

# Transperitoneal Laparoscopic Repair of the Retrocaval Ureter: Our Single-Center Experience

Serdar Aykan<sup>1</sup>, Ahmet Ürkmez<sup>1</sup>, Musab Ali Kutluhan<sup>2</sup>, Mustafa Zafer Temiz<sup>3</sup>,  
 Atilla Semerciöz<sup>3</sup>, Ahmet Yaser Müslümanoğlu<sup>3</sup>

<sup>1</sup>Department of Urology, University of Health Sciences Turkey, Haydarpaşa Numune Health Application and Research Center, Istanbul, Turkey

<sup>2</sup>Department of Urology, University of Health Sciences Turkey, Fatih Sultan Mehmet Health Application and Research Center, Istanbul, Turkey

<sup>3</sup>Department of Urology, University of Health Sciences Turkey, Bağcılar Health Application and Research Center, Istanbul, Turkey

## Abstract

**Introduction:** We aimed to describe our experience in transperitoneal laparoscopic repair of retrocaval ureter (RCU) in this study.

**Methods:** Between February 2010 and February 2017, five patients (1 female and 4 males) who underwent laparoscopic repair with the diagnosis of RCU in our department were included in this study. Patients' mean age was 27 (range 20–32 years). All patients were pre-operatively evaluated using ultrasonography (US) followed by contrast-enhanced computed tomography (CT) intravenous pyelography (IVP). After CT diagnosis of RCU, all patients underwent diuretic renography examination with 99mTc-DTPA. Laparoscopic surgery was performed by the transperitoneal approach using the three-dimensional (3D) vision system in two and two-dimensional vision system (2D) in three patients.

**Results:** All operations were completed laparoscopically without conversion to open surgery. Mean operation time was 168.5±9.89 minutes. Operation time of two patients in whom 3D a vision system was used was shorter (155 and 165 minutes) comparing to others in whom 2D vision systems used. Blood loss was less than 50 mL in all patients. Obliterated ureteric segments were excised in four patients. Four patients were symptom-free after surgery and had regression of hydronephrosis in their kidneys. In one of the cases, there was no resolution of hydronephrosis postoperatively.

**Discussion and Conclusion:** Careful dissection along the planes with good tissue respect and good hemostasis during each step are the key to success for laparoscopic repair of RCU. Pure laparoscopic treatment of RCU seems feasible and technically reliable. At the same, time using a 3D vision system, if available would be preferable because of the dissection and intracorporeal suturing advantages.

**Keywords:** Laparoscopy; minimal invasive surgery; retrocaval ureter.

Retrocaval ureter (RCU) is a rare congenital disease, which may cause obstruction and related symptoms. Firstly, retrocaval ureter was reported by Hochstetter in 1893<sup>[1]</sup>. RCU, also known as circumcaval ureter, occurs due to anomalous development of inferior vena cava (IVC) and not ureter. Open surgery was the classic treatment of this

pathology with excision of the retrocaval segment, anteposition, and ureteroureteral or ureteropelvic reanastomosis<sup>[2, 3]</sup>. Development of laparoscopic techniques and performing skills for urologists have permitted enlargement of indications for this procedure. Laparoscopic dismembered pyeloplasty became the treatment of choice of uretero-

**Correspondence (İletişim):** Ahmet Ürkmez, M.D. Fatih Sultan Mehmet Sağlık Uygulama ve Araştırma Merkezi, Uroloji Kliniği, 34752 Atasehir, Istanbul, Turkey

**Phone (Telefon):** +90 507 766 83 00 **E-mail (E-posta):** ahmeturkmez@hotmail.com

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pelvic junction obstruction (UPJO) with equivalent results compared to open surgery, with less postoperative pain and shorter hospital stay [4, 5]. Therefore, the surgical approach for this entity has shifted from open to laparoscopic and robotic surgery.

Rarity of this congenital disease and incidence added to the vascular risk with the dissection of the vena cava and the technical difficulty to perform laparoscopic ureteral sutures explains the few reported cases of laparoscopic repair of this anomaly. Herein, we describe our experience with five cases of transperitoneal laparoscopic repair of RCU.

