

July 2019

## Management of grade IV blunt renal trauma in adults: Systematic review and meta-analysis

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### Recommended Citation

Bramono IA, Irdam GA, Rodjani A, Wahyudi I. Management of grade IV blunt renal trauma in adults: Systematic review and meta-analysis. Makara J Health Res. 2019;23.

## Management of grade IV blunt renal trauma in adults: Systematic review and meta-analysis

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### Abstract

**Background:** Irrespective of the high incidence of grade IV renal trauma, there is still an ongoing debate regarding the use of conservative and surgical approaches for its treatment. This study aimed to conduct pooled analyses of published studies that concluded evidences regarding the management of grade IV renal trauma. **Methods:** Published studies between 1995 and 2015 from Cochrane Library, EBSCO, Embase, ProQuest, PubMed, and Scopus were reviewed and pooled analysis of eligible studies was conducted using random effects model. Heterogeneity was presented with  $I^2$  and p value. **Results:** Eleven studies reporting on 703 adults were included in the analysis. Conservative approach was used in 611 patients (conservative group) and surgical approach in 92 patients (surgical group); success rate and morbidity were comparable between the groups (risk ratio (RR): 1.15, 95% confidence interval (CI): 0.72–1.83; RR: 0.77, 95% CI: 0.27–2.21, respectively). The trend of mortality was higher in the surgical group than the conservative group. **Conclusions:** A comparable success rate was observed between the groups. Mortality was higher in the surgical group than the conservative group. As advocated by many guidelines, conservative management may decrease unnecessary exploration, which can ultimately reduce reconstruction and/or nephrectomy rate without causing morbidity or mortality.

*Keywords: conservative treatment, kidney, nonpenetrating wounds, surgical treatment*

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### Introduction

Trauma, defined as an injury caused by an external force, has diverse underlying mechanisms and can be caused by traffic accidents, falls from heights, explosions, firearms, stab wounds, or blunt injuries.<sup>1</sup> Renal trauma is the most common type of trauma in the genitourinary tract.<sup>2,3</sup> The incidence rate of abdominal trauma is reportedly 8%–10%, and renal trauma accounts for 50% of all reported genitourinary tract trauma cases.<sup>2–4</sup>

In general, the mechanism underlying renal trauma is classified into blunt and penetrating traumas,<sup>5</sup> with blunt trauma accounting for 90% of all renal traumas.<sup>2–4</sup> The most frequent causes are traffic accidents and falls from height. Meanwhile, penetrating trauma is generally caused by firearms and weapons.<sup>6</sup> Based on the Organ Injury Severity Score by the American Association for the Surgery of Trauma (AAST), renal trauma has been classified into five grades based on their degree of contusion, presence of hematoma, laceration of the renal cortex, and vascular involvements.<sup>7</sup> Microscopic and gross hematuria with minimal hematoma is considered grade I, and presence of parenchymal laceration and vascular involvement is considered higher-grade renal

trauma. Grade IV is defined as parenchymal laceration extending through the corticomedullary junction and into the collecting system and vascular injury to the segmental renal artery or vein with hemorrhage/hematoma.<sup>8</sup> The AAST classification is a validated and widely used tool. Good clinical judgment in accordance with the AAST classification will lead to accurate diagnosis and prompt management.<sup>8</sup> Although some studies have indicated the need for revising this classification, it has been adopted in several guidelines.<sup>1,9–12</sup>

The management of grade IV blunt renal trauma is still controversial. Data obtained from a systematic review of literature about high-grade renal injury (both grades IV and V) in 2017 have shown no significant differences with respect to mortality between surgical and conservative management for this type of trauma.<sup>13</sup> Another recent meta-analysis investigating all grades of renal injury has indicated that conservative management may have beneficial effects with respect to effectivity for higher-grade renal injury, which was defined by the author as grades III–V.<sup>14</sup> However, these data are not specific for grade IV renal trauma.<sup>13,14</sup> In some patients with grade IV renal trauma, surgery cannot be avoided, and to determine whether partial or complete nephrectomy

should be performed, the location of the injury and the presence of vascular damage are considered.<sup>15</sup> Therefore, this meta-analysis aimed to investigate the nature of grade IV renal trauma to identify a better treatment approach for clinical practice.

