Key Words
Penile fracture · Fracture of penis · Trauma to penis · Rupture of corpora cavernosa · Comparative studies · Immediate versus delayed management of penile fracture

Abstract
Objective: To review the causes and management of penile fracture and to compare between surgical and conservative management as well as immediate and delayed interventions in terms of overall and specific complications. Methods: A search of all reported literature was conducted for all articles reporting on the management and outcomes of penile fractures. Full texts of relevant articles were obtained and screened according to the inclusion criteria. Outcomes measures were numbers of patients receiving surgical or conservative management, aetiology of fracture, length of admission, complications as well as the specifics of diagnostic approaches and operative management. Data was collated and where possible meta-analysed using Revman software. Results: A total of 58 relevant studies involving 3,213 patients demonstrated that intercourse accounts for only 48% of cases with masturbation and forced flexion accounting for 39%. Meta-analysis shows that surgical intervention was associated with significantly fewer complications vs. conservative management (p < 0.000001). Surgical intervention results in significantly less erectile dysfunction (ED), curvature and painful erection than conservative management. There was no significant difference in the number of patients developing plaques/nodules (p = 0.94). Meta-analysis shows that overall early surgery is preferable to delayed surgery but that rates of ED are not significantly different. Discussion: Early surgical intervention is associated with significantly fewer complications than conservative management or delayed surgery. The combined outcome of rapid diagnosis by history and clinical examination and swift surgical intervention is key for reconstruction with minimal long-term complications.

Introduction
Penile fracture is an uncommon presentation to Urology departments with an incidence of 1 in 175,000 [1]. It is defined as the traumatic rupture of the tunica albuginea of the corpora cavernosa; common culprits are intercourse when the penis strikes the perineum or masturbation. Other causes include rolling over in bed on to the erect penis, forced flexion to achieve detumescence and external blunt trauma [2]. A widely held view is that the ‘woman on top’ position poses the greatest risk to penile...
fracture although no systematic review has corroborated this. Analysing the literature would seem to suggest a geographical variation in the aetiology of penile fracture [3]. In some Middle Eastern countries, many reported cases are due to patients ‘kneading and snapping’ the erect penis to achieve rapid detumescence in unsuitable situations [2, 4, 5]. The most prevalent example of this practise (also known as ‘Taqaadan’) is one Iranian study where 269 of 352 (76%) patients suffered a penile fracture in the process [5].

Jack et al. [4] states that the strain of buckling the engorged corpora can ‘generate pressures in excess of 1,500 mm Hg, thus exceeding the limit of the thinned tunica’. In an erect penis, the tunica is exceptionally thin (as little as 0.25 mm) making it more vulnerable. While cavernosal lacerations to the flaccid penis are possible via other means, purists will argue that such injuries should not be called ‘fractures’; the flaccid penis lacks a fulcrum for snapping and contains a relatively thick tunica albuginea conferring a protective role [6].

The classic patient gives a history of hearing a cracking noise during sexual activity when the tunica ruptures, rapidly followed by pain, detumescence, and a substantial subcutaneous haematoma leading to an ‘eggplant deformity’ [2]. Historically, penile fracture was managed conservatively, but owing to a relatively high morbidity of up to 30% (erectile dysfunction (ED), plaques, painful erection) [7] contemporary management has shown a trend towards following urgent surgical exploration and repair of the tunical defect. Importantly, while numerous studies have reported their management of penile fractures, their cohorts are small making it challenging to generalise regarding the optimal treatment approach. The rare nature of penile fracture does not lend itself to a prospective trial; therefore, this study aims at systematically reviewing the literature to meta-analyse where possible and to summarise the best of current worldwide practises to thus inform the optimal management modality.

While some authors suggest that diagnostic adjuncts should play no role in diagnosing penile fracture [8], we aimed at assessing the use of diagnostic adjuncts such as MRI, ultrasonography, cavernosography or retrograde urethrography.

Materials and Methods

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses and Cochrane guidelines.

Results

The initial search identified 1,030 potentially relevant studies, of which 278 were excluded on abstract screening due to duplication/irrelevance. A further 652 did not meet inclusion criteria and 31 had insufficient data parameters or n < 5. In all, 58 relevant studies were included (fig. 1).

Study Characteristics

In total, 58 studies from 26 different countries involving 3,213 patients were included. There were no randomised trials and all studies were observational and gen-

Information Source and Search Criteria

Medline (1988 to present) and EMBASE (1988 to present) were searched to April 2015. The following keywords were used: ‘penile fracture’, ‘fracture of penis’, ‘trauma to penis’, ‘rupture of corpora cavernosa’, ‘comparative studies’, ‘immediate vs. delayed management of penile fracture’. Cochrane and Database of Abstracts of Reviews of Effectiveness databases were also checked for any systematic reviews. All English papers were included; however, non-English papers where the data was extractable were excluded. References searches from included articles were evaluated for potentially suitable studies.

Eligibility Criteria

All case series assessing the management of penile fracture were included. Comparative and non-comparative observational studies assessing either surgical or conservative management of penile fracture with n ≥ 3 were included.

Outcome measures were (1) aetiology of fractures, (2) presenting complaint, (3) length of hospitalisation, (4) difference between surgical or conservative management with regards to complications, (5) time to intervention, and (6) type of suture used for repair. Subgroup analysis was performed where possible to offer granularity on various complications as well as to assess outcomes between immediate and delayed surgeries.

Study Selection and Data Collection

The inclusion criteria mentioned earlier were used to select potentially relevant articles through abstract screening. Two authors (R.W. and T.A.) assessed full texts of relevant articles and screened them according to the inclusion criteria. Where differences of opinion emerged, discussions were held with the senior author (O.M.A.) until a consensus was reached. To avoid duplication of published studies from the same authors/institutions, we included only the latest studies.

