Original Article

Traumatic kidney injury in multiorgan trauma patients: experience of trauma center

Leszek Sułkowski, Maciej Matyja[1]

Department of General Surgery, Regional Specialist Hospital, Częstochowa, Poland, [1]Department of General Surgery, Jagiellonian University Medical College, Kraków, Poland

Abstract

Introduction: Traumatic kidney injury (TKI) remains a challenging element of multiorgan trauma. We present a 9-year experience of a trauma center with surgical management of multiorgan trauma patients with TKI.
Materials and Methods: The inclusion criteria for this study were TKI in multiorgan trauma patients receiving surgical management. During 9 years, 10,191 patients were hospitalized to the Department of General Surgery. Forty-nine of these multiorgan trauma patients had associated TKI.
Results: The severity of the kidney injury was classified on a five-point Organ Injury Scale proposed by the American Association for the Surgery of Trauma. Injuries to other organs were also evaluated. The surgical approach was either laparotomy or laparotomy with thoracotomy, depending on the severity of trauma.
Discussion: Abdominal trauma may involve kidneys, especially when the injury is severe and affecting multiple organs. This may be seen in both the adult and pediatric populations. The treatment depends on the severity of organ injuries, hemodynamic stability of the patient and may be either surgical or conservative. Hemodynamically unstable patients received damage control surgery, whereas the stable ones underwent computed tomography before the decision on optimal treatment modality. The most severe vascular injuries are associated with a high mortality rate.
Conclusion: TKIs usually appear in young males and predominantly follow blunt abdominal trauma. TKI is usually an element of complex multiorgan trauma with severe injuries to other organs.

Keywords: Multiorgan trauma, surgery in trauma patient, trauma, traumatic kidney injury

Address for correspondence: Dr. Leszek Sułkowski, Department of General Surgery, Regional Specialist Hospital, Bialska 104/118, 42–218 Częstochowa, Poland.
E-mail: leszeksulkowski@icloud.com

INTRODUCTION

Abdominal trauma, both blunt and penetrating, may involve kidneys located in the retroperitoneal space.[1-3] The main cause of traumatic kidney injuries (TKIs) is blunt trauma, especially occurring in motor vehicle injuries.[2,3] The main goal of TKI management is to preserve a kidney and its function.[4] The treatment modality in each instance would depend on the severity of injury.[1,5-7] We present a 9-year-long experience of a trauma center with surgical management of multiorgan trauma patients with concomitant TKI.

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MATERIALS AND METHODS

The patients included in the study had surgically managed multiorgan trauma with associated TKI. Patients with isolated TKI and no multiorgan trauma and who were managed conservatively were excluded. During 9 years in the Department of General Surgery, of the 10,191 patients were hospitalized, surgical intervention for multiorgan trauma was performed in 393 (3.9%). In 49 patients (12.5% of those requiring surgery for multiorgan trauma, 0.5% of all hospitalized), TKI was noted [Table 1]. These 49 patients—32 males (65.3%) and 17 females (34.7%)—were further evaluated. The mean age was 37 years (36 years for males, 38 years for females, range 18–75 years). The right kidney was involved in 27 patients (55.1%), the left kidney in 24 (49.0%), and in 2 cases (4.1%), there was bilateral kidney involvement.

RESULTS

The TKI predominantly followed blunt traumas (n = 42, 85.7%), a majority related to motor vehicle injuries (n = 33, 78.6% of blunt traumas). Seven TKIs (14.3%) resulted from penetrating injuries, including three gunshot injuries.

The severity of a TKI was classified using the Organ Injury Scale proposed by American Association for the Surgery of Trauma (AAST-OIS) and rated on a five-point scale [Table 2].[8] The factors considered in this scale are kidney contusion, hematoma, laceration, and vascular injury. Kidney contusion (hematuria with a normal urological examination) is a grade I of AAST-OIS. Subcapsular or perirenal hematoma meets the criteria of grades I and II. Parenchymal depth of renal laceration (<1 cm, extending through the renal cortex, medulla, and collecting system, shattered kidney), the presence or lack of urinary extravasation, and the presence or lack of collecting system rupture meet the condition of AAST-OIS grades II–V. Kidney vascular injuries, which are the most severe, include grade IV with the main renal artery or vein injury and grade V with avulsion of renal hilum and kidney devascularization [Table 2]. Of 49 patients evaluated in this study, 17 (34.7%) presented AAST-OIS grade I of TKI, 10 patients (20.4%) grade II, 6 patients (12.2%) grade III, 8 patients (16.3%) grade IV, and 8 patients (16.3%) grade V [Table 3].