## Methods

**Eligibility criteria.** All prospective or retrospective studies written in English and published in international journals between 2005 and 2015 were included. The participants of this study include both female and male adult patients with grade IV blunt renal trauma. Only studies describing conservative and surgical managements were included. The outcome measures were number of patients with successful management, complications, and mortality.

**Source of information.** A literature search was performed by two researchers using PubMed, Embase, ProQuest, Scopus, EBSCO, and Cochrane Library. The last literature search was conducted in June 2015.

**Search.** The search terms used were “kidney,” “trauma,” and “nonpenetrating wounds.” Articles associated with relevant papers were also thoroughly searched.

**Study selection.** Studies regarding the management of grade IV blunt renal trauma were included, whereas case series were excluded.

**Data extraction and quality assessment.** The quality of the assessed studies was determined by reviewing paper titles and abstracts. Two assessors independently conducted quality assessment for each article, and discussion was carried out for finalization.

**Statistical analysis.** Meta-analysis was performed using the random effects model. In cases of single zero-event trial, the random effect model can stabilize the effect estimates and its variance.<sup>16</sup> Moreover, it can overcome the unknown behavior observed in zero-event trials.<sup>16</sup> The heterogeneity of effects was analyzed by calculating  $I^2$ , which indicates the variation that is caused by heterogeneity rather than probability. Statistical analyses were performed using Review Manager 5.3 (Copenhagen, The Cochrane Collaboration, 2012) for the meta-analysis of randomized controlled trials (RCTs).

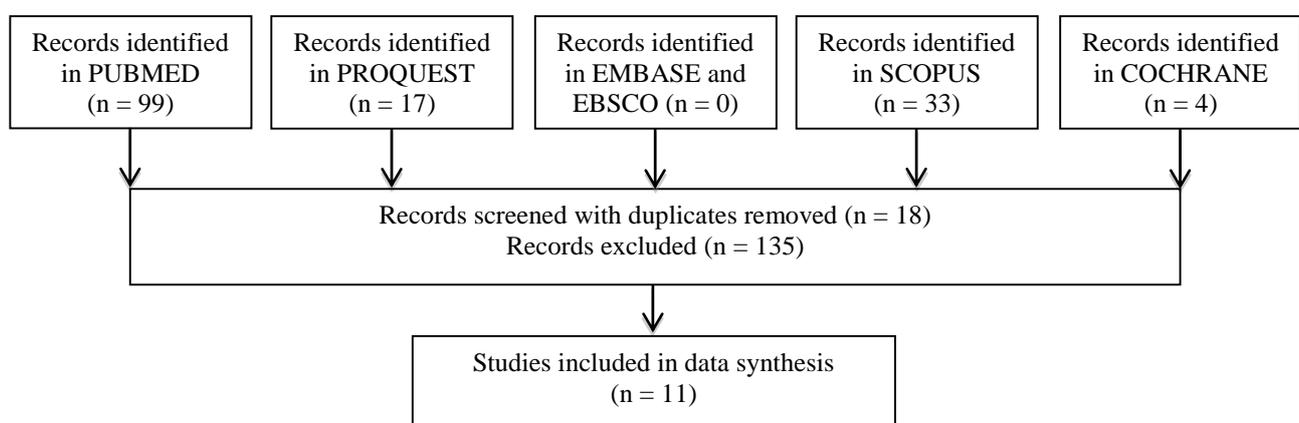
**Ethical clearance.** Because this study is a meta-analysis of published studies, ethical clearance is not applicable.

## Results

**Generation of evidence.** Figure 1 shows the schematic of study selection flow of this systematic review. Two researchers conducted literature search, followed by a discussion for screening and inclusion. The quality of the included articles were then assessed by two independent assessors, followed by a discussion. In all, 11 retrospective cohort studies that described the management of grade IV blunt renal trauma were finally included (Table 1).<sup>2,17-26</sup>

The inclusion criteria were as follows: (1) Participants: adult patients with grade IV blunt renal trauma; (2) Intervention: surgical management; (3) Comparison: conservative management; (4) Outcome measures: number of patients with successful management, complications, and mortality.

The exclusion criteria were as follows: (1) Articles not published in English language; (2) Case reports or case series.