Data were collated on an excel workbook. Where applicable, data were meta-analysed using Revman 5.3. Heterogeneity was analysed using a chi² test on N – 1 degrees of freedom, with an alpha of 0.05 used for statistical significance and with the I² test. I² values of 25, 50 and 75% correspond to low, medium and high levels of heterogeneity. A fixed-effect model was used unless statistically significant high heterogeneity (I² > 75% was considered significantly high heterogeneity) existed between studies. A random-effects model was employed if heterogeneity existed [9, 10].

**Outcome Measures: Aetiology of Penile Fracture**

Thirty-eight studies provided data on the causes of penile fractures [2, 3, 5, 8, 15–17, 19–21, 23–25, 27, 29, 31, 32, 35–41, 43, 46, 48, 49, 51, 52, 54, 58–60, 62–64]. In total, 908 patients had a fracture caused by sexual intercourse, while 1,040 had one caused by ‘other means’ (table 1). Other causes were significantly more likely to result in fracture than intercourse (39 studies, n = 1,908, p = 0.009, I² = 95%; fig. 2).

Meta-analysis shows that ‘other’ (n = 692) mechanisms compared to masturbation (n = 345) were more likely to result in penile fracture (n = 1,037, p = 0.02, I² = 92%). The authors explored the data in depth to add granularity on the ‘other’ mechanisms, which revealed a variety of mechanisms, including one Bulgarian patient having being kicked by a cow [38] and one utilising a Hoover for masturbation [59] (fig. 3 and table 2).

Analysis of sexual positioning was mentioned in 5 studies [3, 15, 19, 24, 62]. Meta-analysis shows that sexual position did not have an impact on relative risk of penile fracture (5 studies, n = 76, p = 0.53, I² = 42%; fig. 4). Specifically, one author [62] speculated on the role of the Internet in inspiring the ‘woman on top’ position in 6 out of 8 cases.

**Investigation of Penile Fracture**

Thirty-one authors used no imaging emphasising that an accurate diagnosis is possible on clinical assessment alone. Meanwhile, 22 authors used various image modalities to confirm the diagnosis: USS [16], cavernography [7], retrograde urethrography [14] and MRI [7] (table 3). Moreno et al. [26] emphasised that complementary tests were helpful, but they were not definitive. They used ultrasound to aid the diagnosis and 100% of their cases were treated surgically.

**Management of Penile Fracture**

In 29 studies, surgery alone was utilised. In 23 studies, some men had conservative management. In total, 95.4% of patients had surgery and 4.6% had conservative management.

**Duration of Inpatient Stay**

Duration of inpatient stay for surgically treated patients ranged from 1 to 21 days and for patients treated conservatively, 0–14 days. An absence of variance data means pooled analysis is not possible in this domain. For those studies that provided data on the mean length of stay, the overall mean after surgical intervention was 3.3 vs. 5.2 days for conservative intervention, indicating that on average, surgery leads to a shorter stay (table 4).

**Incision Type**

The most common incision was subcoronal degloving in 1,091 patients, along with penoscrotal on the median raphe in 4. A degloving approach with second access was used in 364, a direct incision over the suspected haematoma in 73, infrapubic straight in 18 and infrapubic hookstick in 7.
Three studies used absorbable and non-absorbable on a case-by-case basis [5, 37], 25 studies used only absorbable [1, 2, 11, 14–17, 20, 21, 25, 27, 31, 35, 36, 39, 40, 42–44, 46, 49, 53, 58, 59, 62]. Three studies used absorbable and non-absorbable on a case-by-case basis [5, 37], 25 studies used only absorbable [1, 2, 11, 14–17, 20, 21, 25, 27, 31, 35, 36, 39, 40, 42–44, 46, 49, 53, 58, 59, 62]. Three studies used absorbable and non-absorbable on a case-by-case basis [5, 37], 25 studies used only absorbable [1, 2, 11, 14–17, 20, 21, 25, 27, 31, 35, 36, 39, 40, 42–44, 46, 49, 53, 58, 59, 62]. Four studies used absorbable [8, 13, 48, 52] and 18 did not specify the type of suture material used [3, 12, 18, 19, 22, 23, 26, 28–30, 32, 34, 38, 45, 47, 50, 51].

A combination of continuous or interrupted closures was used, with 7 authors using 2/0 [21, 33, 36, 40–42, 59], 10 using 3/0 [1, 2, 8, 16, 20, 27, 31, 35, 36, 39, 40, 42–44, 46, 49, 53, 58, 62] and 4 using 4/0 [15, 43, 46, 52]. Three studies used absorbable and non-absorbable on a case-by-case basis [5, 37], 25 studies used only absorbable [1, 2, 11, 14–17, 20, 21, 25, 27, 31, 35, 36, 39, 40, 42–44, 46, 49, 53, 58, 59, 62]. Four studies used absorbable [8, 13, 48, 52] and 18 did not specify the type of suture material used [3, 12, 18, 19, 22, 23, 26, 28–30, 32, 34, 38, 45, 47, 50, 51].

**Table 2. Presentation of penile fracture**

<table>
<thead>
<tr>
<th>Presentation</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swelling</td>
<td>1,158</td>
<td>39</td>
</tr>
<tr>
<td>Discoloration</td>
<td>1,195</td>
<td>41</td>
</tr>
<tr>
<td>Noise</td>
<td>800</td>
<td>27</td>
</tr>
<tr>
<td>Detumescence</td>
<td>739</td>
<td>26</td>
</tr>
<tr>
<td>Pain</td>
<td>726</td>
<td>24</td>
</tr>
<tr>
<td>Haematoma</td>
<td>619</td>
<td>21</td>
</tr>
<tr>
<td>Curvature</td>
<td>393</td>
<td>13</td>
</tr>
<tr>
<td>Urethral bleed</td>
<td>92</td>
<td>3</td>
</tr>
</tbody>
</table>

**Fig. 2.** Comparison between sexual intercourse and other causes of penile fractures.
### Table 1: Penile Fracture: A Meta-Analysis

