Sexual Medicine Reviews, 2024, **12**, 528–536
https://doi.org/10.1093/sxmrev/qeae007
Advance access publication date 11 March 2024
Review

Early vs delayed insertion of penile prosthesis in patients with refractory priapism: a systematic review and meta-analysis

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Abstract

Introduction: Refractory priapism, characterized by persistent and prolonged painful erections despite initial treatment maneuvers, can significantly impair erectile function secondary to ischemia-induced corporal tissue fibrosis. These patients will likely require subsequent penile prosthesis (PP) surgery to regain sexual activity, yet consensus regarding the optimal timing of implantation remains lacking.
Objectives: To evaluate and compare the clinical outcomes associated with early vs delayed PP implantation in individuals with priapism-induced erectile dysfunction (ED).
Methods: We included studies that focused on refractory priapism leading to ED and its management with PP implantation. We assessed cohort study bias with a risk-of-bias tool and case series bias with the modified Newcastle-Ottawa Scale. Pooled odds ratios (ORs) were calculated by a fixed-effect model.
Results: We included 9 studies, comprising 4 cohort studies and 5 case series, involving a total of 278 patients. Total complications were higher in the delayed group (OR, 4.16; 95% CI, 2.77-6.26). Fibrosis was significantly more pronounced in the delayed group (OR, 118.18; 95% CI, 20.06-696.32). The odds of erosion, infections, and penile injury did not show statistically significant differences between the groups (OR, 2.52 [95% CI, 0.67-9.49], 0.89 [0.38-2.10], 1.83 [0.79-4.26], respectively). Patients' satisfaction resulted in a pooled OR of 0.15 (95% CI, 0.04-0.49) in favor of the early PP insertion group.
Conclusion: The results from this study favor an early approach to ED (within 30 days) following ischemic priapism. However, it is important to consider patients' preferences, values, and psychological factors to make an informed decision.

Keywords: penile prosthesis; priapism; erectile dysfunction; surgery timing; systematic review; meta-analysis.

Introduction

Priapism is an andrologic emergency characterized by a prolonged and often painful penile erection that is unrelated to sexual stimulation.[1] Although it is an uncommon condition, it can have serious implications on a patient's erectile function and psychosexual well-being.[2] During priapism, there is a disruption in the balance between penile blood inflow and outflow, leading to impaired circulation within the corpora cavernosa. The condition is categorized into 2 main types: ischemic (low flow) and nonischemic (high flow).[1] Ischemic priapism, which is the focus of this study, is defined by impaired venous outflow and persistent engorgement of the corpora cavernosa, which cause a state of penile low oxygen tension leading to ischemia and subsequent tissue damage. This oxygen deprivation triggers a series of molecular and cellular changes, including the release of inflammatory mediators, oxidative stress, and the activation of apoptotic pathways. Over time, the cumulative effects of these processes lead to fibrosis and structural alterations in the erectile tissue, replacing functional tissue with noncompliant fibrotic material.[3] This tissue damage can manifest as fibrosis, scarring, or erectile dysfunction.[2]

The management of acute ischemic priapism aims to relieve the prolonged erection, restore normal blood flow, and prevent long-term complications. Management involves conservative treatment with intracavernous injections of sympathomimetic agents such as phenylephrine or surgical shunt procedures and corporal aspiration with or without irrigation.[1,3] Several proximal and distal shunt procedures have been proposed to overcome persistent penile ischemia. However, these are invariably associated with a high incidence of postoperative erectile dysfunction with penile scarring and fibrosis. Moreover, irreversible loss of erectile function is believed to occur in ischemic episodes lasting for >36 hours.[4] Although the specific time frame for irreversible smooth muscle loss remains uncertain, studies indicate that edema and atrophy of smooth muscle can commence as early as 6 hours into a priapism episode.[5] Consequently, as the duration of priapism extends, patients may become less responsive to initial treatment approaches. For these reasons, immediate surgical

Received: December 10, 2023. **Revised:** January 9, 2024. **Accepted:** January 13, 2024

insertion of a penile prosthesis (PP) has been advocated to resolve the acute episode and avoid performing complicated delayed prosthetic surgery.[1] Nonetheless, early PP implantation may be hindered by the extensive tissue edema observed during the acute stage and is potentially associated with a higher risk of surgical infection.[6]

Currently, there is no consensus regarding the optimal timing of PP implantation in patients with ischemic priapism and its impact on postoperative surgical outcome and sexual function.[7] Therefore, a thorough analysis and comparison of studies examining immediate and delayed surgical repair of priapism-related erectile dysfunction is necessary. The aim of this systemic review and meta-analysis is to conduct a comparative analysis between early and delayed PP procedures for patients with ischemic priapism, with a primary focus on assessing complications, patient-centered outcomes (particularly satisfaction and sexual function restoration), prosthesis type, follow-up duration, hospital stay, surgery duration, and an examination of implant length and girth. Such knowledge can assist clinicians in making well-informed decisions and potentially improve outcomes in patients with ischemic priapism.

