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# Selective Management of Isolated and Nonisolated Grade IV Renal Injuries

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**Purpose:** We reviewed all grade IV renal injuries to report outcomes, and determined if operative and selective nonoperative management can lead to high salvage rates. We also determined if management and outcome differ significantly between cases of isolated grade IV renal injuries and those with associated multiorgan injuries.

**Materials and Methods:** We retrospectively reviewed the records of 153 grade IV renal injuries from a 25-year period. We divided these into isolated grade IV renal injuries (43) and those with associated nonrenal injuries (110), and analyzed both groups on the basis of type of renal injury, operative vs nonoperative management, operative nephrectomy rate and renal salvage rate. Salvage was defined as 25% or greater overall renal function (50% or greater function of the injured kidney).

**Results:** Of the 153 patients 103 were treated operatively and 50 nonoperatively with an overall salvage rate of 84%. Penetrating trauma accounted for 87 injuries and blunt trauma 66, while 52% (79 of 153) involved a renal vascular injury. The grade IV renal injuries with concurrent associated injuries requiring operative exploration were repaired at exploration with a 15% nephrectomy rate and an 83% salvage rate. Of the 43 patients with isolated injuries 18 (42%) underwent operative exploration with an average transfusion requirement of 8.5 units packed red blood cells. Two patients (11%) required nephrectomy, 1 kidney was nonfunctional postoperatively and 2 minor complications were identified. The remaining 25 (58%) isolated grade IV renal injuries were managed nonoperatively, with only 12 patients requiring transfusion (average 2.6 units) and a renal salvage rate of 88%. None of the 50 nonoperative cases (isolated or nonisolated renal injuries) required delayed nephrectomy. Six cases demonstrated nonfunctioning kidneys and 4 incurred minor complications.

**Conclusions:** Management of grade IV renal injuries is complex and demanding if renal salvage is to be achieved. Selective operative vs nonoperative management is based on the presence of associated nonrenal injuries, the hemodynamic stability of the patient, the degree of renal staging and the skill of the surgeon. Isolated grade IV renal injuries represent a unique situation to treat the patient based solely on the extent of the renal injury, thus nonoperative management is used more frequently. Persistent bleeding represents the main indication for renal exploration and reconstruction. In all cases of severe renal injury nonoperative management should only occur after complete renal staging in hemodynamically stable patients.

*Key Words: injury severity score, wounds and injuries, kidney, salvage therapy*

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Since the development of the AAST Organ Injury Severity Score, renal trauma management has been better defined with improved outcomes.<sup>1</sup> The majority of renal injuries are grades I to III and can be successfully managed nonoperatively with excellent functional preservation.<sup>2,3</sup> Controversy exists regarding the management of high grade (IV/V) renal injuries, with some arguing for primarily nonoperative management and others citing the necessity of operative exploration and repair.<sup>4-7</sup> At our institution we adhere to the AAST grading system which defines grade V as a hemodynamically unstable renal vascular injury or multiple grade IV parenchymal lacerations requiring renal exploration to prevent life threatening hemorrhage. It is the remaining grade IV renal injuries (specifically isolated grade IV renal injuries) that need further clarification for the role of operative vs nonoperative management. We an-

alyzed our selective management of 153 grade IV renal injuries based on the mechanism of injury, hemodynamic stability, radiographic staging, associated nonrenal injuries and clinical presentation to determine operative vs nonoperative management, and we compared outcomes. Only after complete evaluation and staging can operative vs nonoperative management be selected to achieve the best outcome.

## PATIENTS AND METHODS

Data collected prospectively on 153 cases of grade IV renal trauma during the last 25 years at San Francisco General Hospital were reviewed retrospectively, and several parameters were assessed including the mechanism of injury, hemodynamic stability, radiographic imaging (CT and/or single-shot excretory urogram), associated nonrenal injuries and operative vs nonoperative management. We subdivided these 153 injuries into isolated and nonisolated renal injuries to determine operative vs nonoperative management based solely on grade IV renal injury. Salvage was defined as 50% or greater function of the injured renal unit. In 50% postoperative CT imaging or renal isotope scans were available to assess renal function and healing.

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## RESULTS

Of the 153 patients penetrating and blunt renal trauma occurred in 87 and 66, respectively, while 52% (79 of 153) involved a renal vascular injury. Operative management was selected in two-thirds (103). Of the 103 operative cases 85 (83%) had significant associated nonrenal injuries that required operative exploration, prompting timely renal exploration and attempted reconstruction. The overall renal salvage rate was 84% (128 of 153). The operative nephrectomy rate was 15% (15 of 103), with 13 nephrectomies occurring in a damage control situation in patients with severe multiorgan injuries requiring multiple blood transfusions. Of the reconstructed kidneys 5 demonstrated less than 25% of overall renal function postoperatively and, thus, did not meet renal salvage criteria. Of these kidneys 4 involved vascular repairs (2 arterial, 1 venous, 1 combined arterial and venous) and data from 1 patient were unavailable for detailed review.

