



Comparative Study of Ureteral Injuries After Rectal Surgery Via Laparoscopy vs. Laparotomy

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Abstract

Background: Despite the low frequency rate, ureteral injuries can lead to significant morbidity. Urinary organs can be injured during open or laparoscopic surgery. This study aimed to assess differences in ureteral injury rates between laparoscopic and open surgery for rectal neoplasms.

Methods: This retrospective study included 726 patients with rectal tumors in Shiraz, Iran, from 2000 to 2021. Data collected from the patients' electronic charts included the type of surgery, gender, age, body mass index (BMI), stage, appearance and size of the tumor, preoperative chemoradiotherapy, recurrence, and metastasis. Ureteral injury and urinary incontinence occurrences were recorded.

Results: Abdominoperineal (AP) resection was done via laparoscopy in 131 (22.2%) cases and laparotomy in 42 (30.9%) cases. Low anterior resection was performed by laparoscopy in 254 (43%) cases and laparotomy in 61 (44.8%) cases. The frequency of ureteral injuries was 2.2% for open procedures and 1.5% for laparoscopic procedures (P=0.837). The rate of urinary incontinence was 65 (11.0%) in the laparoscopy and 9 (6.6%) in the laparotomy group (P=0.169).

Conclusion: The frequency of ureteral injury after laparotomy or laparoscopic surgeries was not significantly different. Although the number of side effects of these surgeries was low, it can be concluded that the possibility of damage to the ureter is less in laparoscopic surgery, while that of damage to the nerves of the pelvic floor is more.

Keywords: Sphincter, Rectal cancer, Surgery, Urinary

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Introduction

In the early 1990s, the first laparoscopic approach for colorectal surgery was taken (1). The outcome of laparoscopic and open colectomy has been compared in many studies, and no significant

differences were found in mortality and morbidity. Laparoscopic surgeries usually take longer than laparotomy, but better recovery of bowel function and a shorter hospital stay are the advantages that can not be ignored (2, 3).

Laparoscopic surgery in some areas may increase

the frequency of iatrogenic injuries. For example, laparoscopic cholecystectomy increased the rate of bile duct damage at first, and now it has decreased to a level comparable to open cholecystectomy (0.4%–0.6% vs. 0.1%–0.2%, respectively) (4). In laparoscopic hysterectomy, the risk of iatrogenic damage to the urinary tract is increased compared to abdominal hysterectomy (5).

Ureteral injury (UI) is a serious but rare complication of colorectal surgery. While the rate of total injury for colorectal surgery is unknown, the prevalence of ureteral injury was specifically reported in 0.2–5% of patients with increased morbidity (e.g., urinary incontinence) after colorectal surgery (6–8).

Surgeons always pay close attention to the ureters during rectal surgery; however, the rate of ureteral injury in laparoscopic compared to open rectal surgery has not been evaluated sufficiently. A study on 5,729 patients showed an increased risk of ureteral injury in laparoscopic versus open colectomy (0.66 vs. 0.15%, $P=0.007$) (6). However, a study on 6,027 ureteral injuries showed that laparoscopic surgery caused this complication less often in colorectal surgery, representing a protective factor (odds ratio=0.91) (7). It is not known whether a urinary injury is more common after laparoscopic or open colectomy. The use of a lighted stent to prevent ureteral injury in colorectal surgery is helpful and does not impose a large amount of additional risk (9).

Depending on the severity of the disease, there may be an inherent difference in the population of patients selected for each surgery. Previous studies have reported that the risk factors for urinary incontinence are previous surgery, removal of large pelvic masses, inflammatory disease, malignant neoplasms, and radiation therapy (8). To date, no confirmed information is available on the degree of protection of the urinary sphincter at laparoscopy compared to laparotomy. Some reports show the use of ureteral stents in proctectomy during laparoscopic colorectal surgery (9, 10). Also, some studies indicate that the ureteral injury rate is less when the surgeon observes the ureters (11). Some surgeons believe that if the ureter is not found, the procedure should be converted (12). This study aimed to evaluate the risk of urinary incontinence in laparoscopic and open surgery in patients with rectal tumors.

