Outcomes of Early Endoscopic Realignment Versus Suprapubic Cystostomy and Delayed Urethroplasty for Pelvic Fracture-related Posterior Urethral Injuries: A Systematic Review

Pieter Jan Elshout a,*, Erik Veskimae b, Steven MacLennan c, Yuhong Yuan d, Nicolaas Lumen a, Michael Gonsalves e, Noam D. Kitrey f, Davendra M. Sharma g, Duncan J. Summerton h, Franklin E. Kuehhas i

a Department of Urology, Ghent University Hospital, Ghent, Belgium; b Department of Urology, Tampere University Hospital, Tampere, Finland; c Academic Urology Unit, University of Aberdeen, Aberdeen, Scotland, UK; d Department of Medicine, Health Science Centre, McMaster University, Hamilton, ON, Canada; e Department of Radiology, St George's Healthcare NHS Trust, London, UK; f Department of Urology, Chaim Sheba Medical Centre, Tel-Hashomer, Israel; g Department of Urology, St George's Healthcare NHS Trust, London, UK; h University Hospitals of Leicester NHS Trust, Leicester, UK; i London Andrology Institute, London, UK

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Abstract

Context: The evidence base for optimal acute management of pelvic fracture-related posterior urethral injuries needs to be reviewed because of evolving endoscopic techniques. The current standard of care is suprapubic cystostomy followed by delayed urethroplasty.

Objective: To systematically review the evidence base comparing early endoscopic realignment with cystostomy and delayed urethroplasty regarding stricture rate, the need for subsequent procedures, and functional outcomes.

Evidence acquisition: A systematic search in Medline, Embase, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Review, and www.clinicaltrials.gov without time or language limitations. Both medical subject heading and free text terms as well as variations of root word were searched. Randomised controlled trials (RCTs), nonrandomised comparative studies and single-arm case series were included, as long as ≥10 patients were enrolled. Data were narratively synthesised in light of methodological and clinical heterogeneity. The risk of bias of each included study was assessed.

Evidence synthesis: No RCTs were found. Six nonrandomised comparative studies and met inclusion criteria and were selected for data extraction. Noncomparative studies with more than 10 participants were included resulting in seven eligible studies. From the comparative papers the results of 219 patients were reported: 142 in the realignment group and 77 in the group undergoing cystostomy with delayed repair. The noncomparative studies reported on a further 150 cases. An overall stricture rate of 45% was evident in the endoscopic realignment group. Of these patients, 50% (28.1% overall) could be managed by endoscopic procedures and 40.3% (18.5% of intervention group) required anastomotic repair.

Conclusions: No RCTs were found and the included nonrandomised studies have heterogeneous populations and a high degree of bias. About half of the patients were free of stricture and thus did not undergo delayed urethroplasty in case early endoscopic realignment had been performed.

Patient summary: This systematic review of literature of urethral trauma revealed there are no well conducted comparative studies of newer endoscopic treatments versus standard treatments which include more extensive surgery. The results of the reports we selected based on specific characteristics are often influenced by variable factors. After careful analysis of these results we can conclude that the newer endoscopic techniques might resolve the risk of urethral injury due to pubic fractures in about half of the patients. Because of various confounders we cannot identify those patients who would benefit from this procedure or who might be possibly harmed.

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* Corresponding author. Assistant Guidelines Office, European Association of Eurology, Mr. E.N. van Kleffenstraat 5, Arnhem, 6842 CV, Netherlands. Tel. +3263890680.

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1. Introduction

Blunt trauma to the male pelvis with pelvic ring disruption will result in posterior urethral injuries (PUI) in up to 10% of patients [1]. Certain pelvic fracture subtypes have a higher association with urethral disruption. Fractures not involving ischiopubic rami have almost no elevated risk. Koraitim [2] found the subtypes that are at higher risk are straddle injuries, in which all four pubic rami are fractured, or Malgaigne fractures, involving disruption through ischiopubic rami anteriorly as well as through the sacrum or sacroiliac joint posteriorly. Long-term morbidity of PUIs is substantial, including urethral stricture, erectile dysfunction, and urinary incontinence.

