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REVIEW

What are the risk factors for erectile dysfunction following penile fracture surgery? A systematic review and meta-analysis

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Summary ***Background: Penile fracture is one of the rare urological emergencies resulting in rupture of the tunica albuginea in the penile corpora cavernosa. Sexual intercourse is known to be the most common aetiology of penile fracture, which usually happens during erection. Immediate surgical intervention is crucial to avoid any complications. Erectile dysfunction is the most feared complication after surgery. This meta-analysis aimed to analyse and determine risk factors of erectile dysfunction among patients who underwent penile fracture surgery.***

Methods: Literature searching was conducted in several databases, e.g., Pubmed, Cochrane, ScienceDirect, Google Scholar and DOAJ by applying the Boolean term method. Statistical analyses and risk of bias assessment were calculated through RevMan 5.4.1 and the Newcastle Ottawa Scale (NOS), respectively. Outcomes were presented as odds ratio (OR).

Results: A total of 6 studies were included, encompassing 527 patients who were diagnosed with penile fracture and underwent surgery for repairment. Risk factors for post-surgery erectile dysfunction were calculated. Age (OR = 0.19, 95% CI [0.07, 0.52], p = 0.001), location of fracture (OR = 0.43, 95% CI [0.22, 0.84], p = 0.01), and side of fracture (OR = 0.06, 95% CI [0.02, 0.21], p = < 0.0001) have significant relations with erectile dysfunction. Whereas aetiology, urethral injury, and timing of presentation have statistically non significant effect on the incidence of erectile dysfunction.

Conclusions: This systematic review and meta-analysis showed that patients over 50 years of age, those with midshaft fracture, and those with bilateral fractures are significantly more likely to have erectile dysfunction following penile fracture surgery.

KEY WORDS: Penile fracture; Erectile dysfunction; Impotence; Risk factor; Urethral injury.

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INTRODUCTION

Penile fracture is one of the urological emergencies characterized by rupture of the tunica albuginea in the corpora cavernosa of the penis, which requires an immediate surgical intervention (1). It commonly occurs during erection of the penis. Sexual intercourse is the most common aetiology for penile fracture, besides forceful bending of the penile shaft, masturbation, and blunt or sharp injury to the penis (2). Trauma to the penis, whether it is blunt or sharp trauma, will cause an abrupt raising of intracavernosal pressure, resulting in the tear of tunica albuginea (2). Average arterial pressure of an erect penis is roughly 100 mmHg in the erect state (3).

Penile fracture can easily be diagnosed from the history and physical examination of the patient. In most cases, penile fracture will present with a cracking, snapping sound, rapid detumescence of the penis, acute pain, abrupt swelling, and the presentation of "eggplant deformity" or ecchymosis of the penis. The fracture is more often in the proximal shaft of the penis. The corporal cavernosal tear may occur unilaterally or bilaterally. The most applicable modalities in diagnosing penile fracture are *ultrasound* (US) and MRI (4). US is widely used in the population because of its availability, non-invasiveness, low cost and safety, but the results are operator dependent. Whereas penile MRI can show more accurate and detailed soft tissue disruption, but it's expensive and not available in most hospitals (5, 6).

Penile fracture is a rare case in the urological field, the incidence reported for penile fracture was 1 case for every 175,000 cases of emergency hospital admissions (1). Immediate surgical exploration and closure of the tunica albuginea is now the most preferred treatment approach for penile fracture.

Some complications may occur after surgical treatment of penile fracture, including erectile dysfunction, infections, painful erection, penile curvature, and plaque formation (7, 8). *Erectile dysfunction* (ED) is known as a major concern following the surgery for penile fracture, as it can potentially result in a poor physical and psychological condition for the patient (9).

This study is the first meta-analysis discussing some variables of risk factors (age, mechanism of injury, fracture location, surgical approach, side of fracture, urethral injury, and timing of presentation) and their relationship to the occurrence of erectile dysfunction, especially in post-surgery penile fracture patients. Therefore, this knowledge will be hugely beneficial in preventing erectile dysfunction

among penile fracture patients. Early detection of these risk factors can assist physicians in making clinical decisions. This meta-analysis aims to determine the contributing risk factors regarding erectile dysfunction following penile fracture surgery in order to provide eligible evidence for advances in knowledge and patient services.