Predominantly injured other organs were spleen (n = 43, 87.8%, predominance of AAST-OIS grades III and IV), liver (n = 41, 83.7%, predominance of AAST-OIS grades III and IV), pancreas (n = 18, 36.7%, predominance of AAST-OIS grades II and III), diaphragm (n = 14, 28.6%), inferior vena cava (n = 12, 24.5%), adrenal glands (n = 8, 16.3%), urinary bladder (n = 8, 16.3%), stomach (n = 7, 14.3%), and small bowel (n = 7, 14.3%). Moreover, 12 cases of rib fractures (24.4%) and 8 cases of pneumothorax or pneumohemothorax (16.3%) were noted [Table 4].

The surgical approach depended not only on the severity of TKI, but mostly on the necessity of management of numerous organ injuries (i.e., liver, spleen, diaphragm, and intestines). Laparotomy was chosen in 47 patients (95.9%), whereas laparotomy and thoracotomy were required in 2 cases (4.1%). During the surgery, the injured kidneys were

Table 1: Trauma-related hospitalizations, multiorgan injuries, and traumatic kidney injuries

	No. of patients	% of all hospitalizations	% of trauma-related hospitalizations	% of multiorgan traumas
All hospitalizations	10,191			
Trauma-related hospitalizations	1,702	16.7		
Multiorgan trauma	393	3,9	23.1	
Traumatic kidney injury	49	0.5	2.9	12.5

Table 2: Traumatic kidney injury scale according to the American Association for the Surgery of Trauma–Organ Injury Scale (AAST-OIS)[8]

AAST-OIS grades of kidney injury	Type of traumatic kidney injury		
	Contusion	Laceration	Vascular
I	Microscopic or gross hematuria, urologic studies normal	Subcapsular hematoma, non-expanding without parenchymal laceration	
II		Non-expanding perirenal hematoma confirmed to renal retroperitoneum	<1.0 cm parenchymal depth of renal cortex without urinary extravagation
III		<1.0 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravagation	
IV		Parenchymal laceration extending through renal cortex, medulla, and collecting system	Main renal artery or vein injury with contained hemorrhage
V		Completely shattered kidney	Avulsion of renal hilum, which devascularizes kidney

cauterized (n = 7, 14.3%), sutured (n = 24, 49.0%), or resected (n = 18, 36.7%). We noted 18.3% of intraoperative (n = 9) and 22.5% of postoperative (n = 11) mortality rates. Massive blood loss was the cause of intraoperative mortality, whereas multiorgan failure following severe multiorgan injury was the cause of postoperative mortality. The overall in-hospital mortality rate was 40.8% (n = 20) in the group.

DISCUSSION

Abdominal trauma may involve kidneys, especially when the injury is severe and multiorgan.[1,9] TKIs may concern both the adult and pediatric populations but predominantly concern young males.[3,10] In our series, 65.3% of patients were males with a mean age of 36 years.

Kidney injury may follow both blunt and penetrating injuries, including gunshots.[2] However, the main cause of TKIs remain blunt traumas (up to 96% in the literature and 85.7% in our study), of which the motor vehicle traumas are the most common (up to 72% in the literature and 67.3% in our study).[3,7] The circumstances of the injury are crucial.

Table 3: Grading of traumatic kidney injuries based on the American Association for the Surgery of Trauma–Organ Injury Scale (AAST-OIS)[8]

Grades of AAST-OIS traumatic kidney injury	n (%)
I	17 (34.7)
II	10 (20.4)
III	6 (12.2)
IV	8 (16.3)
V	8 (16.3)

Table 4: Other organ injuries in multiorgan trauma patients with traumatic kidney injury

Organ injuries	n (%)	AAST-OIS for organ specific injuries[8]
Kidney	49 (100.0)	grade I n = 17, grade II n = 10; grade III n = 6, grade IV n = 8; grade V n = 8
Spleen	43 (87.8)	grade I n = 1, grade II n = 3, grade III n = 14, grade IV n = 17, grade V n = 8
Liver	41 (83.7)	grade I n = 3, grade II n = 8, grade III n = 11, grade IV n = 13, grade V n = 6
Pancreas	18 (36.7)	grade I n = 3, grade II n = 5, grade III n = 6, grade IV n = 2, grade V n = 2
Diaphragm	14 (28.6)	
Inferior vena cava	12 (24.5)	
Rib fracture	12 (24.5)	
Adrenals	8 (16.3)	
Urinary bladder	8 (16.3)	
Pneumothorax and pneumohemothorax	8 (16.3)	
Stomach	7 (14.3)	
Small intestine	7 (14.3)	

High-energy TKIs following motor vehicle accidents are usually associated with numerous injuries to other organs, whereas sport-related traumas usually cause isolated TKIs.[10] We noticed a 67.3% of motor vehicle traumas. Penetrating TKIs are rare, mostly in young males, it is as a result of a stab or gunshot wounds. In this study, seven TKIs (14.3%) followed penetrating traumas, including three gunshots (42.9% of penetrating injuries).

