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MEN'S HEALTH (R CARRION, SECTION EDITOR)

A Review on Penile Length and Girth Issues in Penile Prosthetic Surgery

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Abstract

Purpose of Review The goal of this paper is to understand the reasons behind penile length and girth issues after penile prosthesis surgery and review the literature for current strategies employed to decrease these issues.

Recent Findings Measurement inconsistencies triggering further studies have shown there is a real loss of penile length and girth after prosthesis surgery. There have been varying hypotheses of why this happens, and numerous approaches have been proposed to help combat this in the preoperative, intraoperative, and postoperative settings.

Summary Erectile dysfunction prevalence is expected to increase; therefore it is important for urologists to understand the treatment options, including prosthesis surgery. Numerous techniques have been hypothesized and studied in smaller settings in the preoperative, intraoperative, and postoperative settings with regard to prosthetics surgery. However, larger studies are still needed to confirm these findings in order to help to counsel and educate patients preoperatively in addition to employing tactics to help minimize penile shortening.

Keywords Erectile dysfunction · Penile shortening · Penile length · Penile girth · Penile prosthesis

Introduction

In 2015, the 4th International Consultation on Sexual Medicine defined erectile dysfunction (ED) as consistent or recurrent inability to attain and/or maintain penile erections sufficient for sexual satisfaction [1]. In the United States, this is commonly seen in men as they age and associated with increased medical comorbidities [2]. The prevalence of ED is expected to increase worldwide, with 322 million men being affected by 2025, an increase of 111% from 1995 [3], which will increase the number of patients with ED seen by urologists.

There are various nonsurgical and surgical treatments for ED. Nonsurgical include lifestyle modifications, vacuum erection devices (VED), phosphodiesterase type 5 inhibitors (PDE-5I), intraurethral alprostadil, and intracavernosal injections (ICI) [4]. Surgical options are indicated in patients who failed, are not candidates for, or who cannot tolerate nonsurgical management. Surgical treatment is with a penile prosthesis, which generally have high satisfaction rates of above 90%. Satisfaction is typically measured by erectile function, penile length, partner satisfaction, and cosmetic outcome [5]. However, perceived loss of penile length after surgical intervention has been of great concern to both patients and urologists. In this article, we review the current literature in regard to measurement inconsistencies, reasons for length and girth problems, and strategies employed to help decrease these problems.

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Measurement Inconsistencies

Previously, there were conflicting reports in regard to penile length loss versus increase after inflatable penile prosthesis (IPP) surgery. Deveci et al. observed 78% of patients undergoing a 3-piece IPP and 22% undergoing a 2-piece IPP. Seventy-two percent of all patients subjectively reported a decrease in penile length; however there were no statistically significant differences between postoperative measurements

at 1 and 6 months compared with preoperative measurements. Men who complained of loss did have lower index of erectile function (IIEF) scores [6]. However, Habous et al. observed 66% of patients undergoing malleable prosthesis and 34% with an IPP and found the mean preoperative stretched length was 12.8 ± 1.08 cm with mean flaccid girth 10.3 ± 1.2 cm. The postoperative mean erect length and girth were slightly increased at 13.1 cm ± 1.7 cm and 11.3 ± 1.3 cm, respectively, showing overall increase in length and girth [7].

This brought into question the accuracy of measuring penile length and girth as the cause of disparity. Historically, the penis was measured by stretching it in the flaccid state; however measurements have been recorded using various landmarks. A multi-center, multi-observer study was published to better assess accuracy of different penile measurements among multiple observers. Two hundred and one patients had penile girth, length from suprapubic skin to distal glans, and pubis to distal glans measured by one of the seven andrology specialists. All were recorded in the flaccid state and after induction with ICI (10 mcg of Alprostadil). They found assessing patients in the stretched, flaccid state gave a mean underestimate of about 20% of the erect measurement in all parameters (circumference: 21.4%, suprapubic skin to distal glans: 23.4% and pubic bone to distal glans: 19.9%). This was an important finding: stretched length does not equal erect length, and stretched measurements underestimate penile length [8]. This brought into question the accuracy of using stretched, flaccid penile length as a preoperative measurement tool, which prompted further studies using ICI-induced erections.

Xie et al. observed 62 patients undergoing surgery with 3-piece IPP. They measured penile length (pubic symphysis to glans tip) and circumference after Trimix-induced erections preoperatively, compared with postoperative measurement at 6 weeks and 6 months. They found a slight increase in penile length and circumference at 6 weeks and 6 months postoperatively. Mean preoperative penile length was 5 cm with postoperative length of 5.3 cm and 5.2 cm at 6 weeks and 6 months, respectively. Mean preoperative penile circumference was 4.4 cm preoperatively with postoperative circumference of 4.7 cm and 4.9 cm at 6 weeks and 6 months, respectively, concluding an increase in penile length and girth after IPP placement [9]. However, it is difficult to interpret their results since a 5-cm penile length is not functioning in any adults, causing concern about the study's credibility.

