DOI: *10.4081/aiua.2025.13480*

ORIGINAL PAPER

Safety of large reservoirs in inflatable penile prosthesis surgery

Ibrahim Alnadhari [1, 2], Muammer Alshrani [1], Osama Abdeljaleel [1, 2], Omar Ali [1, 2], Abdulla Al-Ansari [2, 3], Ahmad Shamsodini [1, 2]

[1] Urology Section, Department of Surgery, Al Wakra Hospital, Hamad Medical Corporation, Qatar;
[2] Department of Surgery, Qatar University, Qatar;
[3] Urology Section, Department of Surgery, Ambulatory Care Center, Hamad Medical Corporation, Qatar.

Summary ***Introduction: The use of inflatable penile prostheses (IPP) has become a well-established treatment for erectile dysfunction, offering significant improvements in the quality of life for many patients.***
The reservoir site and size in IPP surgery are areas of ongoing research and debate. This study aims to evaluate the outcomes associated with the use of large reservoirs in IPP, focusing on both the surgical techniques and postoperative complications.
Materials and methods: Our study is a retrospective study of 60 patients who underwent inflatable penile prosthesis (IPP) with large reservoir irrespective of the size of the prosthesis in Al Wakra Hospital from the period of 1st of January 2022 to 30th of August 2024.
Result: Successful insertion of the large reservoir was carried out in all patients from the same penoscrotal incision. There was no recorded migration, urethral injury, infection, device failure, pain, erosion or LUTS in our patients. Revision was done in one patient.
Conclusions: The use of large-volume reservoirs in inflatable penile prosthesis (IPP) surgery demonstrates a favorable safety profile, with no significant increase in complication rates compared to standard reservoir sizes.

KEY WORDS: Erectile dysfunction; Penile prosthesis; Reservoir.

Submitted 7 February 2025; Accepted 10 February 10 2025

INTRODUCTION

Erectile dysfunction (ED) is a common medical condition, affecting approximately 150 million men worldwide, with expected increasing prevalence due to aging populations and increasing risk factors such as diabetes and cardiovascular disease (1, 2). For men unresponsive to first-line treatments like oral phosphodiesterase inhibitors or intracavernosal injections, surgical interventions such as penile prosthesis implantation remain the gold standard, offering high efficacy and patient satisfaction rates (3). *Inflatable penile prosthesis* (IPPs) are preferred among the alternatives because they may mimic a natural erectile state while permitting full deflation, improving patient comfort and aesthetic results (4). Recent advancements in IPP design and surgical approaches have led to improved patient outcomes. New features such as antibiotic-impregnated coatings, kink-resistant tubing, and modifications in reservoir placement have contributed to the durability and reliability of these devices (5). Despite these improvements, complications such as infection, mechanical failure, and the need for revision surgery still pose significant challenges.
The fluid reservoir is an essential part of the IPP system and it permits the hydraulic mechanism required for inflation and deflation. In particular, larger reservoirs have been developed to provide greater fluid capacity, improving the functionality of the prosthesis in patients with specific anatomical needs or high fluid volume requirements (6). Despite their potential benefits, the use of large reservoirs poses unique challenges due to proximity of essential organs including bladder, colon, and vascular architecture and placement requiring for more surgical accuracy, especially in patients who have had radiation therapy or previous pelvic procedures (7).
The safety and efficacy of large reservoirs remain areas of active research, with no studies describing the use of large reservoir as routine in all cases of IPP.
This study aims to evaluate the clinical outcomes associated with the use of large reservoirs in all IPP surgery, focusing mainly on their safety profile.

MATERIALS AND METHODS

Participants

Our retrospective study included 60 patients who underwent *inflatable penile prosthesis* (IPP) with large reservoir in *Al Wakra Hospital* from the period of 1st of January 2022 to 30th of August 2024.
The inclusion criteria in our study were being adult patients who underwent IPP with a large reservoir. On the other hand, the exclusion criteria were patients with previous pelvic surgeries that significantly altered pelvic anatomy (e.g., radical prostatectomy, bladder surgeries), or ectopic reservoir. Pre-operative demographics and clinical characteristics including the age of the patient, comorbidities, presence of Peyronie's disease, use of anticoagulants, penile Doppler study were recorded. Type of the IPP, size of the cylinders and size of the reservoir were also recorded. Postoperative complications were documented as well.

