# PRACTICE MANAGEMENT GUIDELINES FOR

# THE MANAGEMENT OF GENITOURINARY TRAUMA

The EAST Practice Management Guidelines Work Group

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## I. STATEMENT OF THE PROBLEM

As our ability to image the genitourinary tract improves, and the concept of nonoperative management of solid organ injury has extended to include renal trauma, the optimal methods of managing injuries to the genitourinary tract have remained controversial. New methods of management, including laparoscopic techniques, complement and, in some cases, supplant traditional techniques.

We initiated our review of management of genitourinary trauma by generating several questions:

1. What are the indications for operative exploration of the kidneys in blunt trauma? In penetrating trauma?

2. How should renal function be assessed intraoperatively if contralateral nephrectomy is contemplated?

3. What is the trigger for exploration of the kidneys following initial nonoperative therapy? Number of PRBCs transfused? Expanding hematoma on repeat CT scan? Urinoma?

4. If nonoperative therapy is selected, is radiographic follow-up required?

5. What are the indications for exploration of the renal vessels in blunt trauma? What is the time frame for operative exploration of the renal vessels in blunt trauma? In which patients should renal vascular repair be attempted? Which patients should undergo primary nephrectomy?

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6. What are the indications for operative exploration of the bladder after blunt trauma? After penetrating trauma?

7. If nonoperative therapy of a bladder injury is selected, should a suprapubic tube or a transurethral catheter be utilized?

8. How should the integrity of the ureter be assessed intraoperatively?

## II. PROCESS

### A. IDENTIFICATION OF REFERENCES

A computerized search was undertaken using Medline with citations published between the years of 1966 and 2003. Using the search words genitourinary, renal, kidney, ureter, bladder, urethra, renovascular, trauma, wounds, and injury, and by limiting the search to citations dealing with human subjects and published in the English language, we identified over 3,300 articles. From this initial search, case reports, review articles, editorials, letters to the editor, pediatric series, and meta-analyses were excluded prior to formal review. Additional references, selected by the individual subcommittee members, were then included to compile the master reference list of 129 citations.

Articles were distributed among the subcommittee members for formal review. A data sheet was completed for each article reviewed which summarized the purpose of the study, hypothesis, methods, main results, and conclusions. The reviewers classified each refence by the methodology established by the Agency for Health Care Policy and

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Research (AHCPR) of the U.S. Department of Health and Human Services.

**B. QUALITY OF THE REFERENCES**

**Class I**: Prospective randomized controlled trials. **(1 reference)**

**Class II**: Clinical studies in which the data was collected prospectively, and retrospective analyses were based on clearly reliable data. Types of studies so classified include: observational studies, cohort studies, prevalence studies, and case control studies. **(4 references)**

**Class III**: Studies based on retrospectively collected data. Evidence used in this class includes clinical series and database or registry review. **(123 references)**

An evidentiary table was constructed using the remaining 128 references. Recommendations were based on studies included in the evidentiary tables.

## III. RECOMMENDATIONS

### A. RENAL TRAUMA

#### 1. Level I

There is insufficient Class I and Class II data to support any standards regarding management of renal trauma.

#### 2. Level II

1) Preliminary vascular control does not decrease blood loss or increase renal salvage.

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2) Conservative management of shattered but perfused kidneys in hemodynamically stable patients with minimal transfusion requirements will result in a low incidence of complications, which can usually be treated with endourological or percutaneous methods.

**3. Level III**

1) Preliminary vascular control may prolong operative time

2) The success of nonoperative management may be enhanced by the use of angiographic embolization.

3) Nonoperative treatment of renal lacerations from blunt trauma associated with extravasation is associated with few complications, which can usually be treated with endourological or percutaneous methods.

4) Conservative management of major renal lacerations associated with devascularized segments is associated with a high rate of urologic morbidity (38 - 82%). In patients who present with a major renal laceration associated with devascularized segments, conservative management is feasible in those who are clinically stable with blunt trauma. The physician must be especially aware of the probable complications within this subset of patients.

5) Operative exploration of the kidney should be considered in patients with major blunt renal injuries with a devascularized segment in association with fecal spillage or pancreatic injury.

6) Nonoperative treatment of penetrating renal lacerations is appropriate in hemodynamically stable patients without associated injuries hwo have

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been staged completely with CT scan and/or IVP. A high index of suspicion is needed to avoid ureteral injuries if a course of nonexploration is chosen.

7) Penetrating Grade III or IV injuries are associated with a significant risk of delayed bleeding if treated expectantly. Exploration should be considered if laparotomy is indicated for other injuries or if the injury is not completely staged prior to exploratory laparotomy for other injuries.

## B. RENOVASCULAR TRAUMA

### 1. Level I

There is insufficient Class I and Class II data to support any standards regarding management of renovascular trauma.

### 2. Level II

There is insufficient Class II data to support any recommendations regarding management of renovascular trauma.

### 3. Level III

There is insufficient Class III data to support any recommendations regarding management of renovascular trauma.

## C. URETERAL TRAUMA

### 1. Level I

There is insufficient Class I and Class II data to support any standards regarding management of ureteral trauma.

### 2. Level II

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There is insufficient Class II data to support any recommendations regarding management of ureteral trauma.

**3. Level III**

There is insufficient Class III data to support any recommendations regarding management of ureteral trauma.

## D. BLADDER TRAUMA

**1. Level I**

There is insufficient Class I and Class II data to support any standards regarding management of bladder trauma.

**2. Level II**

There is insufficient Class II data to support any recommendations regarding management of bladder trauma.

**3. Level III**

1) Conservative, nonoperative management of blunt extraperitoneal bladder rupture has a similar outcome to that of patients treated with primary suturing.

2) Transurethral catheters result in fewer complications and fewer days of catheterization than suprapubic catheters, regardless of the degree of bladder injury, and are therefore preferable to suprapubic catheters whether the patient is being treated nonoperatively or operatively.

## E. URETHRAL TRAUMA

**1. Level I**

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There is insufficient Class I and Class II data to support any standards regarding management of urethral trauma.

**2. Level II**

There is insufficient Class II data to support any recommendations regarding management of urethral trauma.

**3. Level III**

1) Posterior urethral injuries secondary to blunt trauma may be treated either with delayed perineal reconstruction or primary endoscopic realignment, resulting in equivalent outcomes.

## IV. SCIENTIFIC FOUNDATIONS

### A. RENAL TRAUMA

The kidney is the most frequently injured urologic organ, with 70% ot 80% being a consequence of blunt trauma. Although few urologic injuries are immediately life-threatening, they do account for some of the more frequent complications of trauma. Nonoperative management of renal injuries was begun in an attempt to avoid the high nephrectomy rates associated with renal exploration in early series. Widespread use of computed tomography has demonstrated spontaneous healing of ruptured kidneys.

In a retrospective study comprised of 126 patients with blunt renal injury, 90% were treated conservatively[14]. Overall, results were excellent in 87%; there were four deaths unrelated to the renal injury and two patients who required dialysis

In another review of 55 patients with renal trauma (95% blunt) by Goff et al, 69% of hemodynamically stable patients and 38% of hemodynamically unstable patients were

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successfully managed nonoperatively. Operative exploration was primarily required for the treatment of associated injuries[8].

Cheng et al found, in their series of 16 patients with CT-identified Grade III renal injuries (eight blunt and eight penetrating), 13 (81%) were successfully managed nonoperatively[26]. The three patients who underwent immediate exploratory laparotomy did so for associated injuries. Two of the patients managed nonoperatively developed complications, a urinoma requiring percutaneous drainage and a urinary fistula which was repaired operatively.

In a retrospective review of 13 patients with Grade V blunt renal injury, six hemodynamically stable patients with a shattered but perfused kidney were successfully treated nonoperatively. Seven patients with either a nonperfused kidney or hemodynamic instability were treated operatively. The nonoperative group had fewer ICU days, significantly lower transfusion requirements, and fewer complications. A follow-up CT scan of nonoperatively treated patients revealed a functioning kidney in four of the six patients in which it was performed. No patients subsequently developed hypertension, leading the authors to conclude that conservative management of shattered but perfused kidneys is feasible in hemodyamically stable patients with minimal transfusion requirements[1].

This data was supported by a review of 23 consecutive patients with major blunt renal rupture[16]. The first group of 12 received operations for hemodynamic instability or persistent extravasation. Surgery was reserved only for major complications in the second group of 11. In the first group, six patients underwent early exploration, resulting in five nephrectomies. In the second group, nonoperative management was uniformly

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successfully, although four patients required ureteral stents. The authors concluded that in most patients with blunt renal lacerations, conservative therapy is safe. They found that most extravasations spontaneously resolve and minimally invasive techniques will deal with nearly all complications. In their series, renal exploration usually resulted in nephrectomy.

The effect of devascularization was examined in a case series of 20 conservatively managed patients with either Grade IV (15) or Grade V (five) blunt renal injury with urinary extravasation, including 11 patients with devitalized tissue. There was a statistically significant difference in the length of hospital stay (16.3 vs 7.3 days), blood transfusions (six vs two patients, $P < 0.08$) and the need for delayed surgical intervention (nine vs two, $P < 0.01$) between patients with and with no devitalized segments, respectively. Urinary extravasation spontaneously resolved in two of 11 patients with and in seven of nine with no devitalized segment, respectively ($P < 0.05$) The authors concluded that even in the presence of a devascularized segment, conservative management is an appropriate method of therapy for the clinically stable patient.[102].

In another series of 43 hemodynamically stable patients with a devascularized renal segment between 25 and 50%, expectant management resulted in urologic complications in 85% with an associated 6% risk of nephrectomy[29]. Infected urinomas and perinephric abscesses seeded by coexisting enteric or pancreatic injuries were the most common complication, suggesting that renal exploration and surgical repair significantly improve the prognosis only in patients with simultaneous intraperitoneal and renal injuries ($p < 0.01$).

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Shapiro et al analyzed a state database to determine if neurologic impairment impacted the success of nonoperative therapy of solid organ injuries secondary to blunt trauma, including the kidney[90]. They found that there was no difference in the nonoperative failure rate between patients with normal mental status and those with mild to moderate or severe head injuries. Therefore, the literature supports conservative management of shattered but perfused kidneys in hemodynamically stable blunt trauma patients with minimal transfusion requirements. Although persistent extravasation or urinoma can be expected, they can usually be treated with endourological or percutaneous methods.

The management of penetrating wounds to the kidney is similarly evolving. Velmahos et al prospectively identified 79 patients with truncal penetrating wounds involving the urinary tract[10]. Five (6 per cent) patients were managed non-operatively and 16 (20 per cent) more underwent abdominal but not renal exploration. From 21 (26.5 per cent) cases with complications, only three (4 per cent) patients developed complications which were associated with the urinary tract injuries. They advised that, although the majority of patients with gunshot wounds of the urinary tract will require abdominal exploration, invasion of Gerota's fascia may be spared in cases of stable renal hematomas.

Peterson et al reviewed their experience with 60 penetrating renal injuries, of which 42 were explored. Retrospectively determining which patients had unnecessary renal explorations, they deemed 27/60 (45%) to have required renal exploration. In hemodynamically stable patients, they recommended retroperitoneal dissection only if preoperative or intraoperative assessment suggests a major renal injury with extravasation outside of Gerota's fascia, suspicion exists of significant nonurologic retroperitoneal

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injury (great vessels, duodenum, pancreas, color), and/or inspection demonstrates an expanding or pulsatile retroperitoneal hematoma[61].

In a more recent series of 244 patients with renal-proximity stab wounds, a total of 43 injuries were found on IVP, CT, and angiogram. 18/23 patients with minor injuries were managed nonoperatively, and 9/10 patients with vascular injuries were managed successfully with transcatheter embolization. All patients with Grades III or IV injuries were explored. Eastham et al concluded that most renal injuries, when accurately staged, can be safely managed nonoperatively[30].

In a review of 120 patients with Grades II to IV renal lacerations secondary to penetrating trauma, 41 were treated nonoperatively and 70 underwent immediate renal exploration. In patients with Grade II injuries, no complications resulted from nonoperative treatment. 23.5% of patients with Grades III and IV injuries treated nonoperatively experienced delayed renal bleeding, compared to none of the operatively treated patients with Grade III and IV injuries. The authors concluded that Grade II injuries in hemodynamically stable patients can be treated nonoperatively, noting that Grades III and IV injuries are associated with a significant risk of bleeding if treated expectantly[15]. Therefore, nonoperative treatment of penetrating renal injuries is appropriate in hemodynamically stable patients without associated injuries who have been staged completely with CT scan and/or IVP. Exploration should be considered if laparotomy is indicated for other injuries or if the injury is not completely staged prior to exploratory laparotomy for other injuries.

When required for renal injury, nephrectomy is usually due to renal hemorrhage. Carlton first suggested that the nephrectomy rate could be decreased by early control of

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the renal vasculature[123]. In a retrospective review, McAninch found that from 1964 to 1973, their nephrectomy rate was 56%. From 1977 to 1981, they gained control of the renal artery and vein prior to entering Gerota's fascia, with a reduction in their nephrectomy rate to 18%[124]. This, however, has been challenged by several subsequent publications.

Atala et al reviewed 75 patients requiring renal exploration for either penetrating or blunt renal injury. They obtained vascular control prior to opening Gerota's fascia in 32 patients and after opening Gerota's fascia in 43 patients. The nephrectomy rate was found to depend on the degree of injury rather than on the type of renal vascular control obtained. Not only did obtaining vascular control after opening Gerota's fascia not increase the nephrectomy rate, but it was found to shorten operative time by an average of 58 minutes[121].

In a series of 85 explorations for penetrating (66) and blunt (19) trauma, Corriere et al found although formal pedicle control was carried out 33 times, it was never necessary to control parenchymal hemorrhage. They concluded that entering a large retroperitoneal hematoma in the midline to obtain control of the vessels added time to the procedure but little else. They suggested that perirenal hematomas can be safely entered laterally without prior pedicle control using manual pedicle or parenchymal control if needed, reserving formal pedicle control for those wounds overlying the great vessels[36].

The validity of this suggestion was supported by a prospective, randomized trial of 56 patients with penetrating renal injuries, of whom 29 patients received preliminary vascular control and 27 patients received no vascular control prior to opening Gerota's fascia[2]. Gonzalez et al found no difference in the nephrectomy rate or units of blood

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transfused comparing these two groups, but did find a statistically significant increase in average operative time associated with preliminary vascular control. The authors concluded that vascular control of the renal hilum prior to opening Gerota's fascia has no impact on nephrectomy rate, transfusion requirements, or blood loss, although it may prolong operative time.

**B. RENOVASCULAR TRAUMA**

Blunt renovascular trauma is a fairly rare injury. Although the diagnosis is being made more commonly and earlier with the use of sophisticated computerized tomography, there is very little published information regarding the optimal timing and treatment of these injuries. The available literature consists of case series comprised of fewer than ten cases per report. The success of revascularization in these publications is low, and although it has been suggested that repair should be attempted in stable patients with unilateral injury within a certain time period, there is no data to support this recommendation. Further confusing the issue are isolated reports of patients regaining renal function when revascularized 19 hours after injury[129]. Due to the paucity of data, we were unable to make any recommendations with regard to renovascular trauma.

**C. URETERAL TRAUMA**

Ureteral injuries are uncommon, accounting for only 17% of penetrating urologic trauma. The majority of publications in the English literature is comprised of case reports and small case series, making it difficult to make any meaningful conclusions. The largest case series to date, reported by Perez-Brayfield et al, reviewed 118 patients with gunshot wounds to the ureter. A variety of surgical procedures were used to repair the defect, depending on the location and severity of the defect. Complications occurred

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in 24 patients. The authors concluded that a high index of suspicion is essential to avoid missing these injuries[115].

