Current Sexual Health Reports (2019) 11:201–211
https://doi.org/10.1007/s11930-019-00211-0

MALE AND FEMALE SURGICAL INTERVENTIONS (C CARSON AND M KHERA, SECTION EDITORS)

Surgical and Non-surgical Penile Elongation Techniques

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Published online: 8 August 2019

Abstract

Purpose of Review To summarize data on lengthening treatments from PubMed-indexed scientific publications.

Recent Findings Several surgical techniques achieve penile lengthening when combined with penile prosthesis (PP) implantation, including the sliding, incision/excision and grafting, and multiple incision techniques. Other factors associated with greater length with PP include use of AMS 700 LGX devices, new length measurement technique, immediate activation, and regular device cycling. Among non-surgical therapies, penile traction achieves lengthening in most studies, while vacuum therapies demonstrate milder improvements. Other treatments either have failed to demonstrate consistent benefits or have mixed data, including isolated incision/excision and grafting, scrotoplasty, lipectomy/escutcheonectomy, suspensory ligament release, placement of cylindrical silicone (Penuma), or penile injections with silicone, hyaluronic acid, or other similar materials.

Summary Although multiple surgical and non-surgical therapies exist for penile lengthening, most have limited data available. Additionally, injection and surgical treatments can result in severe complications in some cases.

Keywords Peyronie's disease (PD) · Lengthening · Grafting · Sliding technique · Multiple slice technique (MuST) · Plaque incision and grafting (PIG) · Modified sliding technique (MoST) · Penile prosthesis (PP) · Bulking agents

Introduction

Penile size and the desire for increased girth and length are arguably among the most pervasive, recurring topics throughout the history of sexual medicine. For decades, scientific studies have attempted to compare penile lengths by geographic region, nationality, or race, with inconclusive and often contradictory results [1, 2]. Additionally, an abundant volume of literature has been published on the impact of medical/surgical therapies on increasing length and comorbid conditions associated with decreased length. Beyond physical aspects, reduced penile size is also associated with psychological factors such as anxiety, uneasiness, and sexual dysfunction, while larger penile sizes are correlated with virility and overall strength [3]. Interestingly, and despite popular belief, penile size is often a more significant concern for males rather than female partners. In an internet survey of 52,000 heterosexual men and women, 85% of females were satisfied with their partner's penis size, while only 55% of men were similarly content [4]. Penile size is also positively correlated with sexual satisfaction, suggesting that actual or perceived penile size has impacts beyond the physical act of intercourse, including psychological, social, and sexual satisfaction, among others [5].

With this background, it is not surprising that entire industries have emerged to address this pervasive desire, including mechanical or implantable devices, oral therapies, injections, and marketing campaigns that range from the illegitimate and racy to the proven and mainstream. Similarly, multiple surgical procedures have been described purporting to increase penile length and girth. These changes, along with direct to consumer marketing and limited regulatory oversight, have led many to wonder how to differentiate the legitimate from illegitimate. The objective of the current manuscript is

This article is part of the Topical Collection on *Male and Female Surgical Interventions*

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therefore to provide a brief summary of currently available surgical and non-surgical penile elongation therapies, including an analysis of reported outcomes and complications. To accomplish this objective, a PubMed search was performed of all publications relating to penile length from inception through April 2019. Emphasis was placed on more recent publications as well as studies reporting objective measures of penile length prior to and following treatment. Where applicable, commentary is also provided on key methodological limitations to help contextualize outcomes.

History of Penile Lengthening

Therapeutic penile lengthening has been practiced for millenia, with some of the earliest evidence dating back over 20,000 years when African men would hang weights from their penises [6••]. Similarly, cave drawings in 400 BC described male members of royalty that had large penises, while Polynesian cultures utilized woven plant fiber to secure the penis to weighted objects [6••]. Other historical descriptions have been identified among the Cholomec tribe in Peru, sadhus of India, and Papua New Guineans, of whom, ritual practices helped achieve penile lengths of up to 55 cm [7, 8]. Some cultures incorporated even more dangerous techniques, including the Topinama tribe in Brazil (sixteenth century), where men would allow their penises to be bitten by poisonous serpents in an attempt to achieve penile swelling and engorgement.