## Materials and Methods

Between February 2010 and February 2017, five patients (one female and four males) who underwent laparoscopic repair with the diagnosis of RCU in our department were included into this study. All operations were performed by the same surgeon experienced in laparoscopic urologic surgery. Patients' mean age was 27 (range 20–32 years). All patients included in this study were symptomatic, all of them having history of intermittent moderate right-side flank pain. None of the patients developed episodes of fever and pyonephrosis. All patients had serum creatinine levels within normal range ( $0.88 \pm 0.15$  (0.7–1.1) mg/dl). All patients were evaluated using ultrasonography (US) followed by contrast-enhanced computed tomography (CT) (with digital 3D reconstruction) and intravenous pyelography (IVP). Abdominal ultrasound demonstrated right renal hydronephrosis in all patients. All patients had moderate hydronephrosis with upper hydroureter. Additional findings were present in two patients, one patient had ureteral and the other patient had concomitant pelvis stone with a diameter of 5 mm. All of patients had RCU with segment traversing downward and crossing the IVC at L3-L4 vertebral level (Fig. 1). All five patients had classical "Shepherd's crook" appearance on CT (Fig. 2) (Type 1 according to Bateson and Atkinson classification) [6]. After the CT diagnosis of RCU, all patients underwent diuretic renography examination with  $99\text{mTc-DTPA}$  (Fig. 3). Laparoscopic surgery was performed by the transperitoneal approach using the three-dimensional (3D) vision system in two and two-dimensional vision system (2D) in three patients. The 3D high definition (HD) Vision System (Viking Systems, La Jolla, CA) with 30° optic and the 2D Full-HD Endoscopy System (Karl Storz, Tuttlingen, Germany) with 30° optic were used. Patients were followed up by ultrasonography at 3<sup>rd</sup> and 6<sup>th</sup> months, 1<sup>st</sup> year, and thereafter, yearly or if symptomatic. Repeat renal diuretic renography scan or IVP or CT was carried out six months after the surgery.

