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The Rear Tip Extender for Inflatable Penile Prosthesis: Introduction of “Rigidity Factor” and Review of the Literature

Nannan Thirumavalavan, MD¹, Billy H. Cordon, MD², Martin S. Gross, MD³, Jeffrey Taylor⁴,
and Jean-Francois Eid, MD⁵

¹Baylor College of Medicine, Houston, TX USA

²Columbia University Division of Urology at Mount Sinai Medical Center, Miami Beach, FL USA

³Dartmouth-Hitchcock Medical Center, Lebanon, NH USA

⁴Coloplast Research and Development, Minneapolis, MN USA

⁵Advanced Urological Care, New York City, New York USA

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Introduction

The inflatable penile prosthesis (IPP) has become the standard of care for severe erectile dysfunction refractory to non-surgical therapies. IPP placement is a reliable, safe surgical treatment option with high patient satisfaction rates [1–3]. The use of Rear Tip Extenders (RTEs) is an underexplored aspect of IPP placement. Recent data have shown that RTEs are placed in approximately 68% of implants [4]. Other studies show that the use of RTEs has increased from 2000 to 2015 in the percentage of IPP placements, from 6-8% in 2000 to 93% in 2015 [4,5]. In this manuscript, we review the limited literature regarding RTEs and introduce a novel concept, “Rigidity Factor” (RF), to describe the effect of RTEs on the mechanical properties of an erection.

Corresponding Author: Nannan Thirumavalavan, nannan@bu.edu, 1 Baylor Plaza, N709, Houston, TX 77030.

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Conflict of Interest:

Nannan Thirumavalavan – None

Billy H Cordon – Consultant, Coloplast and Boston Scientific

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Jeffrey Taylor – Consultant, Coloplast

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Historical Background

The first rudimentary IPP was introduced by F. Brantley Scott in 1973, and eventually became the American Medical Systems (AMS) 700. This was followed in 1983 by the first Mentor IPP. Early in the evolution of prosthetics, cylinder leaks were a common cause of malfunction. These were thought to be from friction between the tubing and the cylinder (input-tube wear), and generally occurred 12 to 18 months after implantation [6,7]. Rear Tip Extenders (RTEs) were introduced in 1981 [6], in an effort to decrease input wear on the cylinders. RTEs were initially thought to improve appropriate cylinder sizing and mechanical survival [8]. Several authors reported data showing this and argued that RTEs improved mechanical survival [8–12]. However, this was not universally accepted as one study did not find that the RTE reduced the incidence of cylinder leakage [13]. Kink resistant tubing introduced in 1983 likely played a larger role in preventing device leakage than did RTEs [9]. More recently, minor alterations in RTE size and shape have been made. Snap-on RTEs were developed in response to prevent dislodgement during explantation. RTEs have also been made narrower to facilitate easier proximal placement.

Other uses for RTEs have evolved in the last three decades. In patients with long proximal corporal measurements during IPP placement, rear tip usage has been advocated as the conventional wisdom. This recommendation comes from the need to properly locate the pump in the scrotum, particularly in devices with fixed-length tubing. Without RTEs, the anecdotal teaching has been that the pump tends to migrate upwards, which can result in patient discomfort and poor cosmesis. In addition, they have been used as a “hammock” to place a cylinder after a proximal perforation[14], and to anchor penile prostheses to bone in female to male transgender patients[15].

Complications of Rear Tip Extenders

The use of RTEs presents unique complications. One retrospective analysis of implants from 2000 to 2015 showed a two-fold increase in revision rates for implants that used any rear tips [5]. However, it is important to note that this may be confounded by the fact that more experienced surgeons (who may have fewer complications) use fewer rear tips. It has been shown that more experienced surgeons have a lower reoperation rate [16]. The most common complication reported with a rear tip is when it is left behind either during revision/removal surgery or during re-positioning. Many series and case studies have been published regarding methods of RTE removal, including using a nasal speculum, graspers, a Silastic penile measuring rod, a Brooks dilator and cystoscopic (using a cystoscope in the corpora) removal [17–21]. Complete bilateral dislocation of the rear tips has also been reported [22]. Retained rear tips can cause pain or infection in the long term [17].