Depending on the hemodynamic condition, patients with abdominal trauma require diagnostics to evaluate the severity of organ injury or surgery without prior diagnostics.[7,11] Diagnostic opportunities for these patients are ultrasound, including focused assessment with sonography for trauma (FAST), and computed tomography (CT) scans.[12-14] However, the most severely injured patients should receive immediate damage control surgery without prior CT scanning. For the management of multiorgan trauma patients, careful inspection of peritoneal cavity and damage control surgery principles are crucial.[2] In our study, each patient underwent FAST. Then, hemodynamically unstable patients with parenchymal organ injuries received damage control surgery, whereas stable ones underwent CT to evaluate organ injuries.

The treatment modality depends on hemodynamic stability, the severity of organ injuries, and may be either surgical or conservative, including interventional radiology with transarterial embolization.[1,5] Some hemodynamically stable patients may be successfully managed by interventional radiologists or watchfully observed as may be done for minor blunt KIs.[3-5] However, these patients were not evaluated in this study (only surgically managed TKI were included). The application of conservative management has increased and nowadays, even limited cases of more severe injuries can be managed nonsurgically. Guidelines recommend nonoperative management of low AAST-OIS grades of KIs.[6] Over 80% of TKIs in children may be managed conservatively.[15] The initial nonsurgical management may fail as described by Bjurlin *et al.*[16] in 2.7% of conservatively treated patients. The predictive factors of failure of conservative management are higher grades of TKI, revealed other abdominal injuries, penetrating injury versus blunt one.[16]

The higher AAST-OIS grades of TKIs, especially in hemodynamically unstable patients, require surgery.[6,17] The surgery is also preferred in penetrating traumas, which are described to be associated with a high rate of nephrectomies, accounting for approximately one-fourth.[7] Nephrectomies are unavoidable in the majority of cases of major bleeding, injury to the kidney hilum, or shattered kidney.[11] Our rate of nephrectomies was 36.7% and they corresponded to

32.6% of the most severe AAST-OIS grades IV and V of KIs, associated with the injury of the main renal artery or vein, avulsion of renal hilum or shattered kidney [Table 3]. The mortality rate depended also on the number of other organ injuries and hemodynamic stability [Table 4].

The frequency of kidney injury was the same (55.1% right vs. 49.0% left), with a 4.1% rate of bilateral TKI. The injuries to other organs were predominantly severe [Table 4]. We noticed a predominance of AAST-OIS grades III and IV for spleen injury (n = 31, 72.1%), grades III and IV for liver injuries (n = 24, 58.5%), and grades II and III for pancreas injuries (n = 11, 61.1%), diaphragm injury in 28.6%, inferior vena cava injury in 24.5%, and 16.3% had pneumothorax or pneumohemothorax. The injury to adrenal glands or urinary bladder was detected in 16.3% of patients [Table 4]. It is described in the literature that the urogenital injuries are associated with abdominopelvic (38.8%), extremities (31.9%), thoracic (17.1%), and head and neck (12.2%) injuries.[18]

Nephrectomy was necessary for 36.7% of cases (n = 18) and corresponded to 32.6% of grade IV and V TKIs. The other surgical options were parenchymal sutures (n = 24, 49.0%) and cauterization (n = 7, 14.3%) for less severe TKI. In the literature on nephrectomy, it was found that renography ratio is 7:10, even in cases of less severe kidney injuries (50% of grade I and II TKIs).[18] In our study, the nephrectomy:renography ratio was 7.5:10. Keihani *et al.*[19] presented a multicenter series of 47 patients with TKI undergoing surgical interventions, of which 31% were nephrectomies.

The mortality rates presented in the literature (6%–40%) depend on the severity of trauma. In isolated injuries and stable cases, the mortality is significantly lower (6%).[7] However in cases of severe multiorgan trauma, mortality rates are definitely higher (20%–40%), depending on the severity of injury.[18] The high in-hospital mortality rate (40.8%) may be explained by a high rate of the most severe vascular injuries, that is, 16.3% of grade IV (main renal artery or vein injury) and 16.3% of grade V AAST-OIS (renal hilum avulsion with kidney devascularization) [Table 3] as well as a 4.1% rate of bilateral TKI and severe injuries to other organs (i.e., spleen, liver, and pancreas) [Table 4].

The limitation of this study was the size of a sample limited to 49 cases. Only multiorgan trauma patients who were handled with surgery were evaluated, whereas multiorgan trauma patients who were managed conservatively were excluded from further evaluation. The extension of this study may enlarge the sample size.