**Figure 1.** Search strategy used for the systematic review of Grade IV blunt renal trauma

Table 1. Characteristics of the studies

Study	Management approach		Management group		Age (mean years $\pm$ SD)
	Conservative (n)	Surgery (n)	Nonvascular (n)	Vascular (n)	
van der Wilden <i>et al.</i> , 2013 <sup>17</sup>	128	26	N/A	N/A	36.2 $\pm$ 18.3
Menaker <i>et al.</i> , 2011 <sup>18</sup>	104	7	N/A	N/A	33.5 $\pm$ 16.7
Malaeb <i>et al.</i> , 2014 <sup>19</sup>	75	8	N/A	N/A	30.6 $\pm$ 19.2
Figler <i>et al.</i> , 2013 <sup>20</sup>	70	14	79	5	32.7
Shoobridge <i>et al.</i> , 2013 <sup>21</sup>	51	1	N/A	N/A	20–24
Hardee <i>et al.</i> , 2013 <sup>2</sup>	44	8	N/A	N/A	33
Shariat <i>et al.</i> , 2008 <sup>22</sup>	44	7	N/A	N/A	25 (12–80)
McGuire <i>et al.</i> , 2011 <sup>23</sup>	37	5	N/A	N/A	N/A
Sarani <i>et al.</i> , 2011 <sup>24</sup>	27	7	N/A	N/A	39.0 $\pm$ 19.0
Breen <i>et al.</i> , 2014 <sup>25</sup>	22	2	N/A	N/A	23 (18–39)
Aragona <i>et al.</i> , 2012 <sup>26</sup>	11	7	15	3	N/A

\*N/A: there were no related data in the studies; SD, standard deviation

**Participants (intervention and comparison).** Studies reported on the management of grade IV blunt renal traumas involved a total of 703 adult patients, of whom 611 were treated using the conservative approach and 92 using the surgical approach. As only 3 of the 11 studies (Shoobridge *et al.*<sup>21</sup>, Shariat *et al.*<sup>22</sup>, and Breen *et al.*<sup>25</sup>) reported the results of the management, we used these studies for conducting sensitivity analysis.

**Outcome.** Table 2 shows the results of studies that report on the variable outcomes of the management of grade IV blunt renal traumas. We defined successful management as the management of a patient without significantly increasing the risk of complications. The conservative management of renal trauma includes preserving the Gerota's fascia.<sup>17,18</sup> Conversely, the surgical management of renal trauma included the disruption of the Gerota's Fascia.<sup>17,18</sup>

Shoobridge *et al.* demonstrated a success rate of 96% and 100% in the conservative and surgical groups, respectively.<sup>21</sup> Meanwhile, Shariat *et al.* have revealed that the success rates conservative and surgical managements were 72% and 71%, respectively.<sup>22</sup> Breen *et al.* have shown positive outcomes using conservative management in 18 of 22 patients. However, they have reported no such outcomes using surgical management.<sup>25</sup> Shoobridge *et al.* have reported morbidity in two patients according to the Clavien–Dindo classification of surgical complications (grade 1 in one patient and grade 3a in another patient) after undergoing conservative management.<sup>21</sup> In the study conducted by Breen *et al.*, two patients presented with urinoma, one with fever and hypertension, and one with pain.<sup>25</sup> Shariat *et al.* have reported that 12 patients presented with morbidity after

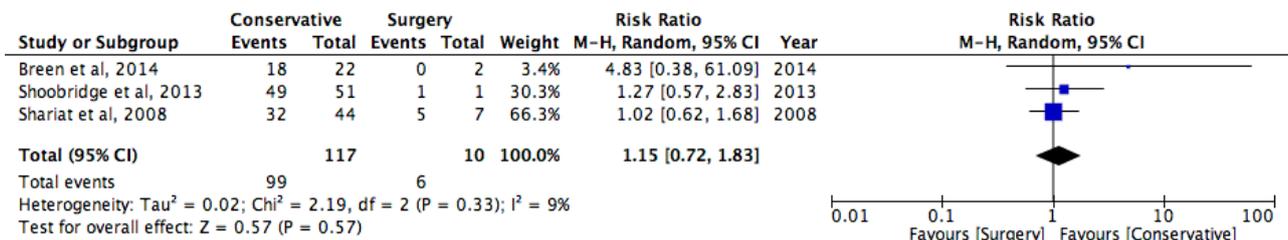
undergoing conservative management.<sup>22</sup> Studies by Shoobridge *et al.* and Breen *et al.* have shown that none of the patients presented with morbidity after undergoing surgery, whereas Shariat *et al.* have reported that two patients with grade IV blunt renal trauma had morbidity after undergoing surgical management.<sup>21,22,25</sup> In the study by Breen *et al.*, all patients (n = 2) in the surgical group died. However, mortality was not observed in the conservative group.<sup>25</sup>