In some instances, patients may be too hemodynamically unstable to tolerate a ureteral repair, and definitive repair must be deferred. In a retrospective review of 41 patients with ureteral injury associated with other injuries, Velhamos et al found that three patients died and 11 (26.8%) developed complications. All 6 ureteral dehiscences developed in the 30 patients with associated colonic injury (20%). These authors concluded that the presence of shock on admission or severe colonic injury requiring colectomy precludes ureteral repair, and suggested ureteral exteriorization or primary nephrectomy in these circumstances[19].

**D. BLADDER TRAUMA**

Extraperitoneal bladder rupture occurs in approximately 60 - 65%%, intraperitoneal rupture in 25%, and combined intraperitoneal and extraperitoneal rupture in 10 - 15%. Intraperitoneal bladder injuries have uniformly been repaired surgically, whereas extraperitoneal ruptures are more controversial. In a number of series, conservative, nonoperative management of blunt extraperitoneal bladder rupture has had a similar outcome to that of patients treated with primary suturing.

Corriere reviewed 100 cases of bladder rupture, of which 62 were extraperitoneal and 59 were associated with pelvic fractures. Complex injuries with extravasation outside the confines of the perivesical space were noted in 42% of the patients. The area of bladder injury was unassociated with the area of the pelvic fracture in 65% of their patients. Forty-one patients were treated with bladder drainage alone. Fourteen patients underwent formal closure with cystostomy tube placement, and seven died before institution of

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therapy. Cystograms ten days after injury demonstrated no extravasation in 36 of the 41 patients treated with similar catheter drainage. In all five patients with persistent extravasation, the bladder wound eventually healed spontaneously without complications. The authors concluded that both male and female patients with any size lesion and with any amount of extravasation can be treated successfully with simple catheter drainage. They also recommended that if the patient was to be explored for another region, the bladder injury should be repaired if the pelvic hematoma can be avoided[45].

In a retrospective review of 164 cases of bladder rupture, of which 57.5% were extraperitoneal, 30 of the extraperitoneal injuries were treated conservatively with a transurethral catheter and one was treated by a percutaneous suprapubic cystostomy alone. Of these patients, two had complications related to the method of management: clot retention in one and formation of a pseudodiverticulum around a bone spike projecting into the bladder that required delayed surgical closure in one. The authors advised that nonoperative management of extraperitoneal rupture was successful in most cases[48].

This statement was supported by a review of 111 patients with bladder ruptures (95 blunt), 39 of 58 patients with extraperitoneal bladder injuries were treated with catheter drainage alone. Patients preferentially received conservative treatment despite the size of the rupture and only underwent formal repair if explored for another reason. Transurethral catheters were used in 30 cases, percutaneous cystostomy in four cases, and five patients had a cystostomy tube placed at the time of exploration for other abdominal injuries. They did not administer antibiotics routinely and they saw no septic complications or pelvic abscesses. Followup cystograms 10 days after the injury showed

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no extravasation in 34 (87%) of the 30 patients treated in this manner. All 39 patients did well without complications. The authors concluded that patients with extraperitoneal bladder ruptures may be treated with simple catheter drainage, if not requiring exploration for associated injuries[54]. .

In another series of 105 cases of extraperitoneal bladder rupture, 65 cases treated with operative repair were compared to 34 patients who received catheter drainage alone. There were three early complications in the group treated by suturing (hematuria with clot retention 2, sepsis contributing to death 1) and four early complications in the conservatively treated group (hematuria with clot retention, pseudodiverticulum with bone spike in its floor, persistent urinary fistula, and sepsis contributing to death one). There were two late complications in 42 patients followed in the group treated by suturing (urethral stricture, frequency and dysuria), and three late complications in 14 patients followed in the conservatively treated group (hyperreflexic bladder, urethral stricture and vesical calculi). Although the early and late complication rates were higher in the conservatively managed group, there was no statistically significant difference from the group treated by primary suturing. The authors reported that poor outcome might be most common in patients with severe pelvic fracture[98].

Therefore, the consensus in the literature is that the majority of extraperitoneal bladder ruptures can be managed with catheter drainage alone. Relative contraindications to conservative management include bone fragments projecting into the bladder, open pelvic fractures, and bladder injuries associated with rectal perforations.

It has been traditional to achieve bladder drainage with a large-bore suprapubic cystostomy catheter alone or in additional to a transurethral catheter in order to ensure

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drainage of blood and clots. This teaching has been challenged in the recent literature. In a retrospective analysis of 47 patients with traumatic bladder injuries (18 blunt and 29 penetrating) requiring bladder repair, 16 patients were treated with a suprapubic catheter, 27 with a transurethral catheter and 4 with a suprapubic and temporary transurethral catheter. All seven urinary complications were noted in patients with suprapubic catheters. The average catheter duration was 42 days in the suprapubic group versus 13 days in the transurethral group. The authors concluded that transurethral catheters result in fewer complications and fewer days of catheterization, regardless of the degree of bladder injury[9].

Volpe et al reviewed 34 patients with bladder injury (82% penetrating, 18% blunt). Following primary repair, 18 patients were drained with suprapubic tubes and 16 were trained with transurethral catheter alone. Urologic complications were found in 28% of the suprapubic tube group versus 19% of the urethral catheter group. The authors suggested that intraperitoneal bladder injuries may be equally well managed by primary bladder repair and transurethral catheter drainage alone versus suprapubic tube drainage[96]. Transurethral catheters for management of blunt and penetrating bladder trauma are effective, cause less morbidity, and may be removed more rapidly that suprapubic catheters for any degree of bladder injury.

**E. URETHRAL TRAUMA**

Urethral injury is usually secondary to blunt trauma, occurring in 5 to 10% of cases of pelvic fracture. The management of urethral distraction injury has changed over the years. The primary options include delayed operative reconstruction or primary stenting of the injury with a urethral catheter, which may be endoscopically-assisted..

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In a retrospective review of 77 cases of traumatic posterior urethral injury, delayed repair (median time to repair of 12 months) resulted in adequate urethral continuity in 94l.8%. Postoperative incontinence occurred in 9% and postoperative erectile dysfunction in 16%[11].

Herschorn et al, in a retrospective series of 20 patients with prostatomembranous urethral disruptions, reported a 96% urethral stricture rate requiring posterior urethroplasty associated with suprapubic tubes, compared to 31% of patients who underwent early transurethral catheterization[106].

Kotkin et al reviewed 32 patients with urethral disruptions; 20 with complete injuries were treated with immediate realignment and 12 with partial or complete injuries were treated with retrograde catheterization alone. They reported similar complication rates in the two groups[107].

A series of 57 patients with posterior urethral disruptions treated with primary urethral realignment within six hours of injury reported no impotence in 79%, with impotence requiring treatment in only 7.5%. Only 3.7% experienced mild stress incontinence, not requiring treatment. Although 68% had evidence of post-realignment strictures, 43% were either simply observed or managed with in-office dilation[104].

Follis et al compared 33 patients with complete prostatomembranous urethral disruptions. Twenty were managed by immediate realignment, while 13 were managed with initial suprapubic tube and delayed urethroplasty. Immediate realignment resulted in an overall potency rate of 80%, compared to only 50% in patients who underwent delayed repair. There was an increased need for a secondary operation when the repair was delayed. Continence rates were similar in both groups[105]. Therefore, it appears as if

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posterior urethral injuries secondary to blunt trauma may be treated either with delayed perineal reconstruction or primary endoscopic realignment.

## V. SUMMARY

The urinary tract may be damaged by a variety of blunt or penetrating trauma to the abdomen. Urinary system injuries occur in approximately 4% of trauma patients. When multiple injuries coexist in the patient with urinary tract trauma, injuries to the urinary tract must be assessed as to their contribution to the immediately life-threatening situation. Although our subcommittee generated innumerable questions regarding the management of urinary tract injuries, we were able to satisfactorily answer only a few.

## VI. FUTURE INVESTIGATIONS

There is a paucity of Class I data analyzing the various methods of managing genitourinary tract trauma, as evidenced by the complete lack of Level I recommendations for the management of these injuries. Future investigations should be carried out in a prospective, randomized manner with a sufficient number of patients to enable clinicians to draw valid, concrete conclusions as to the optimal methods of managing these patients. Unanswered questions remain as to the best way to assess renal function and ureteral integrity intraoperatively and the optimal timing and management of blunt renovascular trauma. Although it is now acceptable to manage selected patients with renal trauma nonoperatively, the indications to declare nonoperative management unsuccessful are not clear. As physicians and health care systems become increasingly more fiscally responsible, the indications for radiographic follow-up in nonoperatively managed patients also need to be addressed. Given the relative infrequency of some of

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these injuries, especially renovascular trauma, these investigations may require large-scale multi-institutional projects.

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# EVIDENTIARY TABLE

| Title | First Author | Journal | Year | Methods | Main Results | Conclusions | Data Class |
|---|---|---|---|---|---|---|---|
| Selective nonoperative management of blunt grade 5 renal injury | Altman | J Urol | 2000 | Retrospective review of 13 grade 5 blunt renal injuries. Six patients with shattered but perfused kidneys and who remained hemodynamically stable were treated successfully nonoperatively. Seven patients with either a nonperfused kidney or a shattered kidney with hemodynamic instability were treated operatively. | Nonoperative cases had fewer ICU days, significantly lower transfusion requirements and fewer complications.F/U CT of nonoperative patients revealed functioning kidneys in 4/6 in which it was performed. No hypertension at followup. | Conservative management of shattered but perfused kidneys is feasible in hemodynamically stable patients with minimal transfusion requirements. | 3 |
| Surgical management of renal trauma: is vascular control necessary | Gonzalez | J Trauma | 1999 | Randomized prospective trial of preliminary vascular control of penetrating renal trauma vs no control | 56 patients, 29 with preliminary vascular control vs 27 with no control. No difference in nephrectomy rate, transfusion requirement or blood loss | Preliminary vascular control does not decrease blood loss or increase renal salvage | 1 |
| Traumatic posterior urethral injury and early primary endoscopic realignment: evaluation of long-term follow-up | Jepson | Urology | 1999 | Retrospective review of 8 patients who underwent endourologic procedures to achieve urethral continuity following blunt trauma | Mean of 50.4 months follow-up. 87.5% continent, 62.5% patent. 4/8 required subsequent internal urethrotomies. | Primary endoscopic realignment is an effective treatment for traumatic posterior urethral injuries | 3 |
| Indications for nonoperative management of renal stab wounds | Armenakas | J Urol | 1999 | Retrospective review of 200 renal injuries due to stabs (75 Grade I, 33 Grade II, 52 Grade III, 38 Grade IV and 2 Grade 5). Associated organ injuries occurred in 61%. | Nonoperative treatment was attempted in 108 (54%). Three of these eventually required surgery due to delayed hemorrhage. Of 92 kidneys explored, 80% were repaired and 12% required nephrectomy. Overall, renal salvage obtained in 94.5%. | Patients with stab wounds can be selected for nonoperative treatment with a high degree of success. Overall renal salvage is excellent. | 3 |
| Early endoscopic realignment as primary therapy for complete posterior urethral disruptions | Rehman | J of Endourology | 1998 | Retrospective review of 6 patients who underwent endoscopic realignment of disrupted posterior urethra | All patients continent, 1/6 with diminished erectile function and 4 required subsequent internal urethrotomies | Endoscopic realignment is an acceptable option for posterior urethral disruptions | 3 |

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|---|---|---|---|---|---|---|---|
| Selective management of renal gunshot wounds | Velmahos | Br J Surg | 1998 | Retrospective review of 52 patients with renal gunshot wounds. Renal injuries explored only if they involved the hilum or were accompanied by continued bleeding | 32 patients were explored, with 17 requiring nephrectomy for major renovascular or parenchymal trauma. The remaining 20 patients were successfully managed without renal exploration. 3 patients died from associated injuries. 2 renal complications occurred, one in each group | Gunshot wounds that produce stable perirenal hematomas do not require exploration. | 3 |
| Posttraumatic renovascular hypertension after occult renal injury | Montgomery | J Trauma | 1998 | Retrospective review of trauma database | 7 patients were identified with new onset hypertension following trauma. Renal injuries not identified during their hospitalization. All had positive renal arteriography; 6/7 had renal-vein renin assays localized to involved kidney. | Newly sustained hypertension following trauma should lead to renal evaluation | 3 |
| Management of renal trauma at a rural level I trauma center | Goff | Am Surgeon | 1998 | Retrospective review of 55 renal injuries (96% blunt). Nine patients had renal artery injuries and 4 had injuries to the collecting system. | Nonoperative treatment was successful in 69% of the hemodynamically stable patients and 38% of the unstable patients. Most of the operative therapy was for associated injuries. Only 8 kidneys were explored, 5 requiring nephrectomy. Two complications occurred, both of which were treated with a ureteral stent. | Majority of renal injuries can be treated nonoperatively with a low incidence of complications | 3 |

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| Method of urinary diversion in nonurethral traumatic bladder injuries: retrospective analysis of 70 cases | Thomae | Am Surgeon | 1998 | Retrospective review of 70 bladder injuries, 40 blunt and 30 penetrating. | 47 patients (18 blunt, 29 penetrating) required bladder repair, with 16 treated with a suprapubic catheter, 27 with a transurethral catheter and 4 with a suprapubic and temporary transurethral catheter. All 7 urinary complications noted in patients with suprapubic catheters. Catheter duration was 42 days for suprapubic vs 13 days for transurethral. | Transurethral catheters result in fewer complications and fewer days of catheterization with any degree of bladder injury. | 3 |
| The management of urinary tract injuries after gunshot wounds of the anterior and posterior abdomen | Velmahos | Injury | 1997 | Prospective data collection on 79 patients with injuries of urinary tract following GSW | 5% managed nonoperatively and 16% were operated upon but the kidneys were not explored. One shot IVP and CT scans failed to visualize the 7 ureter injuries. | Renal exploration is not required in cases of stable renal hematomas. A high index of suspicion followed by exploration is needed to avoid ureteral injuries. | 2 |
| Delayed repair of post-traumatic posterior urethral distraction injuries: long-term results | Tunc | Urology | 2000 | Retrospective review of 77 cases of delayed repair of traumatic posterior urethral injuries. Median time to repair was 12 months. | Mean follow-up of 47 months, urethral continuity adequate in 94.8%. Postop incontinence in 9.1%. Postop erectile dysfunction in 16.2%. | Delayed perineal reconstruction of posterior urethral injuries is a successful treatment option with acceptable morbidity | 3 |
| Penetrating ureteric injuries | Azimuddin | Injury | 1998 | Retrospective review of 21 (2 stab, 19 GSW) penetrating injuries to ureter | Preop screening unreliable. Gross hematuria in only 66%. IVP diagnostic 14%, suspicious in another 42%. Anastomotic leak ocurred in 14%. | Exploration of retroperitoneum remains the only definitive method of excluding ureteric injury | 3 |
| Traumatic posterior urethral injury and early realignment using magnetic urethral catheters | Porter | J Urol | 1997 | Retrospective review of 13 patients with complete urethral disruption treated with endourological realignment using coaxial magnetic urethral catheters | Realignment was established in 11/13 using magnetic urethral catheters. Urethral strictures developed in 5/10 available for follow-up requiring 1.4 corrective procedures per patient. Impotence was noted in 1/7; no urinary incontinence occurred. | Stricture formation, impotence and incontinence rates with this procedure are comparable to those reported for delayed urethroplasty | 3 |