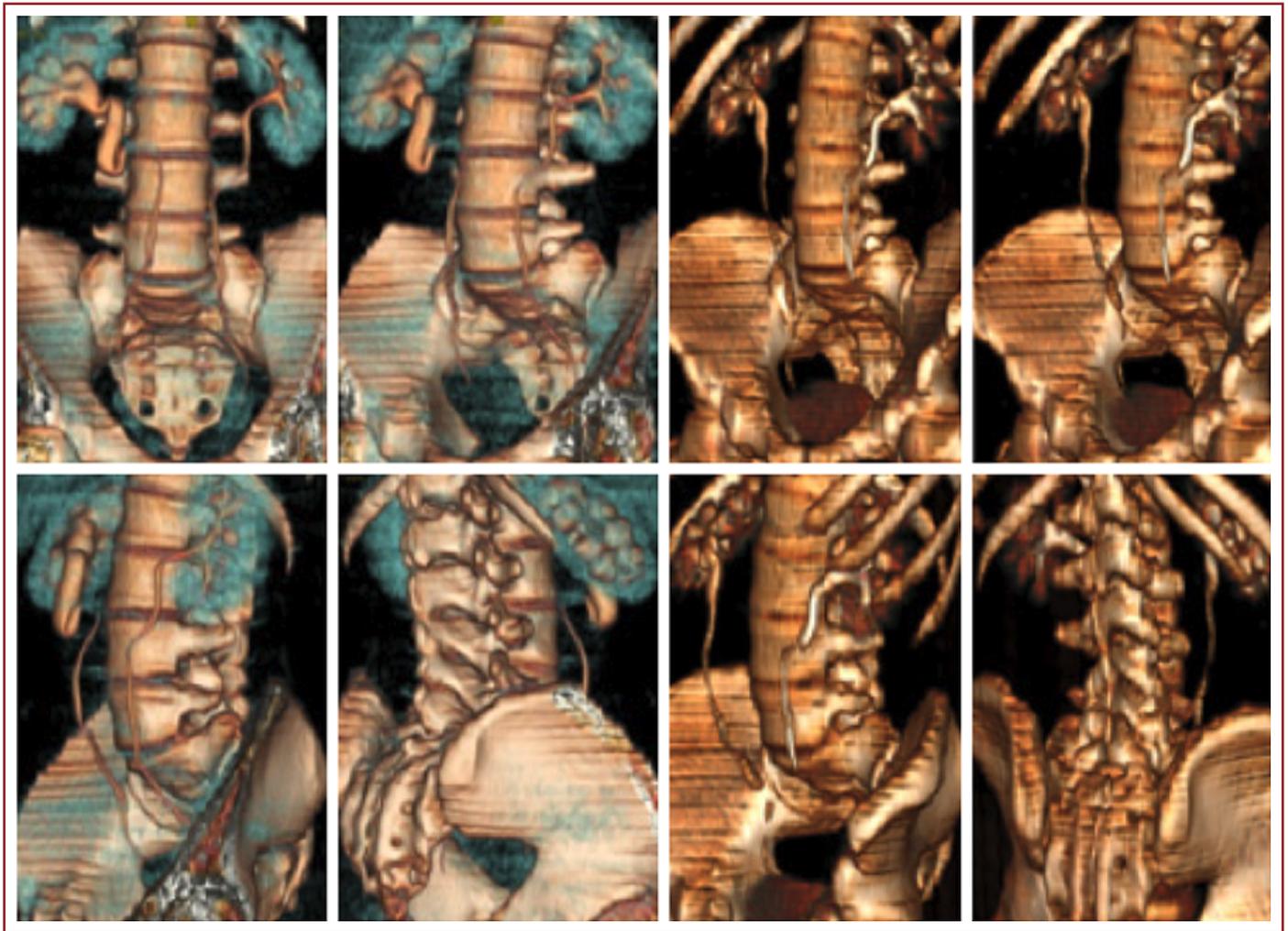


**Figure 1.** Intravenous pyelography images of patients with the retrocaval ureter. Ureters crossing the inferior vena cava at L3-L4 vertebral level.

## Surgical Technique

Operations were performed under general anesthesia. Antibiotic prophylaxis was administered to all patients. Patients were firstly placed in the lithotomy position; cystoscopy and right ascending pyelography were performed to confirm the diagnosis (typical image in the form of a hook or S-shaped ureter) and evaluation of lower ureter, followed by placement of ureteric catheter just below the level of kink. The lower end of the catheter was then kept in a sterile field. In all patients, retrograde pyelography (RGP) showed the presence of RCU and whether additional stenosis was present (Fig. 4).

After endoscopic evaluation, patients were placed in the left lateral decubitus position at a 45° angle for the transperitoneal laparoscopic approach. A pneumo-peritoneum was created using a Veress needle and ports were entered applying a 20 mm Hg intra-abdominal pressure. First, a 10-mm camera port was placed at the umbilicus



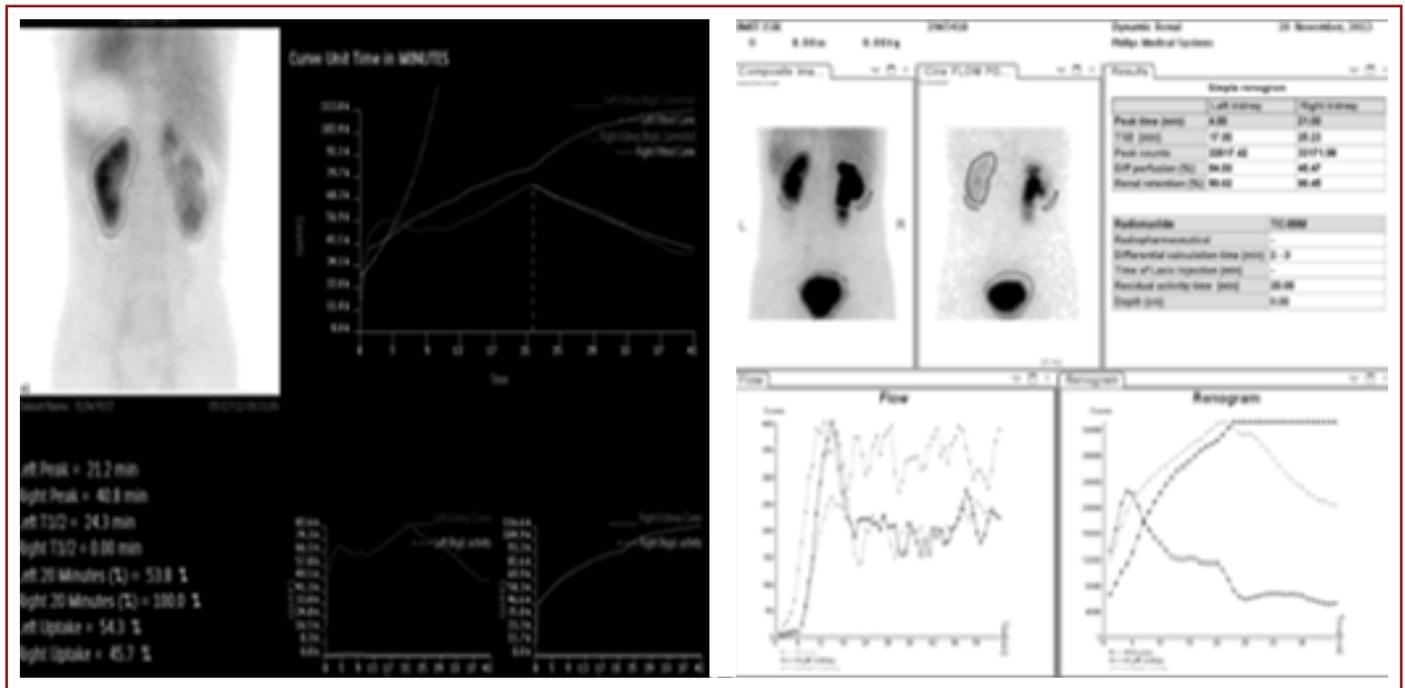
**Figure 2.** Classical “Shepherd’s crook” appearance on computed tomography, 3D constructed.