Materials and methods

Literature search

We performed literature searches in several databases, e.g. *Pubmed, Cochrane, ScienceDirect, Google Scholar*, and *DOAJ*, by applying the Boolean term method. We did the literature searching by applying keywords: "*Penile fracture*" AND ("*Erectile dysfunction*" OR "*Impotence*") AND "*Risk factor*".

Data extraction

The *Population, Intervention, Comparison,* and *Outcome* (PICO) principle was used in this study, with penile fracture patients who underwent surgery repairment as the population, surgery as the intervention, the occurrence of erectile dysfunction as the comparison, and potential risk factors (age, mechanism of injury, fracture location, surgical approach, side of fracture, urethral injury, and timing of presentation) as the outcome. Cohort and case-control studies were included in this meta-analysis.

Information collected from each study included age, smoking history, mechanism of injury for penile fracture, location of fracture, side of fracture, urethral injury, and timing at presentation. The data also included the author's name, year of publication, sample size, age, and follow-up period.

Risk of bias (RoB) analysis

Risk of bias assessment was done by using *Newcastle Ottawa Scale* (NOS) for cohort and case-control studies consisting of 3 variables, i.e., selection of the participants to the study (4 points maximum), comparability of the groups (2 points maximum), and assessment of the outcome to the exposure (3 points maximum), with the cumulative value of 9 points.

Data synthesis

Data analysis was done by using Review Manager version 5.4. The strength of correlation between variables was measured using *Odds Ratio* (OR) and 95% *confidence interval* (CI). Statistical significance of OR was measured by using the p-value from the Z-test and the heterogeneity measured with the inconsistency index (I2) test.

A p-value < 0.05 was deemed as statistically significant. I2 $\geq 50\%$ is considered high heterogeneity, whereas I2 $< 50\%$ is considered low heterogeneity. Furthermore, a Forest plot was generated for each variable to assess the publication bias.

Results

We applied the PRISMA flowchart guideline in the identifying process of the study. At first 1,672 studies were identified, and only 6 articles were eligible for this meta-analysis at the end of the selection process. PRISMA flowchart for identification of the studies and characteristics of the studies are shown in Figure 1 and Table 2, respectively (6, 8, 10-13).

Following the removal of duplicates, 1,586 titles and abstracts were screened, and 18 full texts were retrieved for further appraisal. Evaluation of full-text studies identified 6 articles eligible for inclusion in this meta-analysis, as shown in Figure 1.

Additional reasons for exclusions were studies containing not relevant data, incomplete information, and studies that were not written in English.