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| Nonoperative treatment of major blunt renal lacerations with urinary extravasation | Matthews | J Urol | 1997 | Retrospective review of 46 patients with blunt renal trauma treated nonoperatively. 31 had major extravasation (Grade 4 and 5) and 15 did not (Grade 3). | Urinary extravasation resolved spontaneously in 27/31 (87.1%) of patients, with the remaining 4 resolving after ureteral stenting. No complications occurred in patients without extravasation. | Nonoperative treatment of renal lacerations with extravasations is safe and effective. Complications are uncommon and can usually be treated with endourological or percutaneous methods. | 3 |
| Criteria for nonoperative treatment of significant penetrating renal lacerations. | Wessels, Hunter | Journal of Urology | 1997 | Retrospective review of 120 patients with Grades II to IV renal lacerations secondary to gun shot and stab wounds. Forty-one (41) patients were treated nonoperatively and 79 underwent immediate renal exploration. | Patients treated nonoperatively had significantly lower incidence of gun shot wounds, shock, associated injuries, need for transfusion and high grade renal injuries. In patients with Grade II lacerations, no complications resulted from nonoperative treatment. Twenty-three point five (23.5%) percent of patients treated nonoperatively with Grades III and IV injuries had delayed renal bleeding versus none in group II. | Nonoperative treatment of penetrating renal lacerations is appropriate in hemodynamically stable patients without associated injuries who have been staged completely with CT scan and/or IVP. Grade II injuries can be treated nonoperatively, but Grades III or IV injuries are associated with a significant risk of delayed bleeding if treated expectantly. Exploration should be considered if laparotomy is indicated for other injuries or if the injury is not completely staged prior to exploratory laparotomy for other injuries. | 3 |

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| Management of major blunt renal lacerations: surgical or nonoperative approach? | Robert, Maxine | European Urology | 1996 | Twenty-three (23) consecutive patients with deep blunt renal lacerations were treated from 1986 to 1995. Group 1, 12 patients conservatively with open surgery in cases of hemodynamic instability or persistent extravasation. Group 2, 1990 to 1995, 11 patients with observation with surgery reserved only for major complications. All patients had CT scan staging. | In group 1, 6 patients required early exploration, 4 nephrectomies, 2 renorrhaphies, persistent fistula led to nephrectomy in 1 of the previously operated patients. Length of stay was lower for nonoperated patients. None suffer from hypertension. Group 2, all 11 patients treated conservatively. Four (4) patients required ureteral stents. Extravasation resolved in all. Length of hospital stay was significantly higher in patients who required stents. | In most patients with blunt renal lacerations, conservative approach is safe. Most extravasations spontaneously resolve. Minimally invasive techniques deal with nearly all complications. Open surgery usually results in nephrectomy. | 3 |
| The later treatment of 63 overlooked or complicated ureteral missile injuries: the promise of nephrostomy and role of autotransplanation. | al-Ali, M. | Journal of Urology | 1996 | Sixty-three (63) with 4 related ureteral injuries due to high velocity missle wounds presented with external fistula, internal leakage or ureteral obstruction. No patient presented in the acute phase of the injury. All patients were studied retrospectively. The ureteral injury was missed during initial laparotomy in 47 patients (75%) while the remaining 16 (25%) had undergone primary ureteral reconstruction at the time of the laparotomy. Open nephrostomy was performed in 51 patients or 81%. Delayed reconstruction was performed in 39 including auto-transplantation in 2. | The nephrostomy tube proved to be therapeutic in 20 patients. The remaining patients underwent reconstruction. | When treating complications of ureteral injuries, best results are achieved with initial nephrostomy tube placements followed by reconstruction once urine leakage stopped. Nephrostomy tube drainage alone may prove to be therapeutic. Auto-transplantation is an alternative when extensive ureteral damage has occurred. | 3 |

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|---|---|---|---|---|---|---|---|
| Conservative management of penetrating and blunt Type III renal injuries | Thall, EH | British Journal of Urology | 1996 | This is a retrospective review of 122 patients with blunt abdominal and penetrating trauma. Forty-five (45) patients (32 penetrating and 13 blunt trauma) all with Type III injuries were identified. Twenty-eight (28) patients (17 penetrating and 11 blunt) had their renal injuries treated conservatively. Fourteen (14) patients underwent immediate surgical repair. All had penetrating injuries. | Four (4) patients with penetrating trauma required delayed intervention. Two (2) who had been treated conservatively and 2 who had undergone initial surgical intervention. Three (3) patients required nephrectomy. All in the group treated surgically. Twenty-eight (28) patients were successfully managed conservatively without loss of renal function. | Type III penetrating trauma may be successfully managed conservatively with a similar outcome to those patients with type III blunt injuries. Surgical intervention may only be necessary in those with associated intra-abdominal injuries or who develop hemodynamic instability. | 3 |
| Penetrating ureteral injuries: the impact of associated injuries on management. | Velmahos, George C. | American Surgeon | 1996 | This is a retrospective review of 41 patients with penetrating ureteral trauma. | All 41 patients have other associated injuries and all underwent exploratory laparotomy and primary repair of the injury. Eleven (11) patients developed complications (26.8%). There were 5 ureteral strictures (12.2%). Two (2) of the 5 eventually required nephrectomy. Six (6) patients developed ureteral dehiscences. Three (3) patients died. Two (2) patients required ureteral exteriorization. One (1) eventually had a nephrectomy and 1 had reconstructive surgery. All 6 dehiscences developed in the 30 patients with associated colonic injury (20%). | The presence of shock on admission, intraoperative bleeding, multiple intra-abdominal organ involvement and especially severe colonic injury requiring colectomy have been identified as predictive of poor outcome. Patients presenting with shock or who have severe colonic injury requiring colectomy should not have primary ureteral repair. Ureteral exteriorization should be performed under these circumstances. Nephrectomy might also be considered. | 3 |

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| Internal fixation in pelvic fractures and primary repairs of associated genitourinary disruptions: a team approach. | Routt, ML, Chip | Journal of Trauma-Injury Infection & Critical Care | 1996 | Fifty-four (54) patients associated urologic trauma and pelvic fractures were reviewed. Of these 54, 23 underwent open reduction and internal fixation of the anterior pelvic ring injuries after completion of the genitourinary repairs and formed the basis for this review. | The orthopedist preps and drapes the patients. Pfannenstiel incision is the incision of choice. Urologist realigns the urethra or fixes the bladder prior to internal fixation. Suprapubic tubes are not used. Urologic complications occurred in 7 of the 23 patients. Forty-four (44) percent of those with complete uretheral disruption developed uretheral stricture despite primary realignment. Three (3) of the 18 male patients complained of erectile dysfunction. | Individuals with combined orthopedic and urologic injuries are best managed using team approach. Suprapubic tubes are not required. | 3 |
| Effect of colon injury on the management of simultaneous renal trauma | Wessels, Hunter | Journal of Urology | 1996 | Retrospective review of 62 patients with simultaneous colon and renal injuries. | Renal trauma management was consistent with the grade of the injury. Renal exploration was performed in 58% of the cases, with nephrectomy performed in 16% explorations and only for severely injured kidneys. Urologic complications occurred in 16% of the cases but resulted in loss of only 1 kidney. | Renal injuries and reconstruction should not be treated differently in the face of colon injury including gross fecal contamination. | 3 |

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| Morbidity associated with nonoperative management of extraperitoneal bladder injuries | Kotkin, Leonid | Journal of Trauma. | 1995 | Retrospective review of 10 years, 70 patients with bladder rupture. Thirty-six (36) patients had extraperitoneal injuries caused by blunt trauma and formed the basis of the review. | Twenty-nine (29) patient were treated by catheter management alone. Seven (7) underwent primary bladder closure. Seventy-four (74) percent had spontaneous healing within 10 to 14 days and 26% developed complications. Three (3) patient had delayed healing with eventual healing at 21, 28 and 31 days post-injury. Two (2) patients developed vesicocutaneous fistula. One (1) underwent successful closure. One (1) required ileoconducit conversion. One (1) patient had persistent extravasation 67 days post-injury, underwent surgical closure after recurrent bouts of sepsis. One (1) patient died of an infected pelvic hematoma and sepsis. Main risk factor for complications is poor drainage of the catheter. Most of the patients in this series had 18 French catheters placed. | Patients who undergo surgical laparotomy for other reasons should have their bladder closed. Most patients treated nonoperatively will do well. However, complications do occur and can be significant. Major risk factor seems to be poor catheter drainage due to a small caliber catheter. | 3 |

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| The non-operative approach to major blunt renal trauma. | Matthews, LA | Seminars in Urology | 1005 | Retrospective review of 55 blunt trauma victims with major renal lacerations. Nine (9) patients had grade V, 31 had grade IV, and 15 had grade III lacerations. Nine (9) patients with hemodynamic instability underwent renal exploration. Seven (7) had grade V and 2 with grade IV injuries. The remaining 46 patients were stabilized and observed. | Thirty-one (31) patients treated by observation had extravasation on their initial CAT scan. Twenty-one (21) had major associated injuries and 7 were explored for non-renal injuries. Presence of a non-expanding retroperitoneal hematoma did not represent an indication for exploration. Four (4) patients with extravasation required stent placement. In all 4 patients the extravasation resolved. No patient required exploration. Mean length of hospitalization for patients with isolated injuries was 8.1 days. McAninch reported average hospital stay of 8 days for surgical. Thus the length of stay in this study were comparable. | Selective non-operative management of major renal lacerations associated with major blunt renal trauma successful in the majority of cases even when extravasation devitalized segments are present. Trauma victim who shows persistent hemodynamic instability despite appropriate resuscitative measures requires prompt surgical intervention and should not be observed. | 3 |
| Nephrectomy for traumatic renal injuries | Nash, Peter A. | Journal of Urology | 1995 | This is a retrospective review of 2521 patients who present to the authors with renal trauma. | Renal exploration was performed in 195 patients (202 renal units). Thirty-one (31) kidneys required exploration alone, 145 repair and 26 nephrectomy, yielding an overall nephrectomy rate of 13%. There was a 2.1% incidence of renal exploration in blunt trauma patients. A 41.6% rate of exploration in stab wounds and 73% rate of surgical exploration in gun shot wounds. All patients requiring nephrectomy had major renal injuries. | Conclusion, it is not the exploration that results in the nephrectomy but the extent of the injury itself. | 3 |

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| Ureteral injuries from penetrating trauma. | Brandes, Steven B. | Journal of Trauma | 1994 | A retrospective review of 12 patients who sustained ureteral injuries from penetrating injuries. | Eleven (11) of the 12 ureteral injuries were diagnosed during the course of surgical exploration. Nine (9) of these patients had high dose IVPs performed prior to the surgery. All were non-diagnostic. Hematuria was absent in 45 patients. Eleven (11) of the 12 injuries were diagnosed intraoperatively. In 1 patient the diagnosis was made 2 weeks post injury. All patients underwent primary ureteral repair. | High dose IVP and urinalysis are not reliable in detecting penetrating ureteral injuries. Surgical exploration remains the best way to diagnose traumatic ureteral injury. | 3 |
| Conservative treatment of type III renal trauma | Li-wei Cheng, David | Journal of Trauma-Injury Infection & Critical Care | 1994 | Retrospective review of 21 patients with suspected renal trauma. | Of those 71 patients, 18 proved to have type III renal injuries which was classified as major laceration with or without urinary extravasation. Of the 18 patients (9 blunt and 9 penetrating injuries) 13 had their injuries treated conservatively and 3 patients underwent immediate surgical repair. Two (2) died of other associated injuries. Two (2) of the conservatively treated patients and 1 who had initial repair required subsequent intervention. All 3 patients had penetrating abdominal trauma. Nephrectomy was not required in those 3 patients. | Thirteen (13) of 16 patients with major grade III renal trauma were successfully managed conservatively without the need for surgical intervention. The use of computer tomography to help stage the extent of the injury allows for more aggressive conservative approach and may save the patient unnecessary exploration or possible nephrectomy. | 3 |

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| Outcome after temporary vascular occlusion for the management of renal trauma | Carroll, Peter R. | Journal of Urology | 1994 | This is a retrospective review of 30 patients treated over a 17 year period who required temporary vascular occlusion. These 30 patients represented 17%. One hundred and eighty one (181) renal units that required renal exploration. | Five (5) of the 30 patients required nephrectomy. Twenty-five (25) patients underwent repair with an average warm ischemia time of 39.3 minutes. One (1) patient died. Seventeen (17) complications occurred in 12 patients. Only 2 of the complications were related to the renal injury. Both resolved spontaneously. | Temporary vascular occlusion can be performed safely and may improve the results of major renal trauma. | 3 |
| Management of blunt renal trauma. | Kristjansson A. | British Journal of Urology | 1993 | Retrospective review of 104 patients admitted with renal trauma, all resulting from blunt injury. | Results, 21 of 42 patients with grade II to IV injuries underwent immediate surgery. Please note that their staging system is not what we are currently using. The nephrectomy rate was 1 in 12 cases. Of the 21 patients who underwent surgery, 9 required nephrectomy. Of the 20 patients who were treated conservatively, 9 required surgery at a later date. Three (3) had expanding hematomas. Two (2) with persistent urinary extravasation. One (1) with non-viable renal parenchyma and 1 with persistent abdominal pain and fever. | 1) Computed tomography is more accurate than ultrasound and/or urography. 2) Patients with significant extra renal leakage on urography, angiography or CT scan should receive immediate surgical management. | 3 |

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| Major renal lacerations with a devitalized fragment following blunt abdominal trauma: a comparison between nonoperative (expectant) versus surgical management. | Husmann, DA | Journal of Urology | 1993 | Retrospective review of all blunt renal trauma resulting in a laceration through the renal cortical junction were reviewed. Three (3) selective criteria for inclusion in this study were (1) renal laceration through the cortical medullary junction. (2) kidney had to have a devitalized segment estimated to be between 25 and 50% of the involved organ diagnosed by arteriography or nuclear scanning. (3) patient had to be stabilized with a systolic bp greater than 90. Forty-three (43) cases were studied. | All patients had an IVP or CT scan with contrast. Twenty-seven (27) had co-existing peritoneal and renal injuries in which emergency laparotomy and repair of the non-urologic trauma were done. Fourteen (14) patients did not undergo renal exploration and 13 had renal exploration at the time of exploratory laparotomy. Infected urinomas and perinephric abscesses seeded for co-existing enteric or pancreatic injuries were the most common complication occurring in 57% of the 16 patients without associated intraperitoneal injuries, managed non-operatively. Thirty-eight percent (38%) had urologic morbidity. (Six of 16.) Four (4) patients have persistent urinoma. Three (3) required either stent drainage or percutaneous placement. Two (2) had delayed hemorrhage. One (1) required nephrectomy and was managed without intervention. One (1) patient developed hypertension which did not require exploration. | In the absence of intraperitoneal injuries, expectant management of a devascularized major renal fracture results in urological morbidity of 38% and an associated risk of nephrectomy of 6%. The author suggests that an absolute non-operative protocol for the management of a major renal laceration with a devascularized renal fragment is inappropriate and recommend that renal exploration and surgical management of this injury be considered manidatory when it co-exists with a pancreatic or colonic injury. In addition, the authors believe that surgical intervention should be considered preferable in trauma victims sustaining multi-organ injuries even in the absence of enteric or pancreatic trauma. | 3 |