**Conservative vs. surgical management.** The number of patients in the conservative group was higher than that in the surgical group. Figure 2 shows the results of meta-analysis of the successful management of grade IV blunt renal trauma. Successful management was considered as event (outcome), and the number of patients who were successfully managed was expressed as risk ratio (RR) with 95% confidence interval (CI). This study found low heterogeneity in the result with an  $I^2 = 9\%$  ( $I^2 < 25\%$ ;  $p = 0.33$ ). However, the random effects model was used for conducting pooled analysis owing to the inclusion of a zero-event trial. The overall RR was 1.15 (95% CI: 0.72–1.83). Patients in the conservative group were 1.35 times more likely to be successfully managed than those in the surgical group.

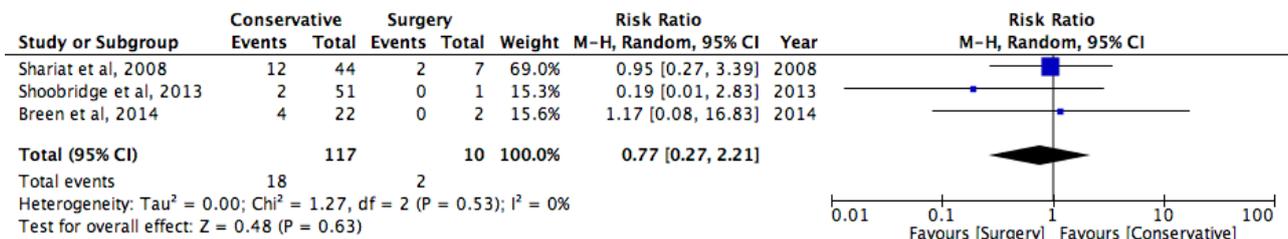
Figure 3 shows the results of the meta-analysis of morbidity event in the management of grade IV blunt renal trauma. Although having low heterogeneity ( $I^2 < 25\%$ ;  $p = 0.54$ ), the random effects model was used for conducting pooled analysis because of the inclusion of a zero-event trial. Patients who received surgical management had a comparable morbidity event compared with those who received conservative management (RR: 0.77, 95% CI: 0.27–2.21).

**Table 2.** Outcomes of the studies

No.	Parameter	Study	Management approach	
			Conservative (n)	Surgery (n)
1.	Successful management	Shoobridge <i>et al.</i> , 2013 <sup>21</sup>	49/51	1/1
		Shariat <i>et al.</i> , 2008 <sup>22</sup>	32/44	5/7
		Breen <i>et al.</i> , 2014 <sup>25</sup>	18/22	0/2
2.	Morbidity	Shoobridge <i>et al.</i> , 2013 <sup>21</sup>	2/51	0/1
		Shariat <i>et al.</i> , 2008 <sup>22</sup>	12/44	2/7
		Breen <i>et al.</i> , 2014 <sup>25</sup>	4/22	0/2
3.	Mortality	Shoobridge <i>et al.</i> , 2013 <sup>21</sup>	0/51	0/1
		Breen <i>et al.</i> , 2014 <sup>25</sup>	0/22	2/2



**Figure 2.** Meta-analysis of the successful management of grade IV blunt renal trauma<sup>21,22,25</sup>



**Figure 3.** Meta-analysis of morbidity in the management of grade IV blunt renal trauma<sup>21,22,25</sup>

**Discussion**

This meta-analysis is the first to investigate the comparability of conservative and surgical management for grade IV blunt renal trauma. It revealed that conservative management can provide comparable results to those of surgical management in patients with grade IV blunt kidney trauma (RR: 1.15, 95% CI: 0.72–1.83). Meanwhile, morbidity was comparable between both groups with OR 0.77 (95% CI: 0.27–2.21), and mortality was suggestive to occur more likely in the surgical group.