Current Practices in RTE Use

The use of rear tips varies depending on surgeon volume. Manufacturer-tabulated IPP patient information forms (PIFs) reported to Coloplast (Minneapolis, MN USA) from January 1, 2012 to April 5, 2015 were reviewed (Table 1). Low volume was defined as surgeons performing 0-10 IPPs per year, mid volume 11-49 and high volume 50 per year. A total of

24,180 PIFs with relevant data were received during the study period. 51% of implants were placed by low volume surgeons, 22% by mid volume surgeons, and 27% by high volume surgeons. There was a difference in the use of RTEs among surgeons of different volume ($p < 0.001$). RTEs were used in 73% of surgeries performed by low volume surgeons, 68% of surgeries performed by mid volume surgeons, and only in 58% of surgeries performed by high volume surgeons. Recent work has suggested an association between the use of RTEs and need for revision surgery. DeLay et al. assessed 65,448 cases of IPP placement between 2000 and 2015, and found that the use of rear tips significantly increased revision rate two-fold (1.34% vs 2.65%) [5].

The use of rear tips may also vary by the surgical approach for prosthetic placement. A multi-institutional study showed that penoscrotal approach to prosthesis placement was associated with increased proximal dilation (10.1 cm vs 8.6 cm, $P < 0.0001$), and resulted in longer RTEs (1.9 cm vs 1.2 cm, $P < 0.0001$), when compared to infrapubic placement [20]. This difference may be because additional RTEs are added in the penoscrotal approach to place the pump lower in the scrotum. Infrapubic prostheses have longer tubing length from the cylinders to the scrotal pump, precluding this need.

Mechanical Properties of Rear Tips

An increased length of RTEs in an implant decreases the ratio of the inflatable to not inflatable component that can be placed in a certain patient. For example, if a patient has corpora cavernosa that measure 24cm, 4cm of RTEs limits the total length of the inflatable cylinder itself to 20cm. Compounding the issue, current inflatable cylinders are truly a hybrid of non-inflatable and inflatable prostheses. The Coloplast Titan implant has a 5cm rigid non-inflatable portion, even if no rear tips are used (See Figure 1). To quantify this, we propose a novel concept termed “Rigidity Factor,” defined as the ratio between the live (inflatable) portion of cylinder over the total length. Rigidity factor thus represents the truly inflatable proportion of a cylinder.

For a given cylinder length there is a maximum Rigidity Factor. All Titan® cylinders have a non-inflatable rear base of 5cm. Therefore, the maximum achievable Rigidity Factor for each cylinder size is (total cylinder length - 5cm)/corporal length). Use of RTEs thus decrease the Rigidity Factor (See Table 2). The inflatable component more closely mimics a natural erection from a patient’s perspective. The proximal portion of the corpora fill with blood and get as erect as the remainder of the corpora in a natural erection. Maximizing the inflatable component of the implant, and in turn the Rigidity Factor, provides maximal benefit to the patient and mimics a more natural erection. This concept was tested in a pilot study using a laboratory model, which demonstrated that increased rear tip use lead to increased angular deflection of the cylinders [24]. Increasing the Rigidity Factor may have some limitations. A larger reservoir may be required to accommodate the additional fluid requirement, and additional pumping may be required, which could present a challenge to men with limited dexterity.

