [41]. They achieved positive results in terms of length, girth, and patient satisfaction. In an effort to avoid blind excavation and possible distal perforation, the authors amended their technique to use ultrasound guidance [42]. When it is not feasible to excise fibrotic cavernous tissue or dilate the cavernous body for successful implantation, one may consider the use of a downsized IPP with a graft. In a series by Knoll et al., of 20 patients using this technique, 19 had a functional device with one patient requiring explantation for an infection [45]. The obvious drawback with this technique is the potential loss of length. Another described technique for implantation into corporal fibrosis or reimplantation following distal prosthesis protrusion is the double-windsock technique, in which two distal neocorpora are created using a polypropylene mesh graft [46]. Urethral injury was noted in 4/69 patients, neuropraxia in 3.4%, and the recovery of orgasmic

### Table 1: Outcomes of surgical treatment of Peyronie’s disease with penile prostheses

<table>
<thead>
<tr>
<th>Study, year</th>
<th>Procedure</th>
<th>No. of the patient</th>
<th>Mean follow-up (months)</th>
<th>Straightening (%)</th>
<th>Shortening (%)</th>
<th>Infection (%)</th>
<th>Need for revision/ removal (%)</th>
<th>Satisfaction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levine, 2010 [9]</td>
<td>IPP</td>
<td>90</td>
<td>49</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>20</td>
<td>84</td>
</tr>
<tr>
<td>Levine, 2000 [5]</td>
<td>IPP</td>
<td>46</td>
<td>39</td>
<td>100</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>NR</td>
</tr>
<tr>
<td>Montague, 1996 [18]</td>
<td>IPP</td>
<td>34, 38</td>
<td>NR</td>
<td>100, 74</td>
<td>NR</td>
<td>6</td>
<td>0</td>
<td>NR</td>
</tr>
<tr>
<td>Egydio, 2013 [25+]</td>
<td>IPP+longitudinal grafting</td>
<td>105</td>
<td>18</td>
<td>97</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>89</td>
</tr>
<tr>
<td>Sansalone, 2012 [27]</td>
<td>IPP+circumferential graft</td>
<td>23</td>
<td>22</td>
<td>85</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>Silvani, 2012 [30]</td>
<td>Soft axial tutors, single incision and saphenous vein grafting</td>
<td>58</td>
<td>12–36</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>NR</td>
<td>75</td>
</tr>
<tr>
<td>Austoni, 2005 [31]</td>
<td>Soft, silicon, axially resistant, prosthetic cylinders</td>
<td>80</td>
<td>113</td>
<td>100</td>
<td>NR</td>
<td>8</td>
<td>0</td>
<td>95</td>
</tr>
<tr>
<td>Grasso, 2008 [32]</td>
<td>Silicon, soft, dynamic anti-extrusion prosthetic implant</td>
<td>12</td>
<td>72</td>
<td>100</td>
<td>NR</td>
<td>8</td>
<td>0</td>
<td>91</td>
</tr>
<tr>
<td>Zucchi, 2013 [33]</td>
<td>Small soft axial+bovine pericardial graft</td>
<td>60</td>
<td>40</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>80</td>
</tr>
<tr>
<td>Chung, 2014 [20]</td>
<td>Plication+IPP</td>
<td>15</td>
<td>11</td>
<td>100</td>
<td>73</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Shaeer, 2011 [29+]</td>
<td>IPP+transcorporeal incision</td>
<td>16</td>
<td>14</td>
<td>100</td>
<td>NR</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

IPP inflatable penile prosthesis, MP Malleable prosthesis

a AMS 700 CX and Coloplast Titan
b AMS 700 CX and AMS Ultrex

c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z.
ability was delayed in 24.6%. All patients were able to perform sexual intercourse. If a proximal perforation is present, the “plug and patch” technique consisting of a nonabsorbable mesh plug can be used to repair the corporal perforation [47]. Alternatively, Mulcahy recommends attaching a rear tip extender to the tunica albuginea as a treatment option to prevent cylinder migration retrograde into the proximal perforation until healing is complete [48]. Finally, in the setting of an infected IPP pump, Köhler et al. described complete removal of the IPP and placement of a malleable prosthesis at the time of washout [49]. Substituting the malleable prosthesis for a new IPP can be done at a later date if the patient wishes.

Penile shortening is a common complaint following reimplantation or implantation into corporal fibrosis [37•]. A few different techniques have been described to address this issue. These include a Y-V flap advancement procedure (3.6–6.5 cm gain in functional length), suspensory ligament release (1.1–2.2 cm gain in erect length), using downsized IPPs as tissue expanders with daily inflation followed by reimplantation several months later (corporal length increase of 2 cm), vacuum erection devices, and daily preoperative penile traction [36, 50–52]. Finally, to avoid loss of penile length and width due to corporal fibrosis in patients with a prosthesis infection and planned delayed reimplantation, Swords et al. described their preliminary experience with the use of a novel, antibiotic-impregnated, temporary synthetic calcium sulfate cast at the time of removal, with no reports of infection following reimplantation [53].

Patient Satisfaction and Complications

Contemporary reported overall patient satisfaction rates after IPP placement are 92–100% and partner satisfaction rates are 91–95% [54•]. Factors associated with satisfaction include decreased preoperative expectations, favorable female partner sexual function, body mass index ≤30, and absence of PD or prior prostatectomy. Determinants of dissatisfaction include perceived/actual loss of penile length, decreased glanular engorgement, altered erectile/ejaculatory sensation, pain, diminished cosmetic outcome, difficulty with device function, partner dissatisfaction, and perception of unnatural sensation, complications, and extent of alternative treatments offered [54•].

Complications or complaints after surgery include penile shortening, hypoesthesia and paresthesia, difficulties using and deflating the device, mechanical failure, erosion, and infections [12•]. With the advent of infection-retardant coatings and a more thorough use of perioperative antibiotics, infection rates following IPP placement have decreased from 3–5% to 1–2% in patients without risk factors and from 8–10% to 2–3% in patients with risk factors [55]. Identified risk factors include poorly controlled diabetes, spinal cord injury, immunosuppression, concurrent urinary tract infection, ileal conduit, and revision surgeries [56–58]. In one large study using antimicrobial-coated IPP and the “no-touch” technique, the rate of infection was further reduced to 0.46% [55].

Conclusions

Penile prosthesis placement in a patient with PD can be a challenge to the implanting surgeon. The first step is placement and inflation of cylinders; however, dilation may be challenging. If a significant residual curve is present, manual modeling is attempted. Multiple plaque releasing incisions is the next step if there still is a residual curve >30° after modeling. Grafting can be recommended in tunical defects >2.0 cm to prevent implant herniation or cicatrix contracture. Similarly, prosthesis placement in the setting of corporal fibrosis can be technically challenging even in expert hands. Available strategies include excision or incision of the scar, corporotomies with or without grafting, use of cavernotomes, implant downsizing, and transcorporeal resections. Complications include those innate to penile prosthetic surgery with a heightened risk of mechanical issues when corporal fibrosis is encountered.
Compliance with Ethics Guidelines

Conflict of Interest  Dr. Faysal A Yafi, Dr. Prem Sant Sangkum, and Dr. Ian Ross McCaslin each declare no potential conflicts of interest.

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