This study was approved by the *Surgical Research Committee, Hamad Medical Corporation* (MRC-01-24-659) and it was conducted in accordance with the Helsinki Declaration, and the need for informed consent was waived from the medical research committee given the retrospective nature of the study and the use of electronic medical records only. However, the privacy of the participant's information regarding this study was maintained with confidentiality.

Surgical technique

All procedures were performed by experienced urologic surgeons. Prophylactic antibiotics were given. All cases were done using penoscrotal incision. Firstly, the reservoir was placed in the traditional space of Retzius through the floor of the external inguinal ring. The bladder was drained prior to the insertion of the reservoir to minimize risks of injury or complications. Access to the retropubic space was achieved by blunt dissection through the transversalis fascia using the index finger, guided by tactile feedback. Key anatomical landmarks include the pubic tubercle, the pubic bone, and occasionally the catheter balloon within the bladder which were felt to guide for safe placement of the reservoir in the space of Retzius. After piercing the transversalis fascia, the Deaver retractor was used to elevate the floor of the inguinal canal. The surgeon inserted the reservoir using wide forceps and the assistance pushed it further into position. The final placement was confirmed by feeling it with a finger. Large reservoir size was routinely used in all the cases irrespective of the size of the prosthesis depending on the type of the penile prosthesis used (*AMS: 100 ml, Coloplast: 125 ml, Rigicon: 110 ml*). Then incisions were made in the corpora cavernosa and the corpora cavernosa were dilated. The length of the corpora cavernosa was measured and the cylinders were inserted according to the measured size. Final steps were the insertion of the pump in the scrotum, connection of the tubing and closure of the incision.

Statistical analysis

Descriptive statistics for categorical variables were centered on frequencies and proportions. For continuous variables, means and standard deviations were reported. All statistical analyses were done using statistical packages SPSS 22.0 (*SPSS Inc. Chicago, IL*) software.

Table 1.
Demographic, clinical features, outcomes and treatment modality of patients with large reservoir (N = 60).

Variable	
Age (yr) M ± SD	60.18 ± 9.07
Range	(34-77)
Comorbidities present n (%)	46 (76.6%)
DM n (%)	39 (65%)
Presence of Peyronie's disease n (%)	4 (6.6%)
Anticoagulant n(%)	17(28.3%)
Penile Doppler Study	
Venous leak n (%)	36 (60%)
Arterial insufficiency n (%)	13 (21.7%)
Mixed n (%)	7 (11.7%)
Exchange n (%)	4 (6.6%)
Prosthesis type (Company)	
AMS n (%)	17 (28.3%)
Coloplast n (%)	38 (63.3%)
Rigicon n (%)	5 (8.3%)
Prosthesis Size	
15 cm	3 (5%)
18 cm	14 (23.3%)
20 cm	17 (28.3%)
21 cm	9 (15%)
22 cm	17 (28.3%)
Size of reservoir	
100 ml	17 (28.3%)
125 ml	38 (63.3%)
110 ml	5 (8.3%)
Follow-up days (M ± SD)	589.4 ± 416.5
Complications	
Migration of reservoir n (%)	0
Erosion n (%)	0
Urethral injury n (%)	0
Device failure n (%)	0
Infection n (%)	0
Pain n (%)	0
LUTS n (%)	0
Revision	1 (1.6%)

Values presented as mean ± SD (range) or number (%); DM: Diabetes mellitus; LUTS: Lower urinary tract symptoms.