In contemporary society, multiple lengthening techniques have been described outside of the scientific community, including a "milking" method that involves shaking of penis approximately 25–50 times after an exercise that purportedly "relaxes" connective tissue. A similar technique of "jelqing" involves aggressive massage of the penis in an attempt to lengthen and expand the penis. Beyond mechanical techniques, some cultures inject the penis with various materials (Vaseline, oils, paraffin, silicone, and others) with variable outcomes and complications [6••, 9].

Clinical Evaluation of Decreased Penile Length

Several different etiologies and classifications for decreased penile length have been described. Congenital conditions associated with decreased penile size include hypogonadotropic hypogonadism (Kallman, Prader-Willi, Laurence-Moon, Bardet-Biedl, Rud syndrome), hypergonadotropic hypogonadism (anorchia, gonadal dysgenesis, LH-receptor defects, Trisomy 21, and Poly-X, Noonan, Robinow, Laurence-Moon, and Bardet-Biedl syndromes), other pituitary hormone deficiencies, defects in testosterone receptors, 5-∝ reductase deficiency, fetal hydantoin syndrome, and cloacal exstrophy, among others [10, 11]. Additionally, several acquired conditions impact penile length, including prostatectomy, diabetes, penile surgery, and Peyronie's disease (PD) [12]. Obesity is also linked to reduced penile length and testicular development; however, some of the observed penile changes may relate to extension of the suprapubic pannus rather than true loss of penile length [13] .

The clinical evaluation of penile length includes an objective stretched measurement, which is most commonly performed from the pubic symphysis to penile corona. Men with penises > 2.5 standard deviations below the mean for age meet criteria for true micropenis, which corresponds with a lower range of normal of 9.3 cm [14]. In contrast, those with apparent micropenis secondary to surrounding tissues (e.g., suprapubic fat pad, balanitis xerotica obliterans) are better classified as concealed penis [10]. Men who have otherwise normal appearing penises but who exhibit significant anxiety relating to their penile size are probably better classified as having body (penile) dysmorphic disorder. Arguably, the majority of men will not fit any of these categories, however, and are seeking treatment to enhance their underlying penile size. Consistent with this statement, a recent systematic review of 17 studies performing surgical and non-surgical interventions identified that the far majority of men undergoing procedures had penile sizes within normal ranges [15]. The authors noted that when psychological counseling was provided, most men came to a recognition that their penile size was normal, and they stopped secondary augmentation therapies. The authors concluded that men with normal-sized penises who desired additional length should undergo counseling primarily, followed by traction if bothersome symptoms persisted. They further opined that based on their review, injectables and surgery should be considered unethical unless performed within the framework of a clinical trial, a recommendation that has been echoed by other investigators [16].

Surgical Therapies for Penile Elongation

Several surgical techniques have been described for penile lengthening, either as a primary therapy or, more commonly, as an adjunctive procedure at the time of curvature correction or penile prosthesis. A summary of surgical procedures with data suggesting increased penile length is detailed in Table 1.

Incision and Grafting

Plaque incision/excision and grafting (I&G) is one surgical technique employed for the management of severe penile curvature or complex penile deformities associated with PD [27]. In contrast to the more commonly performed penile plication, I&G has been associated with a smaller extent of penile length loss, or even penile lengthening in some cases. As one example, in the 2012 European Association of Urology guidelines on penile curvature, I&G is classified as penile lengthening,

Table 1 Summary of published studies evaluating penile length changes with various penile surgeries