The point where the inflatable component meets the malleable component of the implant has an impact on the implant’s performance. This point can act as a fulcrum, allowing the

implant to flex even when fully inflated. The use of longer RTEs advances this focal point more distally in the corpora, which then changes the angle of the erection, and thus decreases the quality of the erection. In a natural erection, this focal point would be at the proximal end of the corpora, at the crura, which are fixed. This phenomenon is similar to what has been described by patients using a vacuum erectile device and a penile ring, where the penile ring acts as a fulcrum and only the corpora distal to this is erect. Patients complain of a “floppy” erection in this situation, which is hinged and thus not become erect as one contiguous structure. Further investigation of these patients’ sexual quality of life and revision rate could help us further understand this phenomenon.

Wallen et al. have also performed and published cadaveric testing of penile prostheses[25]. The authors tested multiple devices (AMS CX, AMS 700 LGX, and Coloplast Titan) in a total of 3 cadavers. Each device underwent longitudinal column load testing, modified cantilever testing, and 3-point bending testing. The authors found when filled to 517 mmHg (what the authors labelled less-than-maximum inflation), increasing RTE length allowed the implants to tolerate a higher column load. Similarly, increased RTE length was associated with increased horizontal stiffness, as defined by modified cantilever deflection. It is important to note that this study was not designed or conducted to investigate the role of RTEs. In addition, this model does not account for the pseudocapsule dilation that occurs in patients and these findings were not found at maximal inflation. The exact effects of RTEs still require further investigation.

Penile prostheses form a pseudocapsule after implantation[26]. For the inflatable component of the implant, inflation of the implant allows the material to fill the entire space within the pseudocapsule. However, anecdotally, we have found that the pseudocapsule around the non-expanding rear tips gradually dilates over time, and pressure atrophy with gradual compression of the surrounding cavernosal muscle and tunica thins out the flesh of the penis. The dilation may cause the device to “wobble” proximally, more so if more rear tips are used. In our experience, this phenomenon is more pronounced with malleable penile prostheses.

Future advances in penile prosthesis development could consider maximizing the Rigidity Factor of prosthetic cylinders. Having a shorter fixed proximal portion (For example Coloplast 3cm instead of 5cm and AMS 2.5cm instead of 4.5cm) would increase the Rigidity Factor and thus improve the quality of the erection, in our opinion. This would also result in a more proximal placement of the junction between the malleable and inflatable components. In addition, having implants in 2cm and 3cm increments makes it more likely that the surgeon will need to use rear tips. As such, producing implants in 1cm increments, at least for the most commonly used sizes, will reduce the need for rear tips. Recent developments have already been made to limit the original concerns for which RTE use was advocated. For example, AMS has increased the length of tubing from the cylinders to the pump, from 9cm to 14cm[27]. This increased length alleviates some concern that the pump will be pulled superiorly in patients with longer proximal corporal measurements.

Conclusions

Rear tip extenders are one of many components developed over the evolution of inflatable penile prostheses. Evidence in the literature shows that their use correlates with increased rates of revision as well as complications associated with their removal. We introduce a novel term, Rigidity Factor, to quantify the inflatable proportion of the implant, and believe surgeons should consider maximizing Rigidity Factor. The biomechanical effects of RTE require further dedicated study to understand their effects on penile and erectile rigidity. Future work should explore the effects of subtle variations in prosthesis surgery, such as RTE usage, to further refine the procedure and improve patient satisfaction.