Results

Variables and correlations are showed in Table 1. The mean age of the patients was 60.18 ± 9.07 years. Comorbidities were present in 46 (76.6%) patients and 39 (65%) were diabetic. Peyronie's disease was present in 4 (6.6%) patients. As regards the etiology of erectile dysfunction, 60% of the patients had bilateral venous leak, 21.7% had bilateral arterial insufficiency, and 11.7% mixed vascular disease. Four (6.6%) patients underwent penile prosthesis exchange for device failure after long period of insertion. Prosthesis size ranged from 15 cm to 22 cm according to the intraoperative measurement of the corpora cavernosa. The largest reservoir size of the used penile prosthesis company was inserted as shown in Table 1. The mean follow up period was 589.4 ± 416.5 days. As for the outcomes, there was no recorded migration, urethral injury, infection, device failure, pain, erosion or *lower urinary tract symptoms* (LUTS) in our patients. Revision surgery was done in one patient.

Discussion

The safety of using large reservoirs in penile prosthesis surgery is a critical factor that influences both surgical outcomes and patient satisfaction. Our rational is that large reservoirs offer certain advantages, such as increased capacity and potentially improved device longevity. With a sufficient fluid supply, the inflation and deflation mechanisms work more efficiently, preventing excessive stress on the internal components, which might degrade over prolonged use. Well-functioning large reservoir ensures smooth cycling of the prosthesis, potentially reducing the

likelihood of fibrotic tissue development around the device, which can affect its durability.

Decision for using a large reservoirs at the beginning of the surgery allows the assistant to begin opening and preparing the reservoir immediately, even before measuring the cylinder size. This helps save operative time and contributes to reducing the risk of infection. On the other hand, use of large reservoir present unique challenges and risks that must be carefully considered. Our study investigated the safety of using large reservoirs in all IPP surgery irrespective to the size of the prosthesis. To the best of our knowledge, this is the first study to incorporate large-volume reservoirs in all IPP procedures. Our findings showed that the use of large reservoirs is safe and can be utilized in most cases without significant increases in complications, offering better performance of the device and enhancing patient satisfaction. Placing the reservoir in the space of Retzius as the first step offers several advantages. It allows the reservoir to be inserted into a clean surgical field before performing corporotomies, which can introduce bleeding and make the field less clear. This also enables early detection of any bleeding from the space of Retzius. Additionally, this approach reduces overall surgical time, as the assistant can begin preparing the reservoir immediately after the initial incision. Henry et al suggested that draining of the bladder and Trendelenburg positioning to increase the distance between inguinal ring and viscera and allow decompression of the external iliac vessels, are useful steps to minimize the risk of complications during the reservoir insertion (8). The survival rate of penile prosthesis is 90.8% and 85.0% at 5 and 10 years follow-up (9). The most common cause of mechanical failure was fluid loss in 75% (10). In addition to fluid loss from the implant system, other mechanical malfunctions are tubing kinks, pump/valve cycling issues, and auto-inflation of the prosthesis. In our study there was no case of mechanical failure, but we had one case who had the reservoir inserted superficially in the inguinal region as the patient was obese. Postoperatively there was an inguinal bulge and pain. Revision and correction of the reservoir with proper placement of the reservoir in the Retzus space was carried out safely.

The use of large reservoirs is particularly beneficial in patients requiring higher volumes for effective inflation, such as those with larger corpora cavernosa. Our data suggest that adopting new surgical protocols with the use of large reservoir in all IPP is safe especially in standard patient with no anatomic challenge.

We acknowledge the limitations of this study that reports a retrospective analysis of a single-centre experience, which involves inherent limitations such as the potential for missing patients and reporting bias. Larger-scale studies with prospective proper evaluation of the patient's satisfaction could provide more information about the efficacy and outcome of the use of large reservoir in IPP.

Conclusions

The use of large-volume reservoirs in IPP surgery demonstrates a favorable safety profile, with no significant increase in complication rates compared to standard reservoir sizes. This approach may offer enhanced outcomes for patients requiring greater fluid volumes to achieve optimal device functionality.