Author (year)	Population (*n*)	F/U	Lengthening	Shortening	AEs/comments
Incision and grafting					
Sayedahmed (2017) [17]	*N* = 43, PD	33 months	28% with increase, 44% no change	12 (28%) with loss	4 persistent penile hypoesthesia, 2 persistent pain
Wimpissinger (2016) [18]	*N* = 30, PD	13 years	NA	13 (43%) with loss	11 (36.7%) ED; 6 (20%) penile hypoesthesia
Sansalone (2011) [19]	*N* = 157, PD	20 months	+ 2.5 cm (1.7–4.1 cm)	NA	12% residual curvature, 3% glanular hypoesthesia
Knoll (2007) [20]	*N* = 162, PD	38 months	49% with increase, 46% no change	8 (5%) with loss	32 (20%) ED (17 oral therapy, 8 ICI/VED, 7 PP)
Kalsi (2005) [21]	*N* = 113, PD	12 months	NA	29 (25%) with > 1 cm loss	10 (15%) ED
Egydio (2004) [22]	*N* = 122, PD; *N* = 13 CPC	NA	+ 2.9 cm	NA	Single incision technique; 6 men with PP included later in Table 1
Sampaio (2002) [23]	*N* = 40, PD	1–6 years	5% change of 1 cm, 95% no change	0%	9 glanular hypoesthesia (8 recovered after 4–12 months); 1 recurrence, 1 partial necrosis of the foreskin
Adeniyi (2002) [24]	*N* = 51, PD	16 months	NA	18 (35%) with loss; 8 (16%) with > 1 cm loss	4 (8%) ED
Akkus (2001) [25]	*N* = 58 PD	12–36 months	NA	13 (22%) with loss	3 (5%) curvature recurrence
Montorsi (2000) [26]	*N* = 50, PD	32 months	30 (60%) no change	20 (40%) with loss	1 (2%) penile hypoesthesia, 1 (2%) glanular ischemia
El-Sakka (1998) [27]	*N* = 113, PD	18 months	83% was same/longer	17% with loss; 15% with < 1 in. loss' 2% with < 2 in. loss	
Autologous fat transfer/suspensory ligament release					
Panfilov (2006) [28]	*N* = 88 (57 AFT; 31 LR + AFT)	NA	+ 2.4 cm	NA	
Dermal fat graft					
Xu (2016) [29]	*N* = 15, adults post-hypospadias	6 months	+ 1.7 cm in FPL	NA	No AE reported
Xu (2016) [30]	*N* = 23	6 months	+ 2.3 cm in FPL; + 3.1 cm in SPL	NA	
Mokhless (2010) [31]	*N* = 9, pediatric	3 months	+ 2.3 cm erect length	NA	Technique - Z-plasty of penoscrotal web, release of suspensory ligament, and suprapubic fat liposuction; no complications
Spyropoulos (2005) [32]	*N* = 11, penile dysmorphophobia	3–10 months	+ 1.6 cm in SPL	NA	20–53% improved sexual self-esteem; 91% improved subjective functioning; *N* = 5, suprapubic skin advancement + LR; *N* = 3, penile lengthening and dermal-fat graft of shaft; *N* = 2, panniculectomy
Penile prostheses					
Kim (2019) [33]	*N* = 342, ED	12 months	3 months + 0.8 cm; 6 months + 0.9 cm; 12 months + 1.1 cm	NA	1 infection; 10 mechanical failures
Fernández (2019) [34•]	*N* = 43, PD/ED	21 months	+ 2.5 cm	NA	Technique - multiple corporal incisions, grafting with collagen fleece; 1 infection; 1 delayed distal corporeal erosion
Egydio (2018) [35•]	*N* = 138, PD/ED and ED alone	15 months	+ 3.1 cm	NA	Technique - multiple slit (MuST); 103 malleable and 35 inflatable; 1 glanular necrosis
Shaeer (2018) [36]	*N* = 22, ED	12 months			

Table 1 (continued)