Methods

We performed a retrospective review of 726 patients who underwent rectal surgery at Mother and Child, Martyr Faghihi, and Abu Ali-Sina hospitals in Shiraz from 2000 to 2021. All surgeries were performed by the same team, although they were performed in three different places. The colorectal surgery service directed and reported all procedures. We evaluated the type of rectal surgery, gender, age, body mass index (BMI), stage and size of the tumor, preoperative chemoradiotherapy, recurrence,

metastasis, and cancer comorbidities. The urinary incontinence status was assessed at the most recent follow-up, as defined by patients.

Ureteral Injury During Surgery

Patients were treated for benign and malignant rectal diseases; no repeat laparoscopic surgery was provided. In all laparoscopic cancers, the ureter was identified during dissection, as in the open method. The number of abdominoperineal (AP) resections was compared between laparoscopy and laparotomy surgeries. A urologist documented whether a complementary procedure such as a double J catheterization, cystoscopy, or ureteroscopy was performed. The number of ureteral injuries in each group was measured. Some patients were suspicious of injury, for whom ureteroscopy or stent insertion was a preventive measure. The rate of ureteral injury was compared between laparoscopy and laparotomy.

Statistics Analysis

Data are presented as numbers and percentages. Differences in variables among the patients operated on using a laparoscopic technique were compared with those for whom an open technique was used; we applied the chi-squared test or Fischer's exact test to analyze the data. All statistical analyses were two-sided, using a significance level of $P<0.05$. Statistical analyses were carried out using SPSS Statistics for Windows, Version 23.0.

Results

There were 470 surgeries from Martyr Faghihi Hospital, 190 from Mother and Child Hospital, and 66 from Abu-Ali Sina Hospital. A total of 287 (39.5%) females and 439 (60.5%) males were evaluated. The patients' mean age was 57.35 ± 13.46 (range: 21–98) years, and the mean BMI was 19.66 ± 10.66 (range: 14.2–44.9) kg/m^2 .

Four hundred seventy-eight patients had neoadjuvant radiochemotherapy, but 333 of them had neoadjuvant chemotherapy. Two hundred twenty-six patients had a recto-sigmoidal tumor or sigmoidal tumor, and the others had a rectal tumor. The mean size of the tumors was 3.04 ± 2.23 (range: 0.01–11.50) cm^2 .

A total of 590 (75.7%) laparoscopy surgeries were performed; among these patients, 53 had bleeding and adhesion to the surrounding tissues, and the surgery was converted to open for them. Also, 136 (17.5%) patients underwent laparotomy surgeries from the beginning (Table 1). The stages of patients in the two groups are shown in Table 2.

Seven hundred and fourteen patients did not show any ureteral injury. During the surgery, five patients were suspicious of ureter injury by negative cystoscopy and ureteroscopy, but for the likelihood of injury, they had stent insertion as the preventive surgery; seven patients had a urethral injury or ureteral injury and were treated by a DJ stent, three

Table 1: Characteristics of patients in the two study groups

Parameters (n=726)		Laparoscopy (n=590) (81.3%)	Laparotomy (n=136) (18.7%)	P value
Age (years) Mean (SD)		57.25 (13.56)	56.80 (13.31)	0.726
Sex (%)	Male	231 (39.15%)	56 (41.18%)	0.734
	Female	359 (60.85%)	80 (58.82%)	0.734
BMI, Mean (SD)		18.99 (11.15)	22.63 (6.64)	0.047
Size of tumors (cm ²), Mean (SD)		2.87 (2.12)	3.57 (2.59)	0.023
Metastasis (%)		117 (19.83%)	36 (26.47%)	0.111
Liver metastasis (%)		28 (4.74%)	8 (5.88%)	0.739
Recurrence of disease (%)		59 (10%)	32 (23.53%)	<0.001
Ureteral injury (%)		9 (1.5%)	3 (2.2%)	0.837
Type of surgery (%)	Abdominoperineal resection	131 (22.2%)	42 (30.9%)	0.042
	Low anterior resection	254 (43.0%)	61 (44.8%)	0.775
	Ultra-low anterior resection	205 (34.7%)	33 (24.3%)	0.026

