Laparoscopic and robotic transperitoneal repair of retrocaval ureter: A comparison of the surgical outcomes from two centres with a comprehensive literature review

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Abstract

Background: The use of minimally invasive surgical approaches for the repair of retrocaval ureter (RCU) has been increased in time. However, the results of the robotic approach have not yet been compared with those of open or laparoscopic approaches. We aimed to compare the results of laparoscopic and robotic transperitoneal repair of RCU from two centres.

Patients and Methods: Initially, we performed a systemic literature search using MEDLINE/PubMed and Google Scholar about the RCU. Finally, a comparison of the efficacy and outcomes of the laparoscopic and robotic transperitoneal approaches for RCU repair was performed with the results of two centers.

Results: The mean age was 27.5 ± 3.6 years. The mean operative time was 147 ± 63.6 min. The median estimated blood loss was 100 (20–423.9) ml. The median drain removing time and hospital stay were 2 (2–3) and 3 (2–4) days, respectively. The mean follow-up period was 17.85 ± 14.6 months. All of the parameters were similar between the laparoscopic and robotic repair groups except for the mean operative time. It was significantly shorter in robotic repair group than those of laparoscopic repair group (P = 0.02). Furthermore, a ureteral stricture of the anastomotic segment was detected in a patient treated with laparoscopy during the follow-up.

Conclusions: Robotic transperitoneal approach may shorten the operative time enabling a greater comfort in repair of RCU.

Keywords: Laparoscopy, outcome assessment, retrocaval ureter, robotics

INTRODUCTION

Retrocaval ureter (RCU) is a rare congenital anomalous which commonly causes urinary obstruction and related symptoms. In fact, it is a vascular anomalous rather than ureteral abnormality. Indeed, the pathogenesis is originally associated with the abnormal development of the inferior vena cava (IVC).[1] After the first report by Hochstetter in
1893, the classic treatment was described as the excision of the retrocaval segment, anteposition and ureteroureteral or ureteropelvic anastomosis with open surgical repair.\[1-3\] The development of minimally invasive surgical technology and techniques has made the treatment choice in almost all off surgical diseases from open to endoscopic procedures, including laparoscopic and robotic approaches. The use of minimally invasive surgical approaches for the repair of RCU has been increased in time as well.\[4,5\] Nevertheless, because of the rarity of the disease, there is a paucity of data about the surgical outcomes and efficacy of the minimally invasive surgical repair of RCU. While the results of open and laparoscopic repair of RCU have been compared by very few research articles, the results of robotic approach have not been compared yet with those of open or laparoscopic approaches.\[6,7\]

In this study, we reviewed the data of the two centres, Bagcilar Training and Research Hospital (Istanbul/Turkey) and All India Institute of Medical Sciences (New Delhi/India), and compared the results of laparoscopic and robotic transperitoneal repair of RCU from these two centres.

PATIENTS AND METHODS

Literature review
Initially, we performed a systemic literature search using MEDLINE/PubMed and Google Scholar about the RCU at the urology clinic of Bagcilar Training and Research Hospital/Turkey. At 10 June 2018, a total of 409 results published between 1946 and 2018 were found in the MEDLINE/PubMed database with the keywords ‘RCU’. Out of them, 39 were about other ureteral anomalous, RCU in animals such as ferret, cat and dog and ureteral intervention for the repair of vascular anomalous in horseshoe kidney, hydatid cyst mimicking RCU and right side ureteral hydronephrosis secondary to lymphadenopathy of Merkel cell carcinoma. All these articles were ignored. We only considered the manuscripts with English and 154 articles written with other languages were excluded from the study. A total of 15 articles about the paediatric RCU ureter were also excluded from the study. After the investigation of remaining 254 publications, it was observed that literature about the RCU commonly existed as case reports or case series consisting of one or more cases. There were also some review articles published about the RCU and its management. We did not find any relevant case series related to robotic repairment of the RCU in the MEDLINE/PubMed database. Although there was an article published by Hemal et al\[8\] about the robot-assisted laparoscopic surgery for the upper and lower ureteral pathologies, including four cases of robotic repair of RCU with other ureteral procedures, the remaining results were about single case reports of RCU with robotic repair. Thus, we performed a systemic literature search with the keywords ‘robot-assisted RCU repair’ and ‘robotic RCU’ using Google Scholar database, as well. We found 595 results and only 10 of them were related with robotic repair of RCU and in English. Video presentations in any congress and/or a journal (five articles), single case reports (two articles), a paediatric case report and a book chapter about the RCU were ignored. The remaining article was about the case series of robotic repair of RCU from the urology clinic of All India Institute of Medical Sciences/India reported by Nayak and Gupta.\[9\] We decided to compare the outcomes of laparoscopic and robotic transperitoneal repair of RCU in cooperation with the urology clinic of All India Institute of Medical Sciences/India. Finally, a comparison of the efficacy and outcomes of the laparoscopic and robotic transperitoneal approaches for RCU repair was performed with the results of the two centres.