Methods

Protocol and registration

This systematic review followed the PRISMA guideline (Preferred Reporting Items for Systematic Reviews and Meta-analyses)[8] and was registered in the PROSPERO database (International Prospective Register of Systematic Reviews; CRD42023443443423). The PRISMA checklist is available in Table S1.

Search strategy

The search strategy was developed by using Medical Subject Heading terms ("priapism," "early," "late," "penile prosthesis," "penile implantation") in multiple electronic databases via a polyglot translator: PubMed, Scopus, Web of Science, Embase, Cochrane Central Register of Controlled Trials, and CINAHL Ultimate.[9] The search included studies from inception of databases to May 6, 2023. The full search strategy for all databases is presented in the supplementary material. The resulting articles were uploaded to the Rayyan platform for deduplication and screening.[10]

Eligibility criteria

Original articles were included when published in English on male participants diagnosed with refractory priapism leading to erectile dysfunction and treated with a penile implantation. Studies had to report data on immediate and/or late outcomes, such as complications, satisfaction, and surgical technique difficulty. Exclusion criteria were nonoriginal articles, case reports/series with <5 patients, studies without penile implants or extractable data, abstracts, editorials, letters to editor, and duplicate data.

Study selection and screening

The Rayyan platform was used to screen titles and abstracts (M.E. and B.E.).[10] Discrepancies were resolved through consensus. Full texts of potentially eligible studies were double screened independently (M.E. and I.E.), with discrepancies referred to the senior authors.

Data extraction

Data extraction included author names, publication year, country, study design, number of participants, patients' mean age, outcomes, and their proportions. Data were compiled in an online spreadsheet accessible to all authors.

Quality of studies

We assessed the risk of bias in cohort studies using ROBINS-I (Risk of Bias in Nonrandomized Studies of Interventions)[11] and case series using Murad and colleagues' modified Newcastle-Ottawa Scale.[12] Cohort studies were categorized as low, moderate, serious, or critical based on the ROBINS-I tool.[11] For the Newcastle-Ottawa Scale, we did not include questions 4, 5, and 6 as the tool's developer suggested because they pertain only to instances of adverse drug events.[12] Case series risk of bias was classified as low (score, 5), moderate (score, 4), or high (score ≤3).

Outcomes

In our comparative analysis of early and delayed PP procedures, we prioritized primary outcomes (ie, complications) that were consistently reported among the articles: structural injuries, infections, erosion, fibrosis, and penile length loss. Penile injury encompasses corporal perforation and urethral injury, while total infections cover wound and prosthesis infections. Unfortunately, none of the studies provided definitions for erosion (or distal erosion), corporal perforation, or urethral injury. We created a total complications group for these combined. Secondary outcomes were prosthesis type, follow-up duration, hospital stay, surgery duration, and patient-centered outcomes (satisfaction and sexual function restoration). Only 3 studies used the 5-item International Index of Erectile Function for satisfaction assessment; therefore, we recorded satisfaction as reported in the original articles. We also examined implant length and girth.

Data analysis

We performed a quantitative synthesis, including studies with early and delayed PP data, while excluding single-group case series. Given the limited number of studies, we used a fixed-effect model for precise estimation of between-study variance.[13] Pooled odds ratios (ORs) were calculated by gathering event counts in both groups, and as a result, only studies with 2 groups were included in the analysis. A post hoc continuity correction of 0.5 was applied to studies with zero cases, including double-zero events.[14] We presented forest plots for pooled estimates and assessed heterogeneity using the I^2 statistic and Cochran Q test ($P < .05$),[15] while examining potential publication bias through standard funnel plots and the Egger regression test ($P < .05$).[16] All analyses, graphs, and plots were conducted with Stata software (version 16.0; StataCorp LLC), utilizing the *metan* package.[17]

Results

Study selection

The study selection followed the PRISMA flowchart (Figure 1). Our comprehensive literature search resulted in the identification of 687 records. Additional searches in ClinicalTrials.gov and the EU Clinical Trials Register did not yield any additional records meeting the inclusion criteria. After duplicates were removed with Rayyan, 408 unique articles remained. Title and