The early management of PUI aims to reduce this long-term morbidity but remains controversial to date. This controversy is based on different treatment options that have been proposed in the early management.

These options include: immediate (<48 h after trauma) or primary delayed urethroplasty (2–14 d after trauma), immediate or primary delayed urethral realignment, or suprapubic cystostomy with delayed (>3 mo after trauma) urethroplasty.

Suprapubic cystostomy with delayed urethroplasty can always be considered in the early phase, but a long period of disability and discomfort due to the suprapubic catheter are clear disadvantages to this treatment strategy. Therefore, this strategy has been challenged by immediate or primary delayed realignment (if possible endoscopic) whenever the clinical condition of the patient allows it.

The aim of realignment is to correct severe distraction injuries rather than to prevent a stricture. Some authors report a lower stricture rate than with suprapubic catheter placement alone [3–5]. If scarring and subsequent stricture formation occurs, the restoration of urethral continuity is easier. For short, nonobliterative strictures, internal urethrotomy can be attempted [3–5]. For longer strictures, or in the case of failure of an internal urethrotomy, urethroplasty is required [3].

The debate against early realignment includes the view that complete urethral disruptions will not result in healing following primary realignment. The reported success rates could be explained by a number of partial urethral injuries which are likely to heal with a suprapubic catheter alone.

Primary realignment in the acute phase is also technically and logistically difficult. In case of failure, it may make subsequent urethroplasty more difficult [6,7].

The European Association of Urology trauma guideline panel conducted a systematic review on this subject to verify the outcomes of early endoscopic realignment (EER) compared to cystostomy with delayed urethroplasty.

2. Evidence acquisition

2.1. Search strategy and selection criteria

The review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-analysis [10]. The search strategy is described in detail in the Supplementary data. In short, Medline (from 1946), Embase (from 1974), Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews (from 2005), and www.clinicaltrial.gov without time, publication format, and language limitations were searched for all relevant publications. Both medical subject headings and free text terms as well as variations of root words were searched. Key terms related to traumatic urethral strictures were combined using the set operator AND with key terms related to endoscopy realignment or cystostomy or urethral/suprapubic catheterisation. Animal studies, studies in children, case reports, and letters were excluded. We also searched for any systematic reviews or randomised controlled trials related to urethra injury and pelvic fracture even if no treatment interventions were mentioned. As there were only a few comparative nonrandomised studies (NRCS), noncomparative studies (eg, single-arm case series; NCS) were included. A systematic literature search was initially performed in April 2015. An update on the search was done in April 2016.

2.2. Patients, intervention, comparator, and outcomes

Included patients were men with traumatic urethral posterior distraction injuries. An intervention group was formed of patients undergoing EER (<14 d). The comparator group was a patient cohort with cystostomy and delayed (>3 mo) urethral repair.

Primary outcomes were stricture rates and the need for auxiliary procedures. Secondary outcomes were post-traumatic urinary incontinence and impotence.

2.3. Data collection and data extraction

Following deduplication, two review authors (P.J.E. and E.V.) independently screened all abstracts and full-text articles for relevance to the defined inclusion and exclusion criteria. Any disagreements were resolved by discussion or by consulting a third review author (N.L.). The references cited in all full-text articles were also assessed for additional relevant articles. There were no limitations on study design or language and also conference abstracts were included. Studies with less than 10 patients per arm were excluded. No time restriction was used. A standardised data extraction form was used. Surgical data, stricture incidence, functional outcomes (urinary continence, sexual outcomes), and retreatment information were extracted.