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Masturbation</th>
<th>Other</th>
<th>M-H, Random, 95% CI</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Derouiche 2008 (1)</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>2.3%</td>
</tr>
<tr>
<td>Ahmadnia, H</td>
<td>13</td>
<td>13</td>
<td>0</td>
<td>23.6%</td>
</tr>
<tr>
<td>Asgari 1996 (2)</td>
<td>0</td>
<td>31</td>
<td>31</td>
<td>2.3%</td>
</tr>
<tr>
<td>Ateyah 2008 (3)</td>
<td>0</td>
<td>18</td>
<td>18</td>
<td>2.3%</td>
</tr>
<tr>
<td>Chung 2006 (4)</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>2.3%</td>
</tr>
<tr>
<td>Dincel 2005 (5)</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>2.4%</td>
</tr>
<tr>
<td>El atat 2008 (6)</td>
<td>23</td>
<td>77</td>
<td>77</td>
<td>4.2%</td>
</tr>
<tr>
<td>El Taher 2004</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>2.3%</td>
</tr>
<tr>
<td>Gamal 2011 (8)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.3%</td>
</tr>
<tr>
<td>Garcia Gómez 2012 (9)</td>
<td>6</td>
<td>61</td>
<td>61</td>
<td>4.0%</td>
</tr>
<tr>
<td>Gedik 2011 (10)</td>
<td>16</td>
<td>22</td>
<td>22</td>
<td>4.0%</td>
</tr>
<tr>
<td>Ghilam Am 2008 (11)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.3%</td>
</tr>
<tr>
<td>Hinev 2000 (12)</td>
<td>0</td>
<td>7</td>
<td>7</td>
<td>2.3%</td>
</tr>
<tr>
<td>Ishikawa 2003 (13)</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>2.3%</td>
</tr>
<tr>
<td>Kamil N 1993 (14)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.3%</td>
</tr>
<tr>
<td>Kochakarn 2002</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2.4%</td>
</tr>
<tr>
<td>Koiffman 2003 (15)</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>2.4%</td>
</tr>
<tr>
<td>Mensah 2010 (16)</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>2.4%</td>
</tr>
<tr>
<td>Muñoztor 2004 (17)</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3.1%</td>
</tr>
<tr>
<td>Mydlo 2000 (18)</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2.9%</td>
</tr>
<tr>
<td>Nason 2013</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.4%</td>
</tr>
<tr>
<td>Nawaz 2010 (19)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.4%</td>
</tr>
<tr>
<td>Ozorak 2013</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>2.3%</td>
</tr>
<tr>
<td>Pandyan 2006 (20)</td>
<td>1</td>
<td>11</td>
<td>11</td>
<td>4.1%</td>
</tr>
<tr>
<td>Pavan 2014 (21)</td>
<td>2</td>
<td>10</td>
<td>10</td>
<td>3.6%</td>
</tr>
<tr>
<td>Reis 2014 (22)</td>
<td>6</td>
<td>10</td>
<td>10</td>
<td>3.9%</td>
</tr>
<tr>
<td>Restrepo 2010 (23)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.3%</td>
</tr>
<tr>
<td>Rivas 2014 (24)</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>3.1%</td>
</tr>
<tr>
<td>Shetty 2014</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2.3%</td>
</tr>
<tr>
<td>Swanson 2014 (25)</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>3.5%</td>
</tr>
<tr>
<td>Tijani 2012 (26)</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>2.3%</td>
</tr>
<tr>
<td>Yamacke 2013 (27)</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>2.3%</td>
</tr>
<tr>
<td>Zargooshi (28)</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>3.8%</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>1,037</td>
<td>1,037</td>
<td>100.0%</td>
<td>0.50 [0.27, 0.91]</td>
</tr>
</tbody>
</table>

**Fig. 3.** Comparison between masturbation and other (non-intercourse) causes of penile fracture.

### Table 2: Penile Fracture: A Meta-Analysis

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Women on top</th>
<th>Other</th>
<th>M-H, Fixed, 95% CI</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mensah 2010 (1)</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>5.6%</td>
</tr>
<tr>
<td>Nason 2013</td>
<td>13</td>
<td>20</td>
<td>20</td>
<td>19.4%</td>
</tr>
<tr>
<td>Pavan 2014 (2)</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>11.1%</td>
</tr>
<tr>
<td>Reis 2014 (22)</td>
<td>14</td>
<td>24</td>
<td>24</td>
<td>27.8%</td>
</tr>
<tr>
<td>Tijani 2012 (3)</td>
<td>8</td>
<td>21</td>
<td>21</td>
<td>36.1%</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>76</td>
<td>76</td>
<td>100.0%</td>
<td>1.11 [0.80, 1.54]</td>
</tr>
</tbody>
</table>

**Fig. 4.** Comparison of positioning during sexual intercourse.
### Table 3. Use of imaging modalities

<table>
<thead>
<tr>
<th>Author</th>
<th>Imaging used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavan</td>
<td>Cavernography, MRI</td>
</tr>
<tr>
<td>Ahmandia</td>
<td>Retrograde urethrography</td>
</tr>
<tr>
<td>Swanson</td>
<td>USS, MRI, retrograde urethrography, cystoscopy</td>
</tr>
<tr>
<td>Rivas</td>
<td>USS</td>
</tr>
<tr>
<td>Reis Lo</td>
<td>USS</td>
</tr>
<tr>
<td>Nason</td>
<td>MRI, cavernography, urethograms</td>
</tr>
<tr>
<td>Garcia Gomez</td>
<td>USS</td>
</tr>
<tr>
<td>Koifman</td>
<td>USS, MRI, retrograde urethrocystogram</td>
</tr>
<tr>
<td>Ibrahim el</td>
<td>USS, MRI, cavernography, ascending urethrogram</td>
</tr>
<tr>
<td>Moreno Sierra</td>
<td>USS</td>
</tr>
<tr>
<td>Gedik</td>
<td>USS</td>
</tr>
<tr>
<td>Kandar</td>
<td>Retrograde urethrography</td>
</tr>
<tr>
<td>Ateyah</td>
<td>USS</td>
</tr>
<tr>
<td>Pandyan</td>
<td>USS, cavernography</td>
</tr>
<tr>
<td>Koifman (different paper than above)</td>
<td>USS, MRI, urethrocystogram</td>
</tr>
<tr>
<td>El bahnasawy</td>
<td>USS</td>
</tr>
<tr>
<td>Hinev</td>
<td>USS, caverography, retrograde urethrograph</td>
</tr>
<tr>
<td>Karadeniz</td>
<td>Cavernography</td>
</tr>
<tr>
<td>Yamaçake</td>
<td>USS, retrograde urethography+</td>
</tr>
<tr>
<td>Mydlo</td>
<td>Cavernography/urethrography, proportion had artificial erection after degloving with saline instillation</td>
</tr>
<tr>
<td>Agarwal</td>
<td>USS, retrograde urethrography, MRI</td>
</tr>
</tbody>
</table>