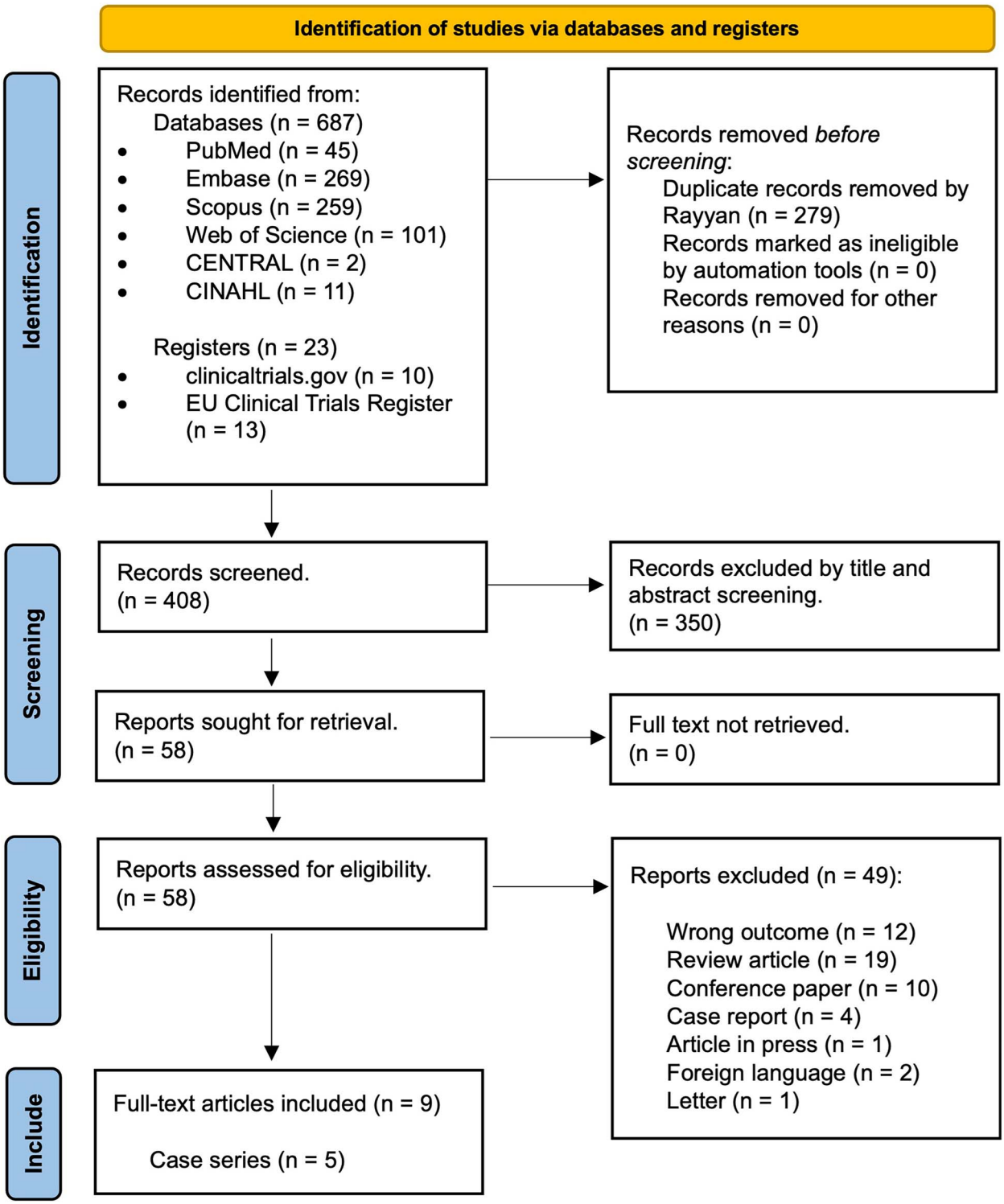

Figure 1. PRISMA flowchart shows the selection process in our systematic review. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-analyses.

abstract screening led to the exclusion of 350 articles. Full-text screening was performed on 58 articles, and 49 were excluded for reasons such as report of different outcomes, article type (review, abstract, case report, letter), non-English language, and in-press status. Finally, 9 articles met the selection criteria and were included in this systematic review.[6,18-25] Details regarding the excluded articles and the exclusion reasons are available in Table S1.

Study characteristics and collected data

Different studies defined early interventions differently. This was evident as 7 of 9 studies had a definition of early intervention within 30 days of the onset of priapism.[18,20-25] This was also true for the definitions of delayed intervention, as 3 of 5 studies defined it as intervening after 30 days had passed from priapism onset.[18,23,25] Specifically, we found data from 4 studies reporting on corporal perforation,[6,18,19,22] 3 on

urethral injury,[6,18,25] 5 on erosion,[6,19,20,23,25] 4 on loss of significant penile length,[21,23-25] 7 on prosthesis infection,[6,19-23,25] 2 on postoperative wound infection,[6,18] 7 on patient satisfaction,[6,20-25] 4 on achieving sexual intercourse,[21-23,25] and 5 on penile fibrosis.[6,18,21,23,25] Fibrosis was diagnosed by different modalities, such as clinical examination, radiologic testing (eg, magnetic resonance imaging), and clinicopathologic biopsy.