The kidney is the most vulnerable genitourinary organ and is highly involved in all trauma cases.<sup>27,28</sup> In particular, blunt injury is more prevalent, accounting for 71%–95% of all trauma cases.<sup>27,28</sup> Deceleration injury in blunt trauma causes disturbances due to renal injury by

the major surrounding attachment elements, such as renal pedicle and uretero-pelvic junction, whereas acceleration injury causes disturbances due to collision of the kidney with surrounding elements, such as the ribs and spine.<sup>27,28</sup> These two mechanisms lead to kidney injury with varying degrees of severity. This varying severity is now used as a treatment approach toward the condition, and the AAST classification system is among the most frequently used tools. Among the grading classifications, grade IV is described as involvement of parenchymal laceration extending to the corticomedullary junction and the collecting system and vascular injury to the segmental renal artery or vein with contained hemorrhage/hematoma.<sup>27–29</sup>

Although our study showed comparability between conservative and surgical managements in patients with grade IV blunt kidney trauma, the trend of mortality was

more likely in the surgical group than in the conservative group. Based on this finding, several other studies have indicated the superiority of conservative management over surgical management.<sup>13,14</sup> One meta-analysis conducted in 2017 has reported significantly lower mortality and morbidity rates in all cases of renal trauma and lower mortality rate in higher-grade renal trauma.<sup>13</sup> Furthermore, another systematic review conducted by Sujenthiran A *et al.* has found better mortality rate as well as better renal preservation rate and lower length of hospital stay in the conservative management group than in the surgical group.<sup>14</sup> In addition, the complication rates between the two groups were comparable.<sup>14</sup> However, the analyses from these two studies were not conducted specifically for grade IV renal trauma, which may affect the results, particularly with the inclusion of grade III renal trauma in the analysis of Mingoli *et al.*<sup>13,14</sup>

A general consensus regarding the conservative management of renal parenchymal injury has been established, indicating that patients with renal parenchymal injury will require surgery if the hemodynamic condition is unstable.<sup>30</sup> Renal hila hematoma and renal vein thrombosis in grade IV renal trauma should be managed with strict monitoring.<sup>30</sup> Nephrectomy may be necessary when renovascular hypertension or bleeding eventually occurs.<sup>30</sup> Meanwhile, in renal artery thrombosis, nephrectomy is advised.<sup>30</sup> Interventions for renal injuries can be conducted in patients with hemodynamic instability caused by renal bleeding, uncorrected renal injury classification, ureter injury, renal pelvis injury, and renovascular injury. Conservative management is based on the findings of computed tomography in patients with hemodynamic stability and results of the intraoperative assessment during laparotomy using one-shot intravenous urography in patients with hemodynamic instability.<sup>1,9,10</sup>

Grade IV renal parenchymal injury without other organ injury can be conservatively managed with minimal complications. Massive bleeding from a torn parenchyma can be well managed by the embolization of blood vessels. Internal ureteral stenting can be used in cases of persistent urinary extravasation, although the extravasation of urine is self-limiting. For grade IV renal blunt trauma without other intra-abdominal organ injuries, conservative management provides extremely satisfactory results.<sup>17,31,32</sup>

The present study had several limitations. First, only a limited number of studies was included. Only three published articles about grade IV blunt renal trauma were available, with a total of 703 adult patients. Second, the groups were not equal in number as only 92 cumulative patients received surgical management. Third, there is also a limitation with respect to the study design of the

included studies. There was no head-to-head RCT conducted in this field, regarding the ethical issue.

## Conclusions

A comparable success and morbidity rates were observed between surgical and conservative groups. Meanwhile, though small, the trend of mortality was higher in the surgical group than in the conservative group. Our study suggested better outcomes in the conservative group, and selective selection of patients given surgical management may prevent exploration of renal injury via surgery. The most important goal of conservative management is to reduce the need for unnecessary exploration, particularly in patients with grade IV renal injury, and the rate of reconstruction and/or nephrectomy maybe decreased without causing morbidity or mortality.

## Acknowledgments

The author would like to thank all the staff in the Department of Urology, Cipto Mangunkusumo National Referral Hospital, for all the supervision and training, which contributed to the writing of this manuscript.

## Funding

This study received no external funding. All expenses were covered by the institution and authors.

## Conflict of Interest Statement

The authors declare no conflict of interest related to this study.

**Received: January 27, 2019 Accepted: May 14, 2019**

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