CONCLUSION

The TKI usually appears in young males and predominantly follows blunt abdominal trauma as the number of female patients with trauma is generally lower than male patients with trauma. TKI is usually an element of complex multiorgan trauma with a high grade of other organ injuries. Multiorgan trauma patients with TKI undergoing surgery require nephrectomy or parenchymal sutures in most cases. Mortality rates are high and correspond to the severity of the injury.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Magistri P, Sirimarco D, Amato S, D'Angelo F, Nigri G, Ramacciato G. Conservative treatment for massive fracture of the kidney after trauma. Chirurgia 2014;27:233-5.
2. Sobnach S, Segobin R, Nicol A, Edu S, Kahn D, Navsaria P. Penetrating trauma to the kidney and Meckel's diverticulum in a patient with unilateral renal agenesis. Int J Surg Case Rep 2015;17:136-8.
3. Shoobridge JJ, Bultitude MF, Koukounaras J, Martin KE, Royce PL, Corcoran NM. A 9-year experience of renal injury at an Australian level 1 trauma centre. BJU Int 2013;112:53-60.
4. Mingoli A, La Torre M, Migliori E, Cirillo B, Zambon M, Sapienza P, *et al.* Operative and nonoperative management for renal trauma: Comparison of outcomes. A systematic review and meta-analysis. Ther Clin Risk Manag 2017;13:1127-38.
5. Prakash SV, Mohan CG, Reddy VB, Reddy VK, Kumar A, Reddy UM. Salvageability of kidney in grade IV renal trauma by minimally invasive treatment methods. J Emerg Trauma Shock 2015;8:16-20.
6. Bryk DJ, Zhao LC. Guideline of guidelines: A review of urological trauma guidelines. BJU Int 2016;117:226-34.
7. Guareschi BL, Stahlschmidt CM, Becker K, Batista MF, Buso PL, Bahten LC. Epidemiological analysis of polytrauma patients with kidney injuries in a university hospital. Rev Col Bras Cir 2015;42:382-5.
8. Moore EE, Cogbill TH, Jurkovich GJ, Shackford SR, Malangoni MA, Champion HR. Organ injury scaling: Spleen and liver (1994 revision). J Trauma 1995;38:323-4.
9. Sulkowski L, Matyja M, Pasternak A. Pancreas injury in multiorgan trauma patients. Int J Anat Radiol Surg 2018;7:SO06-10.
10. Patel DP, Redshaw JD, Breyer BN, Smith TG, Erickson BA, Majercik SD, *et al.* High-grade renal injuries are often isolated in sports-related trauma. Injury 2015;46:1245-9.
11. Moolman C, Navsaria PH, Lazarus J, Pontin A, Nicol AJ. Nonoperative management of penetrating kidney injuries: A prospective audit. J Urol 2012;188:169-73.
12. Sulkowski L, Matyja M, Pasternak A, Matyja A. Operative management of liver injury in polytrauma patients. Experience of one trauma center. MGM J Med Sci 2018;5:1-3.
13. Zięba S, Szewczyk W, Prajsner A. A case of polytrauma with splenic rupture and complete left renal artery avulsion. Cent European J Urol 2013;66:236-8.

14. Sulkowski L, Matyja M, Pasternak A. Aortic injury: A rare, challenging injury in multiorgan trauma patients. Panam J Trauma Crit Care Emerg Surg 2018;7:204-8.
15. Lefter V, Cibu OA. Renal injury in polytrauma in children. Arch Balkan Med Union 2009;44:204-6.
16. Bjurlin MA, Fantus RJ, Fantus RJ, Villines D. Comparison of nonoperative and surgical management of renal trauma: Can we predict when nonoperative management fails? J Trauma Acute Care Surg 2017;82:356-61.
17. Yeung LL, Brandes SB. Contemporary management of renal trauma: Differences between urologists and trauma surgeons. J Trauma Acute Care Surg 2012;72:68-75; discussion 75-7.
18. Javanmard B, Fallah-Karkan M, Razzaghi M, Ansari Djafari A, Ghiasy S, Lotfi B, *et al.* Characteristics of traumatic urogenital injuries in emergency department: A 10-year cross-sectional study. Arch Acad Emerg Med 2019;7:e63.
19. Keihani S, Putbrese BE, Rogers DM, Zhang C, Nirula R, Luo-Owen X, *et al.*; in conjunction with the Trauma and Urologic Reconstruction Network of Surgeons. The associations between initial radiographic findings and interventions for renal hemorrhage after high-grade renal trauma: Results from the multi-institutional genitourinary trauma study. J Trauma Acute Care Surg 2019;86:974-82.