Patients/subjects
A total of 10 patients underwent transperitoneal laparoscopic and robotic repair of RCU between August 2006 and February 2017 at the urology clinics of the two centres were enrolled in the study. All procedures were conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000. Approval of the Ethical Committee on human experimentation was not obtained because of the retrospective nature of the study. The laparoscopic repair was performed in Bagcilar Training and Research Hospital, Istanbul/Turkey in five cases, whereas robotic repair was in All India Institute of Medical Sciences, New Delhi/India in remaining five cases. Intravenous pyelography (IVP) and contrast-enhanced computed tomography with three-dimensional reconstruction/magnetic resonance imaging were used as diagnostic tools in all of the patients at the two departments. The 99m-technetium diethylenetriaminepentaacetic acid (99mTc-DTPA) diuretic renal scintigraphy examinations were also performed in all patients. After the confirmation of the RCU diagnosis, all procedures were performed by a single surgeon and three expert surgeons under general anaesthesia for the repair of the RCU at Bagcilar Training and Research Hospital (Istanbul/Turkey) and All India Institute of Medical Sciences (New Delhi/India), respectively.

Surgical techniques
Laparoscopic transperitoneal repair
After the insertion of ureteral catheter just below the ureteral kink and bladder catheter in the lithotomy position,
the diagnosis of RCU was confirmed with retrograde pyelography. Further, the patients placed in the left lateral position. A pneumoperitoneum was created using a Veress needle. First, a 10-mm camera port was placed at the umbilicus level on the lateral rectus border. Further, a 10-mm port was placed 1 cm below the costal border on the midclavicular line, and a 5-mm port at a point on the lateral one-third of the line between the anterior superior iliac spine and the umbilicus was placed under direct vision. A 5-mm fourth trocar was also placed for traction on midaxillary line at the level of the umbilicus. The conventional 2D vision system (Karl Storz, Tuttingen, Germany) and 3D vision system (Viking Systems, LaJolla, CA) were used in three and two of the patients. The right colon was reflected medially exposing the retroperitoneum, followed by dissection of the right renal pelvis and ureter. The proximal ureter was seen behind the IVC, and it was transected at the point where it went retrocaval. The retrocaval segment was entirely mobilised and inspected. The obliterated ureteral segments were excised till the healthy margin in four cases. The distal segment was transported anterior to the IVC, then ureteroureterostomy or ureteropyelostomy was performed using 4-0 continuous polyglactin suture. After completion of posterior layer of the anastomosis, antegrade stenting was done using a 5F JJ stent. The rest of the anastomosis was completed over the stent, and a suction drain was placed. The JJ stent was removed 6 weeks after the surgery. Patients were followed up at 3rd month, 6th month, 1st year and thereafter yearly or if symptomatic. Repeat renal diuretic renography scan was performed 6 months after surgery.

Robotic transperitoneal repair
After the insertion of bladder catheter and clamping the catheter to keep the bladder distended to aid in the subsequent placement of JJ stent, the patients placed in the left lateral position. A pneumoperitoneum was created using a Veress needle. First, a 12-mm camera port was placed along the lateral border of the rectus abdominis above the umbilicus, and then two 8-mm robotic ports were placed on the midclavicular line, one under the costal margin and one at the spinoumbilical line. A fourth 12-mm port was placed on the midline either above or below the umbilicus for the assistant to help in suction and retraction. The Da Vinci robot was then docked from the back of the patient. The right colon was mobilised to provide exposure to the right-sided retroperitoneal structures. The right renal pelvis and proximal ureter were dissected after the identification of the right renal pelvis and IVC. The proximal ureter was seen behind the IVC. In two patients, transection was performed at the renal pelvis and in the other three patients at the proximal ureter. The retrocaval segment of the ureter was not excised and left in situ. Ureteroureterostomy was performed in three patients and pyelopyelostomy in the other two. After transection at the pelvis or proximal ureter, the distal segment was transposed anterior to the IVC. Then, pyelopyelostomy or ureteroureterostomy was performed using a 4-0 continuous polyglactin suture. After completion of either the anterior or posterior layer of the anastomosis, antegrade stenting was done using a 6F JJ stent. The rest of the anastomosis was completed over the stent, and a suction drain was placed. The JJ stent was removed 6 weeks after the surgery. Patients were followed up at 3rd month, 6th month, 1st year and thereafter yearly or if symptomatic. Repeat renal diuretic renography scan was performed 6 months after surgery.