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References

- [1]. Chung E, Solomon M, DeYoung L, Brock GB. Clinical outcomes and patient satisfaction rates among elderly male aged 75 years with inflatable penile prosthesis implant for medically refractory erectile dysfunction. *World J Urol* 2014;32:173–7. doi:10.1007/s00345-013-1102-7. [PubMed: 23708698]
- [2]. Chung E, Solomon M, Deyoung L, Brock GB. Comparison between AMS 700 CX and Coloplast Titan Inflatable Penile Prosthesis for Peyronie's Disease Treatment and Remodeling: Clinical Outcomes and Patient Satisfaction. *J Sex Med* 2013;10:2855–60. doi:10.1111/jsm.12009. [PubMed: 23210973]
- [3]. Lledó-García E, Jara-Rascón J, Moncada Iribarren I, Piñero-Sánchez J, Aragón-Chamizo J, Hernández-Fernández C. Penile Prosthesis First and Replacement Surgeries: Analysis of Patient and Partner Satisfaction. *J Sex Med* 2015;12:1646–53. doi:10.1111/jsm.12932. [PubMed: 26193766]
- [4]. Cordon BH, Eid JF. 041 Differences in the Utilization of Rear Tip Extenders for Inflatable Penile Prosthesis Amongst Different Volume Implanters. *J Sex Med* 2017;14:e20–1. doi:10.1016/j.jsxm.2016.12.054.
- [5]. DeLay K, Gabrielson A, Yafi F, Hellstrom W. Pd22-06 Rear Tip Extenders During Inflatable Penile Prosthesis Placement: Impact on Need for Revision. *J Urol* 2017;197:e443–4. doi:10.1016/j.juro.2017.02.1057.
- [6]. Scarzella GI. Cylinder Reliability of Inflatable Penile Prosthesis: Experience with Distensible and Nondistensible Cylinders in 325 Patients n.d.
- [7]. Kim S, Keun Seo K, Hwan Yoon S. Fracture At the Input Tube-Cylinder Junction of Ams 700 Inflatable Penile Prostheses As a Complication of a Modified Implantation Technique in a Series of 99 Patients n.d.
- [8]. Malloy TR, Wein AJ, Carpiello VL. Improved Mechanical Survival with Revised Model Inflatable Penile Prosthesis using Rear-Tip Extenders 1982;128:489–91. doi:10.1016/S0022-5347(17)53009-8.
- [9]. Furlow WL, David M Barrett MD. Inflatable Penile Prosthesis. New Device Design and Patient-Partner Satisfaction. *Urology* 1984;24:559–63. [PubMed: 6506395]
- [10]. Fishman IJ, Scott FB, Light JK. Experience with inflatable penile prosthesis. *Urology* 1984;23:86–92. [PubMed: 6719687]
- [11]. Joseph DB, Bruskewitz RC, Benson RC. Long-term evaluation of the inflatable penile prosthesis. *J Urol* 1984;131:670–3. [PubMed: 6708180]
- [12]. Fallon B, Rosenberg S, Culp DA. Long-term followup in patients with an inflatable penile prosthesis. *J Urol* 1984;132:270–1. [PubMed: 6737575]

