

Changing Patterns in Iatrogenic Ureteral Injuries

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Advances in laparoscopic and endoscopic surgery over the past 25 years have changed the preferred methods for performing many operations. We previously reported an increase in the number of patients treated for ureteral injury at our institution that paralleled the introduction of minimally invasive techniques. Since that report, more advanced endoscopic procedures have been introduced. We sought to determine whether the latter influenced the number of ureteral injuries managed at our institution. Reported here are the results of our retrospective study, which sought to determine if the rate of treatment of major iatrogenic ureteral injuries has changed.

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Major changes in surgical approaches for the treatment of disease processes may result in increased complication rates. This occurred during the initial introduction of laparoscopic cholecystectomy, where common bile duct injuries initially became more prevalent.¹ We previously reported an increase in the incidence of ureteral injuries with the introduction of ureteroscopy.² There have been other surgical advancements since that report, including the introduction of robotic-assisted surgery, more aggressive ureteroscopic procedures, percutaneous ablation of renal tumors, and the performance of more complex laparoscopic/robotic procedures, including aortic surgery, partial nephrectomy, radical prostatectomy, radical cystectomy, retroperitoneal lymphadenectomy, hysterectomy, bariatric surgery, and colon resection. We performed a retrospective study to determine if the rate of treatment of major iatrogenic ureteral injuries has changed.

Materials and Methods

A retrospective study of major iatrogenic ureteral injuries managed at Wake Forest University Medical Center (Winston-Salem, NC) was undertaken. Institutional Review Board approval for this study was obtained. An injury was considered major if a laparoscopic or open surgical intervention was required for management. Such cases occurring from January 1996 through December 2008 were reviewed. Cases were divided into two time periods, 1996-2001 and 2002-2008, in an attempt to approximate the introduction of the aforementioned newer surgical techniques. Ureteral injury cases were identified through the use of International Statistical Classification of Diseases codes (ICD) and Current Procedural Terminology codes (CPT) related to ureteral injury (Table 1). Cases identified in this manner were reviewed to determine the nature and location of injury, procedures being performed at the time of injury, and resulting intervention and outcome. An analysis of three surgical specialties was undertaken including urology, gynecology, and general/vascular surgery. An estimate of risk was determined by indexing the number of injuries to the number of admissions for each of these respective services. Data analysis was performed using Fisher's exact

test. A *P* value of < .05 was considered statistically significant.

Results

Total Injuries

Seventy-seven ureteral injuries were managed at our institution between 1996 and 2008, with 29 injuries in

dexed to 10,000 admissions increased from 26.31 to 57.24 across the two time periods (*P* = .03) (Table 1). Three injuries occurred at our institution, two during ureteroscopic stone removal performed by nonendourologists, and one during robotic-assisted radical prostatectomy. There was no increase in the rate of

There was no increase in the rate of urologic ureteral injuries occurring at our medical center. Of the urologic injuries, 32/37 (86%) occurred during ureteroscopic stone removal, 3/37 (8%) occurred during percutaneous nephrostolithotomy, and 1/37 (3%) occurred each during robotic prostatectomy, and transurethral resection of bladder tumor (TURBT).

period 1 (1996-2001) and 48 injuries in period 2 (2002-2008) (Table 1). The mean age of the patients (\pm SE) was 49.1 \pm 1.78 years (range, 12-78 years). Forty-eight patients were women, and 29 were men. There were no statistically significant differences in the treatment of ureteral injuries indexed to 10,000 hospital admissions; 9.40 for period 1 and 12.74 for period 2 (*P* = .21). Fifty-six injuries occurred at other institutions.

Urologic Injuries

A total of 37 injuries occurred during urologic procedures; 3 occurred at our institution. Urologic injuries in-

urologic ureteral injuries occurring at our medical center (Table 2). Of the urologic injuries, 32 of 37 (86%) occurred during ureteroscopic stone removal, 3 of 37 (8%) occurred during percutaneous nephrostolithotomy, and 1 of 37 (3%) occurred each during robotic prostatectomy, and transurethral resection of bladder tumor (TURBT). Ureteroscopic stone removal accounted for 11 of 13 (85%) of major urologic iatrogenic ureteral injuries in period 1 and 21 of 24 (88%) in period 2 (Table 3). Among urologic injuries, 19 of 37 (51%), 5 of 37 (14%), and 13 of 37 (35%) involved the proximal, middle, and distal ureter, respectively.