Among the 9 studies in our analysis (278 patients), 4 studies documented the utilization of malleable PPs; 1 study detailed the use of an inflatable PP; and the remaining 4 studies encompassed both types of implants. Among the 278 cases, 32 patients had revision surgery, and 90 had previously undergone shunting surgery. In total, 214 patients underwent malleable PP implantation, while 61 received inflatable PPs. The duration of patient follow-up exhibited a median range of 11 to 43 months, with the majority of studies (n = 7) reporting a follow-up median of 1 to 2 years.

One retrospective cohort study indicated that early PP recipients experienced an average hospital stay of 3 days, in stark contrast to the 1-day stay observed among cases of late PP.[18] Regarding the duration of implant surgery, 2 studies reported mean ± SD times of 102 ± 17 minutes and 94 ± 31.3 minutes for the early PP group, a significant reduction in comparison with the sole reported time of 169 ± 22 minutes for the late PP group.[6,23] One study revealed a disparity in penile length, with early PP recipients demonstrating a significantly longer penile length (22 ± 1 cm) as compared with late PP recipients (20.7 ± 1 cm).[6] Similarly, 2 studies identified early PP implant recipients as having a significantly greater implant girth, with measurements of 11 mm and 11 ± 0.5 mm, contrasting with late PP recipients who exhibited girth measurements of 10 ± 0.7 mm and 9.5 mm.[6,18]

Table 1 presents the characteristics of the studies in this systematic review, published between 2002 and 2022 with the extracted outcomes of interest. Among the 9 studies, 4 were conducted in the United Kingdom, 3 in Egypt, and 1 in the United States, as well as 1 each in Italy, Iran, and Qatar. The sample sizes ranged from 8 to 95 patients. Five articles were case series, and 4 were retrospective cohort studies. Studies reported a mean age of 41 to 51 years.

Quality assessment

Tables 2 and 3 display the quality assessment score analysis for the studies. The 5 case series analyzed according to the Newcastle-Ottawa Scale are presented in Table 2: 3 studies displayed a moderate risk of bias, while 2 had a low risk of bias. Two retrospective cohort studies had moderate overall bias according to the ROBINS-I tool, as presented in Table 3. For the other 2 studies, 1 had a serious risk of bias, primarily due to confounding, and 1 had a low overall risk. Consequently, the collective assessment suggests that the studies, taken as a whole, were characterized by a moderate level of bias.

Early vs delayed PP: meta-analysis results

Our analysis encompassed data from 5 studies that considered early and delayed PP groups, each involving different patient numbers within their outcome categories. The pooled estimates and final outcomes of the quantitative synthesis are presented in Table 4.

The pooled OR for total complications was 4.16 (95% CI, 2.77-6.26; I^2 = 83.1%; Cochran *Q*, $P < .001$; 241 patients), favoring the early PP group with fewer complications (Figure 2A). The funnel plot displayed no asymmetry (Figure S1), and an Egger regression *P* value of .870 suggests the absence of significant publication bias.

For erosion, 3 studies were analyzed, encompassing a total of 209 patients. The estimated OR was 2.52 (95% CI, 0.67-9.49), suggesting a nonsignificant increase in the risk of erosion in the delayed PP group (Figure 2B). The I^2 statistic indicated a value of 13.4%; the Cochran *Q* test yielded a *P* value of .315; and the Egger regression *P* value was .666, with a symmetrical funnel plot (Figure S2). Fibrosis was assessed with data from 4 studies involving 169 patients (Figure 2C). The substantial pooled OR was 118.18 (95% CI, 20.06-696.32; I^2 = 61.2%; Cochran *Q*, *P* = .052; Egger regression, *P* = .836; Figure S3). Infections, which encompassed prosthesis infection and postoperative wound infection, were evaluated according to data from 5 studies comprising 241 patients (Figure 2D). The estimated OR for infections was 0.89 (95% CI, 0.38-2.10; I^2 = 54.4%; Egger regression, *P* = .979; Figure S4).

Similarly, penile injury showed no significant difference between the groups (OR, 1.83; 95% CI, 0.79-4.26; Figure 2E). There was substantial heterogeneity in this outcome (I^2 = 76%; Cochran *Q*, *P* = .006). The Egger regression *P* value was .648, with symmetry in the funnel plot (Figure S5). Satisfaction was examined in 3 studies with 145 patients. The pooled OR of 0.15 (95% CI, 0.04-0.49) indicates a significantly higher likelihood of patient satisfaction in the early insertion group (Figure 2F). Moderate heterogeneity (I^2 = 64.3%) was observed, with the Cochran *Q* test yielding a *P* value of .061 and an Egger regression *P* value of .345, while the funnel plot showed no asymmetry (Figure S6).