- [13]. Gregory JG, Purcell MH, Standeven J. The inflatable penile prosthesis: failure of the rear tip extender in reducing the incidence of cylinder leakage. *J Urol* 1984;131:668–9. [PubMed: 6708179]
- [14]. Zaroni M, Henry GD. A case of mechanical failure with proximal perforation at the time of revision surgery. *J Sex Med* 2009;6:2629–32. doi:10.1111/j.1743-6109.2009.01475.x. [PubMed: 19817976]
- [15]. Cohen AJ, Bhanvadia RR, Pariser JJ, Hatcher DM, Gottlieb LJ, Bales GT. Novel Technique for Proximal Bone Anchoring of Penile Prosthesis After Radial Forearm Free Flap Neophallus. *Urology* 2017;105:2–5. doi:10.1016/j.urology.2017.01.016. [PubMed: 28163085]
- [16]. Onyeji IC, Sui W, Pagano MJ, Weinberg AC, James MB, Theofanides MC, et al. Impact of Surgeon Case Volume on Reoperation Rates after Inflatable Penile Prosthesis Surgery. *J Urol* 2017;197:223–9. doi:10.1016/j.juro.2016.08.083. [PubMed: 27545573]
- [17]. Hellstrom WJG. Three-piece inflatable penile prosthesis components (surgical pearls on reservoirs, pumps, and rear-tip extenders). *Int J Impot Res* 2003;15 Suppl 5:S136–8. doi:10.1038/sj.ijir.3901090. [PubMed: 14551593]
- [18]. Saw NK, Terry T. Simple Method of Retrieving Retained Rear Tip Extender During Explantation of Penile Prosthesis. *Urology* 2008;72:916–7. doi:10.1016/j.urology.2008.06.058. [PubMed: 18701148]
- [19]. Randrup ER. Penile implant surgery: Rear tip extender that stays behind. *Urology* 1992;39:87. doi: 10.1016/0090-4295(92)90050-7. [PubMed: 1728803]
- [20]. Munk-Hartig A-K, Stübinger SH, Jünemann K-P, Van Der Horst C. Endoscopic Retrieval of a Penile Prosthesis' Rear-Tip Extender. *J Sex Med* 2008;5:1756–9. doi:10.1111/j.1743-6109.2008.00849.x.
- [21]. Thirumavalavan N, Hoover CRV, Gross MS. Surgeon's Corner: Cavernoscopy for Rear Tip Extender Removal. *J Sex Med* 2018. doi:10.1016/j.jsxm.2018.05.010.
- [22]. Joseph D, Bruskewitz RC. Bilateral dislocation of rear tip extenders from the inflatable penile prosthesis. *J Urol* 1982;128:1317–8. [PubMed: 7154196]
- [23]. Trost L, Boonjindasup A, Hellstrom W. Comparison of infrapubic versus transcrotal approaches for inflatable penile prosthesis placement: A multiinstitution report. *Int J Impot Res* 2015;27:86–9. doi:10.1038/ijir.2014.35. [PubMed: 25339138]
- [24]. Thirumavalavan N, Cordon BH, Gross MS, Taylor J, Eid J-F. Rear Tip Extenders and Penile Prosthesis Rigidity: A Laboratory Study of Coloplast Prostheses. *J Sex Med* 2018;15:1030–3. doi:10.1016/j.jsxm.2018.05.001. [PubMed: 29884443]
- [25]. Wallen JJ, Barrera EV, Ge L, Pastuszak AW, Carrion RE, Perito PE, et al. Biomechanical Comparison of Inflatable Penile Implants: A Cadaveric Pilot Study. *J Sex Med* 2018;15:1034–40. doi:10.1016/j.jsxm.2018.05.014. [PubMed: 29960627]
- [26]. Caraceni E, Utizi L, Angelozzi G. Pseudo-capsule “coffin effect”: How to prevent penile retraction after implant of three-piece inflatable prosthesis. *Arch Ital Di Urol e Androl* 2014;86:135–7. doi:10.4081/aiua.2014.2.135.
- [27]. Boston Scientific Corporation. AMS 700™ Inflatable Penile Prosthesis Penoscrotal Optimized Tubing Length. 2018.

Figure 1.

All Coloplast Titan cylinders have a 5 cm non-inflatable portion. In this example adding a 2 cm RTE increases the non-inflatable portion to 7 cm.

Table 1 –

Use of RTEs Stratified by Surgical Volume

	RTEs Used	No RTE	Number of IPPs
Low Volume Surgeons	8,975 (73%)	3,399 (27%)	12,374 (51%)
Mid Volume Surgeons	3,646 (68%)	1,698 (32%)	5,344 (22%)
High Volume Surgeons	3,733 (58%)	2,729 (42%)	6,462 (27%)
Total IPPs	16,354	7,826	24,180
	p = < 0.001	p = < 0.001	

Table 2 –

Coloplast Titan Cylinder Length, Rigidity Factor and RTE Use

Total Cylinder Length	Live Cylinder Length	Maximum Rigidity Factor	1 cm RTE	2 cm RTE	3 cm RTE
28cm	23 cm	0.82	0.78	0.75	0.71
26cm	21cm	0.81	0.77	0.73	0.61
24cm	19cm	0.79	0.75	0.71	0.67
22cm	17cm	0.77	0.73	0.68	0.64
20cm	15cm	0.75	0.70	0.65	0.60