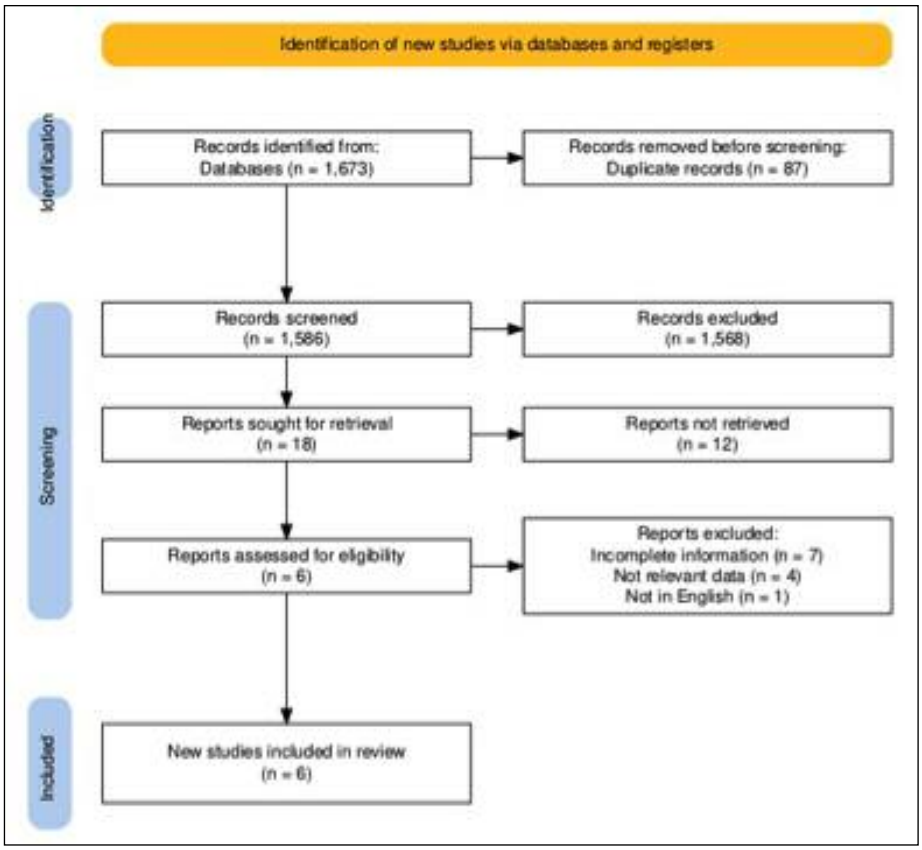


Figure 1.
PRISMA Flowchart of the identification of eligible trials.

Table 1.
Risk of bias assessment using Newcastle Ottawa Scale (NOS) for case-control study and cohort study.

Author, year	Selection				Comparibility		Outcome		
	Representative of the exposed cohort	Selection of external control	Ascertainment of exposure	Outcome of interest not present at the start of the study	Main factor	Additional factor	Assessment of outcome	Sufficient follow-up	Adequacy follow-up
Barros 2021	*	0	0	*	*	*	0	*	*
Assmy 2012	*	*	*	*	*	*	*	*	*
Chaker 2025	*	*	*	*	*	*	*	*	*
Din 2023	*	*	*	*	0	*	*	0	*
Patil 2019	*	*	*	0	0	0	*	*	*
Sharma 2021	*	*	*	*	*	*	*	*	*

Table 2.
Summary of patient characteristics included in meta-analysis.

Author, year	Age range/mean of sample age	Sample size (n)	Time period	Erectile dysfunction (n)	Follow-up period
Barros 2021	24 to 69 years	18 cases	January 2014 to January 2019	3 cases	3 to 18 months
Assmy 2012	35 years	166 cases	January 1989 to May 2010	11 cases	106 months
Chaker 2025	38 ± 12 years	87 cases	2012 to 2023	44 cases	≥ 12 months
Din 2023	35.89 ± 4.2 years	25 cases	January 2022 to February 2023	9 cases	≥ 1 week
Patil 2019	28.8 ± 7.59 years	18 cases	July 2014 to January 2017	8 cases	NR
Sharma 2021	33.64 ± 9.46 years	62 cases	September 2014 to August 2019	7 cases	≥ 2 weeks

NR: not reported.

Inclusion criteria for this meta-analysis were: patients who were healthy prior to injury, original research studies, studies that comprehensively discussed the association between erectile dysfunction and penile fracture surgery, and study designs that were in cohort and case report. The studies were excluded if: patients had sexual problems prior to injury, or if the studies did not mention erectile dysfunction after surgical repair or if the studies included patients with other diseases. Studies were also excluded if they didn't provide OR as the statistic measurement, in addition to this, letters and case reports abstracts were also excluded for analysis.
Out of the 6 studies that are included, 527 patients were enrolled in this meta-analysis. The six studies that were included were published between 2012 and 2025. The characteristics of the selected studies are summarized in Table 1. All of the studies were considered as good quality, as shown in Table 2. Of these 6 studies, 5 were cohort studies and 1 was a case control study.