Discussion

Principal findings

Erectile dysfunction is not an uncommon complication of ischemic priapism, eventually necessitating PP implantation. This review explored the outcomes of early vs delayed PP implantation for the treatment of erectile dysfunction, with a focus on providing essential data regarding the optimal timing for PP insertion in patients with ischemic priapism.

Our analysis suggests that delayed PP insertion is associated with a higher risk of fibrosis (and consequently total complications) and a lower likelihood of patient satisfaction when compared with early insertion. Notably, the odds of erosion in the early group were 2.5 times lower vs the delayed group, with limited evidence against the null hypothesis. Additionally, it is worth noting that the odds of experiencing fibrosis following delayed implantation were 118 times higher, with moderate evidence against the null. In contrast, postoperative infection and patient satisfaction outcomes favored the delayed approach, with 11% and 85% higher odds in the early group as compared with the delayed group, respectively, with insignificant evidence against the null hypothesis. Moreover, the results for erosion, infections, and penile injury did not reach statistical significance.

All funnel plots displayed symmetry, and the Egger regression *P* value was >.05 for all outcomes, indicating no evidence of publication bias. The Cochran *Q* *P* value was statistically

Table 1. Baseline characteristics of studies and the extracted outcomes of interest.

Study[a]																
Group (time)	**Mean age, y**	**Surgery, revision**	**Previous shunt surgery**	**Penile injury**	**Erosion**	**Loss of penile length**	**Total infections**	**Patient satisfaction**	**Achieved sexual intercourse**	**Penile fibrosis**	**PP type**	**Follow-up, mo[b]**	**Hospital stay, d**	**Surgery length, min[b]**	**Implant length, cm[b]**	**Implant girth, mm[b]**
Rees (2002),[21] UK, case series																
Early (<8 d)	41	8, 1	4			0	0	8	7	1	6 malleable, 2 inflatable[c]	17 (5-35)	5			
Salem (2010),[22] Egypt, case series																
Early (<7 d)	43	12, 0	11	1			12	12	12		Malleable	15 (6-36)				
Salman (2023),[6] Egypt, retrospective cohort																
Early (≤3 mo)	55	23, 2	8	1	2		8	21	21	0	Malleable[d]	11 ± 5.5		102 ± 17	22 ± 1	11 ± 0.5
Late (>3 mo)	54	19, 0	13	15	0		2	19	19	19	Malleable[d]	15 ± 4.5		169 ± 22	20.7 ± 1	10 ± 0.7
Sedigh (2011),[23] Italy, Iran, Qatar, case series																
Early (≤20 d)	52	5, 0		0				5		0	1 malleable, 4 inflatable[e]			94 ± 31.3		
Late (>9 mo)	NA	3, 0		0				3		3						
Zacharakis (2014),[25] UK, retrospective cohort																
Early (<17 d)	42	68, 6	28		0	2	5	65	65	6	64 malleable, 4 inflatable[f]	17 (15-24)				
Late (> 2 mo)	45	27, 7			1	11	5	16	25	27	12 malleable, 15 inflatable[f]	21 (20-24)				
Zacharakis (2015),[24] UK, case series																
Early (<14 d)	41.3	10, 0	5		0		0	9			Malleable[g]	13.5 (3-24)				
Elhawy (2021),[18] Egypt, retrospective cohort																
Immediate (at diagnosis)	41.2	8, 0	8	0			4			0	Malleable[h]		3			11
Late (>6 mo)[i]		16, 0		0			3			1	Malleable[h]	43	1			9.5
Hebert (2020),[19] USA, retrospective cohort																
Early (≤4 mo)	NA	30, 2		12	2	2	0				Inflatable	12				
Late (>4 mo)		42, 2		17	9	2	3				Inflatable	12				
Ralph (2009),[20] UK, case series																
Early (<30 d)	46	50, 12[j]	13		3	2	3	48			43 malleable, 7 inflatable[k]	15.7 (4-60)				

Abbreviations: NA, not available; PP, penile prosthesis. [a]First author (year), country, and study design. Data are presented as number of patients unless indicated otherwise. [b]Data are presented as median (range) or mean ± SD. [c]Malleable (Acu-Form), inflatable (AMS 700 CX). [d]AMS Spectra, TUBE Promedon. [e]Malleable (AMS), inflatable (Coloplast Titan OTR, AMS 700 LGX, AMS 700 CX). [f]Malleable (Titan Coloplast), inflatable (CXR AMS). [g]Coloplast Genesis. Malleable first, then all 10 patients underwent further surgery to remove the malleable PP and insert an inflatable PP. [h]Genesis, Coloplast. [i]Two were done later after diagnosis but within 6 months. [j]PP replacement: n = 6. [k]Malleable (Genesis, Acu-Form, Coloplast, AMS 650), inflatable (AMS CX 700).