Author (year)	Population (*n*)	F/U	Lengthening	Shortening	AEs/comments
			86% with increase; + 3.7 cm	16 (73%) of controls; 0% of treatment	Technique - suprapubic lipectomy and PP; compared to PP controls; no infections
Clavell-Hernández (2018) [37]	*N* = 12, PD/ED	16 months	+ 2.6 cm	NA	Technique – sliding, non-degloving, ventral incision + PP; 1 minimal residual curvature
Rolle (2016) [38]	*N* = 28, PD/ED	37 months	+ 3.2 cm	NA	Technique – sliding; 4% with bleeding requiring transfusion; 7% infection
Weinberg (2016) [39]	*N* = 200, PD/ED	6 months	+ 0.6 cm	0%	2% infection; 1% impending distal erosion
Egydio (2015) [40•]	*N* = 143, PD/ED	10 months	+ 3.1 cm	NA	Technique – MoST; malleable 133, inflatable 10; no major complications
Zucchi (2013) [41]	*N* = 60, PD/ED	40 months	+ 2 cm	NA	Technique – corporoplasty with malleable and bovine pericardial graft; 1 prosthesis extrusion; 1 erosion of tip of corpora
Egydio (2013) [42]	*N* = 105, PD/ED	18 months	+ 3.6 cm	NA	Technique – circular and longitudinal grafting; 3% recurrent curvature; 1% infection
Sansalone (2012) [43]	N = 23, PD/ED	22 months	+ 2.8 cm	NA	Technique – circumferential graft; 4 glanular hypoesthesia; 3 persistent curvature
Rolle (2012) [44]	*N* = 3, PD/ED	13 months	+ 3.2 cm	NA	Technique – sliding - double dorsal-ventral patch graft; no major complications
Moncada (2010) [45]	*N* = 100 ED	6 months	+ 1.1 cm without dilation	− 1.2 cm with dilation	Men randomized to +/− corporal dilation; statistically greater length without dilation; 2 crural perforations, 1 urethral perforation, 2 crossovers; 2 infections; pain > in dilated group
Egydio (2008) [46]	*N* = 25, PD/ED	11 months	+ 3.4 cm	NA	Technique - grafting
Austoni (2005) [47]	*N* = 145, PD/ED	13 months	+ 1.3 cm	NA	Technique – grafting and malleable; 4 glanular hypoesthesia
Egydio (2004) [22]	*N* = 6, PD	NA	+ 2.8 cm	NA	Technique – single incision; 122 of patients are included higher in Table 1 (no PP)

AE, adverse events; *AFT*, autologous fat transfer; *ED*, erectile dysfunction; *FPL*, flaccid penile length; *F/U*, follow-up; *ICI*, intracavernosal injection; *IPP*, inflatable penile prosthesis; *LR*, ligament release; *MoST*, modified sliding technique; *MuST*, multiple incision technique; *PD*, Peyronie's disease; *PP*, penile prosthesis; *RCT*, randomized controlled trial; *SB*, single-blinded; *SPL*, stretched penile length; *TAP*, tunica albuginea plication

while plication is considered to be a penile shortening procedure. [48]. The surgery is performed by directly incising the penile plaque at the site of maximal curvature and concavity, stretching the penis to effect curvature correction, and filling the resulting gap with graft material [12, 27]. Despite multiple grafts being described, none have shown clear superiority over another, with the exception of dermal and synthetic materials being avoided due to contraction, scarring, and infection risks [49].

I&G is commonly purported to be a lengthening technique; however, the majority of published studies report penile shortening [18–22, 25–27]. A recent systematic review by Rice and colleagues evaluated 12 studies ($n = 1025$) of men undergoing I&G over a 20-year period and confirmed that 44.2–95.0% of men who underwent surgery reported no change in penile length [50]. The authors ultimately concluded that regardless of grafting material utilized, I&G was not associated with significant changes in penile length. It is notable, however, that some studies which report increases in penile length are specifically due to measurement methodology. As one example, Egydio and colleagues reported outcomes of 122 men who underwent I&G for PD and reported a mean increase in length of 2.9 cm (among the largest increases in any series) [22]. However, upon review of study methodology, the authors had not used stretched penile length (most commonly used method in publications) but rather an erect measurement from the pubic symphysis to the edge of the penis. As such, the straightening itself resulted in the length measurement increasing, rather than due to actual increases in penile length. This context is important to take into consideration when comparing outcomes among series and when critiquing literature that reports improvements in penile length.