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| Urological evaluation and management of renal-proximity stab wounds. | Eastham James | Journal of Urology | 1993 | Retrospective review of 244 consecutive patients with renal proximity stab wounds between the years of 1985 and 1990. Two-hundred and forty-one (241) patients underwent IVPs as the initial radiographic study. | This is an old study where CT scans were not being done and they recommended arteriography as the second line study of choice should IVP be abnormal or non-diagnostic. | They conclude that most renal injuries when accurately staged can safely be managed non-operatively. | 3 |
| Ureteropelvic junction disruption following blunt abdominal trauma | Boone, Timothy | Journal of Urology | 1993 | This is a retrospective review involving trauma patients that presented over a 10 year period. In 7 patients with ureteropelvic junction disruption were identified. Of the 7, 4 were diagnosed more than 36 hours after the traumatic insult. | Three (3) of the 4 missed injuries occurred in patients with hypovolemic shock, non-responsive to massive fluid resuscitation. No imaging studies were obtained in this group. All 3 patients underwent exploratory laparotomy. The kidneys were examined but were not explored and the injuries were missed. | Consideration for the diagnosis of ureteropelvic junction disruption should be based upon the historical finding of a rapid deceleration injury or fall from greater than 20 feet. Patients who present in shock and undergo abdominal exploration without direct visualization of the kidney should still undergo radiographic evaluation to rule out and avoid missing ureteropelvic junction disruption. | 3 |
| Combined penetrating rectal and genitourinary injuries: a challenge in management. | Franko, Edward R. | Journal of Trauma-Injury Infection & Critical Care | 1993 | This is a retrospective review of 17 patients with combined rectal and urologic injuries. | High incidence of complications unless the GI tract as well as the GU tract is well debrided, closed in layers and separated using well vascularized tissue such as omentum. Also recommended is both GI and GU urinary diversion. | Combined GU and GI injuries from penetrating trauma requires debridement of all necrotic tissue, urinary and fecal diversion, tension free closure with well vascularized tissue, adequate drainage and separation of the injured sites with well vascularized omentum to minimize the high incidence of complications. | 3 |
| Angiographic embolization of renal stab wounds. | Eastham, James A. | Journal of Urology | 1992 | This is a retrospective review of 16 patients with renal branch arterial injuries secondary to knife wounds. All who had undergone angiography and | Of the 16 patients, 14 had prompt hemostasis. Two (2) patients had persistent or increased bleed, both required partial nephrectomy. | Angiography with embolization provides safe and effective means of managing renal artery branch injury secondary to stab wounds. | 3 |

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| | | | | embolization of these injuries. | | | |
| Selective surgical management of renal stab wounds | Heyns, C.F. | British Journal of Urology | 1992 | This is a retrospective review of 95 patients between the years from 1984 and 1990. | There were 2 groups. Group 1 consisted of non-operative management and included 60 patients. Group 2, 35 patients were selected for primary surgical exploration. Mean periods of hospitalization was significantly shorter in group 1, 6.1 days than in group 2, 9.9 days. All patients were staged with IVP as CT scanning was not readily available. Complications occurred in 15 group 1 patients (25%) and 15 group 2 patients, the surgically repaired group (43%). Major complication of those being observed was secondary hemorrhage which occured in 10 of the 15. Six (6) underwent selective arterial embolization, 2 underwent nephrectomy and 1 underwent hemi-nephrectomy. Two (2) patients hematuria resolved spontaneously. | Observation is an alternative to surgical exploration of patients with renal stab wounds. | 3 |

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| Increasing role of angiography and segmental artery embolization in the management of renal stab wounds. | Heyns, C.F. | Journal of Urology | 1992 | Retrospective review of 93 patients with stab wounds. | Two groups, group 1, 79 patients treated at the authors institution. Group 2, 14 patients referred after complications occurred from an outside institution. Thirty-three (33%) of the group 1 patient or 26 individuals required surgical exploration due to severe blood loss or associated intra-abdominal injury. Seven (7) required nephrectomy. Non-operative management was selected in 53 patients of 67% in group 1. Hemorrhage occurred in 8 for 15% incidence. Patient who developed bleeding complications regardless of the group underwent renal arteriography and attempted segmental selective embolization of the segmental artery. This was successful in 9 of the 11 patient of 82%. | Renal angiography and selective embolization is an option in patients who develop hematuria with vascular injury following stab wounds. | 3 |

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| Intraoperative decision-making in renal trauma surgery. | Corriere, Joseph | Journal of Trauma-Injury Infection & Critical Care | 1991 | The authors attempt to define and answer 3 questions. 1) Should the kidney hematoma be explored. 2) Is pedicle control necessary. 3) What procedure should be performed. This is a retrospective review of 85 patients that underwent surgical exploratory between the years of 1979 to 1988. Penetrating and blunt injuries were included. | Of 85 explorations, 51 were secondary to gun shots, 15 stab, 19 blunt injuries. Fifteen (15) kidneys were explored secondary to penetrating injuries where the missle passed completely through the kidney and minimal repair was required leading the authors to suggest they could have been treated in a non-operative manner. Forty-six (46) of the entire 85 kidneys could have been treated in a non-operative manner. Thirty-three (33) of 85 patients had primary control of the renal pedicle. Only 6 of these cases was vascular occlusion actually performed to facilitate the surgery. Two (2) of these patients required majory injury repair and 4 required nephrectomy. | Renal parenchymal compression can accomplish the same control of renal hemorrhages as direct vascular control accept in cases of injury to the renal artery or renal vein. Unless the wound overlies the great vessel, perirenal hematomas can safely be entered laterally without prior pedicle control using manual pedicle or parenchymal control if needed. | 3 |
| Evaluation and treatment of blunt renal trauma | Herschorn, S. | Journal of Urology | 1991 | Retrospective analysis of 126 patients with blunt trauma, treated at a regional trauma center during a 13 year period. | One-hundred-fourteen (114) patients were treated conservatively. Nine (9) underwent renal exploration. All patients who had microscopic hematuria without shock had minor injuries. Computer tomography was normal in all cases when performed, more sensitive and specific than an IVP. | Majority of patients with renal trauma can be treated conservatively with excellent results. | 3 |

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| Renal reconstruction after injury | McAninch, Jack W. | Journal of Urology | 1991 | Retrospective 11 year review of 127 patients who underwent renal exploration (133 renal units). | Blunt trauma accounts for 87.5% of renal injuries but only 2.5% required surgery. Stab wounds 7.8% of the total with 45% requiring surgery. Gun shot wounds 4.7% of the total cases and 76.6% required surgery. Criteria for evaluation included gross or microscopic hematuria greater than 5 red cells per high power field, suggest a physical findings, positive findings on imaging studies and/or confirmation of imaging laparotomy. Indications for surgery included evidence of persistent bleeding, expanding peri-renal, retroperitoneal hematoma and pulsatile hematoma. Relative indications were urinary extravasation, non-viable renal tissue and incomplete staging of the renal injury. All explorations were performed via a transabdominal approach. Renal vessels were isolated before renal exploration. Clamping was only done to control heavy bleeding. Five (5) patients underwent renal reconstruction of the main renal artery for either thrombosis or evulsion, none of whom regained normal renal function. Reconstructive techniques included renorrhaphy 45.9%, partial nephrectomy 17.3%, vascular repairs in | Salvage was successful in 88.7% of the kidneys explored. Total nephretomy as required in 11.3%. The success rate was based on early vascular control and reconstructive techniques of renorrhaphy, partial nephrectomy, vascular repair and coverage with omental pedicle flaps. Complications occurred in 10% of the cases, none resulting in renal loss. When indicated renal exploration after trauma is safe and in a high percentage of cases, reconstruction will be successful. | 3 |

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| | | | | | 8%. Follow-up 11 patients died, 1 patient due to delay in diagnosis of a renal vein injury. All others unrelated to the surgery. | | |

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| Renovascular trauma: risk assessment, surgical management, and outcome | Carroll, Peter R. | Journal of Trauma-Injury Infection & Critical Care | 1990 | This is a retrospective review of 36 patients with 37 renovascular injuries treated over an 11 year period from 1977 to 1988 at San Francisco General Hospital. | Thirty-seven (37) renovascular injuries, main renal artery was injured in 9, the renal vein in 12, both main renal vein and renal artery in 6. Segmental renal vein or artery injuries were identified in an additional 10 patients. Twenty-three (23) patients sustained penetrating injuries and 13 blunt injuries. Twelve (12) were due to stab wounds and 11 to gun shot wounds. Gross hematuria was present in 16. Microscopic hematuria in 10. Seven (7) had no hematuria. Average transfusion requirements 7,500 cc. Only 4 patients had isolated renal injuries. Seven (7) patients died. Fifteen (15) patients sustained main renal artery injury with or without injury to the main renal vein. Six (6) underwent nephrectomy without attempted repair. Nine (9) underwent some type of arterial repair. Six (6) patients had either persistent thrombosis or preservation of only marginal function. Complete renal preservation was achieved in only 2 kidneys, 1 treated with end-to-end anastamosis and 1 with primary repair of an incomplete laceration. Nephrectomy was required in 3 of 12 main renal vein injuries but in none of 10 isolated segmental vessel | Patients with injuries to the main artery and vein tended to be more severely injured as assessed by transfusion requirement, iss in death and complication rates. Patient with segmental vascular injuries faired better as assessed by lower nephrectomy and death rates. Patient with renal vascular injuries represent a high risk group, usually due to the extent of associated injuries. Renal preservation is dependent on the extent of vascular injury and the time to diagnosis. Renal preservation is likely with incomplete laceration to the main renal vein or injury to segmental renal vessels. Restoration of normal function is unlikely with the main renal artery is injured. Reconstruction of renal artery injury should be attempted in all patients with single kidneys or bilateral renal injury. Repair of unilateral arterial injuries should be undertaken IF the injury is incomplete or recognized early in the presence of a non-ischemic kidney and a hemodynamically stable patient. | 3 |

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| Attempted nonoperative management of blunt renal lacerations extending through the corticomedullary junction: the short-term and long-term sequelae | Husmann, DA | Journal of Urology | 1990 | Retrospective review of 50 consecutive patients with renal laceration extending through the corticomedullary junction by blunt trauma. No patient had shattered kidney or major renal pedicle injury. All patients were managed in a non-operative manner. | All patients were staged with IVP and/or CT scans. Patients who could not be stabilized, systolic pressure less than 90, underwent exploratory laparotomy. Stabilized patients with a question of devitalized renal fragments underwent functional studies by either aortic angiography or renal scans to document the vascular status of the renal fragments. Nine (9) patients underwent immediate exploration due to vascular instability. All 9 required nephrectomy. Thirty (30) of 41 patients had vascularized fragments. One (1) died in post-operative period. Four (4) 13% sustained morbidity related to the urologic injury. All 4 had delayed hemorrhage ranging anywhere from 48 to 3 months after the injury. Two (2) patients required arteriographic embolization which as successful. Two (2) other patients required partial nephrectomy. Eleven (11) patients had a major laceration associated with the devascularized fragment. Nine (9) or 82% had moridity realted to the urologic injury. Four (4) with perinephric abscess. Three (3) had infected urinomas. Two (2) had delayed hemorrhage. All 9 underwent delayed | Non-operative management of a major renal laceration is associated with vascular fragments is a viable and proper method of treatment. However, an individual with a major renal laceration associated with a devitalized fragment heightened awareness of probable complications must exist. If the surgeon believes that these additional risks would adversely affect survival, we believe that immediate exploration and repair are indicated. | 3 |

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| | | | | | operation consisting of partial nephrectomy and appropriate drainage. Three (3) of the 4 patients with perinephric abscess had significant associated intra-abdominal trauma. Two (2) with pancreatic lacerations and 1 devialized portion of the decending colon. | | |

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| Penetrating renovascular trauma | Ivatury, Rao R. | Journal of Trauma-Injury Infection & Critical Care | 1989 | Retrospective review of 39 patients with 40 renovascular injuries. | Nine (9) of 39 patients, 23% died within 24 hours of the injury. None of the deaths were attributable solely to renovascular trauma. Three (3) patients died of sepsis in the post-operative period. Overall mortality 30%. Of the 30 patients who lived more than 24 hours, 10 had nephretomy for hilar injuries (33%). Only 20 of the patients of 51.3% of the total had a kidney that was potentially salvagible. None (9) of these 20 had nephrectomy because of hemodynamic instability. None (9) patients with a successful renalvascular ligation or repair had funtioning kidneys based on clinical course, renal scans or follow-up IVP. Renal salvage was achieved in 9 of 45% of the 20 patients. | Save a kidney with renovascular injury is determined by the nature and extent of associated trauma. Renal artery injuries are rarely reparable and attempts at repair often are futile. Renal vein injuries have a better prognosis. Nephrectomy should remain treatment of choice in unstable patients with multi-system trauma. | 3 |

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| Ureteral and renal pelvic injuries from external trauma: diagnosis and management. | Presti, Joseph C. | Journal of Trauma-Injury Infection & Critical Care | 1981 | Retrospective review of 18 patients with ureteral and/or renal pelvic injuries. | Seventeen (17) patients with unilateral injuries, 1 bilateral for a total of 19. Ten (10) or 52% from gun shot wound, 6 or 32% from stab wounds, and 3, 16% from blunt trauma, including 1 bilateral injury. Sixteen (16) patients had urinalysis at admission. Gross hematuria in 8 for 50%. Microscopic hematuria in 3, 19%. No hematuria in 5, 31%. IVPs in 11 cases, 4 studies were normal, 4 studies, non-diagnostic. Only 1 patient had an abdominal CT which showed bilateral extravasation. Diagnosis of made at the time of injury in 16 or 88%. Twelve (12) were diagnosed intraoperatively by direct inspection in 9 and inspection assisted by indigo carmine in 3. | Both intravenous urography and initial urinalysis may be unreliable indicators of ureteral and renal pelvic injury. Thus thorough exploration of the collecting system is indicated. Reconstruction is usually possible. Stents are helpful in diverting the urine. | 3 |

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| Management of extraperitoneal ruptures of bladder caused by external trauma | Cass, A.S. | Urology | 1989 | Retrospective review of 99 patients 1959 to 1985 with extraperitoneal bladder rupture. Twelve (12) had intraperitoneal component as well. Six (6) patients died before treatment. Eighty-three (83) had their diagnosis made by cystogram, 16 by laparotomy. | Sixty-five (65) had primary bladder repair and catheter drainage while 34 had catheter drainage only. Three (3) patients had complications treated by primary suturing. Four (4) patients treated by catheter drainage alone had complications. Long-term complications, 6 in the primary suturing group had complications, 4 related to associated injuries. Two (2) patients had long-term complications related to the bladder injury. One (1) uretheral stricture and frequency and dysuria in 1. There were 5 long-term complications out of 14 patients treated by catheter drainage only. Two related to other injuries, 3 related to bladder injury and its management. One (1) hyper-reflexia and 2 uretheral stricture and bladder calculus in 1. There was no statically significant difference between the complications related to the bladder injury and its management in the 2 groups. | Catheter drainage alone for extraperitoneal rupture from external trauma was simple, quick to perform and appealing in a multi-injured patient. Although the early and late complication rates is higher in the conservatively managed group, there was no statistically significant difference from the group treated by primary suturing. | 3 |
| Blunt urethral injury: results of initial management | Malangoni MA | American Surgeon | | Retrospective review of 14 men with blunt urethral disruption. All patients had a suprapubic cystostomy for management of the urethral injury. | Thirteen of 14 patients survived (93%). The major complication was perineal sepsis. | Aggressive and appropriate management of hemorrhage, pelvic fracture and concomitant injuries is important to minimize mortality. | 3 |