2.4. Risk of bias in individual studies

Two reviewers (P.J.E and E.V.) assessed the ‘risk of bias’ (RoB) of each included study independently. A modified version of the RoB assessment tool was used in assessing NRCSs [8]. A list of the five most important potential confounders for harm and benefit outcomes was developed a priori with clinical content experts (EAU Trauma guideline panel). The potential confounding factors were: age, preoperative continence rate, associated injuries, type of intervention and body mass index (BMI). The included studies were assessed
on whether the outcomes could have been influenced by baseline imbalance or lack of adjustment in analysis for the pre-specified confounders. RoB in single arm case series, focus was redirected to assessing external validity (applicability of results to different people, places or time) by assessing whether study participants were selected consecutively or representative of a wider patient population. Attrition bias, selective outcome reporting and whether an a priori protocol was available (indicating prospective study design), was also assessed. This is a pragmatic approach informed by the methodological literature [9,10]. The systematic review was entered into the register of PROSPERO (http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42015027974).

2.5. Statistical analysis

Methodological and clinical heterogeneity of the included studies meant that meta-analysis was inappropriate. Instead, a narrative synthesis was performed due to the methodological and clinical heterogeneity of the included studies (https://www.york.ac.uk/crd/guidance/). Possible reasons for heterogeneity were explored using the available information such as differences in the population studied, the treatment given, or the way in which the outcomes were assessed. Intended formal subgroup analysis was not possible due to the inclusion of NRCS. Therefore, any subgroup differences were discussed narratively to explore potential effect size differences based on the subgroups mentioned above. A planned sensitivity analysis to assess the robustness of our review results, by repeating the analysis only including studies with an overall medium to low risk of bias, was not possible.

3. Evidence synthesis

3.1. Quality of the studies

Two reviewers independently screened 570 abstracts, of which 84 papers were selected for full-text screening; 29 were comparative studies (mainly retrospective and non-randomised) and 55 were single-arm case series (Fig. 3). There was significant heterogeneity in the assessment and treatment evaluation in these studies. Ultimately, six NRCS and seven NCS reporting on ≥10 patients met inclusion criteria. After the update search (April 2016) one more NRCS was added to the 62 studies identified. RoB is summarised in Fig. 1 (NRCS) and Fig. 2 (NCS).

![Fig. 1 – Risk of bias table of comparative nonrandomised studies.](http://dx.doi.org/10.1016/j.euf.2017.03.001)
3.2. **Study details**

One NRCS out of five and one NCS out of seven are conference abstracts [11,12]. Recruitment periods ranged from 1987 to 2013 and publication dates from 2001 to 2015 (Table 1).

3.2.1. **Patients**

From the comparative papers (NRCS) the results of 219 patients were retrieved: 142 in the realignment group and 77 in the group with cystostomy with delayed repair. Heterogeneous populations were evident in the included studies. Only one conference abstract excluded partial injuries [11]. Three studies excluded bladder neck involvement [11,13,14].

Allocation to different treatment groups was not randomised in any study. In three papers patients were allocated to the cystostomy group if they were haemodynamically unstable [15], significant associated lesions, or if endoscopic realignment was not successful [14–16].

In the noncomparative papers (NCS) data of 150 patients could be extracted. Only two of the papers have strict exclusion criteria. Patients with severe associated injuries who needed laparotomy were excluded by Abdelsalam et al [17] and partial injuries were excluded by Kim et al [18]. Four noncomparative papers initially placed suprapubic catheter in all patients [4,17,19,20]. One paper did not exclude all cases with open realignment [12].

Details on partial ruptures or rupture classification (Colapinto) were available in three of the NRCS. There were no significant differences between the two groups [14,15].

Details of diagnostic assessment were not given by all papers [4,12–14]. Radiographic studies (retrograde and/or...
antegrade urethrogramy) were performed in the majority of NRCS [11,15,16,21] and NCS [17–20,22].

Two of the NRCS papers used only retrograde cystoscopy (flexible and radiographic control) [14,15]. Four other papers used a combination of retrograde and antegrade cystoscopy (through the cystostomy) [11,13,16,21]. All the NCS papers combined retrograde and antegrade realignment (Fig. 3).