Wang, et al. compared erect penile length induced by ICI preoperatively with erect length after 3-piece IPP placement. Erections were induced with 0.25 mL of Trimix preoperatively, and a measurement was obtained from pubis to glans tip by a single examiner. Postoperative erect penile length was measured at 6 weeks, 6 months, and 1 year after surgery. Erect penile length induced by ICI preoperatively was 13.2 ± 0.4 cm, while postoperative length at 6 weeks was 12.4 ± 0.3 cm, at 6 months was 12.5 ± 0.3 cm, and at 1 year was 12.5 ± 0.4 cm. Thus showing an overall decrease of penile length postoperatively at 6 weeks, 6 months, and 1 year after surgery of 0.83 ± 0.25, 0.75 ± 0.20, and 0.74 ± 0.15 cm, respectively [10•]. Although there was a decrease in penile length, there was no difference in the effectiveness of treating ED. Sexual Health Inventory for Men (SHIM) score was compared between patients who complained of shorter penises to those with no complaints. SHIM scores were the same at 1 months and 1 year follow-up [10•].

The results of Wang's study were further confirmed by Osterberg et al., which compared preoperative length (in flaccid state and ICI induced with Alprostadil) with postoperative IPP length at 6 weeks after placement of 3-piece IPP. All three measurements were obtained from pubic bone to glans tip. Forty-three percent of patients reported subjective loss of penile length at twelve weeks after surgery, with 70% showing objective decreases in penile length (median loss 0.5 ± 1.5 cm) at 6 weeks follow-up [5]. Although majority of patients had a decrease in penile length, this was subjectively perceived by less than half of patients.

Reasons for Length and Girth Issues

The exact mechanisms of penile shortening after an IPP procedure are not known; however there are likely multiple contributing factors occurring in the preoperative, intraoperative, and postoperative settings. Those occurring preoperatively have been discussed previously—accurate and consistent preoperative and postoperative measurements. An important consideration preoperatively is the etiology of ED. Patients presenting with ED after radical prostatectomy will commonly need an IPP [11•]. This patient population is unique in that the cause of ED is likely due to nerve damage in combination with decreased arterial flow. This leads to denervation atrophy with hypoxia and apoptosis of erectile tissues causing penile shrinkage [12].

Intraoperative reasons include incorrect measurement of corporal length, which can result in decreased corporal length due to incorrect downsizing of the cylinders. Post-operatively this produces a supersonic transportation (SST) like deformity [10•]. After surgery, patients may notice lack of glans tumescence, leading to perceived decreased length [13]. Postoperative fibrotic changes resulting in tunical scarring/fibrosis can limit the elasticity of the tunica albuginea [14]. Increases in prepubic fat, recall bias, and capsular contraction could also be contributing factors [5, 15]. The loss of penile length after a penile prosthetic implant is real; however an important point to consider is it is not due to the device itself.

Strategies Used to Enhance Penile Length and Girth

Studies have shown a decrease in penile size, which poses a problem for both patients and urologists. This needs to be

addressed in order to properly counsel and educate patients preoperatively. Various techniques have been employed by urologists preoperatively, intraoperatively, and postoperatively to help enhance penile appearance. Preoperative strategies include VED rehabilitation and external traction rehabilitation prior to IPP placement. Intraoperative strategies include maximal sizing for cylinder placement, the use of length and girth expansion devices, ventral phalloplasty, suprapubic fat pad excision, suspensory ligament release, V-Y flap advancement, sliding technique, and circumferential tunical incision with graft. Postoperative strategies include VED rehabilitation, IPP rehabilitation with scheduled inflations, and medical therapies to help increase appearance of the glans.

Preoperative Strategies

Preoperative VED use can promote penile length, especially in men who have not had an erection for years and are at risk for corporal fibrosis [16]. Canguven et al. had patients use VEDs for 1 month prior to surgery in hopes it would increase flaccid stretched length and facilitate easier corporal dilations intraoperatively. Of the 51 patients, 25 underwent treatment with VED for 1 month (use for 10–15 minutes per day for at least 30 days). The other 26 patients did nothing. In the VED group, their mean stretched penile length was significantly more, by a mean of 0.8 ± 0.38 cm, in addition to easier corporal dilation [17]. Of note, this study did have a small sample size and there was only short-term follow up of 3–6 months. In general, the use of VED is relatively easy, has few contraindications, and is widely available. VED has been known to play a key role in the maintenance of penile length and girth and return to sexual activity after a radical prostatectomy as evidenced by early postoperative use at 1 versus 6 months [18].