Statistical analysis
Statistical analyses were performed using SPSS 22 software (IBM Corp., Armonk, NY, USA). Test of normality was performed using the Shapiro–Wilk method. Data were expressed as mean and standard deviation or median and interquartile range. Comparison of the parameters was performed using independent t-test and Mann–Whitney U-test in normal distributed and non-normal distributed data, respectively. Although there is a doubt about the use of parametric statistical tests when the sample size is small, most authors revealed that when the population distribution is normal and the sample size is as small as 4 or 5, the parametric tests have very adequate achievement. Therefore, we used the parametric independent t-test without any hesitation after the confirmation of the test of normality.

RESULTS
All operations were achieved laparoscopic or robotic approaches without conversion to open surgery. Two patients were female and eight were male. The mean age was 27.5 ± 3.6 years. The mean operative time was 147 ± 63.6 min. The median estimated blood loss was 100 (20–423.9) ml. The median drain removing time and hospital stay were 2 (2–3) and 3 (2–4) days, respectively. The mean follow-up period was 17.85 ± 14.6 months. Age, estimated blood loss, drain removal time, hospital stay and follow-up times were similar between the laparoscopic and robotic repair groups. However, the mean operative time was significantly shorter in the robotic repair group than those of laparoscopic repair group (P = 0.02) [Table 1]. All the patients were symptom-free on follow-up with reduction of the hydronephrosis and obstruction in the robotic repair group. However, persistent symptoms were seen 3 months after the operation in a patient treated
with laparoscopic approach without the excision of the retrocaval segment. A ureteral stricture of the anastomotic segment was detected in the $99m$ Tc-DTPA and retrograde pyelography examinations. The patient managed with laparoscopic repair, including the excision of the stricture and reanastomosis of the ureteric segment. He was symptom-free during his 6-month follow-up with reduction of the hydronephrosis and obstruction.

**DISCUSSION**

Outcomes of laparoscopic and robotic approaches were compared almost in all urologic procedures such as prostatectomy, nephrectomy and adrenalectomy. However, previously, no such study has compared the laparoscopic and robotic approach for the repair of RCU.[11] The present study has a great importance because of being the first of such comparative study.

The traditional treatment of RCU has been relocation and ureteroureteral anastomosis of the ureter usually with the excision or bypass of the retrocaval segment with open surgery. With the technical improvement, laparoscopic procedures have replaced open surgery for the repair of RCU, as such in other urologic procedures.[4,5] The first laparoscopic repair of RCU was reported by Matsuda et al.[12] in 1996. Then, the use of laparoscopic approach gathered speed by 2000s and several relevant case series were reported with favourable outcomes. However, to the best of our knowledge, there are only two comparative research articles associated with the laparoscopic repair of RCU. First one published by Ji et al.[7] in 2014 investigated the outcomes of transperitoneal and retroperitoneal laparoscopic repair of RCU in 18 patients. The authors found no significant differences regarding surgical outcomes such as operative time, blood loss and post-operative complications. The second one, published by Mao et al.[6] in 2017, compared the clinical efficacy and safety of retroperitoneal laparoscopic and open repair of RCU with a total of 14 patients. The authors revealed considerable advantages of retroperitoneal laparoscopic approach, including decreased blood loss and urine leak, shorter hospital stay and recovery time, even though it had taken longer operative time. In time, robotic repair of RCU has become the current issue by means of the popularisation of minimally invasive surgery with robot-assisted technology. The first robotic approach to RCU was published in 2006 by Gundeti et al.[13] for a paediatric patient. Just after, following robotic RCU repair cases were published.[14-18] The majority of the publications associated with robotic repair of RCU were single case reports. However, a case series published by Nayak and Gupta[9] presented an experience of robotic repair of RCU with five consecutive patients. In the present study, the outcomes of laparoscopic repair of RCU from Bagcilar Training and Research Hospital Istanbul/Turkey were compared with those of robotic repair by Nayak and Gupta.[9]