3.3. Outcomes

3.3.1. Post-traumatic stricture rate (Table 2)

All included studies evaluated stricture incidence with uroflowmetry. In almost all reports, a maximum urinary flow rate (Qmax) of <15 ml/s or subsequent urethral intervention was considered as treatment failure or indication of subsequent urethral manipulation. One paper defined

![Fig. 3 - The Preferred Reporting Items for Systematic Reviews and Meta-analyses flow diagram of the literature search.](http://dx.doi.org/10.1016/j.euf.2017.03.001)
stricture as moderate or severe according to the frequency of urethrotomies [15]. In the abstract from Abdalla et al [11] two asymptomatic patients with a Qmax of <15 ml/s were not treated.

Stricture rates range from 10% to 40% in the delayed treatment group. Two papers report a stricture rate of 100% in the cystostomy group but this evaluation was done before the delayed urethroplasty [13,14].

For endoscopic realignment in NRCS, the selected papers report stricture rates ranging from 14.3% [14] to 100% [11]. In NCs papers, strictures were observed in 25% [19] to 73.7% [22] of patients.

3.3.2. Urinary incontinence (Table 3)
Urinary incontinence was not assessed in a standardised fashion. Three studies [7,17,19] reported the number of pads used/d. The other studies made a decision based on patients reporting only. Incontinence was considered to be present for a case if it met the criteria of the reporting article. Across the included studies, incontinence rates were around 10% without remarkable difference between treatment groups.

3.3.3. Erectile dysfunction (Table 3)
Erectile dysfunction was not assessed by standardised questionnaires but was mainly self-reported, or not reported at all [14]. In NCs and NCs, erectile dysfunction ranged from 5% to 45% of included patients.

3.3.4. Subsequent procedures (Table 4)
Strictures treated after suprapubic cystostomy and delayed urethroplasty could be treated endoscopically in up to 40% of patients. The necessity to perform urethroplasty in 100% of cases in the Hadjizacharia et al [14] paper reflects the stricture rate as discussed above. The paper does not provide stricture rates or need for subsequent procedures after urethroplasty. Similarly, in Johnsen et al [13], 78.6% of patients underwent urethroplasty, with 3/13 (21.4%) patients with suprapubic cystostomy refusing further intervention.

In failed EER cases with stricture formation, 14.3% [14] to 50% [11] could be managed endoscopically, compared with 0% [14,19] to 57.9% [22] requiring urethroplasty.

4. Conclusions
Acute management of PUIs is challenging and complex. They are usually associated with more serious and even life-threatening injuries. This is one of the reasons why it is not essential to have bladder drainage (either suprapubic or transurethral) the first hours after trauma. However, it is preferable to have it as quick as possible in order to monitor urinary output, treat retention, and minimise extravasation. A gentle attempt of urethral catheterisation is unlikely to do any additional damage. If urethral catheterisation is not successful, suprapubic catheter should be placed [23]. Diagnosis of PUI relies on retrograde urethrography which is able to differentiate between a complete or partial injury.

Table 2 – Outcomes (stricture rates).

<table>
<thead>
<tr>
<th>Study ID</th>
<th>SPS + DU</th>
<th>EER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdalla [11]</td>
<td>6 (37.5)</td>
<td>16 (100)</td>
</tr>
<tr>
<td>Boulma [21]</td>
<td>3 (20)</td>
<td>7 (35)</td>
</tr>
<tr>
<td>Hadjizacharia [14]</td>
<td>7 (100)</td>
<td>2 (14.3)</td>
</tr>
<tr>
<td>Ku [15]</td>
<td>13 (65)</td>
<td>21 (60)</td>
</tr>
<tr>
<td>Moudouni [16]</td>
<td>4 (40)</td>
<td>8 (26.6)</td>
</tr>
<tr>
<td>Johnsen [13]</td>
<td>14 (100)</td>
<td>17 (63)</td>
</tr>
<tr>
<td>Shrestha [19]</td>
<td>2 (25)</td>
<td>0</td>
</tr>
<tr>
<td>Abdelsalam [17]</td>
<td>23 (56)</td>
<td></td>
</tr>
<tr>
<td>Moudouni [4]</td>
<td>12 (41)</td>
<td></td>
</tr>
<tr>
<td>El Kady [12]</td>
<td>9 (60)</td>
<td></td>
</tr>
<tr>
<td>Sofer [20]</td>
<td>5 (45.5)</td>
<td></td>
</tr>
<tr>
<td>Ledyd [22]</td>
<td>14 (73.7)</td>
<td></td>
</tr>
<tr>
<td>Kim [18]</td>
<td>8 (53)</td>
<td></td>
</tr>
</tbody>
</table>

DU = delayed urethroplasty; EER = early endoscopic realignment; ID = identification; SPS = patient cohort with cystostomy.