### Table 4. Length of stay

<table>
<thead>
<tr>
<th>Author</th>
<th>Admission length for surgical patients, days (range)</th>
<th>Admission length for conservative patients, days (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavan et al. [19], 2014</td>
<td>5.6 (3–15)</td>
<td>2.5 (0–11)</td>
</tr>
<tr>
<td>Swanson et al. [15], 2014</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Muentener et al. [25], 2004</td>
<td>5.1±1.8</td>
<td>3.1±3.4</td>
</tr>
<tr>
<td>Pandyan et al. [20], 2006</td>
<td>7 (3–31)</td>
<td>Not stated</td>
</tr>
<tr>
<td>Brandes [11], 2005</td>
<td>2</td>
<td>Not stated</td>
</tr>
<tr>
<td>Chung et al. [51], 2006</td>
<td>4 (3–21)</td>
<td>Not stated</td>
</tr>
<tr>
<td>Gedik et al. [40], 2011</td>
<td>1.2 (1–4)</td>
<td>5 (4–7)</td>
</tr>
<tr>
<td>Yapanoglu et al. [12], 2009</td>
<td>3 (2–5)</td>
<td>8.5 (5–14)</td>
</tr>
<tr>
<td>Yamaçake et al. [54], 2013</td>
<td>1.6 (1–5)</td>
<td>Not stated</td>
</tr>
<tr>
<td>Total</td>
<td>3.38 (1–21)</td>
<td>5.2 (0–14)</td>
</tr>
</tbody>
</table>
In one paper [45], a comparison between absorbable and nonabsorbable sutures showed a highly significant tendency to scar formation with nonabsorbable sutures (p < 0.001).

Complications of Penile Fracture

A cumulative analysis of all the included studies found that 3,045 patients were treated surgically and 168 patients were treated conservatively. Complications occurred in 20.6% in the surgical group and in 46% in the conservatively managed group (table 5).

Urethral Injury

Urethral bleeding and injury were documented in 26 studies (n = 131). It showed that 5.6% of patients presented with urethral bleeding, but overall 6.1% (NS) were found to have urethral injury. The lack of significance implies that urethral bleeding is a strong indicator for urethral injury, but its absence does not exclude it (fig. 5). Fifteen authors utilised retrograde urethography if they suspected urethral injury [1, 3, 5, 8, 36, 38, 40, 42, 51, 52, 54, 59, 63–65].

Immediate Surgical Intervention vs. Conservative Management

Pooled analysis of the 22 studies that directly compared immediate surgery vs. conservative management was possible; 422 of 908 (46.4%) patients in the surgical group and 93 of 104 patients (89%) in the conservative group had complications. Meta-analysis using a fixed-effects model ($I^2 = 42\%$) shows that surgical intervention is associated with significantly fewer complications when compared to conservative management (22 studies, 1,042 patients, $I^2 = 46\%$, p < 0.0001; fig. 6).

Erectile Dysfunction

Early surgical intervention results in significantly less ED than conservative intervention (12 studies, 793 participants, $I^2 = 65\%$, p < 0.0001; fig. 7).

Plaques/Nodules

There were fewer patients developing plaques/nodules in those undergoing early surgery than conservative management (9 studies, 650 participants, $I^2 = 77\%$, p = 0.05; fig. 8).

Penile Curvature

Those conservatively managed were more likely to develop penile curvature as opposed to those surgically managed (18 studies, 678 participants, $I^2 = 23\%$, p < 0.0001; fig. 9).

Painful Erections

Emergent surgery was associated with significantly fewer cases of painful erections (10 studies, 628 participants, $I^2 = 15\%$, p < 0.0001; fig. 10).

Duration of Admission

Duration of inpatient stay ranged from 1 to 21 days for surgically treated patients and 0–14 days for patients treated conservatively. An absence of variance data means pooled analysis is not possible in this domain. For those studies that provided data on the mean length of stay, the overall mean after surgical intervention was 3.5 vs. 5.2 days for conservative intervention, indicating that on average, surgery leads to a shorter stay (table 4).

Immediate vs. Delayed Surgical Intervention

Fifteen studies were identified making comparisons between immediate vs. delayed surgery for penile fracture. One conference abstract of a meta-analysis on this subject has been published [66]. Our review process has highlighted further papers suitable for inclusion to enable us to perform subgroup analysis in this domain.