Table 2: Tumor stages of patients in the two groups (n=726)

	Stage	Laparoscopy (n=590) (81.3%)	Laparotomy (n=136) (18.7%)	P value
Staging	---	83 (14.1%)	14 (10.29%)	0.299
	0	16 (2.71%)	11 (8.09%)	0.006
	I	171 (28.98%)	29 (21.32%)	0.089
	II A	115 (19.49%)	41 (30.15%)	0.009
	II B	11 (1.86%)	1 (0.73%)	0.576
	II C	2 (0.34%)	0 (0%)	0.822
	III A	40 (6.78%)	4 (2.94%)	0.135
	III B	107 (18.13%)	25 (18.38%)	0.956
	III C	29 (4.91%)	4 (2.94%)	0.443
	IV A	16 (2.71%)	7 (5.15%)	0.233
M stage	---	82 (13.9%)	9 (6.62%)	0.030
	M1a	14 (2.37%)	6 (4.41%)	0.308
	M1b	0 (0%)	2 (1.47%)	0.041
	MX	494 (83.73%)	119 (87.5%)	0.336
N stage	---	81 (13.73%)	9 (6.62%)	0.034
	N1a	78 (13.22%)	18 (13.23%)	0.891
	N1b	18 (3.05%)	6 (4.41%)	0.593
	N1c	40 (6.78%)	3 (2.2%)	0.066
	N2a	24 (4.07%)	7 (5.15%)	0.744
	N2b	21 (3.56%)	4 (2.94%)	0.923
	No	328 (55.59%)	88 (64.7%)	0.066
	NX	0 (0%)	1 (0.73%)	0.430
T stage	---	81 (13.73%)	9 (6.62%)	0.034
	T0	12 (2.03%)	12 (8.82%)	0.002
	T1	45 (7.63%)	8 (5.88%)	0.600
	T2	183 (31.02%)	33 (24.26%)	0.147
	T3	228 (38.64%)	69 (50.73%)	0.013
	T4a	30 (5.08%)	4 (2.94%)	0.401
	T4b	7 (1.19%)	0 (0%)	0.428
	Tis	3 (0.51%)	0 (0%)	0.925
	Tx	1 (0.17%)	1 (0.73%)	0.829

of whom had laparotomy surgery, and the others had laparoscopy surgery.

During ten years, 726 patients who had undergone rectal surgeries were questioned after surgery about urinary incontinence; 74 (10.2%) patients had urinary incontinence, 65 (11.0%) of whom had undergone

laparoscopy, and 9 (6.6%) of whom had a laparotomy (P=0.169). One patient had undergone repair surgery in the bladder, but the ureter and ureteral area were not defective.

Urinary incontinence was recorded in 22 (12.0%) patients with AP resection, 33 (9.6%) patients with

low anterior resection, and 21 (8.4%) patients with ultra-low anterior resection. There was a significant relationship between tumor size and urinary incontinence ($P=0.024$). Radiotherapy was seen in 337 (57.12%) patients in the laparoscopy group and 104 (76.47%) patients in the laparotomy group ($P<0.001$). The numbers and percentages were higher in the laparotomy group than in the laparoscopy group. Also, 52 (68.42%) of patients with urinary incontinence had undergone radiotherapy, while 40 (52.63%) patients with urinary incontinence had undergone chemotherapy.