As mentioned above, according to Mao et al.,[6] decreased blood loss, decreased urine leak, shorter hospital stay and recovery time were reported with the retroperitoneal laparoscopic approach compared to open approach. However, significantly, higher operative time was detected with the laparoscopic repair of RCU. Robotic technology could decrease the operative time during the surgery. A study comparing the outcomes of laparoscopic radical prostatectomy and robot-assisted laparoscopic prostatectomy (RALP) in 2386 consecutive patients with localised prostate cancer revealed that RALP had several benefits, including reduced blood loss and shorter operative time and hospital stay.[19] On the other hand, in a systemic review and meta-analysis, no significant advantages regarding operative time, estimated blood loss and hospital stay reported for robotic approaches in partial nephrectomy compared to laparoscopic approaches.[20] Similarly, for adrenalectomy, no significant advantages regarding the operative time were detected with robotic compared to the laparoscopic approach; however, lower estimated blood loss and shorter hospital stay were reported in favour of the robotic approach.[21,22] In a most recent systemic review and meta-analysis, published in January 2018 by Roh et al.,[8] shorter operative times were reported with robotic approaches compared to conventional laparoscopic approaches for adrenalectomy and cystectomy, but not for nephrectomy and prostatectomy. Nevertheless, there are controversial data about the effects of using robotic technology on surgical outcomes such as operative time, blood loss and length of hospital stay in any procedure.[11]
Our surgical outcomes with a mean of 147 ± 63.6 min. Operative time, a median 100 (20–423.9) ml estimated blood loss, a median 2 (2–3) days drain removing time and a median 3 (2–4) days hospital stay are consistent with the literature shown in Tables 2-4.\cite{8,9,23-34} We did not find significant differences regarding estimated blood loss, drain removal time and hospital stay between the laparoscopic and robotic repair of RCU, in the present study. However, the mean operative time was significantly shorter (92 ± 48.27 vs. 190 ± 46.36 min) with the robotic approach without any complications. According to our results, the use of robotic technology may overcome the longer operative time issue with the similar favourable outcomes of the laparoscopic approach in repair of RCU. In conclusion, the repair of RCU is a complex surgery with a technical difficulty and higher vascular injury risk. In this respect, when considering this complexity of the procedure, we thought that robotic approach might have provided a shorter mean operative time by making easier the dissection and ureteral sutures with greater visualisation, enhanced dexterity and more comfortable surgical performance during the surgery.

There are some limitations in our study. The small number of the study cohort can be accepted as a major limitation. However, it seems that the sample size may be acceptable when considered the rarity of the disease. We compared the results of the two different centres and differences in surgical experiences might have affected the results. On the other hand, the main strength of the current study is that it is the first comparative study of laparoscopic and robotic approaches for repair of RCU.

### Table 2: Outcomes of the published literature about the transperitoneal laparoscopic repair of the retrocaval ureter

| Authors                        | Number of cases | Operative time (mean or median min) | Estimated blood loss (mean or median mL) | Drain removal time (mean or median days) | Length of hospital stay (mean or median days) | Complications | Follow-up                |
|-------------------------------|-----------------|-------------------------------------|------------------------------------------|------------------------------------------|-----------------------------------------------|---------------|--------------------------|
| Ramalingam and Selvarajan, 2003\cite{23} | 2               | 225                                 | Minimal                                  | 3                                        | 4-5                                           | Short-term ileus in one patient | Uneventful    |
| Simforoosh et al., 2006\cite{24} | 6               | 180                                 | <50                                      | 4                                        | 4                                             | No            | Uneventful               |
| Bagheri et al., 2009\cite{25}  | 3               | 210                                 | <50                                      | 2-3                                      | 3-4                                           | No            | Uneventful               |
| Dogan et al., 2010\cite{26}    | 4               | 210                                 | Not reported                             | 2                                        | 2                                             | No            | Uneventful               |
| Ding et al., 2012\cite{27}     | 4               | 135                                 | <60                                      | 3.6                                      | 7.3                                           | Post-operative urine leakage for 8 days in one patient | Uneventful    |
| El Harrech et al., 2016\cite{28} | 3              | 140                                 | <50                                      | 3-4                                      | 5                                             | No            | Uneventful               |
| Tamhankar et al., 2017\cite{29} | 6              | 163.2                               | 50-100                                   | 2-4                                      | 3.8                                           | No            | Uneventful               |