Table 1
Total Number of Ureteral Injuries Managed at Wake Forest University Medical Center and Ureteral Injury Rates Indexed Per 10,000 Admissions

Specialty	Ureteral Injuries		Ureteral Injuries/10,000 Admissions		
	1996-2001	2002-2008	1996-2001	2002-2008	<i>P</i> Value
Urology	13	24	26.31	57.24	.03
Gynecology	11	7	65.40	43.64	.48
General surgery	5	17	2.06	5.33	.055
Total	29	48	9.40	12.74	.21

Table 2
Ureteral Injuries Occurring at Wake Forest University

Specialty	Ureteral Injuries		Ureteral Injuries/10,000Admissions		
	1996-2001	2002-2008	1996-2001	2002-2008	P Value
Urology	1	2	2.02	4.77	.6
Gynecology	3	1	17.84	6.23	.63
General surgery	1	13	0.41	4.08	.006
Total	5	16	1.62	4.25	.077

Table 3
Surgical Procedures Taking Place at the Time of Injury

	Procedure at Injury	1996-2001	2002-2008	Totals
Urology	URS	11 (85%)	21 (88%)	32 (86%)
	PCNL	1	2	3
	TURBT	1	0	1
	RAP	0	1	1
	All	13	24	37
General surgery	Open colon resection	2 (40%)	12 (71%)	14 (70%)
	Laparoscopic colectomy	0	2	2
	Aortic bypass	1	1	2
	Pelvic tumor resection	0	1	1
	Exploratory laparotomy	1	0	1
	Whipple	0	1	1
	Iliac artery aneurysm repair	1	0	1
	All	5	17	22
Gynecology	Radical hysterectomy	7 (64%)	4 (57%)	11 (61%)
	Oophorectomy	1	2	3
	Unknown pelvic surgery	2	0	2
	Laparoscopic hysterectomy	0	1	1
	Vaginal prolapse repair	1	0	1
	All	11	7	18

PCNL, percutaneous nephrostolithotomy; RAP, robotic-assisted prostatectomy; TURBT, transurethral resection of bladder tumor; URS, ureteroscopy.

General Surgical Injuries

Twenty-two injuries occurred during general surgical procedures, 14 of which occurred at our institution. The general surgery injury rate per

10,000 admissions increased from 2.06 to 5.33 across the two time periods but was not statistically significant ($P = .055$) (Table 1). The rate for general surgical injuries occurring at

our institution increased from 0.41 per 10,000 admissions to 4.08 per 10,000 admissions ($P = .006$) (Table 2). Open colectomy was responsible for 14 of 22 (70%) of general surgical injuries

Table 4
Management Techniques for Ureteral Injuries by Location of Injury

Management Technique	Proximal	Middle	Distal	Total
Ileal ureter	11	3	4	18
Boari flap	—	1	17	18
Ureteroureterostomy	5	2	4	11
Nephrectomy	2	1	4	7
Dismembered pyeloplasty	2	—	—	2
Ureteral re-implant	—	1	18	19
Ureterocalicostomy	2	—	—	2
All	22	8	47	77

(Table 4), and 18 of 22 (81%) involved the distal ureter.

Gynecologic Injuries

A total of 18 injuries occurred during gynecologic procedures. There were no significant changes in the incidence of gynecologic injuries as a whole or institutionally across the two time periods. The gynecologic injury rate was 17.84 and 6.23 per 10,000 admissions for the two time periods ($P = .63$). Radical hysterectomy was responsible for 11 of 18 (61%) (Table 3), and 16 of 18 (89%) involved the distal ureter.

Reconstructive Results

A total of 70 reconstructive operations were performed. Nine patients were lost to follow-up. The mean follow-up (\pm SE) was 32 ± 3.64 months (range, 1-108 months). There was no radiographic evidence of obstruction of the involved kidney at the last time of follow-up as assessed by nuclear renography or intravenous pyelography for those patients with documented follow-up. One of the 18 patients subjected to ileal ureter reconstruction required a revision that was successful. Seven patients were subjected to nephrectomy as the involved renal unit had negligible function and the other renal unit was functioning normally.

Discussion

Our current study demonstrates that the most common procedure associated with major iatrogenic ureteral injury is now ureteroscopic stone removal. In our earlier series, in which we analyzed such injuries occurring between 1985 and 1989, we treated 13 patients with major iatrogenic ureteral injuries, of which 7 occurred during gynecologic surgery and 6 occurred during attempts at ureteroscopic stone removal.² This represents a shift in the nature of major iatrogenic ureteral injuries we

such injuries were in the proximal ureter.

There is limited contemporary information (year 2000 and beyond) regarding the patterns of iatrogenic ureteral injuries.³⁻⁵ Parpala-Spärman and colleagues from Finland analyzed ureteric injuries managed at their institution over three different time periods: 1986-1992, 1993-1999, and 2000-2006. They reported that iatrogenic ureteral injuries significantly increased over time and that this was associated with laparoscopic gynecologic procedures but not ureteroscopic interventions.³ Our series did not demonstrate changes in the rate of treatment of major iatrogenic, gynecologic ureteral injuries. The reasons for differences between our results and those of Parpala-Spärman and colleagues are not clear. Perhaps more aggressive ureteroscopic surgery was not being conducted in Finland during these time periods or the gynecologists were still in the learning curve phases of advanced laparoscopic interventions.