In contrast to I&G performed for men with PD alone, when performed at the time of penile prosthesis (PP) implantation, it may result in increased penile length. A recent study by Fernandez-Pascual and colleagues reported on 43 PD men treated with multiple incisions and collagen fleece grafting and demonstrated a mean increase in penile length of 2.5 cm compared with baseline [34•]. Overall, 82% of men reported satisfaction with length following surgery. Further studies are required to determine if the length improvements are reproducible in other series.

Sliding Technique, Modified Sliding Technique, and Multiple Slice Technique

Several different variations of surgical lengthening via circumferential incisions have been described. To our knowledge, the earliest recorded description of this concept was published in 2012, when Rolle and colleagues reported outcomes of three men undergoing a "sliding technique" at the time of PP placement [44]. The surgery is performed by elevating the penile neurovascular bundle and then making two, offset hemicircumferential incisions on opposing sides of the penis (dorsal/ventral). Additional incisions are made longitudinally to connect the ends of the prior circumferential cuts, which allows for a lengthening of the penis. The resultant gaps are then filled with graft material (small intestinal submucosa in this specific case). Findings from the three men demonstrated increases in length ranging from 2.5 to 4 cm with no ischemia or decreased sensation reported. A later, multi-institutional study of 28 men undergoing the procedure at three tertiary referral centers demonstrated a mean 3.2-cm length increase, with 4% of men requiring a blood transfusion for profuse bleeding and 7% requiring device removal for infection [38].

Two subsequent manuscripts expanded upon the sliding technique by adding possible longitudinal incisions for additional girth and use of Buck's fascia in lieu of grafting materials (modified sliding technique (MoST)) [40•, 51]. The technique was otherwise performed in an identical manner to the original and was done concomitantly with placement of a penile prosthesis. The authors reported outcomes of 143 men undergoing the procedure, with the majority of men having combined PD/ED and 133 of whom received malleable implants. At a mean follow-up of 10 months, results demonstrated an average of 3.1-cm length gain, 5% temporary glans numbness, and 11% temporary anorgasmia.

A further modification to MoST was reported in 2018 and includes multiple hemicircumferential incisions to limit the extent of the tunical defect created (multiple slice technique (MuST)) [35•]. The resultant gaps are subsequently covered with Buck's fascia to serve as the grafting material. Results from 138 men undergoing the technique (malleable placed in 103) demonstrated temporary glans numbness in 3%, temporary anorgasmia in 5%, and glans necrosis in 1%. No infections of the PP were encountered, and length increased by 3.1 cm (range 2–5 cm) at a mean follow-up of 15 months.

Despite the significant increases in penile length reported in the above series, the techniques have not experienced widespread adoption since their description seven years prior. Although exact reasons are unclear, it may be due to concerns for permanent complications, including sensory loss, orgasmic dysfunction, and penile necrosis. Additionally, the original series utilized predominantly malleable prosthetics with limited follow-up, and as such, the occurrence of inflatable device herniations is not well established. This concern for herniation may also potentially explain the need for a further modification from MoST to MuST, as the latter would be expected to reduce the extent of herniation encountered over time. One notable series reported by Wilson and colleagues described 21 men who experienced glanular necrosis after PP placement from at least six separate high-volume surgeons [52•]. The authors noted that the most common factor among these men was the use of a circumcising incision (86%), while an occlusive wrap (62%) and sliding technique (33%) were the 2nd and 3rd most common associated findings. Although

the study does not allow for an assessment of the true incidence of glanular necrosis, it does suggest that it is a legitimate concern which must be taken into consideration when contemplating the procedure at the time of PP.

Penile Prosthesis Selection and Other Adjuvant Surgical Techniques

One of the most common complaints of men undergoing PP is actual or perceived reduced penile length following surgery [53, 54]. To address this concern, several authors have reported adjuvant techniques that may be performed at the time of PP implantation. Henry and colleagues described a new length measurement technique, whereby a slightly longer prosthesis is implanted than would otherwise be selected by intraoperative measurements [55]. A subsequent study was performed of 40 men who underwent PP placement with the new technique and were counseled to inflate the device daily × six months followed by maximally for one–two h daily for an additional six months [56]. At the end of 12 months, patients experienced an approximately 1-cm length gain when compared with immediately post-operatively, and 65% were satisfied with their length, with approximately 29% feeling that their length was longer compared with pre-op.