Traction therapy has been used in other surgical fields to help induce tissue growth. Penile traction therapy with a penile extender uses a nonsurgical device that puts mechanical traction on the penis to help improve length and girth in the flaccid and erect states. Gontero et al., observed 15 patients who underwent use of a penile extender for at least 4 hours a day for 6 months to see if there was an increase in size from baseline at 1, 3, 6, and 12 months. They found after 6 months, the mean gain in length in the flaccid and stretched length were 2.3 cm and 1.7 cm, respectively, with no change in girth [19]. Levie et al. evaluated 10 men who underwent external traction therapy, applying the device for 2–4 hours daily for 2–4 months prior to surgery. Seventy percent of men had length gain compared with baseline, an average of 1.5 cm of stretched flaccid penile length. After IPP placement, none had subjective or objective penile length loss and there were no adverse events [20]. Both preoperative VED and external traction use have the potential to increase length. However, long-term studies with larger sample sizes are needed to justify their use.

Intraoperative Strategies

Over the last few years, maximal sizing for cylinder placement in combination with aggressive dilation has led to longer cylinders being implanted. Prior to the IPP, the non-inflatable semi rigid penile prosthesis was used. The training in insertion of these was to downsize the rods to help avoid erosion distally [14]. This would lead to downsizing of the cylinders by 0.5 cm; however this is not recommended with placement of an IPP. A study done by Welliver et al. published in 2015 sought to determine if measured corporal length or implanted device size had changed over the years. Data obtained from American Medical Systems and Coloplast (2005–2010) showed an overall increase in implant device sizes in the US market in both companies, with 16-cm cylinders being used less frequently and 20- and 22-cm cylinders being used more frequently [21]. However, there are studies needed to assess if these findings result in objective length maintenance/increase of penile size and in patient satisfaction.

The use of tissue expansion is common in plastic surgery, but its use in urology has been limited. Upsizing of the penile cylinders in IPP has been hypothesized to serve as a tissue expander to help increase internal penile length by stretching the corpora gradually over time when inflated. A study of 2749 patients assessed if IPP cylinder length increased at times of device replacement. The cylinder lengths were calculated as the total length of both cylinders plus rear tip extenders. Patients who underwent device replacement at $\geq$ 2 years had significant increases in mean length of 1 cm across all types of implant devices. This shows an IPP can provide tissue expansion; however the study did not show any correlation to patient satisfaction or functional length [22].

Implantation of length and girth expansion prosthesis helps to preserve penile length without the need for additional procedures. The AMS LGX IPP is designed to expand in girth and length up to 25%. Negro et al. followed 36 patients after placement of 3-piece inflatable AMS 700 LGX IPP to assess penile length, mechanical reliability, and patient satisfaction at 6 and 12 months postoperatively. Penile length was measured at baseline and at 6 and 12 months after surgery. They used three penile lengths: stretched and flaccid (pubic bone to meatus) and with prosthesis 50% and 100% inflated, from pubic bone to meatus. They found an increase in stretched penile flaccid length: 13.1 ± 1.1 cm, to 13.7 ± 1.1 cm, to 14.2 ± 1.2 cm between baseline, 6 months, and 12 months, respectively. There was a mean increase of 10% (1.3 ± 0.4 cm) from baseline to 12 months in the 100% inflated patients. There were no significant differences in patient satisfaction measured by the IIEF and Erectile Dysfunction Inventory of Treatment Satisfaction (EDITS) scores [23].

Although this data seemed promising, there were conflicting results found in a study done a by Wallen et al., also following 26 patients after placement of AMS 700 LGX

IPP. Preoperative measurements included stretched penile length (pubopenile skin junction to meatus) and penile girth. Measurements were taken postoperatively at 6 and 12 months. All patients showed increases in penile circumference and width from baseline to 12 months (9.2 cm to 11.6 cm and 2.8 cm to 3.9 cm respectively). However, there was overall a slight decrease in stretched penile length from baseline to 12 months, 12.5–11.2 cm [15]. These conflicting results show the need for further studies to assess the benefit in penile length and girth using a device designed to expand.