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| Mechanisms of injury, patterns of extravasation and management of extraperitoneal bladder rupture due to blunt trauma. | Corriere JN Jr | Journal of Urology | | Retrospective review of 100 cases of bladder rupture, 62 extraperitoneal. | The 41 patients who were treated with catheter drainage alone did well. NEED MORE INFO FROM ABSTRACT. | Patients with extraperitoneal bladder rupture can be treated with catheter drainage alone. | 3 |
| Emergency management of lower urinary tract injuries | Monstrey SJ | Netherlands Journal of Surgery | | Retrospective review of 4ourteen cases of bladder rupture and 16 cases of urethral laceration. | NO INFO IN ABSTRACT | NO INFO IN ABSTRACT | 3 |
| Urological trauma and severe associated injuries | Monstrey SJ | British Journal of Urology | | Retrospective review of 212 cases of urinary tract injury in multiply-injured patients compared to 441 cases of isolated urinary tract injury during the same period. | NO INFO IN ABSTRACT | NO INFO IN ABSTRACT | 3 |
| Features of 164 bladder ruptures | Cass AS | Journal of Urology | | Retrospective review of 164 cases of bladder rupture. Of these patients 145 (88 per cent) suffered blunt trauma, and 59 (35.5 per cent) suffered intraperitoneal, 93 (57.5 per cent) extraperitoneal and 12 (7 per cent) both types of rupture. | Although surgical repair has been the traditional method of management of all bladder ruptures, nonoperative (catheter) management of extraperitoneal rupture was successful in most cases. PULL THIS ARTICLE | Although surgical repair has been the traditional method of management of all bladder ruptures, nonoperative (catheter) management of extraperitoneal rupture was successful in most cases. | 3 |

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| Renal failure and mortality after nephrectomy for severe trauma in multiply-injured patient: no inordinate risk | Cass AS | Urology | | Retrospective review of 88 patients with multiple injuries and severe renal injuries (laceration, rupture) or pedicale injury. Partial or total nephrectomy had been performed in 50 patients, renorrhaphy in 23, and 15 were managed without renal operation. | In patients with renal lacerations, the numbers of associated injuries (including intra-abdominal injuries) were similar to those managed conservatively or by operation, and the rates of acute renal failure and mortality were the same with conservative management, renorrhaphy, or nephrectomy. Patients with renal pedicle injuries who had a nephrectomy did have a higher rate of acute renal failure than those managed conservatively (75% vs 0%; p less than 0.05), but they also had more associated injuries (2.8 vs. 1.6/patient; p less than 0.04) and they were older. | Outcome is related to age and associated injuries, rather than the form of management (nonoperative, renorrhaphy, or nephrectomy) of the renal injury in multiply-injured patients. | 3 |
| Renal trauma in rural Virginia | Yarbro ES | J. Trauma | | Retrospective review of 148 blunt renal injuries & 7 penetrating injuries. | Nine of the patients with nonpenetrating injuries (6%) had major renal parenchymal injuries and were observed. None required operation and followup in eight of nine suggested no renal functional impairment. Six patients with penetrating injuries underwent exploration and four required nephrectomy for major renal parenchymal or renal pedicle injuries. | A conservative approach to nonpenetrating minor and major renal parenchymal injuries may be successful. | 3 |
| Conservative management of renal lacerations in blunt trauma | Roberts RA | Canadian Journal of Surgery | | Retrospective analysis of 133 cases of blunt renal trauma, including 26 cases of renal | PULL ARTICLE FOR RESULTS | Our experience confirms a low rate of both nephrectomy and secondary complications using conservative management. | 3 |

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| | | | | laceration. | | | |
| Diagnostic and treatment problems in renal injuries | Wilson RF | American Surgeon | | Retrospective review of 112 patients with 116 renal injuries; 83 injuries due to GSW, 18 due to SW, 11 due to blunt trauma. | The incidence of shock was 38 per cent in patients with injuries not requiring renal explorations, 69 per cent in patients with renal parenchymal injuries requiring surgery, and 93 per cent in patients with pedicle injuries requiring repair or nephrectomy. Of 65 stable renal injuries treated conservatively (without exploration of the renal parenchyma), there were nine (14%) complications including three reoperation for missed injuries and three perinephric abscesses. In 46 injuries that were explored (38 for bleeding and eight without bleeding), there were only two complications (5%), including a perinephric abscess. | Although it is generally believed that traumatic perirenal hematomas should not be explored, there was an increased incidence of complications with this approach in this series. | 3 |
| Blunt renal injury--an experience of 30 cases | Singh PB | Injury | | Retrospective review of 30 cases of blunt renal injury. | PULL ARTICLE FOR RESULTS. | All minor injuries can be managed without operation. For major injuries, a conservative approach, if necessary followed by surgical exploration, avoids loss of organ in most of the cases. | 3 |

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| Management of the ruptured bladder: seven years of experience with 111 cases. | Corriere JN Jr | J Trauma | | Retrospective review of 111 patients with bladder rupture, 95 blunt and 16 penetrating. | All 16 patients with penetrating injuries, as well as an additional 34 patients with intraperitoneal injuries, nine patients with extraperitoneal injuries, and five with both intra- and extraperitoneal injuries from blunt trauma, had formal closure of the wound and urethral or suprapubic catheter drainage. All did well. A total of 39 patients with extraperitoneal bladder injuries were treated with only catheter drainage and all did well. Eight patients died before institution of therapy. | Patients with blunt, extraperitoneal bladder injuries may be treated with only catheter drainage. | 3 |
| Diagnosis and treatment of posterior urethral injury | Fowler JW | British Journal of Urology | 1986 | Retrospective review of 28 patients with posterior urethral trauma | PULL ARTICLE FOR RESULTS | | 3 |

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| Renal vascular injuries | Meacham PW | American Surgeon | | Retrospective review of 15 patients with renovascular trauma, 9 penetrating and 6 blunt. | Time from admission to time of operation averaged 6.4 hr for patients with blunt trauma and 1.25 hr for patients with penetrating trauma.Associated nonvascular abdominal injuries were found in all 15 patients. Efforts were made to repair renal vascular injuries with suture or grafting of the injured vessel in eight cases (53%). These efforts were successful in four patients, but in four the repair failed and a nephrectomy could not be avoided. Two patients died in the operating room or immediately postop in spite of successful repair of their renovascular injury. One injured left renal vein was ligated and nephrectomy was not necessary. In five patients, ligation of the injured renal artery and nephrectomy were necessary. There were five deaths (33%). Three of the deaths occurred in the operating room and two were postoperative deaths. Only one of the patients who died had a renal vessel injury without other major vessels involved. He did, however, have serious liver and kidney injuries. Multiple associated vascular, nonvascular, and head injuries were present in all four of the other deaths. | | 3 |

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| Pathogenesis and management of ureteric injuries | Grizic AM | South African Medical Journal | | Retrospective review of 72 ureter injuries | PULL ARTICLE FOR RESULTS | | 3 |
| Management of perirenal hematoma found during laparotomy in patient with multiple injuries | Cass AS | Urology | 1985 | Retrospective review of 158 patients with perirenal hematoma found during laparotomy for intra-abdominal injury from external trauma. | Small perirenal hematomas were usually associated with renal contusions and renal artery thrombosis, while large perirenal hematomas often were present with large renal lacerations, renal ruptures, and renal pedicle injuries with rupture of the renal vein, renal artery, polar artery, or branch of the renal artery. PULL ARTICLE FOR SPECIFIC RESULTS. | The management of the perirenal hematoma found during laparotomy depends on the degree of the underlying renal injury and not on the size or extent of the perirenal hematoma. | 3 |
| Segmental urethrectomy and urethrorrhaphy for treatment of fresh and late traumatic urethral | Chatelain C | European Urology | | Retrospective review of 41 cases of urethral injuries treated with segmental urethrectomy and end-to-end urethrorrhaphy. | Two thirds of the patients had a correct and stable urethral stream, complete bladder emptying, and normal urinary control and sexual function. | Primary segmental urethrectomy with end-to-end urethrorrhaphy is an appropriate treatment for patients with urethral trauma. | 3 |
| Surgical technique and results of primary repair in recent urethral injuries: a review of 49 consecutive cases | Janosz F. | European Urology | | Retrospective review of late results after primary repair of 40 urethral injuries treated by sutures of realignment with splinting, suprapubic and perineal drainage. | In 15 straddle injuries the results were excellent. Of 34 injuries associated with pelvic fracture, 50% had satisfactory results. 12% had marked, but tolerable difficulties in micturition. | A preference for primary repair in comparison with early cystostomy and delayed reconstruction of the urethra is confirmed. | 3 |
| Renal trauma. When to operate | Peterson NE | Urology | 1974 | Retrospective review of 144 cases | Try to be conservative is usually successful. 37% blunt injuries needed operation and 45% of penetrating | A conservative initial approach is often successful in hemodynamically stable patients, although 37% blunt injuries needed operation and 45% of penetrating injuries in this series | 3 |

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| Long-term results of bladder flap repair of ureteral injuries | Thompson IM | Journal of Urology | 1974 | This is a review of 25 patients with ureteral injuries with up to 14 years of long term followup | The bladder flap repair technique is associated with long term reflux but no infection or long term renal injury | The bladder flap repair technique is associated with long term reflux but no infection or long term renal injury | 3 |
| Urological management and complications of fractured pelvis and ruptured urethra | Gibson GR | Journal of Urology | 1974 | Retrospective review of 66 cases. | These are "life long tragedies" if not managed properly and followed closely | Need proper early diagnosis and long term management | 3 |
| The management of renal injuries coincident with penetrating wounds of the abdomen | Tynberg PL | Journal of Trauma | 1973 | Retrospective review of 60 cases of penetrating renal injuries | General review of diagnosis and management | A high rate of suspicionis required to make an early diagnosis, and diagnosis often subtle, especially in the face of renovascular trauma. | 3 |
| Comparison of the conservative and surgical management of the more severe degrees of renal trauma in multiple injured patients | Cass AS | Journal of Urology | 1973 | review of 172 patients with renal injury to examine conservative versus surgical management | surgical treatment was associated with 3 times the renal loss, but less morbidity and need for late operation (required in 37% of conservative management cases). Initial vascular control reduced nephrectomy rate to same as conservative group. | Initial vascular control reduces nephrectomy rate to same as conservative group. | 3 |
| Management of bladder and urethral injury in conjunction with the immediate surgical treatment of the acute severe trauma patient | Villar RG del | Journal of Urology | 1972 | Review of 74 patients with GU trauma associated with other intraabdominal injuries | Look for these injuries in multiple trauma with simple films (IVP & RCG) and repair if possible at first operation | Immediate treatment gives best outcome | 3 |
| Ureteral gunshot wounds | Fisher S | Journal of Urology | 1972 | review of 9 patientw with ureteral GSW | Often explored for other reasons prior to evaluation of GU system, so look for ureteral injuries in OR | Best time to repair is at first exploration, so be suspicious, look for them--easy to miss them otherwise | 3 |

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| Renal artery occlusion secondary to blunt abdominal trauma | Sullivan MJ | Journal of Trauma | 1972 | Retrospective review of 6 cases blunt renal artery occlusion diagnosis and management. | Outcome depends on very early diagnosis. Problem more common than generally appreciated. May be a longer period of potential renal salvage than previously thought in some patients even with thrombosis of main renal artery. | Outcome depends on very early diagnosis. Problem more common than generally appreciated. May have no hematuria. | 3 |
| Management of renal injuries in the severely injured patient. | Cass AS | Journal of Trauma | 1972 | 100 cases of combined GU and other trauma reviewed and lessons extracted | GU injuries should be evaluated in OR by exam and IVP/RUG and repaired immediately if possible. Early control of vessels will help with renal salvage | Suspected GU injuries should be evaluated in OR by exam and IVP/RUG and repaired immediately if possible. Early control of vessels will help with renal salvage | 3 |
| The initial management of ureteral injuries: a report of 78 cases | Carlton CE | Journal of Urology | 1971 | 78 cases of ureteral trauma reviewed | Spatulate anastomosis--stent not necessary. If watertight anastomosis done initially, post op morbidity almost zero. | Be very suspicious to pick up early. Spatulated anastomosis best. Stents not helpful if anastomosis done well. Key is excellent watertight initial anastomosis. | 3 |
| Renal trauma | Morrow JW | Journal of Urology | 1970 | Retrospective review of 48 cases of renal trauma studied by IVP and angio (some also had renal scans) | 87% correlation between IVP and angiogram confirms utility of IVP. Other studies (only a few were done) did not correlate as well. Injury grade (roughly defined) correlated with renal salvage rate. | IVP a good study to define injury and outcome depends on injury grade | 3 |
| Solid organ injuries in Vietnam. Emergency hemostasis with N-butyl cyanoacrylate adhesive | Heisterkamp CA | Archives of Surgery | 1973 | 23 cases reviewed | Case series demonstrating the use of CN glue spray in diffuse bleeding from solid organs (including kikney) in combat setting (Viet Nam) | CN glue following compression hemostasis can be used effectively to control solid organ diffuse bleeding | 3 |

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| Spontaneous closure of traumatic renal arteriovenous fistulas | Halpern M | Am J Roentgenology, Radium Therapy & Nuclear Medicine | 1969 | This is a series of 5 consecutive patients with traumatic AV fistulas. | Three were the result of gunshot wounds, two were the result of blunt injury. All had repeat angiography within one year of injury showing spontaneous closure of the AV fistula with minimal loss of parenchyma. | This is an early report on the natural history of traumatically induced AV fistulas. All closed spontaneously. | 3 |
| Injuries of the ureter due to external violence. | Walker JA | Journal of Urology | 1969 | Retrospective review of 27 patients with ureteral injuries over an 8 year period. | There were 24 of 770 patients who sustained injuries of the ureter for an incidence of 3.1% of gunshot wounds to the abdomen. Blunt trauma accounted for 3 additional ureteral injuries. Location: upper third 10, middle third 12, distal third 5. 19 of 24 injuries were diagnosed prior to or during the original operation. The remaining 5 were diagnosed between 3 and 39 days after injury. Only one patient died because of the urinary tract injury. | Preoperative IVP aided greatly in the diagnosis of 87% of the injuries in this series. Site of the injury is usually in the middle or upper ureter in gunshot wounds and at the UP junction in blunt trauma. | 3 |
| Diagnosis and early management of renal trauma: a study of 120 patients | Kazmin MH | Journal of Urology | 1969 | Retrospective study of 120 patients. Diagnostic studies included IVP, retrograde pyelogram, renal scan and aortogram. | There were 120 patients included in this series. Injuries were classified as either contusions (N-71) or lacerations (N=49) | IVP performed with 60-150 cc's of contrast was superior imaging study for early diagnosis. The coupling of IVP with renal scan was highly effective in distinguishing between renal contusions and lacerations. | 3 |