Table 3 – Functional outcomes.

<table>
<thead>
<tr>
<th>Study ID</th>
<th>Incontinence outcomes, n (%)</th>
<th>Impaired potency, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SPS + DU</td>
<td>EER</td>
</tr>
<tr>
<td>Abdalla [11]</td>
<td>12 (2.5)</td>
<td>0</td>
</tr>
<tr>
<td>Boulma [21]</td>
<td>0</td>
<td>2 (20)</td>
</tr>
<tr>
<td>Hadjizacharia [14]</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Ku [15]</td>
<td>2 (10)</td>
<td>3 (8.6)</td>
</tr>
<tr>
<td>Moudouni [16]</td>
<td>1 (10)</td>
<td>4 (40)</td>
</tr>
<tr>
<td>Johnsen [13]</td>
<td>1 (9.1)</td>
<td>2 (8.7)</td>
</tr>
<tr>
<td>Shrestha [19]</td>
<td>0</td>
<td>1 (5)</td>
</tr>
<tr>
<td>Abdelsalam [17]</td>
<td>3 (7)</td>
<td>13 (32)</td>
</tr>
<tr>
<td>Moudouni [4]</td>
<td>0</td>
<td>4 (13.7)</td>
</tr>
<tr>
<td>El Kady [12]</td>
<td>0</td>
<td>6 (55)</td>
</tr>
<tr>
<td>Sofer [20]</td>
<td>0</td>
<td>4 (21)</td>
</tr>
<tr>
<td>Ledyd [22]</td>
<td>3 (20)</td>
<td>7 (47)</td>
</tr>
</tbody>
</table>

DU = delayed urethroplasty; EER = early endoscopic realignment; ID = identification; NR = not reported; SPS = patient cohort with cystostomy.

Table 4 – Need for auxiliary procedures (NFAP).

<table>
<thead>
<tr>
<th>Study ID</th>
<th>SPS + DU</th>
<th>NFAP, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Endoscopic</td>
<td>Open</td>
</tr>
<tr>
<td></td>
<td>EER</td>
<td></td>
</tr>
<tr>
<td>Abdalla [11]</td>
<td>2 (12.5)</td>
<td>2 (12.5)</td>
</tr>
<tr>
<td>Boulma [21]</td>
<td>2 (20)</td>
<td>1 (10)</td>
</tr>
<tr>
<td>Hadjizacharia [14]</td>
<td>NR</td>
<td>7 (100)</td>
</tr>
<tr>
<td>Ku [15]</td>
<td>8 (40)</td>
<td>5 (25)</td>
</tr>
<tr>
<td>Moudouni [16]</td>
<td>4 (40)</td>
<td>0</td>
</tr>
<tr>
<td>Johnsen [13]</td>
<td>0</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Shrestha [19]</td>
<td>2 (25)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Abdelsalam [17]</td>
<td>15 (36.6)</td>
<td>8 (19.5)</td>
</tr>
<tr>
<td>Moudouni [4]</td>
<td>10 (34.5)</td>
<td>2 (6.9)</td>
</tr>
<tr>
<td>El Kady [12]</td>
<td>4 (26.6)</td>
<td>5 (31)</td>
</tr>
<tr>
<td>Sofer [20]</td>
<td>2 (18.2)</td>
<td>3 (27.3)</td>
</tr>
<tr>
<td>Ledyd [22]</td>
<td>3 (15.8)</td>
<td>11 (27.9)</td>
</tr>
<tr>
<td>Kim [18]</td>
<td>6 (40)</td>
<td>7</td>
</tr>
</tbody>
</table>

DU = delayed urethroplasty; EER = early endoscopic realignment; ID = identification; NFAP = need for auxiliary procedures; SPS = patient cohort with cystostomy.
This injury to the urethral mucosa will lead to fibrosis and scarring with risk of stricture formation. A partial injury might heal without consequences, with a nonobliterative stricture or with an obliterator stenosis. A complete injury is a distraction defect between the mucosal edges. The gap between them is filled with scar tissue, which will lead to an obliterator stenosis.