Table 2. Risk-of-bias assessment scores for the case series.

First author (year)	1	2	3	4	5	Risk of bias
Rees (2002)[21]	Yes	Yes	Yes	Yes	Yes	Low
Salem (2010)[22]	Yes	Yes	Yes	Yes	No	Moderate
Sedigh (2011)[23]	Yes	Yes	Yes	Yes	No	Moderate
Zacharakis (2015)[24]	Yes	Yes	Yes	Yes	No	Moderate
Ralph (2009)[20]	Yes	Yes	Yes	Yes	Yes	Low

(1) Does the patient represent the whole experience of the investigator (center), or is the selection method unclear to the extent that other patients with similar presentation may not have been reported? (2) Was the exposure adequately ascertained? (3) Was the outcome adequately ascertained? (4) Was follow-up long enough for outcomes to occur? (5) Is the case described with sufficient details to allow other investigators to replicate the research or to allow practitioners make inferences related to their own practice?

Table 3. Risk-of-bias assessment scores for the cohort studies.

First author (year)	1	2	3	4	5	6	7	Overall bias
Salman (2023)[6]	Low	Low	Low	Low	Low	Low	Low	Moderate
Hebert (2020)[19]	Serious	Low	Moderate	Low	Low	Low	NI	Serious
Elhawy (2021)[18]	Low	Low	Moderate	Low	Moderate	Low	Low	Moderate
Zacharakis (2014)[25]	Low	Low	Moderate	Low	Low	Low	Low	Low

Abbreviation: NI: No information. (1) Bias due to confounding. (2) Bias in selection of participants into the study. (3) Bias in classification of interventions. (4) Bias due to deviations from intended interventions. (5) Bias due to missing data. (6) Bias in measurement of outcomes. (7) Bias in selection of the reported result.

Table 4. Meta-analysis results of early and delayed penile prosthesis procedures.

						P value	
Outcome variable	No. of studies	No. of patients	Estimated odds ratio	95% CI	I^2, %	Cochran *Q*	Egger regression
Total complications	5	241	4.16	2.77-6.26	83.1	<.001	.870
Erosion	3	209	2.52	0.67-9.49	13.4	.315	.666
Fibrosis	4	169	118.18	20.06-696.32	61.2	.052	.836
Infections	5	241	0.89	0.38-2.10	54.4	.067	.979
Penile Injury	4	146	1.83	0.79-4.26	76	.006	.648
Patients' satisfaction	3	145	0.15	0.04-0.49	64.3	.061	.345

significant in total complications ($P < .001$) and penile injury ($P = .006$), indicating significant heterogeneity. This heterogeneity is most likely attributed to differences in the complications within those outcomes, with penile injury including corporal perforation and urethral injury. Other outcomes exhibited moderate heterogeneity, suggesting systematic differences among the studies and variations in the definition of early and delayed groups.

We found that 90 (32.4%) patients had shunting procedures done before the insertion of penile implants. After a Winter shunt, caution is needed regarding a potential weakness at the corporal tip, which may lead to erosion or perforation.[20,22] A study revealed no statistically significant difference in intra- and postoperative complications between the studied groups, except for a higher incidence of intraoperative corporal perforation in the delayed insertion group due to extensive corporeal fibrosis.[6] Postoperative penile edema was more prevalent in the early insertion group. In the early group, distal shunt procedures had a low incidence of intraoperative corporal perforation due to small shunt openings and the absence of tissue fibrosis.[6] Therefore, we advise against performing unnecessary shunt surgery or delaying the procedure for a few days to allow for the resolution of bruising and edema and to administer broad-spectrum antibiotics for bacterial contamination clearance.

Defining early vs delayed PP implantation

Different studies in this meta-analysis defined early and delayed PP implantation differently. This created difficulty in analyzing the data because not all studies provided individualized outcomes for their patients. Corresponding authors were contacted, but we were not able to retrieve all required data. Therefore, while analyzing the data, we used each study's version of the definition of early vs delayed prosthesis implantation (Table 1). For the sake of discussion, we defined early prosthesis implantation as within 30 days of erectile dysfunction diagnosis. Yet, delayed prosthesis implantation was defined as intervals >30 days since the diagnosis. This definition proved to be the least problematic as it was true for 7 of 9 studies and 3 of 5 reporting data on early and delayed intervention, respectively. We recommend a universal consensus for defining early prosthesis implantation as within 30 days of erectile dysfunction diagnosis.