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| Vietnam experience with 252 urological war injuries | Salvatierra O, Jr. | Journal of Urology | 1969 | Retrospective review of medical records | There were 214 injured patients. Preoperative IVP was valuable for diagnostic examination and to establish the presence and function of the contralateral kidney. There were 79 renal injuries. All were managed transperitoneally. 35 required nephrectomy. There were 9 ureteral injuries, 37 bladder injuries, 8 prostate injuries, 14 urethral injuries, 41 penile injuries, 64 scrotal injuries | Primary closure of extensive urethral injuries is unsatisfactory. A two-staged repair is suggested. | 3 |
| Trauma to the genitourinary tract: a 5-year experience with 251 cases | Waterhouse K | Journal of Urology | 1969 | Review of one institution's experience with 250 patients sustaining injuries to the genital urinary tract (2.5%) | Injuries were classified as contusion (N=77, 82.8%); lacerations (N=12, 12.9%); shattered kidney (N=4, 4.3%). The only diagnostic study utilized with IVP. There were no ureteral injuries. There were 38 bladder injuries (N=28, 74%), Blunt - all patients had good outcomes with conservative management. Operative management was limited to hemodynamically unstable patients with renal injury and intraperitoneal bladder rupture. | Outcome was good with described management except in patients with rupture of the urethra at the apex of the prostate which had a high degree of stricture. | 3 |

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| Penetrating injuries of the kidney: an analysis of 181 patients | Scott R, Jr. | Journal of Urology | 1969 | This is a retrospective review of 2,525 penetrating wounds to the abdomen from 1955 through 1967. There were 181 (7%) renal injuries. Of the 181 patients, only 139 had complete medical charts for review. The wounds were classified as minor parenchymal, major parenchymal or renal pedicle. | 41 patients (29%) did not have hematuria. NIVP was obtained and 121 patients (67%). There were 54 minor parenchymal injuries. 12 (22%) were stab wounds. There were 56 major renal wounds. 16 of 19 stab wounds underwent primary repair. One required nephrectomy. 37 major wounds were the result of a gunshot. 11 (30%) required nephrectomy. 13 wounds (35%) were managed with primary repair of the renal wound. The vascular pedal was injured in 29 patients. Both vessels were involved in 10 patients in which 9 required nephrectomy. There were 13 cases of renal vein laceration and 6 cases of renal artery injury in which 5 were successfully repaired. The suggestive plan of management is: Delineation of location and extent of injury N=2. Renal vascular pedicle control N=3. Debridement of parenchymal wound N=4. Meticulous hemastasis N=5. Primary approximation of wound margins N=6. Extra-peritoneal drainage of the renal fossa. | The absence of hematureia cannot be relied upon to rule out the presence of renal trauma inasmuch as 23 percent of renal injuries. | 3 |

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| Management of shotgun injuries to the pelvis and lower genitourinary system | Tiguert R | Urology | 2000 | Retrospective chart review and telephone interview to assess organs injured, initial treatment, follow-up, surgeries, mortality, and erectile function. | There were 10 patients who sustained shotgun blasts with a mean age of 20. Mean follow-up was 4 years (range 1-7 years). There were 2 deaths - 1 in the O.R. and 1 one week later from sepsis. 5 patients sustained a bladder injury. 2 of the bladder injuries were concomitant with complete posterior urethral transection. Initial management consisted of repairing the non-GU injuries in 8 cases (80%). These injuries most commonly involved the rectum and small bowel. 4 patients required a suprapubic cystostomy. There were 4 urethral injuries. 2 were treated with delayed urethroplasties and 3 required permanent supravesical diversion. 306 patients reported erectile dysfunction during a telephone interview. | Shotgun wounds to the lower GU tract are associated with significant soft tissue injury and morbidity. Hemodynamically stable should be evaluated with retrograde urethrograms and cystograms. Primary repair should be attempted for distal, urethral, testicular, and corporal injuries. Delayed repair with staged reconstruction should be reserved for extensive loss of wounds involving extensive loss of urethral tissue. These extensive perineal wounds are associated with a high incidence of impotence. | 3 |
| Therapeutic urogenital modalities during the last three years of the Iran and Iraq War (1985-1987) | Heidarpour A | Military Medicine | 1999 | Purpose of the study was to assess the incidence of different surgical modes and intervention for urogenital injuries of the Iranian front during the last 3 years of the war. Cross-sectional descriptive analytical study of urogenital injuries which occurred on the Iranian front from March 21, 1985 to March 21, 1987. | there were a total of 1,094 patients during the study period. There were 541 operations completed (49.5%). The most common was bladder repair (N=117, 12%). There were 50 nephrectomies performed (9%). Partial nephrectomy was required in 111 patients (20%). Ureteral was required in 29 cases (5.2%). | The results suggest progress in the triage of patients with urogenital injuries. A low incidence of these injuries should be interpreted cautiously because it may be attributed to different combat field conditions. | 3 |

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| Ureteric injuries: diagnosis, management, and outcome | Ghali AM | J Trauma | 1999 | Retrospective analysis of 35 patients who sustained 40 ureteric injuries from 1991-1996 | . 28 patients with 32 iatrogenic injuries and 7 patients with 8 injuries associated with external trauma. Gynecologic procedures caused 63% of iatrogenic injuries and MVCs caused 75% of external injuries. Successful diagnostic rate was 33% for intraoperative direct inspection and intravenous urogram vs. 100% for retrograde and antegrade pyelogram. Indications for radiologic investigation within 24hrs postop included anuria, urinary leakage from wound, and frank hematuria. Late indications for radiologic investigation (3-120 days-avg. 22 days) included ureterogenital fistula, persistent pain, fever, advanced hydronephrosis. Treatment primary open repair in 26 cases, staged procedure in 7 cases, endoscopic stenting in 5. 36 cases were F/U with complications in 25% with surgical correction of 78%of these cases. Nephrectomy resulted in 8%, adverse factors associated with </= 12yrs, prox. ureter injury, delayed recognition, presence of urinoma, associated organ or vascular injury. | Iatrogenic trauma is the leading cause of ureteric injuries. Wound inspection and IVP are not reliable for early and accurate diagnosis of iatrogenic or traumatic injury. Retrograde pyelogram is recommended as soon as logistically possible in suspected injuries from external trauma. "Useful clues" for injury are hematuria with a normal urinary tract on other imaging modalities, the direction of the wound in penetrating trauma, and the mechanism of blunt injury (hyperextension of the spine). Stenting the ureter with a double-pigtail across any anastomosis ensures adequate and immediate drainage and "seems" to reduce complications associated with urinary leakage. Adverse factors affecting outcome are young age, injury to upper ureter, associated injuries with external trauma. | 3 |
| Renal Salvage in Penetrating Kidney Injuries: A Prospective | Nicol, AJ | The Journal of Trauma | 2002 | The purpose of the study was to Assess the efficacy of renal salvage in patients | 50 patients with penetrating renal injuries over 2 years(1997-1999). Gunshot | The overall renal salvage rate for penetrating renal trauma in this study was | 2 |

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| Analysis | | Injury, Infection, and Critical Care | | who underwent routine exploration of the injured kidney and document complicationsawo year prospective study with emergency laparotomy performed on patients with persistent hemodynamic instability, acute abdomen, and denervated abdomens with penetrating abdominal injuries. IVP was performed in stable patients with macroscopic hematuria and 3+ blood(250 RBCs/uL) on dipstick. Study included a control abdominal radiograph and then 100 mL of nonionic water-soluble iodinated contrast medium injected. Radiographs performed at 5 and 10 minutes, delayed films "as needed". IVPs performed in the resuscitation room. "Single shot" IVP performed in the operating room before nephrectomy in hemodynamically unstable patients. All retroperitoneal bullet tracts were explored | in 86% and stab wound in 14%. 74% had macroscopic hematuria on presentation, 18% with microscopic hematuria, and 8% without hematuria on urinalysis. Four patients with no hematuria were found at lap. to have two grade 1, three grade 3, and one grade 4 kidney injuries. Preop. IVP was performed in 27 cases with an injury detection rate of 78%. The remaining six (22%) normal studies included one grade 2, three grade 3, and two grade 4 injuries. At lap., 13 patients (26.5%) were found not to be bleeding and were tx. with simple drainage, 16 patients (35%) were managed by renal suture over pledgets, 6 partial nephrectomies(12%), 13 patients (26.5%) required a nephrectomy. Renal salvage rate for all was 73.5%. | 73.5%. This includes injuries tx. with drainage, renal repair, and partial nephrectomy. Routine exploration of the injured kidney in this study did not appear to increase the nephrectomy rate. | |

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| Endovascular management of blunt traumatic renal artery dissection | Lee JT | J Endovasc Ther | 2002 | Purpose of study was to describe the importance of accurate diagnosis and successful emergent endovascular repair of intimal injury to the renal artery from sudden deceleration. Case report of a 22 y.o.male who jumped from a fourth floor window with resulting skull/facial fractures as well as gross hematuria upon placement of a Foley catheter and a serum creatinine of 2.0mg/dL. CT of the abdomen (did not specify single/double/triple contrast) depicted decreased enhancement and delayed excretion in one kidney as well as a fracture. Angiogram with selective renal artery catheterization demonstrated 2 intimal injuries @ 0.5 and 3.0 cm from the orifice. Two 5mm X 2cm Palmaz Stents were placed successfully with no residual defects seen on angiogram (performed within 4 hours of admission). No postop. anticoagulation was used. | Patient had an uneventful postop course and underwent a followup renal scan after discharge (time not specified) with 42% of total renal function in the affected kidney perserved and had a normal serum creatinine. | Supports the use of renovascular therapy for traumatic renal artery dissection in patients with multiple concomitant acute injuries. | 3 |

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| Blunt renal trauma: minimally invasive management with microcatheter embolization experience in nine patients | Dinkel HP | Radiology | 2002 | Purpose of study was to evaluate superselective embolization therapy for the management of arterial damage in patients with severe renal trauma. Nine consecutive patients with renovascular injuries after blunt trauma underwent superselective embolization. Substantial hematuria following flank trauma was the leading symptom in all patients; all had renal blood loss requiring transfusion. Six patients had pseudoaneurysms or traumatic arteriovenous fistulas and were tx. secondarily after a delay ranging from 5 days to 3 years from the date of initial trauma. Three patients had frank, uncontained extravasation (two shattered kidneys, one complete pedicle avulsion) and were treated immediately after admission. Two of the latter patients were hemodynamically unstable. All patients underwent embolization with particles or microcoils. | Procedural and medical success and complications (postembolization syndrome, abscess, permanent serum creatinine elevation, hypertension) were retrospectively assessed from the patients' records. Medical success was defined by the disappearance of gross hematuria 3 days after embolization, absence of recurrent hematuria, absence of recurrent need for RBC transfusion, absence of recurrent decrease of Hgb by more than 1.5g/dL, and or need for repeat angiographic tx. or surgery. | Superselective embolization may be used for effective, minimally invasive control of active renovascular bleeding. | 2 |

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| Factors Affecting Management and Outcome in Blunt Renal Injury | Kuo, RL | World J. Surg | 2002 | Purpose of study was to define factors predictive of mortality and need for nephrectomy in patients with blunt renal trauma. Study involved a retrospective review of 11,847 trauma patients. | Of 11,847 trauma patients, 0.80% (95) had blunt renal trauma (avg. ISS 23.7) evaluated with CT, IVP, or operation. 46 patient received RBCs (avg 3.3 units) in 1st 24 hrs., incidence of gross or microscopic hematuria did not correlate with injury grade. 9 nephrectomies, 1 partial nephrectomy. Of the 85 patients without nephrectomy, 76 had no operation and of the remaining 9 all had invasive renal procedures latter requiring 1 nephrectomy and 1 ureteral stent. | Blunt renal trauma patients who require nephrectomy often present with high grades of renal injury, higher transfusion requirements, and a higher ISS. | 3 |
| Diagnosis and Treatment of Renal Trauma in 298 Patients | Qin, R | Chinese J. of Traumatology | 2002 | Retrospective analysis of 298 patients with renal trauma, 91.3% blunt, 8.7% penetrating. All patients had hematuria, 47.3% gross, 18.8% shock, 82.9% flank pain, 30.5% peritoneal irritation. 39 patients received "normal dose IVU, 44 "double dose IVU, 109 had US, and 45 patients underwent CT. | "Normal dose IVU" had poor visualization in 51.3%, "double dose IVU" presented "excellent imaging", US indicated renal trauma in 78.9%, abominocentesis had 85.3% positive results……..these are the results and terminology stated. | Hematuria is a useful indicator of renal trauma degree, but 40% of renal trauma cases do not have hematuria. The presence of shock should suggest multiple organ injury including renal. The diagnostic rates for renal trauma by normal dose and double dose IVU are 48.7 and 90.9% respectively. US has a high diagnosis value for renal trauma and the CT diagnostic rate is 97.8% | 3 |

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| Severe Blunt Renal Trauma: a 7-Year Retrospective Review From a Provincial Trauma Centre | Baverstock, R. | The Canadian J. of Urology | 2001 | BC Trauma Registry restrospective review identifying 227 renal injuries | Of 227, 93.4% had blunt and 6.6% penetrating renal trauma. 18.3% Blunt renal trauma patients were grade III, IV, V. Of these 80% had gross hematuria and 80% associated injuries. Management was conservative in 87.5% of grade III and 77.7% of grade IV. 90.9% of grade V went immediately to the OR (mean ISS 34.2). | Blunt renal trauma managed conservatively is associated with few complications in the hemodynamically stable patient. Grade V injuries still result in a nephrectomy rate of 90.0% with hemodynamic instability the indication in 100% of patients. | 3 |
| Management of Major blunt Renal Lacerations: Is a Nonoperative Approach Indicated? | Moudouni, SM | European Urology | 2001 | 64 patients with blunt renal lacerations were reviewed over an 11 yr. period. All patients were initially managed by fluid resuscitation and CT staging. Initial management was conservative: group 1 (35) delayed hemorrhage, persistent urinoma, or hemodynamic instability were tx. with open surgery; group 2 (29) most complications were tx. endoscopically. Open surgery was reserved exclusively for major complications. | Mean ISS 21.5 Group 1: 7 patients were managed conservatively, 28 surgically. 20 patients underwent nephrectomy, 8 open drainage of perinephric collection &/or renorrhaphies. Four patients in this group developed fistulae and were tx. with ureteral stents. Group 2: persistent hemodynamic instability led to nephrectomy in 1 case and 28 patients were managed conservatively with 5 cases requiring ureteral stenting | For most patients and with close follow-up available, conservative tx. Represents a real alternative to open surgery in major blunt renal lacerations. Open surgery usually results in loss of renal parenchyma. | 3 |

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| The Role of Nephrectomy in the Acutely Injured | DiGiacomo, JC | Arch Surg | 2001 | Retrospective review of 78 patients with renal injuries identified by using the International Classification of Diseases, Ninth Revision codes. Based on outcomes, the patients were assigned to either the survivor or non survivor group. For patients who underwent nephrectomy, intraoperative core temp. changes, estimated blood loss, and operative time were also reviewed. | 78 patients with renal injuries who underwent exploratory laparotomy were identified. 29 patients underwent laparotomy with conservative management of renal injuries of whom 5 (17.2%) died. Compared with nephrectomy survivors, nephrectomy nonsurvivors had a lower initial SBP, higher ISS, higher incidence of extra-abdominal injuries, shorter operative time, higher estimated operative blood loss. Nephrectomy survivors' core temp. increased a mean of 0.5 C in the OR, nonsurvivors cooled a mean of 0.8 C. | Trauma nephrectomies tend to occur in the severely injured and hemodynamically unstable and occur as part of damage control. The high percentage of patients that die after nephrectomy represents an overall constellation of severe injury and not a consequence of nephrectomy. | 3 |