Another technique which may increase penile length is the use of limited dilation at the time of cylinder placement. Moncada and colleagues randomized 100 men to undergo traditional dilation or limited dilation at the time of PP placement [45]. Results demonstrated a 1.1-cm length gain among the non-dilator group compared with a 1.2-cm length loss in the standard dilation cohort. Outcomes were maintained at 6-month post-op. These findings are intriguing, as they suggest potential benefits from preserving cavernosal erectile tissue.

Device selection may also have some role in optimizing penile lengths among men undergoing PP placement. Of the currently available PPs, the AMS 700 LGX (Boston Scientific, Marlborough, MA, USA) expands in both length and girth by approximately 30% compared with baseline. Limited clinical data confirms length improvements in men who received the prosthesis, with a study of 342 men demonstrating a 1-cm length gain by three-month post-operatively compared with baseline [33]. Similar results have also been confirmed by other investigators [57•].

The timing of device activation is also a key factor in achieving optimal penile lengths following PP placement. Caraceni and colleagues noted a 3.3-cm difference between men who underwent immediate post-operative device activation versus at four weeks [58]. The authors hypothesized that this difference was secondary to capsular formation around the prosthetic itself, limiting the overall length.

Several other adjuvant techniques have been described including scrotoplasty, suspensory ligament release, and suprapubic lipectomy/escutcheonectomy and may be performed with or without a PP. These specific procedures have been performed for several decades with varying results and outcomes [59]. In contrast to the other topics discussed in the current manuscript, these methods do not directly impact penile length but rather are intended to improve visible or perceived length. Similarly, surgical implantation of a silicone sleeve may increase penile girth but has no impact on penile length [60].

Non-surgical Penile Lengthening Therapies

Penile Traction Devices

Penile traction therapy (PTT) is one of the most commonly used therapies for penile lengthening due to its ready availability, low cost, and minimal side-effect profile. Although the specific mechanisms of increasing length are not well defined, its effects likely go beyond stretching of ligaments, collagen, and connective tissue. In vitro assessments of mechanical traction demonstrate induction of several cellular pathways including apoptosis, gene expression, cellular growth/differentiation, and collagen remodeling [61, 62].

Several studies have evaluated the efficacy of PTT on increasing penile length, including as a primary therapy or when combined with other PD treatments (Table 2). One of the earliest studies evaluating traction was performed by Levine and colleagues who treated 10 PD men with PTT for 2–8 h daily for a period of six months. Results demonstrated a non-statistically significant improvement in length of 1 cm with no notable adverse events reported [70•]. Since that time, several additional studies have reported variable results, with a recent meta-analysis confirming a mean 1-cm improvement in length overall [81]. The main limitation with these studies, however, is the need to utilize traction for 3–9 h daily to observe any benefits on length [64•, 65–67, 69]. More recently, a novel traction device has been developed (RestoreX, PathRight Medical, Plymouth, MN, USA) which has demonstrated statistically significant length improvements of 1.5–1.9 cm when used for < 1 h daily for three months [63••, 71•]. In addition to length, limited data exist on the impact of PTT on hourglass or indentation deformities. In one of the few studies available on the topic, 54% of men who used RestoreX reported improvements in hourglass or other indentation deformities, of whom, 50% felt that the improvements were moderate or significant [63••].

Vacuum Erection Devices

In contrast to PTT, much less data is available on the efficacy of vacuum erection devices (VED) on penile length (Table 2). In a limited study of 31 PD men treated with a VED for three months, 35% experienced length improvements (mean

Table 2 Summary of published studies evaluating penile length changes with traction or vacuum devices