Outcomes in favor of early PP implantation

Early PP implantation postrefractory ischemic priapism involves prompt surgical intervention.[7] Complications such as penile injury, erosion, and penile fibrosis were less likely to occur with early intervention. Early intervention could avoid the formation of fibrotic tissue within the corpora cavernosa, which would make the implantation procedure otherwise technically challenging.[26] By avoiding operating on fibrotic tissues, there would be a lower risk of surgical complications during dissection and implant placement, resulting in a lesser likelihood of corporal perforation and urethral injury and erosion.[27]

Moreover, shorter surgery times and larger PP sizes were observed in the early implant group when compared with the

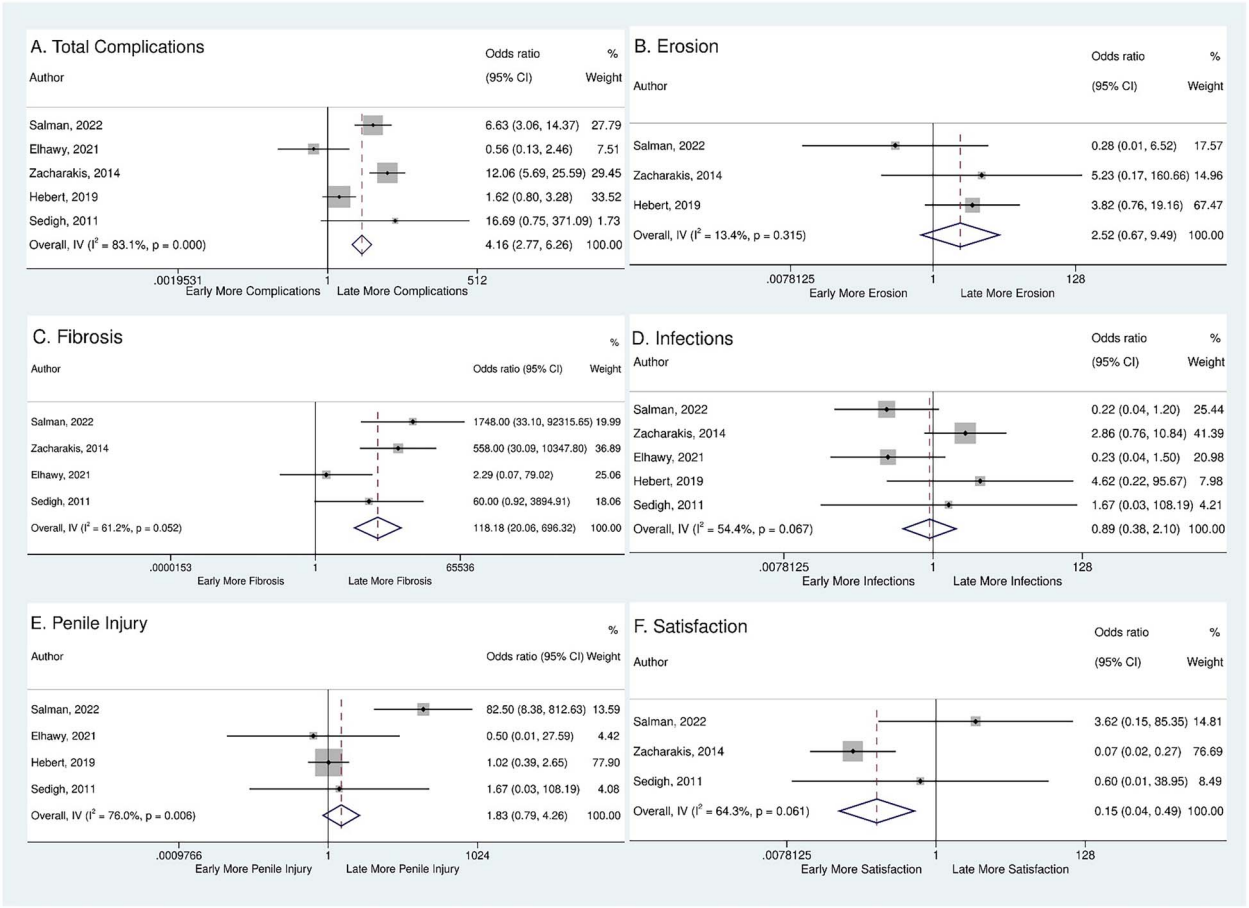

Figure 2. Forest plots show the pooled odds ratio per outcome from our quantitative synthesis: (A) total complications, (B) erosion, (C) fibrosis, (D) infections, (E) penile injury, and (F) satisfaction.

delayed group. Prompt surgical correction within a shorter time frame from the onset of priapism may lead to less severe tissue damage and a relatively healthier surgical site, potentially facilitating a smoother and quicker surgical procedure, with a larger implant size. In contrast, delayed implantations may encounter more extensive fibrotic tissue, necessitating additional surgical steps for tissue excision, manipulation, or revision.[26]

Outcomes in favor of delayed PP implantation

While early PP implantation may offer advantages in terms of reduced rates of penile injury, erosion, and fibrosis, delayed intervention may have specific benefits as well. Delayed implantation surprisingly allowed for reduced infection rates and greater rates of patient satisfaction.[28]

However, it is not surprising that early intervention may increase the likelihood of infection due to several underlying factors. First, early implantation typically involves dealing with extensive tissue edema, a consequence of the prolonged accumulation of ischemic, hypoxic blood within the corpora cavernosa. This edematous tissue environment can impede proper wound healing and predispose the surgical site to infection. Second, early implantation usually succeeds repetitive first-line manipulations that are performed to overcome the ischemic episode, including needle aspirations and injections. These interventions may be performed under relatively less sterile conditions as compared with elective surgery, as they are often carried out urgently in response to priapism episodes.