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| Nonoperative Management of Solid Abdominal Organ Injuries from Blunt Trauma: Impact of Neurological Impairment | Shapiro, MB | American Surgeon | 2001 | The purpose of the study was to define the role of nonoperative management of solid abdominal organ injury from blunt trauma in neurologically impaired patients. 2327 patients with injuries to the kidney, liver, or spleen (AIS >=2)(>12 yrs.of age)(diagnosed by CT) from blunt trauma were identified from the Pennsylvania Trauma Systems Foundation Registry by retrospective data collection. Patients were stratified into 3 groups: GCS (15), (8-14), (<=7). | Of the 2327 patients, 1561 were managed nonoperatively (66 per cent). The nonoperative approach was initiated less frequently in those patients with greater impairment in mental status: GCS 15, 71%; GCS 8 to 14, 62%; GCS<= 7, 50%. Mortality, hospital length of stay, and intensive care unit days were greater in the operatively managed GCS 15 and 8 to 14 groups, but were not different on the basis of management in the GCS <=7. Failure of nonoperative management occurred in 94 (6%). There was no difference in the nonoperative failure rate between patients with normal mental status and those with mild to moderate or severe head injuries. | Nonoperative management of neurologically impaired, but hemodynamically stable victims of blunt abdominal trauma with injuries to liver, spleen, or kidney was successful in more than 90% of cases. | 3 |

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| A Conservative Approach to Major Blunt Renal Lacerations with Urinary Extravasation and Devitalized Renal Segments | Moudouni, SM | British Journal Urology International | 2001 | The purpose of the study was to determine the feasibility of a conservative (expectant) approach to major blunt renal laceration with urinary extravasation and devitalized renal segments. All patients treated conservatively who presented with major renal laceration (grade 4 and 5) were retrospectively reviewed to determine whether urinary extravasation and devitalized segments adversely affected the outcome. Data collection included: CT findings, assoc. injuries, duration of hospital stay, transfusion requirements, complications and F/U imaging. | Of 20 patients with blunt trauma resulting in grade 5 (5) and grade 4 (15) renal lacerations with urinary extravasation, 11 had coexisting devitalized segments. There was a statistically significant difference in length of hospital stay (16.3 vs. 7.3 days), blood transfusions (6 vs 2 patients0 , and the need for delayed surgical intervention (9 vs. 2) btw. patients with and without devitalized segments respectively. Urinary extravasation spontaneously resolved in 2 of 11 patients and in seven of nine with no devitalized tissue. | Urinary extravasation will resolve spontaneously in most patients with blunt trauma and expectant management does not compromise the outcome or prolong hospitalization. Persistent extravasation or urinoma can be expected, but are usually managed successfully with endourological techniques. With the patient who presents with major renal trauma assoc. with devascularized segment and without coexisting bowel or pancreatic injury, conservative management is a viable and appropriate method of tx. for the clinically stable patient. | 3 |

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| How to Treat Blunt Kidney Ruptures: Primary Open Surgery or Conservative Treatment with Deferred Surgery When Necessary? | Danuser, H | European Urology | 2001 | Analysis of kidney ruptures resulting from blunt renal trauma and determining whether outcome is better after initial surgical or initial conservative treatment. Two consecutive series of 69 and 34 patients with blunt renal ruptures grade 2-4 (excluded pedicle injuries of the main renal vessels) were evaluated. Group A received primarily surgical tx. For kidney rupture (1973-1988). Group B was tx. primarily conservatively (1989-1995). Rates of surgery, time of surgery, surgical procedures, loss of renal parenchyma by surgery or trauma were analyzed. Blood loss was estimated, postoperative HTN was evaluatedfor all except those tx. with nephrectomy. | In group A, 42 of 69 had surgical intervention, all open (61%), group B, 11 of 34 (35%) had 12 interventions including 5 percutaneous or internal drainages and 5 partial or total nephrectomies (42%). Blood loss in patients with isolated grade 4 kidney rupture appeared to be less when tx. conservatively or with deferred surgery vs. immediate open surgery. | Primary conservative tx. of the ruptured kidney in place of emergency surgery seems to reduce blood loss and the need of an open surgical revision. Secondary surgery, if necessary, can be deferred if the patient is hemodynamicallyand hemostatically stable. Rate of HTN after renal trauma is not increased. | 3 |

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| Nonoperative Management of Hepatic, Splenic, and Renal Injuries in Adults with Multiple Injuries | Sartorelli, KH | The Journal of Trauma Injury, Infection, and Critical Care | 2000 | Purpose of study: Nonoperative management of abdominal solid organ injuries could be attempted in adult patients with multiple injuries without any increase in morbidity or mortality compared with patients with an isolated abdominal solid organ injury. 7 year retrospective chart review from the trauma registry including all patients age >= 17 yrs. with liver, spleen, or renal injuries resulting from blunt trauma. All patients underwent CT scanning with oral and IV contrast, organ injury scores were assigned based on CT scan or OR findings using the AAST scoring system for liver, spleen, renal injuries. In the last year of patient accrual, FAST was used on all patients, but followed by CT when abd. tenderness or free fluid was noted. All patients had follow-up CT or US at 6-12 weeks after the injury to assess healing of ASO injuries. 126 adult patient charts were reviewed who underwent NOM of an ASO injury for success of NOM, transfusions, and complications. Patients were divided into two groups: group 1 had isolated ASO injuries (n=48); group 2 had an ASO injury and at least one | NOM was successful 89.6% of group 1 and 93.6% of group 2 patients (p=0.55). Group 2 had higher Injury Severity Scores (20.7 +/- 9.8 vs. 8.3 +/- 4.9, p< 0.05) and transfusion requirements (30.8% vs. 14.6%, p< 0.05) than group 1. Complication rates were not different (group 1, 20.8% vs. 26.9% group 2, p=0.58). | NOM of ASO injuries may be attempted in adult patients with multiple injuries without increased morbidity. | 3 |

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| | | | | additional injury with and Abbreviated Injury Score >= 2 (n=78). | | | |

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| Selective Nonoperative Management of Blunt Grade 5 Renal Injury | Altman, AL | The Journal of Urology | 2000 | Retrospective review of the trauma registry over a 5 year period of all patients with grade 5 renal injury. Initial evaluation included "contrast CT of the abdomen and pelvis" with delayed images. Patients tx. nonoperatively (group 1) and those tx. surgically (group 2). Each group was compared with respect to the initial ER evaluation, CT findings, associated injuries, duration of hospital stay and ICU stay, transfusion requirements, complications and follow-up imaging. | Of 218 renal injuries, 13 were grade 5. In group 1, 6 patients were tx. nonoperatively and group 2, 7 underwent exploration. Each group had similar average hospitalization (12.0 vs.12.8 days, respectively). Patients in group 1 had fewer ICU days (4.3 vs 9.0), significantly lower transfusion requirements (2.7 vs. 25.2 units, p=0.0124) and fewer complications during the hospital course. F/U CT (before D/C home) of nonoperatively managed cases revealed functioning renal parenchyma with resolution of retroperitoneal hematoma. | Conservative management of blunt grade 5 renal injury is feasible in patients who are hemodynamically stable at presentation | 3 |
| The Role of Interventional Radiology in the Management of Blunt Renal Injury: A Practical Protocol | Hagiwara, A | The Journal of Trauma Injury, Infection, and Critical Care | 2001 | The purpose of this study was to evaluate the efficacy of a protocol designed to minimize the need for surgery in the management of severe blunt renal injury. 46 of 752 trauma patients had evidence of renal injury on CT. Two patients required emergency laparotomy, and the remaining 44 were classified by CT grade using the AAST classification system. Patients with CT grade 3 and over underwent renal angiography. Grade 1 and 2 were conservatively managed. | 21 patients had a high-grade injury on CT (>=3). Eight had angiographic evidence of extravasation from renal arterial branches and underwent transarterial embolization. One patient with a grade 5 injury had extravasation from a main renal vein and underwent immediate laparotomy. This was the only patient requiring surgery. | Surgery can be avoided in most cases of blunt renal injury. Hemodynamic instability and injury to the main renal veins remain indications for surgical exploration. | 2 |

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| Is there a difference in outcome when treating traumatic intraperitoneal bladder rupture with or without a suprapubic tube? | Volpe MA | J Uro | 1999 | Retrospective review of 34 patients with bladder injujry (82% penetrating, 18% blunt) | Following primary repair, 18 patients had bladder drainiage with suprapubic tubes vs urethral catheter only in 16. Urologic complications were found in 28% of the suprapubic tube group vs 19% of the urethral catheter only group. | Intraperitoneal bladder injuries may be equally well managed by primary bladdder repair & urethral catheter drainage only versus suprapubic tube drainage. | 3 |
| Nonoperative management of bladder rupture from external trauma. | Cass AS | J Uro | 1983 | Retrospective review of 18 patients with extraperitoneal rupture of the bladder who were managed nonoperatively. | Complications occurred in 4/18 patients, comparable to a 20 - 25% complication rate in the literature | Nonoperative management will give a satisfactory result in patients with small extraperitoneal bladder rupture. | 3 |
| Management of extraperitoneal ruptures of bladder caused by external trauma. | Cass AS | J Uro | 1989 | Retrospective review of 105 cases of extraperitoneal bladder rupture; 65 received primary repair and 34 were managed nonoperatively. | There were 3 early and 2 late complications in the patients who were managed operatively, versus 4 early and 3 late complications in the patients managed nonoperatively. There was no statistically significant difference in the complication rate. | Catheter drainage alone for extraperitoneal rupture is particularly appealing in the multiple-injured patient. | 3 |
| Penetrating ureteric injuries. | Azimuddin K | Injury | 1989 | Retrospective review of 21 patients with penetrating ureteral and renal pelvic injuries who underwent operative repair. | Anatomotic leak developed in 3 patients, 1 required operative correction. | | 3 |
| Ureteral and renal pelvic injuries from external trauma: diagnosis and management | Presti JC Jr | J Trauma | 1989 | Retrospective review of 18 patients with collecting system injuries, 16 penetrating & 3 blunt. All injuries were operatively repaired. | Followup of 14 patients demonstrated normal imaging in 13, mild caliectasis in 1 and a resolving urinoma in 1 patient. | The urinary tract can usually be satisfactorily reconstructed. | 3 |

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| A conservative approach to major blunt renal lacerations with urinary extravasation and devitalized renal segments | Moudouni SM | BJU Int | 2001 | Retrospective review of 20 patients with major renal lacerations (5 grade V and 15 Grade 4). 11 had devitalized segments.. | There was a statistically significant difference in the length of hospital stay (16.3 vs 7.3 days), blood transfusions (six vs two patients, P < 0.08) and the need for delayed surgical intervention (nine vs two, P < 0.01) between patients with and with no devitalized segments, respectively. Urinary extravasation spontaneously resolved in two of 11 patients with and in seven of nine with no devitalized segment, respectively (P < 0.05) | Urinary extravasation will resolve spontaneously in most patients with blunt renal trauma, and expectant treatment does not adversely affect the outcome or prolong hospitalization. In patients who present with a major renal laceration associated with devascularized segments, conservative management is feasible in those who are clinically stable with blunt trauma. However, the physician must be especially aware of the probable complications within this subset of patients. | 3 |
| Management of low velocity gunshot wounds to the anterior urethra: the role of primary repair versus urinary diversion alone | Husmann DA | J Urol | 1993 | Retrospective review of 17 patients with partial transection of the anterior urethra secondary to penetrating trauma. 9 patients were managed with suprapubic diversion, skin debridement and corporeal closure with a transurethral catheter; 8 patients were managed by suprapubic diversion, debridement, closure of the corporeal bodies & a primary sutured reapproximation of the anterior urethra. Urethral strictures developed in 7/9 of the first group and only 1/8 in the second group. | Patients with partial transection of the anterior urethra secondary to low velocity gunshot wounds should be managed by aggressive wound debridement, corporeal repair, placement of a suprapubic catheter and primary repair of the urethra. | 3 | |

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| Comparison of long-term results according to the primary mode of management and type of injury for posterior urethral injuries. | Ku JH | Urol Int | 2002 | Retrospective review of 55 patients with traumatic posterior urethral injuries. 35 patients (Group I) underwent immediate realignment over a transurethral catheter; 20 patients (Group 2) underwent suprapubic cystostomy followed by delayed urethroplasty. Of group 1, mild, moderate and severe urethral strictures developed in 7 (20.0%), 8 (22.9%) and 6 (17.1%), respectively, and developed in 6 (30.0%), 2 (10.0%) and 5 (25.0%), respectively, of group 2. Six (17.1%) and 2 (20.0%) had decreased potency and 4 (11.5%) and 1 (5.0%) were impotent in group 1 and 2, respectively. Of group 1, incontinence developed in 3 patients but 1 did not need treatment, and developed in 2 (10.0%) but 1 (5.0%) did not need treatment of group 2. The score test for trend demonstrated that there were no significant differences of these results. | Complications in patients with posterior urethral injuries are not related to the primary mode of management. | 3 | |

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| Long-term followup and evaluation of primary realignment of posterior urethral disruptions | Elliott DS | J Uro | 1997 | Retrospective review of 57 patients with posterior urethral disruptions, 56 complete and 1 partial. All patients underwent primary urethral realignment within 6 hours of injury. 42/53 patients (79%) reported no erectile dysfunction, 7/53 (13%) had reduced quality of erection but required no treatment, and 4/53 (7/5%) had erectile dysfunction requiring treatment. 2/53 patients (3.7%) reported mild post-realignment stress incontinence. Both patients did not require treatemtn for incontinence or protective padding. 36/53 patients (68%) had post-realignment strictures, but 23 (43%) were either observed or managed with in-office dilation. . | Immediate primary realignment results in negligible intraoperative morbidity, and acceptably low incidences of impotence, incontinence, and symptomatic strictures. | 3 | |
| Immediate management of prostatomembranous urethral disruptions | Follis HW | J Uro | 1992 | Retrospective review of 33 patients with complete prostatomembranous urethral disruptions. 20 were managed by immediate realignment, while 13 were managed by initial suprapubic tube and delayed urethroplasty. Immediate realignment resulted in an overall potency rate of 80% compared to only 50% in patients who underwent delayed repair. There was an increased need for a secondary operation when the repair was delayed. Continence rates were | Immediate urethral realignment results in impotence and incontinence rates that are comparable to or better than delayed repair techniques without the need for multiple surgical procedures. | 3 | |

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| | | | | similar in both groups. | | | |
| The value of immediate or early catheterization of the traumatized posterior urethra | Herschorn S | J Uro | 1994 | Retrospective review of 16 patients with posterior urethral rupture. 13 patients were treated with a transurethral catheter either immediately or within 1 to 5 weeks after injjury. Three patients were treated with a suprapubic catheter alone. All three patients treated with suprapubic catheter alone subsequently required urethroplasty for an obliterative stricture. These 3 patients were also impotent. 7/13 patients treated with a transurethral catheter developed a stricture, of which 4/13 required urethrotomy. 5/12 patients became impotent after injury, while 1 was impotent prior to injury. No patient experienced incontinence. | Careful urethral catheter realigment either immediately or within five weeks of injury is safe and obviates total urethral closure. Impotentce appears to result from the severity of the injury and not from management. | 3 | |