There was an increase in the index of overall major iatrogenic ureteral

There was an increase in the index of overall major iatrogenic ureteral injuries for the general surgical cohort that approached statistical significance. This rate did reach statistical significance within our institution.

have managed. We cannot definitively identify the reason for this occurrence. One possibility is that urologists have become more aggressive with ureteroscopic procedures in the kidney and proximal and middle ureter. This has perhaps been driven by the development of new technology such as better flexible ureteroscopes, new lasers, grasping devices and baskets, and the utilization of ureteral access sheaths. Our findings support this because the majority of

injuries for the general surgical cohort that approached statistical significance. This rate did reach statistical significance within our institution. The majority of injuries occurred during colon resection procedures and the reasons for this trend may be the introduction of laparoscopic colon resection and more aggressive open surgical interventions.

Our results demonstrate that, if such injuries occur, reconstructive ureteral surgery may yield excellent

renal salvage rates. Although open surgical techniques were used in all reconstructive procedures reviewed in this series, we recognize that some of these patients can now be treated with either laparoscopic or robotic-assisted surgery.⁶⁻⁸

The finding that a significant number of major iatrogenic ureteral injuries are still occurring during ureteroscopic stone removal underscores the importance of proper patient selection, patient preparation, and surgical technique. Although the technology has expanded the indications for such procedures, one must always proceed with caution and patience when embarking on ureteroscopic stone removal.

We recognize that this study has certain limitations. We used an estimate based on number of hospitalizations per admitting surgical specialty to determine the at-risk population because the true denominator was not available. The

true denominator would be patients undergoing surgical procedures where the ureter would be at risk at our medical center and those occurring at the referring institutions. The numerator which we used could also be inaccurate because all such injuries occurring at the other centers were not necessarily managed at our institution. This was also a retrospective study that by design would have its own inherent deficits including inaccurate ICD and CPT coding. We are also a referral center for such injuries in our area and this may have introduced selection bias.

Conclusions

The majority of major iatrogenic ureteral injuries occur during ureteroscopic stone removal. This underscores the importance of proper patient selection and employment of appropriate surgical techniques. Renal salvage is attainable in the majority of these cases with reconstructive ureteral surgery. ■

References

1. Shea JA, Healey MJ, Berlin JA, et al. Mortality and complications associated with laparoscopic cholecystectomy. A meta-analysis. *Ann Surg.* 1996;224:609-620.
2. Assimos DG, Patterson LC, Taylor CL. Changing incidence and etiology of iatrogenic ureteral injuries. *J Urol.* 1994;152(6 Pt 2): 2240-2246.
3. Parpala-Spärman T, Paananen I, Santala M, et al. Increasing numbers of ureteric injuries after the introduction of laparoscopic surgery. *Scand J Urol Nephrol.* 2008;42:422-427.
4. Chou YH, Chen MT, Huang CH. Changing trends of ureteral injuries. *Kaohsiung J Med Sci.* 1998;14:751-753.
5. Selzman AA, Spirnak P. Iatrogenic ureteral injuries: a 20-year experience in treating 165 injuries. *J Urol.* 1996;155:878-881.
6. Allaparthi S, Ramanathan R, Balaji KC. Robotic distal ureterectomy with boari flap reconstruction for distal ureteral urothelial cancers: a single institutional pilot experience. *J Laparoendosc Adv Surg Tech A.* 2010;20: 165-171.
7. Singh I, Kader K, Hemal AK. Robotic distal ureterectomy with reimplantation in malignancy: technical nuances. *Can J Urol.* 2009;16:4671-4676.
8. Thiel DD, Leroy TJ, Winfield HN, Igel TC. Robotic-assisted laparoscopic reconstruction of the upper urinary tract: tips and tricks. *Urology.* 2010;76:488-493.

Main Points

- The current study demonstrates that the most common procedure associated with major iatrogenic ureteral injury is now ureteroscopic stone removal.
- Urologists have become more aggressive with ureteroscopic procedures in the kidney and proximal and middle ureter, which may be due to the development of new technology such as better flexible ureteroscopes, new lasers, grasping devices and baskets, and the utilization of ureteral access sheaths.
- The authors demonstrated that reconstructive ureteral surgery may yield excellent renal salvage rates when treating ureteral injuries. Although open surgical techniques were used in all reconstructive procedures reviewed in this series, it is recognized that some of these patients can now be treated with either laparoscopic or robotic-assisted surgery.
- The majority of major iatrogenic ureteral injuries occur during ureteroscopic stone removal. This underscores the importance of proper patient selection and employment of appropriate surgical techniques. Renal salvage is attainable in the majority of these cases with reconstructive ureteral surgery.