The authors of the meta-analysis [66] concluded that complication rates did not differ between delayed and immediate repair of penile fractures. A paper by Kozacioglu

### Table 5. Complications of surgically managed patients and conservatively managed patients

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surgical complications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plaques/nodules</td>
<td>393</td>
<td>13.9</td>
</tr>
<tr>
<td>Curvature</td>
<td>78</td>
<td>2.7</td>
</tr>
<tr>
<td>Erectile dysfunction</td>
<td>55</td>
<td>1.94</td>
</tr>
<tr>
<td>Pain</td>
<td>40</td>
<td>1.40</td>
</tr>
<tr>
<td>Infection</td>
<td>7</td>
<td>0.24</td>
</tr>
<tr>
<td>Mild chordee</td>
<td>4</td>
<td>0.14</td>
</tr>
<tr>
<td>Reoperation</td>
<td>3</td>
<td>0.10</td>
</tr>
<tr>
<td>Aneurysm</td>
<td>2</td>
<td>0.07</td>
</tr>
<tr>
<td>Wound oedema</td>
<td>1</td>
<td>0.04</td>
</tr>
<tr>
<td>Urinary disorder</td>
<td>1</td>
<td>0.04</td>
</tr>
<tr>
<td>Total</td>
<td>584</td>
<td>20.6</td>
</tr>
<tr>
<td><strong>Conservative complications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erectile dysfunction</td>
<td>37</td>
<td>22</td>
</tr>
<tr>
<td>Curvature</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>Plaques/nodules</td>
<td>33</td>
<td>19.1</td>
</tr>
<tr>
<td>Pain</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Chordee</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Infection</td>
<td>4</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>81</td>
<td>46</td>
</tr>
</tbody>
</table>
et al. [30] used patient feedback to evaluate this area, by using the International Index of Erectile Function questionnaire. They found that in patients without urethral involvement there was no statistical difference of ED or deformities between immediate vs. delayed surgery. The mean number of hours from trauma to surgery in this study was 11.3 ± 8.5 [30].

Overall Complications
Pooled analysis of 14 studies (511 participants) demonstrates significantly fewer complications with immediate surgery ($I^2 = 7\%$, $p < 0.00001$; fig. 11).

Erectile Dysfunction
Meta-analysis shows no significant difference in rates of ED when comparing emergent vs. delayed surgery (12 studies, 472 participants, $I^2 = 0\%$, $p = 0.59$; fig. 12).

Curvature
Meta-analysis demonstrates fewer cases of curvature with early surgery (5 studies, 116 participants $I^2 = 46\%$, $p = 0.0004$; fig. 13).

Plaques/Nodules
Early surgery is not associated with fewer cases of plaques (5 studies, 101 participants, $I^2 = 42\%$, $p = 0.51$; fig. 14).

One study [2], which did not provide sufficient numerical data for pooled analysis, also suggests that immediate surgical repair is preferable to delayed surgery. They temper this with the suggestion that in cases where surgical delay is unavoidable, the timing of the repair may be safely delayed for a brief period of conservative treatment with comparable results (assuming the patient has no other injuries such as urethral involvement).
Table 1: Risk of total complications based on immediate surgical or conservative management.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Surgical Events</th>
<th>Total</th>
<th>Conservative Events</th>
<th>Total</th>
<th>Weight</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chung 2006</td>
<td>3</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>1.4%</td>
<td>1.27 [0.10, 16.33]</td>
<td></td>
</tr>
<tr>
<td>Gamal 2011</td>
<td>0</td>
<td>56</td>
<td>0</td>
<td>21</td>
<td></td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Hinev 2000</td>
<td>3</td>
<td>18</td>
<td>0</td>
<td>7</td>
<td>1.2%</td>
<td>2.95 [0.17, 50.74]</td>
<td></td>
</tr>
<tr>
<td>Morey 2012</td>
<td>0</td>
<td>56</td>
<td>9</td>
<td>21</td>
<td>23.0%</td>
<td>0.02 [0.00, 0.33]</td>
<td></td>
</tr>
<tr>
<td>Muentjen 2004</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>17</td>
<td>3.5%</td>
<td>0.28 [0.01, 5.30]</td>
<td></td>
</tr>
<tr>
<td>Nale 2008</td>
<td>0</td>
<td>11</td>
<td>13</td>
<td>21</td>
<td>16.0%</td>
<td>0.07 [0.00, 1.04]</td>
<td></td>
</tr>
<tr>
<td>Ozorak 2013</td>
<td>0</td>
<td>21</td>
<td>2</td>
<td>10</td>
<td>5.6%</td>
<td>0.10 [0.01, 1.91]</td>
<td></td>
</tr>
<tr>
<td>Pandyan 2006</td>
<td>2</td>
<td>25</td>
<td>0</td>
<td>1</td>
<td>1.6%</td>
<td>0.38 [0.03, 5.58]</td>
<td></td>
</tr>
<tr>
<td>Swanson 2014</td>
<td>6</td>
<td>27</td>
<td>1</td>
<td>2</td>
<td>3.1%</td>
<td>0.44 [0.09, 2.10]</td>
<td></td>
</tr>
<tr>
<td>Yamanoe 2013</td>
<td>4</td>
<td>35</td>
<td>2</td>
<td>6</td>
<td>5.7%</td>
<td>0.34 [0.08, 1.48]</td>
<td></td>
</tr>
<tr>
<td>Yapanoglu 2009</td>
<td>0</td>
<td>37</td>
<td>4</td>
<td>5</td>
<td>13.0%</td>
<td>0.02 [0.00, 0.29]</td>
<td></td>
</tr>
<tr>
<td>Zargooshi</td>
<td>1</td>
<td>362</td>
<td>8</td>
<td>11</td>
<td>26.0%</td>
<td>0.00 [0.00, 0.03]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>670</td>
<td>123</td>
<td>100.0%</td>
<td></td>
<td>0.13 [0.07, 0.22]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 422

Heterogeneity: Chi² = 27.60, d.f. = 15 (p = 0.02); I² = 46%
Test for overall effect: Z = 5.31 (p < 0.00001)

![Fig. 6.](image-url) Comparison of total complications based on immediate surgical or conservative management.