Author (year)	Device	Study design	Population (*n*)	Treatment duration	Lengthening	AE/comments
Penile traction as primary therapy						
Ziegelmann (2019) [63••]	RestoreX	RCT, SB, PD	*N* = 110, PD	0.5–1.5 h/day × 3 months	+ 1.6 cm (94% of men)	No moderate/severe AE, improved length, curvature, erectile function, 100% preferred over other devices
Moncada (2019) [64•]	Penimaster PRO	RCT, multicenter	*N* = 93, PD	3–8 h/day × 3 months	Unclear in text (1.8 cm SPL)	No moderate/severe AE, improved length, curvature
Nowroozi (2015) [65]	AndroPenis	Prospective	*N* = 44, subjective small penis	4–6 h/day × 6 months; some f/u 32 months	6 months; FPL + 1.7 cm,; SPL + 1.2 cm	32 months f/u with FPL + 1.6 cm, SPL + 1.2 cm; pain in 5%, numbness in 2%, ecchymoses 2%
Martinez-Salamanca (2014) [66]	Andropeyronie	Prospective, controlled trial	*N* = 96, acute phase PD	6–9 h/day × 6 months	PTT + 1.5 cm; no PTT − 2.6 cm	Erythema 2%, transient pain 25%
Nikoobakht (2011) [67]	Golden erect	Prospective	*N* = 23, subjective small penis	4–6 h/day × 2 weeks; 9 h/day × 2.5 months	FPL + 1.7 cm; SPL + 1.7 cm	
Gontero (2009) [68]	Andropenis	Prospective	*N* = 15, short penis	4–6 h/day × 6 months	FPL + 2.3 cm; SPL + 1.7 cm	
Gontero (2009) [69]	Andropenis	Prospective	*N* = 15, PD	≥ 5 h/day × 6 months	SPL + 1.3 cm; FPL + 0.83 cm	Ecchymoses 13%, pruritus 7%
Levine (2008) [70•]	FastSize	Prospective	*N* = 10, PD	2–8 h/day × 6 months	SPL + 0.5–2.0 cm	
Traction as adjunctive therapy						
Alom (2019) [71•]	CCH and RestoreX	Prospective	*N* = 113, PD	1 h/day	+ 1.9 cm	Compared CCH, CCH + other traction, CCH + RestoreX; no difference in AEs among groups; CCH + RestoreX 11× more likely to have ≥ 20% length improvement
Ziegelmann (2017) [72]	Predominantly andropenis	Retrospective	*N* = 51, PD	3 h/day (1.2 h/day)	PTT + 0.4 cm; no PTT − 0.35 cm	Compared CCH alone to CCH + PTT, only 37% used PTT > 3 h/day
Yafi (2015) [73]	Andropenis	Retrospective	*N* = 112, PD	≥ 2 h/day	PTT + 0.2 cm; no PTT + 0.1 cm	PTT >3 h/day = +0.4 cm
Rybak (2012) [74]	US PhysioMED	Retrospective	*N* = 111, PD, post-op	2–6 h/day × 3 months	TAP+PTT + 0.9 cm; TAP alone − 0.5 cm; PEG+PTT + 1.5 cm; PEG alone + 0.2 cm	Compared TAP/PEG + PTT vs TAP/PEG alone; PTT initiated 3–4 weeks post-op
Abern (2012) [75]	US PhysioMED	Prospective	*N* = 74, PD	2–8 h/day × 1 months	PTT + 0.3 cm; no PTT − 0.7 cm	Combined therapy with intralesional verapamil and PTT; no mod/severe adverse events, estimated + 0.38 cm/h of daily use
Levine (2011) [76]	FastSize	Prospective	*N* = 10, short penis pre-IPP	≥2 h/day × 2–4 months	Post-PTT + 1.6 cm post-PP + 0.9 cm	No mod/severe adverse events
Vacuum erection device						
Raheem (2017) [77]	VED	Prospective	*N* = 53, PD	10 min, 2×/day × 3 months	+ 0.4 cm	9% hematoma due to VED

Table 2 (continued)

Author (year)	Device	Study design	Population (*n*)	Treatment duration	Lengthening	AE/comments
Aghamir (2005) [78]	ErectAid	Prospective	*N* = 37, short penis	20 min, 3×/week × 6 months	+ 0.2 mm	1 hematoma
Raheem (2010) [79]	VED	Prospective	*N* = 31, PD	10 min, 2×/day × 3 months	35% with + 0.5 cm	7% failed to operate pump, 5% painful venous engorgement
Lue (1999) [80]	VED	Retrospective	*N* = 4, PD	30 min, 1×/day × 6 months	VED + 5.1 cm; no VED + 2.5 cm	Status post incision and grafting