Age
Three cohort studies discussed the relationship between age at injury and the occurrence of erectile dysfunction following surgery, which divided patients < 50 years as group 1 and patients ≥ 50 years as group 2. The statistical analysis for this variable was calculated through Review Manager 5.4. The OR for age and erectile dysfunction following surgery were statistically significant. In addition to this, we found a 0% inconsistency index in this calculation.

Mechanism of injury
Three cohort studies, which were included in this meta-analysis investigated the correlation between mechanism of injury or etiology and postoperative erectile dysfunction. As the mechanisms of injury were varied, we divided them into a sexual intercourse group and a non-sexual intercourse group. From the calculation we found that the OR was 0.70 (CI 95%: 0.39-1.24, p = 0.22) which was considered as not statistically significant. With 0% of I^2, there was also no risk of heterogeneity in this calculation.

Location of fracture
Four studies, consisting of 3 cohort studies and 1 case-control study, discussed the potential relationship between the location of fracture and ED occurrence. The OR reported was 0.43 (CI 95%: 0.22-0.84, p = 0.01). The calculation showed that the location of fracture (proximal or middle shaft) was statistically significant as risk factor of erectile dysfunction following surgical repair for penile fracture.

Surgical approach
A study from Chaker et al. 2025 investigated the correlation between surgical approach and ED occurrence.
The OR for this variable was 5.09 (CI 95%: 2.03-12.78, p = 0.0005), which is statistically significant. From this result we can figure out that patients with a coronal approach are 5 times more likely to have ED in the future than the control group.

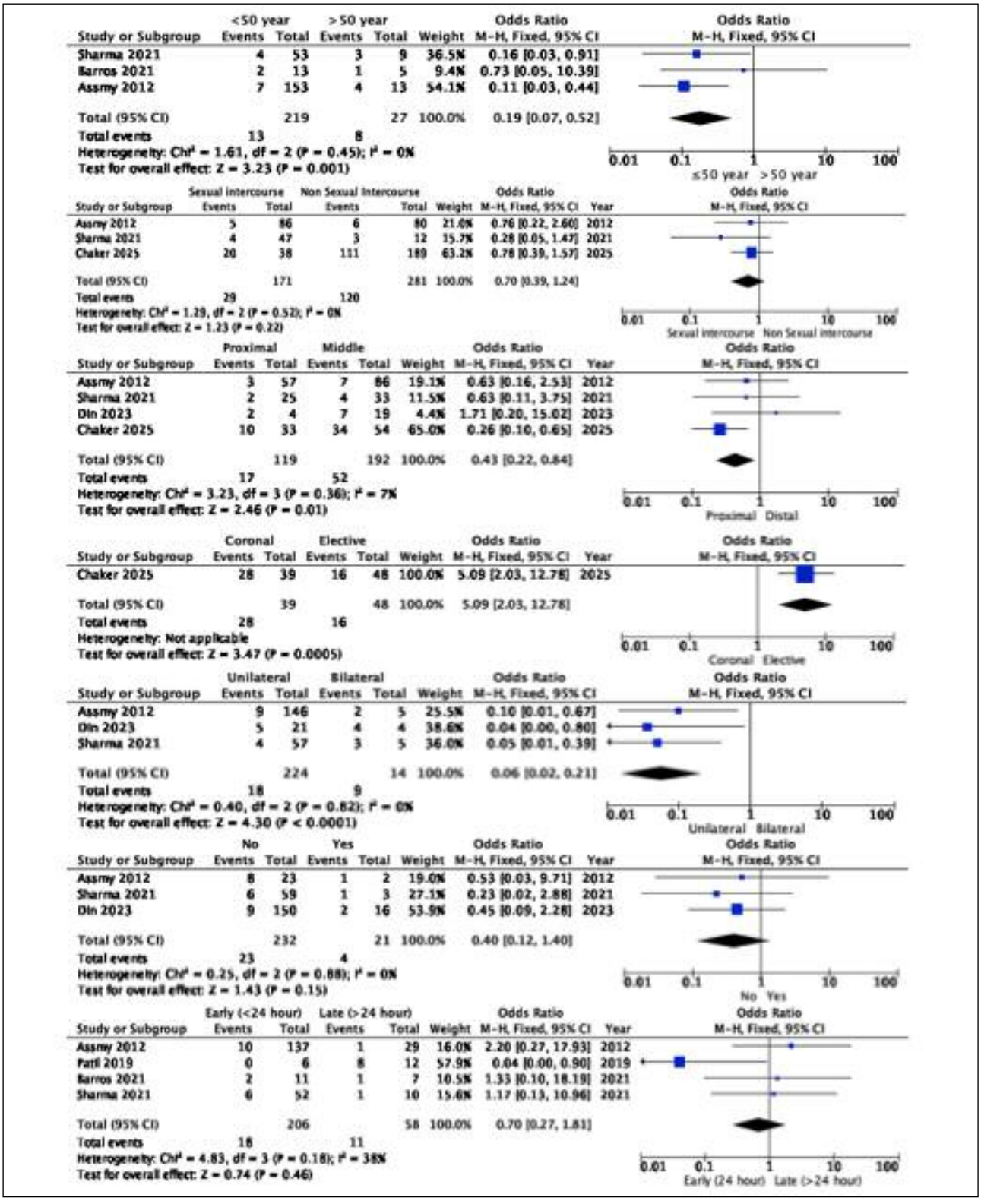
Side of fracture
The location of the fracture was divided into unilateral and bilateral groups. Two cohort studies and 1 case-control study were included. The OR was 0.06 (CI 95%: 0.02-0.21, p < 0.0001) which was considered to be significant. These results showed that if the fracture occurs on both sides, there is a 94% probability of having ED following the repairment surgery.