Table 2: Development of ED.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Surgical Events</th>
<th>Total</th>
<th>Conservative Events</th>
<th>Total</th>
<th>Weight</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chung 2006</td>
<td>3</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>1.4%</td>
<td>1.27 [0.10, 16.33]</td>
<td></td>
</tr>
<tr>
<td>Gamal 2011</td>
<td>0</td>
<td>56</td>
<td>0</td>
<td>21</td>
<td></td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Hinev 2000</td>
<td>3</td>
<td>18</td>
<td>0</td>
<td>7</td>
<td>1.2%</td>
<td>2.95 [0.17, 50.74]</td>
<td></td>
</tr>
<tr>
<td>Morey 2012</td>
<td>0</td>
<td>56</td>
<td>9</td>
<td>21</td>
<td>23.0%</td>
<td>0.02 [0.00, 0.33]</td>
<td></td>
</tr>
<tr>
<td>Muentjen 2004</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>17</td>
<td>3.5%</td>
<td>0.28 [0.01, 5.30]</td>
<td></td>
</tr>
<tr>
<td>Nale 2008</td>
<td>0</td>
<td>11</td>
<td>13</td>
<td>21</td>
<td>16.0%</td>
<td>0.07 [0.00, 1.04]</td>
<td></td>
</tr>
<tr>
<td>Ozorak 2013</td>
<td>0</td>
<td>21</td>
<td>2</td>
<td>10</td>
<td>5.6%</td>
<td>0.10 [0.01, 1.91]</td>
<td></td>
</tr>
<tr>
<td>Pandyan 2006</td>
<td>2</td>
<td>25</td>
<td>0</td>
<td>1</td>
<td>1.6%</td>
<td>0.38 [0.03, 5.58]</td>
<td></td>
</tr>
<tr>
<td>Swanson 2014</td>
<td>6</td>
<td>27</td>
<td>1</td>
<td>2</td>
<td>3.1%</td>
<td>0.44 [0.09, 2.10]</td>
<td></td>
</tr>
<tr>
<td>Yamanoe 2013</td>
<td>4</td>
<td>35</td>
<td>2</td>
<td>6</td>
<td>5.7%</td>
<td>0.34 [0.08, 1.48]</td>
<td></td>
</tr>
<tr>
<td>Yapanoglu 2009</td>
<td>0</td>
<td>37</td>
<td>4</td>
<td>5</td>
<td>13.0%</td>
<td>0.02 [0.00, 0.29]</td>
<td></td>
</tr>
<tr>
<td>Zargooshi</td>
<td>1</td>
<td>362</td>
<td>8</td>
<td>11</td>
<td>26.0%</td>
<td>0.00 [0.00, 0.03]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>670</td>
<td>123</td>
<td>100.0%</td>
<td></td>
<td>0.13 [0.07, 0.22]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 19

Heterogeneity: Chi² = 28.79, d.f. = 10 (p = 0.001); I² = 65%
Test for overall effect: Z = 7.26 (p < 0.00001)

![Fig. 7.](image-url) Development of ED.
Discussion

This systematic review and meta-analysis aim to provide an in-depth analysis of the causes, presentation and management leading to complications of this uncommon urological emergency. While historically surgeons favoured conservative management, the presented evidence distils worldwide practice to show that early surgical repair achieves significantly better outcomes compared to conservative management or delayed surgery.
Penile Fracture: A Meta-Analysis

Thirty-eight observational studies showed that intercourse accounts for only 46% of cases. Surprisingly, subgroup analysis revealed that forced flexion (21%) was a more common cause than masturbation (18%). This would appear to be more prevalent in Eastern cultures than Western ones. It has previously been suggested [11] that the ‘woman on top’ position is more likely to result in penile fracture, but meta-analysis of 5 studies [3, 15, 19, 24, 62] did not find this finding to be significant (p = 0.59).

The most frequent signs on examination were swelling (43%) and discoloration (33%), in keeping with the typical aubergine sign/eggplant deformity on presentation. Meta-analysis showed that urethral bleeding was seen in 5.6% of cases, whereas confirmed urethral injury was present in just under 6.1% of patients. This implies this sign, along with blood at the meatus and urinary symptoms [51] is highly indicative of urethral rupture. This percentage is far less than reported in earlier studies of up to 30% [19], but there is no consensus with regard to the

---

**Fig. 10. Development of painful erections.**

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Surgical Events</th>
<th>Surgical Total</th>
<th>Conservative Events</th>
<th>Conservative Total</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brandes 2004</td>
<td>1</td>
<td>9</td>
<td>0</td>
<td>3</td>
<td>1.20 [0.06, 23.70]</td>
<td></td>
</tr>
<tr>
<td>Kamdar 2008</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>0.08 [0.01, 1.37]</td>
<td></td>
</tr>
<tr>
<td>Morey 2012</td>
<td>0</td>
<td>56</td>
<td>9</td>
<td>21</td>
<td>0.02 [0.00, 0.33]</td>
<td></td>
</tr>
<tr>
<td>Muenten 2004</td>
<td>0</td>
<td>12</td>
<td>4</td>
<td>17</td>
<td>0.15 [0.01, 2.62]</td>
<td></td>
</tr>
<tr>
<td>Ozorak 2013</td>
<td>0</td>
<td>21</td>
<td>2</td>
<td>10</td>
<td>0.10 [0.01, 1.91]</td>
<td></td>
</tr>
<tr>
<td>Pandyan 2006</td>
<td>3</td>
<td>25</td>
<td>0</td>
<td>1</td>
<td>0.54 [0.04, 7.18]</td>
<td></td>
</tr>
<tr>
<td>Pavan 2014</td>
<td>3</td>
<td>14</td>
<td>1</td>
<td>6</td>
<td>1.29 [0.17, 10.00]</td>
<td></td>
</tr>
<tr>
<td>Saporta 1997</td>
<td>0</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>0.06 [0.00, 1.02]</td>
<td></td>
</tr>
<tr>
<td>Yamacke 2013</td>
<td>4</td>
<td>35</td>
<td>1</td>
<td>6</td>
<td>0.69 [0.09, 5.13]</td>
<td></td>
</tr>
<tr>
<td>Zargooshi</td>
<td>2</td>
<td>362</td>
<td>0</td>
<td>11</td>
<td>0.17 [0.01, 3.26]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>551</td>
<td>77</td>
<td>100.0%</td>
<td></td>
<td>0.19 [0.10, 0.39]</td>
<td></td>
</tr>
<tr>
<td>Total events</td>
<td>13</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 10.57, d.f. = 9 (p = 0.31); I² = 15%  
Test for overall effect: Z = 4.63 (p < 0.00001)