AE, adverse events; *FPL*, flaccid penile length; *F/U*, follow-up; *PD*, Peyronie's disease; *PEG*, partial excision and grafting; *RCT*, randomized controlled trial; *SB*, single-blinded; *SPL*, stretched penile length; *TAP*, tunica albuginea plication; *VED*, vacuum erection device

+ 0.5 cm) with few complications [79]. Similarly, among men undergoing treatment with Collagenase Clostridium Histolyticum (CCH) or prior to PP, VED use increased length by + 0.4 and + 0.6 cm, respectively [77, 82]. Overall findings suggest a statistically significant but clinically limited benefit when compared with other methods of mechanical lengthening. In contrast to PTT devices, no studies have been published evaluating the efficacy of VED as a primary therapy to improve hourglass or indentation deformities in PD men.

Injectable Therapies

Injectable therapies have been purported to increase penile girth and length and commonly include hyaluronic acid, liquid silicone, polyacrylamide, and mineral oil, among others. From a historical perspective, and similar to traction, injectable agents are likely one of the oldest therapies used to augment penile size, with multiple agents used for 50+ years [83–87].

Limited data on outcomes suggests consistent benefits with increasing girth in men undergoing penile injections. However, to the author's knowledge, no injectable agent has been shown to increase stretched penile length. Specifically, injectable agents have been associated with moderate to severe complications, including penile distortion, pain, granulomas, swelling, and sexual dysfunction [60, 83, 87–89]. The true rate of complications with injectable therapies is not well understood, as there are no rigorous studies which have been performed of this therapy to date. One study of polymethylmethacrylate-based soft tissue fill injections reported an overall, long-term complication rate of 0.4%; however, this is likely due to significant underreporting [90, 91]. Additionally, the potential for injectable migration, vascular compromise, glanular necrosis, sepsis, and systemic hypersensitivity can, on occasion, lead to life-threatening complications [85, 92, 93]. Due to these factors, injectable agents are not commonly recommended or used in developed nations due to their high rate of side effects, variable efficacy, and superior alternative therapies.

Conclusions

Penile lengthening has been sought after for thousands of years by nearly every race and culture. Although some men seek treatment for pathologic causes of decreased penile length, arguably the far majority of treatments are administered for esthetic reasons. Among surgical lengthening therapies, the far majority are performed concomitantly with PP placement and include either limited or circumferential incisions to the tunica. Some of the more aggressive surgical treatments are associated with greater improvements in length but at the expense of potentially devastating complications. Other adjunctive PP techniques include the use of AMS 700

LGX devices, new length measurement technique, device activation immediately after surgery, and cycling the prosthesis regularly. Outside of PP, lengthening techniques which have been described include scrotoplasty, lipectomy/escutcheonectomy, suspensory ligament release, and placement of cylindrical silicone, although none have consistently demonstrated objective, significant improvements in penile length. Similarly, non-surgical penile injections have demonstrated no improvements in penile length and are associated with potentially significant complications. Among mechanical therapies, VEDs are generally minimally effective, while PTT has more consistently demonstrated the greatest improvements in length with few complications. However, key issues with all traction devices except one include a need to use 3–9 h daily, limiting their clinical utility.

Acknowledgments The authors wish to acknowledge the generous gift from a patient who wishes to remain anonymous and which has facilitated Peyronie's disease research.

Funding Sources This work was fully supported by internal institute funds and from a benefactor patient who wishes to remain anonymous.

Compliance with Ethical Standards

Conflict of Interest Dr. Landon Trost and Mayo Clinic are patent holders for a penile traction technology. The Mayo Clinic Conflict of Interest Board has reviewed the conflict and cleared Dr. Trost to participate in research on the topic.

Kiran L. Sharma and Manaf Alom each declare no potential conflicts of interest.

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

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