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| Impotence and incontinence after immediate realignment of posterior urethral trauma: result of injury or management? | Kotkin L | J Uro | 1996 | | Retrospective review of 32 patients with urethral disruptions, 20 with complete injuries of whom were treated with immediate realignment and 12 with partial or complete were treated with retrograde catheterization alone.. 83% of patients treated with immediate realignment and 80% of patients treated with retrograde catheterization alone were continent. 76% of patients treated with immediate realignment and 70% treated with retrograde catheterization alone were potent. | Impotence and incontinence in this setting are the result of the injury and not of attempts at immediate surgical management. | 3 |
| Management of prostatomembranous urethral disruption: 13-year experience | Morehouse DD | J Uro | 1980 | | | | 3 |
| Renovascular trauma: risk assessment, surgical management, and outcome | Carroll P | J Trauma | 1990 | Retrospective review of 9 renal artery injuries, 12 renal vein injuries, and 2 patients with both renal artery and vein injuries, and 10 patients with segmental vessel injuries alone. 23 patients sustained penetrating injuries and 13 sustained blunt injuries. | Two patients died before surgery could be attempted. Of the remaining 15 patients with main renal artery injuries, 9 underwent reconstruction and 6 underwent immediate nephrectomy without attempt of repair. 2 immediate nephrectomies were performed after failed attempt at repair. 6 patient had either persistent thrombosis or preservation of only marginal renal function. Complete renal preservation was achievedc in only 2 kidneys. | Renal preservation is likely with incomplete lacerations of the main renal vein or injury to segmental renal vessels. Restoration of normal renal function is unlikely when the main renal artery is injured. Reconstruction of renal artery injuries should be attempted in all patients with single kidneys or bilateral renal injury. Repair of unilateral arterial injuries should be undertaken when the injury is incomplete or recognized early in the presence of a nonischemic kidney and a hemodynamically stable patient. | 3 |

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| Mortality and renal salvage after renovascular trauma | Turner W | Am J Surg | 1983 | Retrospective review of 16 patients with isolated renal artery injuries (9 main renal artery, the remainder renal artery branches), 45 patients with isolated renal vein injuries, and 33 patients with combined renal artery and vein injuries. 69 patients had injuries as a result of penetrating trauma vs 30 patients with blunt trauma. | Nine complete renal artery occlusions were found in 8 patients. 4 repairs were undertaken, 3 primary nephrectomies performed, and 2 lesions observed. Of the 4 repairs, 3 patients required subsequent nephrectomy and the remaining patient had a nonfunctioning kidney. 43/45 isolated renal vein injuries were treated operatively: 28 underwen t repair, 2 ligation, and 13 patients received nephrectomies. Renal salvage was accomplished in 23 patients with isolated renal vein trauma. | Revascularization of patients with renal artery occlusions was uniformly unsuccessful in our series. The success of revascularization of traumatically occluded renal arteries is low and should probably be pattempted only in unusual circumstances, such as bilateral injuries. Most isolated renal vein injuries are repairable, and reconstruction should be attempted in stable patients. | 3 |

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| Renovascular trauma | Brown MF | Am J Surg | 1980 | Retrospective review of 154 patients with 249 renovascular injuries, 24 patients had blunt trauma while the remaining patients had penetrating trauma. 96 patients had 133 isolated renovascular injuries, including 34 patients with injuries to both the artery and vein on the same side. 22 patients had isolated renal artery injuries & 43 patients had isolated renal vein injuries. Two patients had bilateral renal artery and one had bilateral renal vein injuries. | 58 patients required immediate nephrectomy for hilar injury involving both the renal artery & vein. 47/96 patients with isolated renovascular injuries required immediate nephrectomy for control of hemorrhage, irreparable damage, or expediency due to the patient's overall condition and number of associated injuries. The remaining 49 patients with 64 isolated renovascular injuries and potentially salvageable kidneys underwent vessel repair, revascularization or ligation. Among 25 patients having 27 attempted renal reconstructions, 4 required late nephrectomy for perinephric abscess of hypertension with a nonfunctioning kidney. 7 patients with arterial reconstruction had nonfunctioning kidneys by renal scanning., 10 of the remaining 16 repaired arteries had functioning kidneys. There were 32 deaths, 25 from exsanguination secondary to multiple associated injuries, 3 from sepsis, 4 from ARDS & acute renal failure. The results are not stratified as to the mechanism of injury.l | Arterial revascularization is seldom indicated in patients with a normal contralateral kidney who have multiple associated injuries, hilar injuries, long segmental arterial injuries or prolonged renal ischemia. An attempt at renal artery revascularization is justified with bilateral injuries, when only one kidney is present, or when a solitary artery injury can be repaired by simple lateral arteriorrhaphy. | 3 |

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| Renal artery injuries caused by blunt trauma | Clark DE | Surgery | 1981 | Retrospective review of 10 patients with renal artery injuries. | 310 patients had their arteries repair: intimal flap with 8 hours to diagnosis had minimal function, intimal flap with 2 hours to diagnosis had normal function, arterial occlusion with 2 hours to diagnosis had no function & hypertension, complete occlusion with 36 hours to diagnosis had renal failure and required a renal allograph. 3 patients had nephrectomies & recovered, 3 patients were observed of which 2 regained normal function and 1 had nonfunction but was normotensive. | Repair of a unilateral injury is indicated only if it is promptly diagnosied in a young, stable patient. Immediate bilateral repair is indicated in all cases of bilateral renal arterial injury. | 3 |
| Proper management of renal artery injury from blunt trauma | Lock JS | S Med J | 406 | Retrospective review of 3 patients with blunt renal artery injury | 1 patient had intimal injury with retained flow and had a successful repair. 1 patient had damage control pedicle ligation and expired. 1 patient was treated nonoperatively and did not regain renal function. He had a delated nephrectomy for an unclear reason. | | 4 |
| Renal pedicle injury in patients with multiple injuries | Cass AS | J Trauma | 1985 | Retrospective review of 41 patients with life-threatening multiple system injuries and renal pedicle injuries, 76% blunt. | Nonoperative management was performed in 13 patients with injury to renal artery in 9 and a branch of the renal artery in 4, with a renal loss/delayed nephrectomy rate of 9/9 renal artery injuries. Immediate surgical management was performed in 23 patients, with a renal salvage rate of 7/21 renal artery and/or vein injuries (arvery vs vein not | Cannot draw conclusions based on the data availabe in the results section. | 3 |

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| Gunshot wounds to the ureter: a 40-year experience at Grady Memorial Hospital | Perez-Brayfield MR | J Urol | 2001 | Retrospective review of 118 patients with gunshot wounds to the ureter. | A variety of surgical procedures were used to repair the defect, depending on the location and severity of the defect. Complications occurred in 24 patients. | A hgh index of suspicion is essential to avoid missing these injuries. A predefined trauma protocol, as defined in the author's algorithm, may decrease the number of missed ureteral injuries. | 3 |
| Penetrating ureteral trauma at an urban trauma center: 10-year experience | Palmer LS | Urology | 199 | Retrospective review of 20 patients with penetrating ureteral injuries | 100% of ureteral injuries were associated with other injuries. Admission urinalysis failed to show gross or microscopic hematuria in 25% of cases. 15 cases were diagnosed intraoperatively. Delayed diagnoses were made in 4 cases. Every reapir was stented for a mean of 38 days. 3 major complications occurred, and 13 patients with long-term follow-up demonstrated no evidence of obstruction. | Ureteral injuries must be considered early during the evaluation of penetrating abdominal injuries. The surgical repair should be stented. | 3 |

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| Value of proximal diversion and ureteral stenting in management of penetrating ureteral trauma | Franco I | 32 | | Retrospective review of 21 cases of penetrating ureteral trauma seen in two hospitals. | Early urologic complications, defined as urine drainage from the wound for greater than 2 weeks or a need for a second operation, occurred in 50% of patients with a proximal ureteral injury but were less common when a nephrostomy and stent were used in the repair. The rate of complications was also lower if a stent was used on midureteral repairs. None of the patients with distal ureteral injuries suffered a urologic complication. | Repair of penetrating ureteral injuries should include stenting and nephrostomy tube drainage in cases of proximal injuries, as well as generous debridement and water-tight closure. Midureteral injuries accompanied by GI, pancreatic, and major vascular injuries should be stented and proximal diversion considered when prosthetic materials are used for vascular repairs. | 3 |
| Gunshot wounds of the ureter: a 15-year review of 63 consecutive cases | Holden S | J Urol | 1976 | Retrospective review of 63 consecutive cases of gunshot wounds of the ureter | | Particular attention should be being placed on adequate debridement and spatulated splinted watertight ureteroureterostomy. | 3 |
| Gunshot injuries of the ureter | Rober PE | J Trauma | 1990 | Retrospective review of 16 consecutive patients with gunshot wounds of the ureter. | Two patients died from complications unrelated to their ureteral injujries. The remaining 14 patients had good results. | Proper management consists of early diagnosis and repair, adequate debridement of devitalized tissue, tensionless spatulated watertight anastomosis with absorbable suture, internal stenting, and drainage of periureteral tissues. | 3 |

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| Management of renal injury in conjunction with the immediate surgical treatment of the acute severe trauma patient | Del Villar R | J Uro | 1972 | Retrospective review of 100 patients with renal injuries, 93% blunt | Associated injuries were present in 57/100 patients. Chest injuries were found in 9 & associated abdominal injuries in 19. All 19 deaths occurred in patients with associated injuries for a mortality rate of 21% in patients with renal contusions, 50% with renal lacerations, & 50% with pedicle injuries. 6 patients had pedicle injuries; 2 had nephrectomies, 1 was found at autopsy & 3 had devitalized kidneys left in situ. | Patients with an injured urinary tract often have severe multiple injuries. | 3 |
| Preliminary vascular control for renal trauma | Atala A | SGO | 1991 | Case series of 75 patients who underwent renal exploration for trauma. Vascular control was obtained prior to entering Gerota's fascia in 32 & after entering Gerota's fascia in 43. | 5 patients with blunt trauma had vascular control before opening Gerota's fascia, with a nephrectomy rate of 60% compared to 57% in 7 patients in whom vascular control was obtained after opening Gerota's fascia. 27 patients with penetrating trauma had vascular control obtained prior to opening Gerota's fascia, with a nephrectomy rate of 59% compared to 33% in the 36 patients who had vascular control obtained after opening Gerota's fascia. These differences were not statistically significant. | Adequate vascular control can be obtained after Gerota's fascia is opened, without increasing the risk of nephrectomy or additional blood loss. The nephrectomy rate depended on the degree of injury and not on the type of vascular control. | 3 |

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| The mangement of penetrating injuries of the kidney | Carlton CE | J Trauma | 1968 | Retrospective review of 114 patients with penetrating renal injuries | 42 patients with minor parenchymal injuries; 2 patients underwent nephrectomy for associated pedicle injuries. 44 patients had major renal wounds & 11 underwent nephrectomy. There were 10 patients with renal artery & vein injuries; nephrectomy was performed in 9 & repair was successful in one. Time to definitive repair was not reported. There were 13 isolated injuries to the renal vein; 3 underwent nephrectomy & 10 underwent successful primrary repair of the vein. There were 5 cases of isolated renal artery injury; 1 underwent nephrectomy & 4 underwent primary arterial repair. The time & results of the patients undergoing primary arterial repair were not reported. In patients with preliminary vascular control, 1/14 patients underwent nephrectomy, compared to 6/30 patients who did not have preliminary vascular control. The reasons for preliminary vascular control were not described. | Securing the vascular pedicle prior to opening Gerota's fascia has essentially eliminated the necessity of performing nephrectomy for control of hemorrhage. These conclusions do not appear to be clearly supported by the data provided. | 3 |

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| Renal trauma: kidney preservation through improved vascular control---a refined approach | McAninch JW | J Trauma | 1982 | Retrospective review of 198 patients who underwent routine preliminary vascular control prior to entering Gerota's fascia with historical control of 185 patients in whom prelimninary vascular control was inconsistent and variable. | The nephrectomy rate was 7/190 who underwent routine preliminary vascular control versus 19/185 who underwent inconisistent preliminary vascular control. There was no statistical analysis of these results. Additionally, the degree of renal injury is not described. | Early renal vessel isolation reduces nephrectomy rates dramatically. | 3 |
| Bilateral traumatic renal artery thrombosis | Morton JR | Ann Surg | 1972 | Case report of a patient with bilateral traumatic renal artery thrombosis secondary to blunt trauma. | Revascularization was performed 18 hours after injury. Subsequent renal scan demonstrated irregular areas of renal function bilaterally with 90% stenosis of the distal left vein graft & occlusion of the superior branch of the right renal artery. Further reconstruction was performed with resultant Creatinine clearance of 54 ml/minute, representing 50% of normal renal function. He required long-term antihypertensives but his renal function did not change on four year follow up. | In patients with bilateral renal artery thrombosis, vascular reconstruction should be attempted. | |

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| Renal pedicle injury in the multiple injured patient | Cass AS | J Uro | 1979 | Retrospective review of 14 patients with renal artery injury, 5 branches of renal artery, 8 renal vein injury, 4 combined renal artery and vein. | 2 patients had renal artery repairs, 1 died postop and the other had 25% function. 3 patients had suturing of lacerated renal veins; 2/3 died postop. 14 patients were observed. 7/14 died, of the 7 that were discharged, 6 had no hypertension and there was no followup in 1 patient. Of these 6, the injuries were 5 renal artery occlusions & 2 ruptures of polar arteries. | In the multiple injured patient, one must balance the desire for preservation of renal tissue against the increased magnitude of the procedure. In this study the vascular repair group had the highest mortality rate (50%) compared to the nephrectomy group (36%) and the nonsurgical group (43). However, the number of patients involved in ecach group was too small for a definite conclusion to be drawn. None of the 6 patients in the non surgical treatment group had hypertension after an average of 29 months of followup. | 3 |

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| Renal vascular injuries | Meacham PW | Am Surg | 1986 | Retrospective review of 15 patients: 9 with injuries to the renal artery and 6 with injuries to the renal vein. 9 were due to penetrating trauma, six blunt. Time from admission to time of operation average 6.4 hours for patients with blunt trauma and 1.25 hours for patients with penetrating trauma. Attempts were made to repair4 of the 9 renal artery injuries, whereas in four other cases, immediate nephrectomy was necessary because of excessive time lapse between injury & operation in 2 patients (6 & 13 hours) and massive bleeding in the other two. In one patient, an emergency nephrectomy was done at the time of a second operation 3 hours after an initial exp lap with nonexploration of a stable retroperitoneal hematoma. | 1/4 attempted renal vascular repairs was successful. 7/9 patients with renal artery injuries survived. | Attempts at renal salvage in this series were not as encouraging as those reporrted by others. | 3 |
| Renal artery injuries following blunt trauma | Gothlin J | Acta Chir Scand | 1976 | Retrospective review of 2 patients with blunt renal artery injuries, repaired at 23 hours and 3 days. | 0/0 repairs successful | Attempts at renal salvage in this series were not as encouraging as those reporrted by others. | 3 |

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| Traumatic renal artery occlusion: a 15-year review | Haas CA | J Trauma | 1998 | Retrospective review of 12 patients with complete trauma renal artery occlusion secondary to blunt injury. Renal artery revascularization was attempted in five patients with a median warm ischemia time of 5 hours (range, 4.5 - 36 hours). | 4/5 surgical revascularizations were deemed technically successful intraoperatively. Of these 4, 3 showed no function and one showed minimal function on postop renal scans. Of these 4, 2 required delayed nephrectomy for complications and one died from complications of the original injury. 1/4 patients with unilateral renal artery occlusion had a successful revascularization. Of the 7 patients who were not revascularized, hypertension developed in 3 patients who required a nephrectomy for blood pressure control. | Based on these results, the authors are unable to advocate emergency surgical revascularization solely for renal salvage in patients with unilateral renal artery occlusion in the presence of a normally functioning contralateral kidney unless the patient is hemodynamically stable and the presumed ischemia time is less than 5 hours. | 3 |

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