Urethral injury

Urethral injury coexisting with penile fracture was also investigated as a risk factor for ED in 2 cohort studies and 1 case-control study. Even though the calculation showed that patients with urethral injury are 60% more likely to have ED in the future, as shown in Figure 2, the result

Figure 2.

Forest plot for the impact on risk factors on incident erectile dysfunction: age, etiology, location of fracture, surgical approach, side of fracture, urethral injury, and timing of presentation.



was not statistically significant [OR 0.40 (CI 95%: 0.12-1.40, p = 0.15)].

Timing at presentation

Timing to the operating room was also considered as a risk factor for ED occurrence in some studies. Four studies that were included in this meta-analysis. The results indicate that timing at presentation (< 24 hours vs ≥ 24 hours) was insignificant to the occurrence of ED following penile fracture surgery. The OR was 0.70 (CI 95%: 0.27-1.71, p = 0.46).

Discussion

Treatment options for penile fracture include conservative and surgical intervention approaches (14). The surgical exploration was the treatment of choice when a penile fracture is suspected. Surgical approach was preferred because of the good functional and cosmetic outcome with minimal complication (15). Surgical exploration combined with circumcision was recommended to maintain local hygiene, prevent phimosis, and provide a better aesthetic outcome (16).

Some patients may develop post-surgery complications. Complications following the surgery repair are varied, such as ED, deviation of the penis, development of fibrous plaque, and voiding problems. ED is a huge problem that impacts both the physical and the psychological condition of the patient (6, 15, 17-20). Some studies showed that the ratio of ED after surgery varied from 0 to 16.6% of patients (21, 22).

According to the study by *Zhu et al. 2024*, a multivariate analysis was made to investigate the correlation between age and post-surgery ED. The report said that age was not significantly related to the occurrence of postoperative ED (OR 1.004 and p = 0.922) (9). This finding contradicted our findings, which depicted a major association between age at injury and the incidence of ED [OR 0.19 (CI 95%: 0.007-0.52, p = 0.001)]. Along with our findings, a study by *Avci et al.* 2023 over 58 penile fracture patients also reported a significant correlation between age and post-surgery ED (p = 0.004) (23). Similarly, the study by *Ortac et al. 2020* reported that the patients with ED were older compared to non-ED patients (p-value 0.001) (24).

