Evaluation of Renal Function After Major Renal Injury: Correlation With the American Association for the Surgery of Trauma Injury Scale

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Abbreviations and Acronyms

AAST = American Association for the Surgery of Trauma

CT = computerized tomography

DMSA = dimercapto-succinic acid

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Purpose: In this study we evaluated the effect of major kidney injury on renal function.

Materials and Methods: A retrospective cross-sectional analysis was conducted of all patients who sustained renal trauma between 1977 and 2008 at San Francisco General Hospital, and underwent post-injury dimercapto-succinic acid renal scan (67). Decrease in renal function was defined as the absolute percentage difference between the affected and unaffected kidney on dimercapto-succinic acid scan. Univariate (Spearman rank correlation) and multivariate (linear regression) analyses of the American Association for the Surgery of Trauma renal injury grade, patient age, mechanism of injury (blunt vs penetrating), side of injury, treatment used (nonoperative vs surgery), shock, gender, presence of gross hematuria, serum creatinine on hospital admission, postoperative complications and associated injuries were performed.

Results: Of the 67 renal injuries 23 (34%) were managed nonoperatively. There were 43 (64%) injuries due to penetrating trauma and 24 (36%) due to blunt injury. Mean decrease in renal function for grade III, IV and V injuries was 15%, 30% and 65%, respectively. Univariate analysis demonstrated a significant association between decrease in renal function and injury grade (rho 0.43, $p < 0.005$). There was no difference in the decrease in kidney function between parenchymal and vascular causes for grade IV and V injuries. Although the right kidney demonstrated a greater decrease in function (rho 0.26, $p = 0.033$) on univariate analysis, multivariate analysis showed that only American Association for the Surgery of Trauma injury grade correlated with decreased function (correlation coefficient 14.3, 95% CI 4.7–24.8, $p < 0.005$).

Conclusions: Decrease in kidney function is directly correlated with American Association for the Surgery of Trauma renal injury grade.

Key Words: technetium Tc 99m dimercaptosuccinic acid, radioisotope renography, wounds and injuries, trauma severity indices, kidney

STAGING renal injuries using CT has provided valuable information in assessing and establishing injury grade. The AAST organ injury severity scale for kidney injury, which predominantly uses CT findings for establishing injury grade, has provided guidance in the management of renal injury. The AAST injury grade has clinical importance and validity in that increasing renal injury grade is directly correlated with the need for renorrhaphy or nephrectomy.[1] Increasing renal trauma grade was also the strongest predictor of the need for hemodialysis and inpatient mortality

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after blunt renal injury, and of the need for nephrectomy after penetrating trauma.[2,3] More recently Shariat et al developed a nomogram to predict the need for renal exploration in renal trauma, which also demonstrated that the AAST injury scale is predictive of operative intervention.[4]

However, post-injury followup is poor and data regarding kidney function after injury are lacking in the literature. Three studies on the effect of trauma on kidney function are inconclusive and only examined the effects of blunt renal trauma in children.[5–7] To our knowledge the functional outcome of renal injuries using post-injury ^{99m}technetium DMSA scans has not previously been reported in adults. We hypothesize that renal trauma deleteriously affects kidney function and that greater loss of function results from higher grade injuries. The current study was performed to determine whether injury grade correlates with change in kidney function as determined by DMSA renal scintigraphy after blunt and penetrating traumatic kidney injury.

MATERIALS AND METHODS

This is a cross-sectional secondary analysis of a urological trauma database (3,704) prospectively collected from 1977 to 2008 at San Francisco General Hospital. A total of 426 patients sustained major (grade III to V) renal trauma during this period. In all cases of grade III or higher renal trauma a DMSA scan was ordered. However, due to the poor followup of this patient population 67 (15.7%) underwent post-injury DMSA nuclear renogram (table 1). The range of time after injury during which the DMSA scan was obtained was 1 to 818 days.

Table 1. *Patient demographics*

	No. (%)
Gender:	
F	5 (7)
M	62 (93)
Age:	
Younger than 18	4 (8)
Older than 18	62 (92)
Renal trauma grade:	
3	23 (34)
4	39 (58)
5	5 (8)
Shock:	
No	44 (66)
Yes	23 (34)
Associated injuries:	
No	19 (28)
Yes	48 (72)
Side:	
Lt	40 (60)
Rt	27 (40)
Complications:	
No	62 (93)
Yes	5 (7)
Gross hematuria:	
No	23 (34)
Yes	44 (66)

Renal injury grade according to the AAST organ injury severity scale for the kidney was determined by CT or operatively if CT was not obtained. Grade IV and V injuries were subclassified based on vascular or parenchymal injury. Decrease in renal function was defined as the absolute percentage difference between the affected and unaffected kidney. AAST renal injury grade, patient age, mechanism of injury (blunt vs penetrating), side of injury, treatment used (nonoperative vs surgery), shock, gender, presence of gross hematuria, serum creatinine on hospital admission, postoperative complications and associated injuries were identified, and were included in the statistical analysis.

All statistical analysis was performed with Stata®. Mean percentage decrease in kidney function for each injury grade was calculated. Univariate analysis using the Spearman rank correlation coefficient was used to determine an association between each of the previously identified clinical variables and decrease in renal function. A multivariate analysis of the variables in table 1 was performed with multivariate linear regression. Additional univariate analysis was performed to determine if the decrease in renal function differed between types of grade IV injuries (vascular or parenchymal laceration). Additional subanalysis of grade IV vascular injuries due to segmental artery injury, or main renal artery or vein injury was performed. Finally to determine if timing of the DMSA scan affected the detected loss of kidney function, subanalyses (controlling for grade) were performed comparing the loss of renal function of those patients whose scans were obtained within vs after the first 7 days of injury. Confidence intervals were set to 95% and significance was based on $p < 0.05$. This study was approved by the University of California, San Francisco Committee on Human Research.

RESULTS

Of the 67 renal injuries 43 (64%) were due to penetrating trauma and 24 (36%) were due to blunt injury. There were 44 (66%) injuries managed with renal exploration and repair, and all grade V injuries were managed surgically. Of the grade III injuries 11 (48%) and of the grade IV injuries 28 (72%) required surgical intervention. Complications of renal surgery occurred in 5 patients (1 grade III, 3 grade IV and 1 grade V). DMSA scans were obtained on average 36.1 days after renal trauma (range 1 to 818). Of the DMSA scans 37 (55%) were obtained in the first 7 days after injury. Mean patient age was 27.9 years (range 6 to 54) (table 1). This group was comparable to the larger population of patients with renal trauma who did not undergo DMSA scan (data not shown). Of the grade IV injuries 18 (46%) were due to vascular injury (segmental artery or contained injury to the main artery or vein) isolated or in conjunction with a parenchymal laceration. Of the grade V injuries 4