Another finding was the higher rate of patient satisfaction in the early group. This may be explained by the fact that these persistent priapism episodes can have a significant psychological impact on patients, leading to anxiety, depression, and fear of erectile dysfunction.[29] Overcoming these fears with PP implantation may allow patients to return early to sexual activity with minimal or no impact on the quality of their sexual encounter or penile appearance.

Regarding the duration of hospital stay, a longer stay was seen in the early group. This could have been influenced by the extensive manipulations that were performed during the initial phases of the priapism episode leading up to implantation surgery. Following such cases, physicians may be keen to follow patients closely in the early postoperative period due to fear of infection. Moreover, the rarity of the data comparing the duration of hospital stay between the groups could have attributed to this finding. Therefore, we encourage more studies to instill hospital stay as a comparison point to formulate more reliable data on this matter.

Types of prosthesis

Our data revealed notable distinctions between the options: malleable and inflatable devices. The installation of 214 malleable devices vs 104 inflatable devices highlights a greater prevalence of malleable prostheses in our study. Malleable prostheses demonstrate advantages, particularly for patients with a history of shunt surgery and associated edema, as

they are usually preferable in such cases.[20] Furthermore, malleable prostheses aid in maintaining penile length and facilitate the subsequent insertion of inflatable devices, serving as interim solutions for patients desiring inflatable prostheses.[25] However, this dual-surgery approach exposes patients to increased surgical risks. While malleable devices are cost-effective and easier to explant in case of infection, they do not permit complete penile detumescence, affecting patient satisfaction.[30] In contrast, inflatable prostheses allow for penile flaccidity, yielding better functional outcomes and a lower risk of distal erosion.[20,30] Strategies for inflatable devices, such as using antibiotic-coated devices and oversizing the cylinders, were identified to minimize infection risk and penile length loss, respectively.[23] Early postoperative counseling on regular device cycling was also emphasized to reduce the likelihood of fibrosis. Therefore, the choice between malleable and inflatable PPs should be tailored to individual patient characteristics and preferences, weighing the benefits against potential risks and considerations.

Limitations

Several limitations should be acknowledged in this meta-analysis. First, the analysis involved studies with varying designs and definitions of early and delayed PP procedures, which might have contributed to heterogeneity and potential biases. The limited number of studies available, particularly for certain outcomes, may restrict the generalizability of our findings. Moreover, the absence of standardized definitions for complications such as erosion, corporal perforation, and urethral injury across the studies posed challenges in assessing and comparing these outcomes accurately. Furthermore, we acknowledge that some of the results mentioned in this study were statistically insignificant due to the rarity of data. Last, the retrospective nature of the studies introduces inherent limitations in terms of data accuracy and completeness, which could affect the reliability of the findings.

Conclusion

The current systematic review revealed that early intervention, within 30 days, is more likely to be favored in cases of refractory ischemic priapism. However, it is important to consider that the decision between early and delayed PP implantation should be based on individual patient characteristics, including the severity of priapism, overall health status, and patient preferences. A multidisciplinary approach involving urologists, hematologists, and psychologists is essential to tailor the treatment strategy to each patient's unique needs and to optimize each one's overall outcome.

Author contributions

M.E.: writing–original draft, conceptualization, methodology, supervision, data collection, investigation, data curation, writing–review and editing, and project administration. A.A.: moderating, writing–review and editing, and project administration. I.E.: writing–original draft, formal analysis, visualization, methodology, data collection, investigation, data curation, and writing–review and editing. B.E.: writing–original draft, data collection, drafting the tables, and data quality assessment. I.A.K.: conceptualization, writing–review and editing, and supervision. M.A.: drafting the manuscript and supervision. K.K.: drafting the manuscript and supervision. M.A.: writing–original draft, conceptualization, supervision, writing–review and editing, and validation. A.M.: writing–original draft, conceptualization, supervision, writing–review and editing, and validation. K.A.: supervision and writing–review and editing.

Acknowledgement

Open Access funding provided by the Qatar National Library.

Supplementary material

Supplementary material is available at *Sexual Medicine Reviews* online.

Funding

None declared.

Conflict of interests

None declared.

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