Ventral phalloplasty and suprapubic fat pad excision are adjunct procedures used at the time of IPP placement to help enhance penile appearance [16]. Ventral phalloplasty removes the penoscrotal web. The scrotum is held along the median raphe with the penis on stretch, which delineates the extent of webbing. A check mark excision of the penoscrotal web is made, ensuring the Y-axis marked is one fingerbreadth's clearance from the shaft. The line is carried to the penoscrotal angle and a convex curved line is taken up to the scrotal skin, forming the "check mark." The skin is excised and the dartos is approximated along the axis of the penile shaft, forming a new penoscrotal angle [14, 24, 25]. Miranda-Sousa et al. observed 43 of 90 patients undergoing IPP placement with simultaneous takedown of the penoscrotal webbing. Thirty-nine of the 43 patients had an IPP placed and 4 had a semi-rigid prosthesis placed. Both groups were sent a questionnaire to assess patient satisfaction 3 months postoperatively. Ninety-eight percent of the group with takedown of the penoscrotal junction had good overall satisfaction. Eighty-four percent of that group reported a degree of increase in penile length compared with the other group with no takedown, where 84% reported penile shortening [26]. While an interesting study, this was not designed to take into account objective penile length before and after the procedure. Another factor to consider is the potential wound complications added by this extra procedure, particularly in patients with diabetes due to increased wound dehiscence [27]. Overweight men in whom fat deposition causes the penis to be buried underneath the excess panniculus may benefit by suprapubic fat pad excision with plastic surgery at the time of IPP placement [14, 16, 24, 25]. However, it's important to consider the added risks of these procedures, in particular postoperative infections [28].

Suspensory ligament release and skin flaps, such as the V-Y flap advancement, are other adjunctive techniques. Ligating the suspensory ligament causes the penis to drop into a more dependent position [14, 25]. On average, this procedure adds 1 cm to flaccid penile length [26]. Risks in releasing the suspensory ligament are minimal, however one to be aware of is the risk of reattachment, which can be combated by using a weight or stretch device postoperatively [14, 24, 25]. Borges et al. released the suspensory ligament in 303 patients at the time of IPP placement. Their main outcome was patient satisfaction, with 93% of patients reporting satisfaction with IPP performance, penile length, and willingness to undergo the same surgery again. In a subset of 18 patients, penile length was measured prior and after surgery. There was a mean increase of 2.4 cm in flaccid length and 1.7 cm with erect length [29]. It is also common to perform a skin flap onto the penis via a V-Y plasty. Common issues include the possibility of reattachment of the penis to the pubis, alteration of erection angle, and a hump forming at the base of the penis. To combat this, Shaeer et al. described a new technique, the "V-Y half skin half fat advancement flap" with a "T closure." This sought to minimize loss of gained length and they found 6 months after surgery there was no loss in length gained, angle of erection was similar to prior to the procedure and there was no issues with a formed hump at base of the penis [30]. However, there are further studies that need to be done in order to confirm these findings.

The use of the sliding technique during IPP placement has been shown to help increase length, especially in patients with Peyronie's Disease. Rolle et al. reported a new "sliding technique," which involves degloving the penis, mobilizing the neurovascular bundles and urethra, and making two longitudinal incisions 3–4 cm in length on the tunica albuginea of the corpora cavernosa laterally. These are joined by semicircular incisions on the ventral and dorsal penis. This allows for transection of the corpora and ability to stretch the penis to maximum lengths, with two rectangular defects being left. The IPP is placed and the defects are then covered with a graft. Although only 3 patients underwent this procedure, the average increase in length was 3.2 cm [31•].

There have been modifications to the sliding technique; one is the Multiple Slice Technique (MUST), which is similar, however no graft is used. The distal defect is covered by compressed cavernosum and corpus spongiosum. Buck's fascia was re-approximated to cover the proximal dorsal defect. Egydio et al. observed 138 patients undergoing the MUST procedure, in addition to a non-inflatable prosthesis (103 patients) and an inflatable prosthesis (35 patients) with 15.2 month follow-up. The patients had various etiologies of penile shortening: Peyronie's disease, severe ED, radical prostatectomy, androgen deprivation therapy ± brachytherapy or external beam radiation, and penile fracture. Mean penile length gain was 3.1 cm with a range of 2–5 cm. They did report one glans necrosis [32]. Wilson et al. examined a cohort of 21 patients with glans necrosis after IPP. Preoperative risk factors include arteriosclerotic cardiovascular disease (90%), diabetes (81%), smoking history (81%), previous prosthesis explanation (57%), and previous radiation therapy (48%). Intraoperative and postoperative factors include sub-coronal incision used for penile degloving (86%), wrapping with an occlusive elastic bandage (62%), and the use of sliding technique for penile lengthening (33%) [33].