Mechanism of trauma has no significant relation as the risk factor of ED following penile fracture surgery, as reported by *Silva et al. 2024* (p = 0.896) (25). These results are presumably in accordance with our study, as we also reported no significant relationship between the mechanism of injury (sexual intercourse and non-sexual intercourse) and ED incidence [OR: 0.70 (0.39, 1.57), p = 0.22].

Original research by *Silva et al. 2024* showed a significant connection between lesion location and erectile function (p-value = 0.035) (25). This report is also in line with our study, which investigated the correlation between fracture location (proximal vs middle shaft) and ED occurrence [OR: 0.43 (0.22, 0.84), p = 0.001].

Although we included only one study that discussed the relationship of surgical approach and ED incidence, we concluded that there was a significant relation between different types of surgical approaches (coronal vs elective) and ED incidence [OR: 5.09 (2.03, 12.78), p = 0.0005]. However, a study conducted by *Ouanes et al. 2021* in 138 cases with a mean age of 31.2 years reported differently. They investigated the correlation of the incision type that was used by surgeons and the occurrence of ED. The results reported that the incision type (elective vs circumferential degloving) was not statistically related to ED occurrence, as they measured a p-value > 0.05 (26).

Silva et al. 2024 reported that lesion laterality (right/left/bilateral) has a correlation to the occurrence of ED after penile fracture repair, although not statistically significant (p = 0.667) (25).

Our review compared only two groups in relation to laterality: unilateral vs bilateral. We calculated the relationship between unilateral or bilateral fracture and the occurrence of ED among postoperative patients showing a significant correlation between the two groups, with OR 0.06 (0.02-0.21) and p < 0.0001.

Urethral injury is suspected whenever hematuria, blood in the meatus, and voiding symptoms are present, although the absence of the findings can't exclude it (27-29).

The tunica albuginea thickness of the penis will decrease from 2 mm in the flaccid state to 0.25 mm in the erect state along with the increase of intracavernous pressure, which makes it very easy to rupture against penile trauma (5, 28-30).

A multivariate analysis done by *Zhu et al. 2024* reported the OR of postoperative ED in presence of urethral injury was 11.330 (p = 0.002) which was statistically significant, although this report is contradicted by our study [OR 0.40 (CI 95%: 0.12-1.40, p = 0.15)] (9).

In our study, the timing of presentation to the operating room was insignificant. Our study reported a OR of 0.70 (0.27, 1.81) with p-value of 0.46 for the correlation between timing of presentation and ED occurrence.

A study by *Bulbul et al.* also found a result similar to ours (p = 0.979) (31), whereas *Ouanes et al.* showed a different result reporting a p-value of 0.03 in their study (26).

A meta-analysis done by *Amer et al. 2016* reported that there was no significant association while comparing immediate and delayed surgery to the rates of ED (RR 0.82: 0.41-1.66, p = 0.59) (32). Finally, a study conducted by *Ortac et al.* also obtained results similar to ours, reporting a p-value of 0.235 for the correlation of the time of presentation to the hospital after injury and the postoperative erectile dysfunction (24).

The strength of our study is that this is the first meta-analysis that extensively discusses the risk factors of erectile dysfunction after penile fracture surgery. Other meta-analyses (32-36) have previously evaluated the outcomes of penile fracture repair surgery but have not focused their analysis on the risk factors for the occurrence of erectile dysfunction after the procedure. This study showed us which risk factors have a significant relationship to the occurrence of erectile dysfunction and which do not. Despite this strength, our study was limited by the small number of studies available. More study and reviews are needed in the future in order to increase the validity of the potential risk factors and also to discover other risk factors that might be related to the occurrence of erectile dysfunction following a penile fracture surgery.

Conclusions

This systematic review and meta-analysis showed that patients over 50 years of age, those with midshaft fracture, and those with bilateral fractures are significantly more likely to have erectile dysfunction following penile fracture surgery.

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Declarations

Ethical approval and consent for participate: *Ethical approval was not needed since this is a systematic review and meta-analysis.*

Availability of data and material: *Data available on request from the authors.*

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