Discussion

The pelvic cavity contains sensitive and vital organs and tissues, such as vessels, ureters, and nerves; surgery in this area, especially for a neoplasm, has consequences such as damage to the ureter and nerves of the pelvic floor (13). Many colorectal surgeries are oncologic in nature, and patients may have undergone prior abdominal surgeries or may receive chemotherapy and/or radiotherapy before or after the operation. Thus, the outcomes of the urinary repair may be compromised. As such, it is important to determine whether injuries occur more frequently in a particular patient population or during specific operative circumstances. Risk factors for ureteral injuries after rectal cancer were reported by an odds ratio of 1.85 and protective factors by using laparoscopy were reported by an odds ratio of 0.91 (7). Ureteral injuries are associated with higher mortality, morbidity, hospital charge, and length of stay, and their frequency can be predicted by several factors (7).

The chance of damage to the ureter has varied across open and laparoscopic surgery (6, 14). In the study of Zafar et al., a higher rate of injury was reported in open surgery (14), while in the study of Palaniappa et al., ureteral damage was more in laparoscopic surgery than in open surgery (6). In this retrospective study, the chance of damage to the ureter in open surgery was 6.6% vs. 11.0% in laparoscopic surgeries. The inferior chance of damage to the ureter in laparoscopy is probably because we defined the ureter completely during the operations.

Pelvic nerve injury is a complication of pelvic dissection in colorectal surgery, and the rate of urinary and sexual dysfunction varies from 5–40% depending on the surgery and the underlying pathology (15). Also, the chance of involvement of the pelvic floor nerves such as sympathetic and parasympathetic ones, and urinary incontinence disorder were reported more in laparoscopic surgery than in open surgery in the study of Jayne et al. (16). From the results of these studies, there appears to be no distinct advantage of the laparoscopic technique in preserving autonomic function compared to the

open approach as previously purported. It must also be mentioned that the creation of stomas profoundly impacts the quality of life. To the best of our knowledge, no large-scale prospective study directly measures the impact of laparoscopic or open proctectomy on stoma creation and its resultant impact on the quality of life (17). A significantly lower laparoscopic surgery rate was found in males and females who reported sexual dysfunction after surgery than those who had undergone open surgery (18).

Damage to the surrounding organs has been reported more in the case of larger tumor size, adhesion to the surrounding tissues, and receiving radiation before the operation. However, the number and percentage of urinary incontinence and nocturnal enuresis, which may be a sign of damage to the pelvic floor nerve, were higher in laparoscopic surgery than in open surgery. It is also possible that radiotherapy and chemotherapy may affect the urinary incontinence rate. If these factors are eliminated, the difference between open and laparoscopic surgery can be attributed to nerve damage.

Conclusion

The frequency of ureteral injury after laparotomy or laparoscopy was not significantly different. Although the number of side effects of these surgeries is low, it can be concluded that in laparoscopic surgery, the possibility of damage to the nerves of the pelvic floor is higher. It is suggested that more studies should be conducted to investigate this issue. From a technical point of view, it seems that pelvic floor surgery should be performed similarly to nerve-sparing surgery, in which by identifying the nerves in the area, the chance of damage to them will be reduced.

Limitations

This was a retrospective study from an administrative database.

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Authors' Contribution

Seyed Vahid Hosseini: design of study, data analysis, and writing and approve of final revision, Seyed Hossein Hosseini, data analysis, writing and approve of final revision, Hajar Khazraei, data analysis, writing and approve of final revision, Mahboobeh Pourahmad: data analysis and approve of final revision