References

1. Ayta IA, McKinlay JB, Krane RJ. The likely worldwide increase in erectile dysfunction between 1995 and 2025 and some possible policy consequences. BJU Int. 1999; 84:50-6.

2. Feldman HA, Goldstein I, Hatzichristou DG, et al. Impotence and its medical and psychosocial correlates: results of the Massachusetts Male Aging Study. J Urol. 1994; 151:54-61.

3. Levine LA, Becher EF, Bella AJ, et al. Penile prosthesis surgery: current recommendations from the International Consultation on Sexual Medicine. J Sex Med. 2016; 13:489-518.

4. Wilson SK, Cleves MA, Delk JR. Comparison of mechanical reliability of original and enhanced Mentor Alpha I penile prosthesis. J Urol. 1996; 155:145-7.

5. Van Dyke M, Baumgarten AS, Ortiz N, et al. State of the Reservoir: Current Concepts of Penile Implant Reservoir Placement and Potential Complications. Curr Urol Rep. 2021; 22:20.

6. Carson CC, Mulcahy JJ, Harsch MR. Mechanical reliability and safety of, and patient satisfaction with, the AMS 700 inflatable penile prosthesis: results of a long-term multicenter study. J Urol. 2011; 186:1216-20.

Declarations

Statement of Ethics: *This study was approved by the Surgical Research Committee, Hamad Medical Corporation (MRC-01-24-659) and it was conducted in accordance with the Helsinki Declaration, and the need for informed consent was waived from the medical research committee given the retrospective nature of the study and the use of electronic medical records only. However, the privacy of the participant's information regarding this study was maintained with confidentiality.*

Data Availability Statement: *All data generated or analyzed during this study are included in this manuscript. Further enquiries can be directed to the corresponding author.*

Conflict of Interest Statement: *The authors have no conflicts of interest to declare.*

Funding Sources: *This study was not supported by any sponsor or funder.*

Author Contributions: *All authors have made significant contributions to the manuscript including design, drafting and revising. I.A, Conception and design, Data Collection, data analysis and interpretation of data, Drafting the manuscript and Final approval of the version to be published. M.A. Data Collection, data analysis and interpretation of data, Drafting the manuscript and Final approval of the version to be published. O.A. Data analysis and interpretation of data, Drafting the manuscript and Final approval of the version to be published. O.A. Data analysis and interpretation of data, Drafting the manuscript and Final approval of the version to be published. A.A. Data analysis and interpretation of data, Drafting the manuscript and Final approval of the version to be published. A.S. Conception and design, data analysis and interpretation of data, Drafting the manuscript and Final approval of the version to be published.*

7. Martínez-Holguín E, Lledó-García E, González J, Hernández-Fernández C. Three-piece inflatable penile prosthesis: ectopic reservoir placement. Actas Urol Esp (Engl Ed). 2020; 44:367-76.

8. Henry G, Hsaio W, Karpman E, et al. A guide for inflatable penile prosthesis reservoir placement: pertinent anatomical measurements of the retropubic space. J Sex Med. 2014; 11:273-8.

9. Chung E, Van CT, Wilson I, Cartmill RA. Penile prosthesis implantation for the treatment for male erectile dysfunction: clinical outcomes and lessons learnt after 955 procedures. World J Urol. 2013; 31:591-5.

10. Amini E, Saldivar R, Hammad MA, Barham DW. Malfunction and mechanical failure of the inflatable penile prosthesis: a narrative review of etiologies and management. AME Med J. 2024; 9:28.

Correspondence

Ibrahim Ahmed Alnadhari (Corresponding Author)
ibrahimah1978@yahoo.com

Muammer Alshrani
malshrani@hamad.qa

Osama Abdeljaleel
oabdeljaleel@hamad.qa

Omar Ali
oali@hamad.qa

Ahmad Shamsodini
aabbas@hamad.qa

Urology Section, Department of Surgery, Al Wakra Hospital, Hamad Medical Corporation, Qatar

Abdulla Al-Ansari
aalansari1@hamad.qa

Department of Surgery, Qatar University, Qatar