### Table 3: Outcomes of the published literature about the retroperitoneal laparoscopic repair of the retrocaval ureter

| Author                        | Number of cases | Operative time (mean or median min) | Estimated blood loss (mean or median mL) | Drain removal time (mean or median days) | Length of hospital stay (mean or median days) | Complications | Follow-up                |
|-------------------------------|-----------------|-------------------------------------|------------------------------------------|------------------------------------------|-----------------------------------------------|---------------|--------------------------|
| Xu et al., 2009\cite{30}      | 7               | 128.6                               | 20                                       | 3.8                                      | 6.5                                           | No            | Uneventful               |
| Li et al., 2010\cite{31}      | 10              | 82                                  | <10                                      | 3.5                                      | 6.5                                           | No            | Uneventful               |
| Chen et al., 2011\cite{32}    | 12              | 112                                 | 35                                       | 3-5                                      | 6                                             | No            | Uneventful               |
| Ricciardulli et al., 2015\cite{33} | 27            | 131                                 | 28.5                                     | 2.5                                      | 3.8                                           | Grade 1 in 4 patients | Uneventful (except one patient with persistent pain) | Uneventful    |
| Liu et al., 2016\cite{34}     | 9               | 103                                 | Not reported                             | Not reported                             | 7                                             | No            | Uneventful               |

### Table 4: Outcomes of the published literature about the retroperitoneal robotic repair of the retrocaval ureter

| Author                        | Number of cases | Operative time (mean min) | Estimated blood loss (mean mL) | Drain removal time (mean days) | Length of hospital stay (mean days) | Complications | Follow-up                |
|-------------------------------|-----------------|---------------------------|-------------------------------|-------------------------------|------------------------------------|---------------|--------------------------|
| Hemal et al., 2010\cite{35}   | 4               | 80                        | 100                           | 1                             | 3                                  | No            | Uneventful               |
| Nayak and Gupta, 2012\cite{36} | 5               | 92                        | 55                            | 1                             | 2                                  | No            | Uneventful               |
CONCLUSIONS

Laparoscopic and robotic repair of RCU has comparable outcomes. The robotic transperitoneal approach may shorten the operative time enabling an easy surgical dissection and suturing with a greater comfort to the surgeon in the repair of RCU.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Sandercoc GD, Brooke-Cowden GL. Developmental anomaly of the inferior vena cava. ANZ J Surg 2003;73:356-60.
2. Anderson JC, Hynes W. Retrocaval ureter: a case diagnosed pre-operatively and treated successfully by a plastic operation. Br J Urol 1949;21:209-14.
3. Abeshouse BS, Tankin LH. Retrocaval ureter: report of a case and a review of the literature. Am J Surg 1952;84:383-93.
4. Bauer JJ, Bishoff JT, Moore RG, Chen RN, Iversion AJ, Kavoussi LR, et al. Laparoscopic versus open pyelopyelostomy: Assessment of objective and subjective outcome. J Urol 1999;162:692-5.
5. Baldwin DD, Dunbar JA, Wells N, McDonagh EM. Single-center comparison of laparoscopic pyeloplasty, acuice endopyelotomy, and open pyeloplasty. J Endourol 2003;17:155-60.
6. Mao L, Xu K, Ding M, Pan J, Guo Z. Comparison of the efficacy and safety of retroperitoneal laparoscopic and open surgery for the correction of retrocaval ureter. Ther Clin Risk Manag 2017;13:697-701.
7. Ji C, Zhang G, Zhang S, Zhao X, Lian H, Li X, et al. Transperitoneal and retroperitoneal laparoscopic ureteroureterostomy for retrocaval ureter. Zhonghua Wai Ke Za Zhi 2014;52:580-3.
8. Hemal AK, Nayar R, Gupta NP, Dorairajan LN. Experience with robot assisted laparoscopic surgery for upper and lower benign and malignant ureteral pathologies. Urology 2010;76:1387-93.
9. Nayak BD, Gupta PN. Robotic repair of retrocaval ureter: A case series. Afr J Urol 2012;18:43-7.
10. Johnson R. Choosing between parametric and non-parametric tests. J Undergrad Res Minn State Univ Mankato 2009;9:1.
11. Roh HF, Nam SH, Kim JM. Robot-assisted laparoscopic surgery versus conventional laparoscopic surgery in randomized controlled trials: A systematic review and meta-analysis. PLoS One 2018;13:e0191628.
12. Matsuda T, Yasumoto R, Tsujino T. Laparoscopic treatment of a retrocaval ureter. Eur Urol 1996;29:115-8.
13. Gundeti MS, Duffy PG, Mustaq I. Robotic-assisted laparoscopic correction of pediatric retrocaval ureter. J Laparoendosc Adv Surg Tech A 2006;16:422-4.
14. Hemal AK, Rao R, Sharma S, Clement RG. Pure robotic retrocaval ureter repair. Int Braz J Urol 2008;34:734-8.
15. Smith KM, Shrivastava D, Ravish IR, Nerli RB, Shukla AR. Robot-assisted laparoscopic ureteroureterostomy for proximal ureteral obstructions in children. J Pediatr Urol 2009;5:475-9.