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References

1. Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). *Surgical laparoscopy & endoscopy*. 1991;1(3):144-50.
2. Green BL, Marshall HC, Collinson F, Quirke P, Guillou P, Jayne DG, et al. Long-term follow-up of the Medical Research Council CLASICC trial of conventional versus laparoscopically assisted resection in colorectal cancer. *The British journal of surgery*. 2013;100(1):75-82.
3. Ohtani H, Tamamori Y, Arimoto Y, Nishiguchi Y, Maeda K, Hirakawa K. A meta-analysis of the short- and long-term results of randomized controlled trials that compared laparoscopy-assisted and open colectomy for colon cancer. *Journal of Cancer*. 2012;3:49-57.
4. Richardson MC, Bell G, Fullarton GM. Frequency and nature of bile duct injuries following laparoscopic cholecystectomy: an audit of 5913 cases. *West of Scotland Laparoscopic Cholecystectomy Audit Group. The British journal of surgery*. 1996;83(10):1356-60.
5. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. *The Cochrane database of systematic reviews*. 2009(3):Cd003677.
6. Palaniappa NC, Telem DA, Ranasinghe NE, Divino CM. Frequency of iatrogenic ureteral injury after laparoscopic colectomy. *Archives of surgery (Chicago, Ill : 1960)*. 2012;147(3):267-71.
7. Halabi WJ, Jafari MD, Nguyen VQ, Carmichael JC, Mills S, Pigazzi A, et al. Ureteral injuries in colorectal surgery: an analysis of trends, outcomes, and risk factors over a 10-year period in the United States. *Diseases of the colon and rectum*. 2014;57(2):179-86.
8. Marcelissen TA, Den Hollander PP, Tuytten TR, Sosef MN. Frequency of Iatrogenic Ureteral Injury During Open and Laparoscopic Colorectal Surgery: A Single Center Experience and Review of the Literature. *Surgical laparoscopy, endoscopy & percutaneous techniques*. 2016;26(6):513-5.
9. Boyan WP, Jr., Lavy D, Dinallo A, Otero J, Roding A, Hanos D, et al. Lighted ureteral stents in laparoscopic colorectal surgery; a five-year experience. *Annals of translational medicine*. 2017;5(3):44.
10. Speicher PJ, Goldsmith ZG, Nussbaum DP, Turley RS, Peterson AC, Mantyh CR. Ureteral stenting in laparoscopic colorectal surgery. *The Journal of surgical research*. 2014;190(1):98-103.
11. Garg R, . Ureteric Injury in Gynecology Surgery. *Urinary Tract Infection and Nephropathy - Insights into Potential Relationship* 2021.
12. Yellinek S, Krizzuk D, J JN, S DW. Ureteral Injury During Colorectal Surgery: Two Case Reports and a Literature Review. *Journal of the anus, rectum and colon*. 2018;2(3):71-6.
13. Kim NK, Kim HS, Alessa M, Torky R. Optimal Complete Rectum Mobilization Focused on the Anatomy of the Pelvic Fascia and Autonomic Nerves: 30 Years of Experience at Severance Hospital. *Yonsei medical journal*. 2021;62(3):187-99.
14. Zafar SN, Ahaghotu CA, Libuit L, Ortega G, Coleman PW, Cornwell EE, 3rd, et al. Ureteral injury after laparoscopic versus open colectomy. *JLS : Journal of the Society of Laparoendoscopic Surgeons*. 2014;18(3).
15. Nesargikar PN, Kaur V, Cocker DM, Lengyel J. Consenting for pelvic nerve injury in colorectal surgery: need to address age and gender bias. *Annals of the Royal College of Surgeons of England*. 2010;92(5):391-4.
16. Jayne DG, Brown JM, Thorpe H, Walker J, Quirke P, Guillou PJ. Bladder and sexual function following resection for rectal cancer in a randomized clinical trial of laparoscopic versus open technique. *The British journal of surgery*. 2005;92(9):1124-32.
17. Chan DK, Chong CS, Lieske B, Tan KK. Laparoscopic resection for rectal cancer: what is the evidence? *BioMed research international*. 2014;2014:347810.
18. Attaallah W, Ertekin SC, Yegen C. Prospective study of sexual dysfunction after proctectomy for rectal cancer. *Asian journal of surgery*. 2018;41(5):454-61.