**Fig. 11. Development of overall complications based on immediate vs. delayed surgical intervention.**

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Immediate surgical Events</th>
<th>Immediate surgical Total</th>
<th>Delayed surgical Events</th>
<th>Delayed surgical Total</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agarwal 2009</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>3</td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Alzubaidi 2012</td>
<td>4</td>
<td>98</td>
<td>2</td>
<td>11</td>
<td>8.6% [0.05, 1.09]</td>
<td></td>
</tr>
<tr>
<td>Anselmo 2008</td>
<td>0</td>
<td>11</td>
<td>1</td>
<td>2</td>
<td>5.7% [0.00, 1.58]</td>
<td></td>
</tr>
<tr>
<td>Cummings 1998</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>3</td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>El-Assmy 2011</td>
<td>9</td>
<td>149</td>
<td>2</td>
<td>31</td>
<td>7.9% [0.21, 4.12]</td>
<td></td>
</tr>
<tr>
<td>Hinev 2000</td>
<td>8</td>
<td>17</td>
<td>5</td>
<td>6</td>
<td>17.7% [0.30, 1.05]</td>
<td></td>
</tr>
<tr>
<td>Ishikawa 2003</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>1</td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Kardeniz 2012</td>
<td>0</td>
<td>18</td>
<td>3</td>
<td>3</td>
<td>13.9% [0.00, 0.48]</td>
<td></td>
</tr>
<tr>
<td>Kozacioglu 2009</td>
<td>9</td>
<td>39</td>
<td>1</td>
<td>3</td>
<td>4.4% [0.13, 3.79]</td>
<td></td>
</tr>
<tr>
<td>Pavan 2014</td>
<td>7</td>
<td>14</td>
<td>5</td>
<td>5</td>
<td>18.8% [0.31, 0.96]</td>
<td></td>
</tr>
<tr>
<td>Saporta 1997</td>
<td>0</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Shetty 2004</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>4.0% [0.03, 5.96]</td>
<td></td>
</tr>
<tr>
<td>Tijani 2012</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>2</td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Yamacke 2013</td>
<td>4</td>
<td>23</td>
<td>6</td>
<td>12</td>
<td>18.9% [0.12, 1.00]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>423</td>
<td>88</td>
<td>100.0%</td>
<td></td>
<td>0.42 [0.29, 0.61]</td>
<td></td>
</tr>
<tr>
<td>Total events</td>
<td>41</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 8.62, d.f. = 8 (p = 0.38); I² = 7%  
Test for overall effect: Z = 4.55 (p < 0.00001)
<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Immediate surgical</th>
<th>Delayed surgical</th>
<th>Risk Ratio</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Events Total</td>
<td>Events Total</td>
<td>M-H, Fixed, 95% CI</td>
<td>M-H, Fixed, 95% CI</td>
</tr>
<tr>
<td>Hinev 2000</td>
<td>2 17 0</td>
<td>6 3.6%</td>
<td>1.94 [0.11, 35.63]</td>
<td></td>
</tr>
<tr>
<td>Kardeniz 2012</td>
<td>0 18 3</td>
<td>3 29.1%</td>
<td>0.03 [0.00, 0.48]</td>
<td></td>
</tr>
<tr>
<td>Pavan 2014</td>
<td>1 14 5</td>
<td>5 39.5%</td>
<td>0.11 [0.02, 0.51]</td>
<td></td>
</tr>
<tr>
<td>Saporta 1997</td>
<td>0 10 1</td>
<td>1 12.8%</td>
<td>0.06 [0.00, 1.02]</td>
<td></td>
</tr>
<tr>
<td>Shetty 2004</td>
<td>0 2 2</td>
<td>5 8.4%</td>
<td>0.40 [0.03, 5.96]</td>
<td></td>
</tr>
<tr>
<td>Yamacke 2013</td>
<td>3 23 1</td>
<td>12 6.6%</td>
<td>1.57 [0.18, 13.48]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>84 32</td>
<td>100.0%</td>
<td>0.27 [0.13, 0.55]</td>
<td></td>
</tr>
<tr>
<td>Total events</td>
<td>6 12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 9.24, d.f. = 5 (p = 0.10); I² = 46%  
Test for overall effect: Z = 3.56 (p = 0.0004)

Fig. 12. Development of ED based on immediate vs. delayed surgical intervention.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Immediate surgical</th>
<th>Delayed surgical</th>
<th>Risk Ratio</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Events Total</td>
<td>Events Total</td>
<td>M-H, Fixed, 95% CI</td>
<td>M-H, Fixed, 95% CI</td>
</tr>
<tr>
<td>Anselmo 2008</td>
<td>0 11 1</td>
<td>2 31.0%</td>
<td>0.08 [0.00, 1.58]</td>
<td></td>
</tr>
<tr>
<td>Hinev 2000</td>
<td>1 17 0</td>
<td>6 9.3%</td>
<td>1.17 [0.05, 25.37]</td>
<td></td>
</tr>
<tr>
<td>Pavan 2014</td>
<td>5 14 0</td>
<td>5 9.2%</td>
<td>4.40 [0.29, 67.86]</td>
<td></td>
</tr>
<tr>
<td>Saporta 1997</td>
<td>0 10 1</td>
<td>1 32.8%</td>
<td>0.06 [0.00, 1.02]</td>
<td></td>
</tr>
<tr>
<td>Yamacke 2013</td>
<td>1 12 2</td>
<td>23 17.7%</td>
<td>0.96 [0.10, 9.53]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>64 37</td>
<td>100.0%</td>
<td>0.73 [0.28, 1.88]</td>
<td></td>
</tr>
<tr>
<td>Total events</td>
<td>7 4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 6.88, d.f. = 4 (p = 0.14); I² = 42%  
Test for overall effect: Z = 0.65 (p = 0.51)