Other perioperative complications were perinephric abscess (1), wound/urinary tract infection (4) and prolonged flank/abdominal pain (5). Complications in the 50 nonoperative cases comprised ureteral stent placement in 2 (1 adult and 1 child for nonresolving large urinomas), wound infection in 1 and death in 1 child unrelated to the renal injury. No delayed renal exploration was required in the nonoperative group.

Isolated grade IV renal injuries occurred in 43 of 153 (28%) patients (table 1). Blunt and penetrating trauma occurred in 24 of 43 (56%) and 19 of 43 (44%) patients, respectively. The majority of operative cases had a penetrating injury. Operative exploration was performed in 18 of 43 patients (42%) with an 11% nephrectomy rate (2 of 18) and an overall renal salvage rate of 83% (1 kidney was nonfunctioning postoperatively). Both nephrectomies were the result of a stab wound requiring blood transfusions of 4,000 and 5,000 ml. The remaining 25 of 43 (58%) isolated grade IV renal injuries were managed nonoperatively with a renal salvage rate of 88%. Of these 25 patients 3 retained less than 25% of overall renal function in the injured kidney secondary to main artery thrombosis in 2 and post-segmental artery embolization in 1.

In the isolated grade IV renal injury group the average transfusion requirement for operative cases was 8.5 units prbc (median 7.9) and for nonoperative cases (12 of 25) 2.6 units ( $p < 0.002$ ). Average hospital stays were similar at 11.8 and 11.9 days for the isolated renal operative and nonoperative groups, respectively.

TABLE 1. Isolated grade IV renal injuries

	Operative	Nonoperative	Totals
No. blunt	4	20	24
No. penetrating stab/ gunshot wounds (total)	11/3 (14)	5/0 (5)	16/3 (19)
Av/median transfusion units	8.5/7.9	2.6/Not applicable*	
No. nephrectomy	2 (stab wounds)	0	2
No. renal function less than 25%	1 (gunshot wound)	3†	4
Salvage rate (%)	83	88	86
Av hospital days	11.8	11.9	11.8

\* Of 25 patients 12 received blood transfusions.  
† Renal artery thrombosis in 2, post-segmental artery embolization in 1.

## DISCUSSION

The incidence of renal trauma in the literature has been reported at 2% or less to 3% in large urban trauma centers.<sup>3,8</sup> The majority of these injuries are minor, requiring only observation. Screening and staging of renal injuries are now well integrated into urological trauma education and care.<sup>1,2,4</sup> After a case has been appropriately staged based on clinical presentation, hemodynamic stability, mechanism of injury and radiographic imaging, management can be selected.<sup>6,9</sup> The literature has determined definitively that grades I to III renal injuries can be managed nonoperatively with rare exception. It is our belief that grade V renal injuries by definition represent a hemodynamically unstable situation requiring immediate operative exploration. Thus, it is the management of grade IV renal injuries that remains controversial. For an optimal outcome the treating physician needs to be able to manage the case operatively or, alternatively, to provide judicious nonoperative management. Ideally the patient should be treated by an experienced urological or trauma surgeon at an institution equipped to provide high level acute care with a broad arsenal of treatment styles.

In the last 25 years we have managed 153 grade IV renal injuries as defined by the AAST renal injury grading scale (fig. 1). Often grade IV renal injuries occur in the setting of other severe associated injuries that require immediate operative exploration (77% [85 of 110] in our series),<sup>10,11</sup> obviating preoperative CT staging and, thus, requiring renal exploration, intraoperative staging and management (fig. 2). In this setting the care is dictated by the associated injury, the stability of the patient and the skill of the surgeon. To avoid needless nephrectomy a trained urologist or trauma surgeon experienced with immediate vascular control and renal reconstructive techniques should be involved to prevent the unacceptably high 40% to 60% nephrectomy rate in recent reports.<sup>8,12-14</sup> In our series we had an operative nephrectomy rate of 15% which we believe is directly due to our participation in the operative care of the patient. In a damage control situation in which the patient is unstable and has sustained a severe renal injury, immediate nephrectomy may be the best option.

Controversy in the management of grade IV renal injuries arises when immediate exploration is not warranted yet a severe renal injury has occurred. To assess this situation we focused on isolated grade IV injuries for which management was dictated by these alone.

Of our 153 grade IV renal injuries 43 involved the kidney only, 42% were explored, while the remaining 58% were managed nonoperatively (table 1). Persistent bleeding requiring multiple blood transfusions prompted renal exploration in the majority of the operative group, with an average transfusion requirement of 8.5 units prbc. Our guidelines for intervention are hemodynamic instability causing severe hypotension and shock, a rapidly expanding renal hematoma, persistent hemodynamic instability despite 3 units prbc, and clinical decompensation. Angioembolization (5 patients in our series) can be an attractive alternative to renal exploration in hemodynamically stable patients requiring multiple blood transfusions. Additional relative indications for renal exploration include ureteropelvic junction injury, significant devitalized renal tissue, incomplete staging or limited observational facilities.

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