Identifying these preoperative risk factors can help minimize risk of postoperative glans necrosis, in addition to

modifying surgical techniques. A non-degloving technique has been described, which includes a ventral incision instead of a circumcising incision to deglove the penis. The ventral incision line is extended from the frenulum to penoscrotal junction, and the points of maximum curvature are marked. The incision is made ventrally with mobilization and dissection of the neurovascular bundles and urethra. The skin and neurovascular bundles should be mobilized away, allowing for minimal attachments to the corpora cavernosa. At this point, various techniques, such as sliding technique and MUST, can be employed on the corpora cavernosa [34]. Clavell et al. observed 7 patients who underwent sliding technique procedure (five had non degloving ventral incision) and found at a mean of 15.5 month postoperative follow up, mean penile length gain was 2.6 cm using this approach, with no vascular complications [35•]. Although a small sample size, this technique shows promise and warrants more studies incorporating the ventral incision technique.

Postoperative Strategies

Postoperative IPP rehabilitation with regular cycling of the device has been employed to decrease the risk of penile shortening. Henry et al. conducted a prospective, multicenter study including 40 patients who underwent Coloplast Titan IPP placement with aggressive dilation and maximal cylinder placement in addition to postoperative rehabilitation cycling regimen. This included daily inflation at 6 weeks postoperatively for 6 months and then inflate maximally for 1-2 hours for 6–12 months. Fifteen penile measurements were taken. They found a significant improvement in length (pubic bone to meatus) at 12 months for the erect, flaccid, and stretched measurements: 1.14, 0.99, and 1.04 cm, respectively, compared with the immediate postoperative measurement. Of the patients, 74.2% had perceived penile length that was the same or longer than prior to surgery. Of the patients, 93.4% were satisfied with the overall function and dimensions of their IPP [36]. These findings were further confirmed by Pryor et al. on the same group of patients at 2 years follow-up. They took measurements in 28 patients from postoperative 12 months compared with postoperative at 24 months. There was a significant increase in measurements from pubic bone to meatus in the erect, flaccid, and stretched state of 0.87 ± 1.18, 0.58 ± 0.88, and 0.6 ± 1.34 cm from 12 to 24 months. The penile circumference and width from 12 to 24 months postoperatively went from 1.08 to 1.39 cm and 0.47 to 0.58 cm, respectively. At 2 years, 96.5% of the patients reported being very or extremely satisfied with the surgery fulfilling their expectations [37].

The lack of glans tumescence after IPP placement can give the perception of decreased penile appearance distally. The use of intraurethral alprostadil or oral PDE-5I can be used to help enhance the glans tissue. Benevides et al. assessed the efficacy of Alprostadil (250 mcg with dose escalation up to 100 mcg) in 17 patients who had undergone an IPP with complaints of non-engorgement of glans. Ten of 17 patients were satisfied or highly satisfied with treatment due to penile engorgement or improved sensation. Seven of 10 who were not satisfied with the medication complained of penile pain or had a poor response [38]. Mulhall et al. studied the effects of sildenafil 50 mg (maximum of 100 mg) on patients who had undergone IPP placement versus IPP alone. Thirty-two patients used the IPP alone for at least ten attempts and completed the IIEF questionnaire and then used the IPP in conjunction with Sildenafil for at least four doses and completed the IIEF questionnaire. Twenty-six of 32 patients who underwent placement of a 3-piece IPP and the remaining 6 underwent placement of 2-piece IPP. They found all patients had some degree of glans engorgement with sildenafil and IIEF showed significant improvement in scores when sildenafil was added [39]. When comparing intraurethral alprostadil versus oral PDE-5I, the oral PDE-5I may be easier to administer and does not have the side effect of penile pain.

Conclusion

Erectile dysfunction prevalence is expected to increase worldwide, especially as men are living a longer lifespan. In addition to a longer lifespan, these men will likely present with more medical comorbidities, making the treatment of ED more challenging. There is a perceived and actual reduction in penile length and girth, which continues to be a valid concern among patients and treating urologists. Fortunately, there have been numerous strategies employed in the preoperative, intraoperative, and postoperative setting. Deciding on which strategies and which combinations of strategies to use will vary from patient to patient while also taking into consideration the experience of the surgeon. Although most of these techniques are novel, they have shown promising results in smaller studies. However, in order to be able to incorporate the techniques and strategies into the urologist repertoire, there still needs to be large, multi-institutional, prospective, randomized controlled studies to prove the effectiveness and provide better guidance for future urology practice patterns.

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Compliance with Ethical Standards

Declaration of Interest None.

Conflict of Interest Run Wang, MD, FACS – Consultant for Boston Scientific, Coloplast, and Teleflex.

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Human and Animal Rights This article does not contain any studies with human or animal subjects performed by any of the authors.

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