Early realignment is an option in the acute management of partial and complete injuries. In a partial injury, realignment, and translurethral catheterisation avoids extravasation of urine in the surrounding tissues reducing the inflammatory response. In a complete injury, it aims to correct severe distraction rather than to prevent a stricture. It is wrong to assume that urethral healing is attributable to a urethral catheter, because healing will occur regardless of it.

In this review, about half of the patients treated with EER were free of recurrence. These good results can be explained in part by inclusion of partial injuries. The fact that partial injuries might heal without consequences is supported by a hallmark animal study [24], which demonstrated that if one-third of the urethral circumference is preserved, a full spontaneous restoration of the urethral patency is possible with urethral catheterisation only. One paper explicitly excluded partial injuries and they describe a stricture ratio of only 53% cases [18]. This is in contrast to the above-mentioned animal study, where all animals with a complete urethral distraction developed a stricture. However, in the animal study, the distraction defect was 5 cm. After realignment, the urethral mucosal edges can be approximated in close contact to each other, promoting the urethral regeneration. Furthermore, it is sometimes difficult to discriminate between partial and complete injuries. Therefore, it is possible that some complete injuries might be misdiagnosed partial injuries. Nevertheless, the potential benefit of avoiding a subsequent stricture in some of the patients after EER remains very interesting. It supports the practice of organising an attempt of realignment when the patient is stabilised and other major injuries have been treated. Until this time, bladder drainage can be secured by cystostomy. With the cystostomy in place, realignment can be performed in an antegrade and/or retrograde fashion. When patients with PUI are taken to operating theatre for any kind of intervention, they could be considered for any kind of realignment. Barrett et al [25] conducted a systematic review about acute management of urethral injuries. They discuss two reports of endoscopic realignment [14,15] but mainly other methods of realignment as an open procedure (Davis interlocking sounds, railroading, etc.). Their meta-analysis of stricture ratio favours primary realignment.

Two papers concluded that urethroplasty with anastomotic repair has worse outcomes after previous manipulation [26,27]. Singh et al [26] concluded that previous manipulation negatively influences subsequent anastomotic repair. Their intervention group consisted of seven endoscopic realignment cases and eight urethroplasias. Culty and Boccon-Gibod [27] retrospectively analysed a urethroplasty database and concluded that patients with failed realignment or urethrotomys had more restenosis and worse satisfactory rates after urethroplasty. One could also state that failed realignment cases probably were those cases with more severe trauma and tissue damage. This demonstrates how difficult it is to compare different trauma patients. Furthermore, it is difficult to retrieve the definition of failed realignment. It can be that realignment was not possible and aborted. In this case, we hypothesise that it will not negatively influence further outcomes. However, it is possible that a failed realignment was a wrong realignment, where the urethral catheter was not inserted in the bladder but in the pelvic haematoma. This mistake might be recognised in a delayed fashion if the suprapubis catheter was also maintained. We hypothesise that this wrong realignment can have a negative further impact. However, with endoscopic realignment, direct visual control should minimise the risk of wrong realignment.

There is too much publication bias to conclude which patients will have the most benefit from EER. Only one abstract [11] and one NCS paper excluded partial injuries [18] and they report respectively a 100% and a 53.3% failure rate. Kim et al [18] published 7/15 patients requiring no further treatment after EER. These results are especially remarkable because most patients had concomitant bladder or other organ injuries indicating severe trauma. The other papers have included partial injuries and so their results could be accounted on this. It seems common sense that those partial injuries (in stable patients) would be the ideal candidates for EER but subgroup analysis could not be performed to prove this statement.