Fig. 13. Development of curvature based on immediate vs. delayed surgical intervention.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Immediate surgical</th>
<th>Delayed surgical</th>
<th>Risk Ratio</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Events Total</td>
<td>Events Total</td>
<td>M-H, Fixed, 95% CI</td>
<td>M-H, Fixed, 95% CI</td>
</tr>
<tr>
<td>Alzubaidi 2012</td>
<td>4 98 2</td>
<td>11 27.5%</td>
<td>0.22 [0.05, 1.09]</td>
<td></td>
</tr>
<tr>
<td>Anselmo 2008</td>
<td>0 10 0</td>
<td>3 Not estimable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cummings 1998</td>
<td>0 7 0</td>
<td>3 Not estimable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>El-Assmy 2011</td>
<td>9 149 2</td>
<td>31 25.3%</td>
<td>0.94 [0.21, 4.12]</td>
<td></td>
</tr>
<tr>
<td>Ishikawa 2003</td>
<td>0 8 0</td>
<td>1 Not estimable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kozacigolu 2009</td>
<td>9 39 1</td>
<td>3 14.2%</td>
<td>0.69 [0.13, 3.79]</td>
<td></td>
</tr>
<tr>
<td>Pavan 2014</td>
<td>1 14 0</td>
<td>5 5.5%</td>
<td>1.20 [0.06, 25.53]</td>
<td></td>
</tr>
<tr>
<td>Saporta 1997</td>
<td>0 9 0</td>
<td>2 Not estimable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shetty 2004</td>
<td>0 2 0</td>
<td>5 Not estimable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yamacke 2013</td>
<td>4 23 0</td>
<td>12 5.0%</td>
<td>4.88 [0.28, 83.67]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>387 85</td>
<td>100.0%</td>
<td>0.82 [0.41, 1.66]</td>
<td></td>
</tr>
<tr>
<td>Total events</td>
<td>30 7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 4.56, d.f. = 5 (p = 0.47); I² = 0%  
Test for overall effect: Z = 0.54 (p = 0.59)

Fig. 14. Development of plaques/nodules based on immediate vs. delayed surgical intervention.
role for urethrography; with 12 of 21 authors who commented on urethral injury recommending its use when suspected clinically and others finding its use unnecessary [15, 19, 24–26, 29, 39, 44, 46, 49]. This view is shared by Derouiche et al. [49], who report that as well as gross haematuria, microscopic haematuria is an indicative sign in 50% of cases. The same group’s practice is to drain the bladder via a suprapubic cystotomy rather than risk injury with a urethral catheter. They also believe that invasive diagnostics are not required, as the urethral injury tends to be located at the same level as the corporal tear. Kamdar et al. [36] offers the practical solution of an on-table flexible cystoscopy at the time of repair allowing direct visualisation of the urethra without introducing a time delay.

Some studies used 3 modalities of imaging, whereas several used none at all and felt imaging only delayed treatment, potentially leading to poorer outcomes [8, 12, 32, 59]. Ahmadnia et al. [8] states that retrograde urethrography was time consuming and not cost effective. They felt that retrograde urethrography was necessary only if there was gross haematuria or urethrorrhagia. However, in contrast, Pavan et al. [19] states that radiological investigation is essential to plan appropriate intervention as it will confirm the diagnosis, assess the site and extent of damage and exclude urethral involvement.

This systematic review has categorically confirmed what most modern centres have reported – that early surgery produces favourable outcomes with regards to long-term complications vs. conservative management. This is specifically the case for ED, curvature and painful erections. Our subgroup analysis has confirmed that overall early surgery also results in significantly fewer complications vs. delayed surgery (p < 0.00001). Rates of penile curvature are also significantly lower in patients having emergent rather than delayed surgery (p = 0.0004). There was no difference on pooled analysis between plaque formation and rates of ED in immediate vs. delayed treatment. Pavan et al. [19] touches on another important but under-reported consequence of penile fracture; the fear of incurring another injury. This is a risk with or without the presence of any of the reported complications above. This can lead to performance anxiety and reluctance to perform certain positions. Such considerations might persuade urologists to follow up patients for longer than previously planned.

Surgical intervention could also be associated with a lower cost to hospitals, given the shorter duration of stay calculated in this review. This review has identified a plethora of incisions, sutures and approximation techniques. One study [8] with 116 surgically treated cases, used an inverted continuous 3/0 non-absorbable nylon suture and reported only one complication, a painless nodule. The most common incision is the subcoronal circumferential degloving incision. It would appear that this approach is favoured, as it gives unparalleled access to the 3 corpora [62].

A lack of multi-centre prospective comparative studies will always be a limitation of a review of rare conditions such as this. The reality is that such studies would take an extremely long time even in a multi-institution setting. However, randomisation to conservative management, given the above compelling evidence to the contrary might also be deemed unethical. In this review, only 5.5% of participants had conservative treatment raising questions about the suitability of meta-analysis. Heterogeneity can obviously have an impact on one’s ability to generalise the findings of pooled analysis. We have attempted to mitigate this by defining heterogeneity as well as adopting a random effects model when heterogeneity is deemed ‘high’. The main determining factors for choosing conservative treatment were the patient’s objection to surgery and delayed presentation. Many patients delayed in presenting themselves to the hospital due to embarrassment, with the longest delay in presentation being 2 months.

Nevertheless, this study has emphasised the compelling need for penile fractures to be treated surgically in a timely manner so as to minimise physical and psychological morbidity as well as reduce the length of inpatient stay.

References