This review revealed that one out of two recurrences after EER can be treated with endoscopic incision. These findings are in line with those of Moudouni et al [16]. We cannot confirm whether the subsequent urethroplasty in the other recurrences was more difficult or less successful. Tausch and Morey [6] concluded that endoscopic realignment cases had more reinterventions and that time to definitive resolution was longer than in patients with cystostomy and delayed urethroplasty. They analysed only patients that were referred for urethroplasty. We regarded this a major confounder because previous treatment probably failed. But we realise that repeated urethrotomys and other manipulations could result in a longer time until definitive resolution. For some patients this could be bothersome and a disadvantage of endoscopic treatment. In which way this could influence patient satisfaction, is an interesting question that needs to be investigated.

No major differences between groups were observed in terms of erectile dysfunction and incontinence. Therefore, it can be assumed that these complications are merely related to the severity of the injury itself rather than the method of initial management [15]. Erectile dysfunction is observed in 34% of patients with pelvic fracture related urethral injury in the systematic review from Blaschko et al [28]. They also concluded that lower dysfunction rates in the endoscopic realignment group were probably due to less severe injury or differences in reporting erectile dysfunction.

A systematic review of literature was carried out but no randomised clinical trials were found. This is not unsurprising as it is difficult to conduct multicentre randomised controlled trials in the setting of trauma. Trauma is by
definition an unexpected event. This results in patients transferred as an urgency to the nearest hospital instead of the most competent. Transfer to the appropriate department and planning of the EER can be hindered by logistic limitations.

To date no well-designed comparative trials have been conducted. Some papers claim to be comparative but a rigorous evaluation of the methods revealed that control groups consisted of failed endoscopic realignment. Others had a serious selection bias: cases with associated injuries or a severe distraction defect were included in the control group (ie, suprapubic cystotomy and delayed urethroplasty). Therefore, it is very likely that the urethral trauma has been more extensive then in patients with successful endoscopic realignment. Again, comparing results of these groups can be misleading. This was also one of the reasons why a meta-analysis and further statistical analysis was not performed. In general, NCS were more rigorous concerning inclusion and exclusion criteria. The highest level of evidence of included series was Level 3 [29]. This is the major limitation of this review.

From this review of the existing literature it is clear that a considerable number of urethral ruptures by pelvic fracture can be healed by EER, but others may be harmed by the procedure or it may be less cost effective. Based on the basic principles of wound healing and a few animal experiments one can expect that EER is most successful when the distance between both disrupted ends is short. This is the majority of cases. An attempt to EER can be advocated in the 1st 2 wk after trauma in these patients if their condition allows.

To develop a better view on the right indications of EER we should develop multicentre observational studies, in which all attempts, failures, and successes of EER are registered.

This systematic review revealed there are no well conducted comparative studies of EER versus cystostomy and delayed urethroplasty. The mainstay of reports are case series with a high degree of bias and heterogeneity. EER might resolve the urethral injury in about half of PUIs and this supports an attempt of EER when the patient is stabilised in the 1st 2 wk after trauma. Because of the many possible publication bias we could not identify those patients which will benefit of the procedure or will be possibly harmed.

**Author contributions:** Robert Sheperd had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**Study concept and design:** Kitrey, Kuehhas, Djakovic, Sharma, Serafetindis, Lumen, Gonsalves, Summerton.

**Acquisition of data:** Elshout, Vesikma, MacLennan, Yuan.

**Analysis and interpretation of data:** Elshout, Vesikma.

**Drafting of the manuscript:** Elshout, Vesikma.

**Critical revision of the manuscript for important intellectual content:** Lumen, MacLennan.

**Statistical analysis:** None.

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**Appendix A. Supplementary data**

Supplementary data associated with this article can be found, in the online version, at [http://dx.doi.org/10.1016/j.euf.2017.03.001](http://dx.doi.org/10.1016/j.euf.2017.03.001).

**References**