level on the lateral rectus border. After the placement of the first port, the others were placed under direct vision. The intracorporeal pressure was decreased to 12 mm Hg after the placement of the ports.

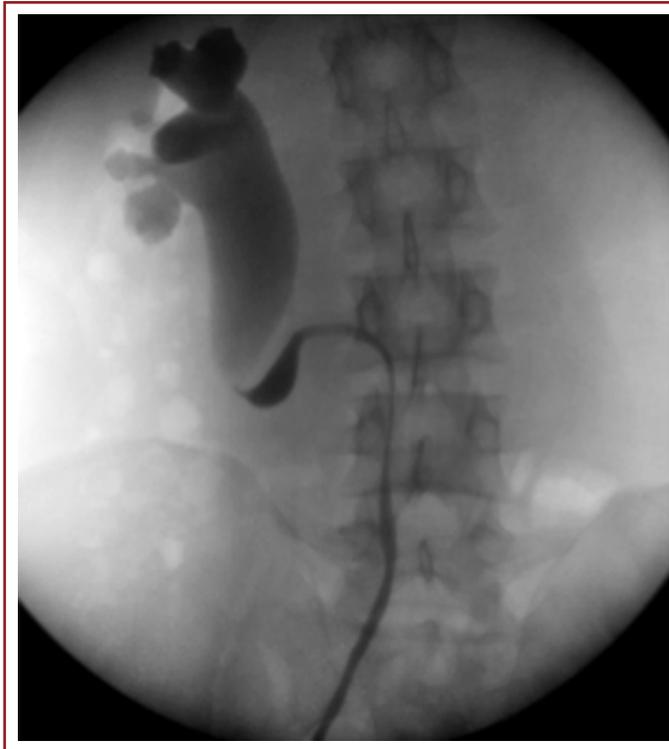
After the medialization of the colon, the ureter was traced near the ureteropelvic junction and dissected lower down till the lateral aspect of IVC and from the level of iliac vessels to the interaortocaval region. In the interaortocaval area, the ureter was identified and dissected caudally. Then, the proximal ureter was transected at the point where it went retrocaval. The lower end was dissected out from the posterior aspect of IVC. Thus, the ureter ends were brought anterior of the vena cava. Using sharp and blunt dissection, the retrocaval segment of the ureter was then entirely mobilized and separated from the IVC. Utmost care was taken to preserve the vascularity of ureter. The segment was inspected for patency and vascularity. If an obliterated ureteral segment was detected, it was excised till to the

healthy margin. Then, the renal pelvis and the ureter were re-anastomosed with running 4-0 polyglactin sutures in a normal anatomic position.

Two patients had concomitant calculi, one patient had ureteral, and the second patient had renal pelvis calculi. Stone removal was done in both cases during the same session. Because of the advanced dilatation in two patients, the ureter was directly anastomosed to the pelvis using uretero-pyelostomy dismembered technique. In the other three cases, uretero-ureterostomy was performed. The two ends were spatulated, and ureteroureterostomy was carried out with polyglactin 4-0 round body continuous sutures posteriorly. Considering the probable risk of ureteral stenosis, suturing was carried out anterior and posteriorly with two separate stitches. After the posterior wall, anastomosis was completed; the JJ stent was inserted antegradely. The placement of JJ stent’s lower end was confirmed by fluoroscopic imaging. The upper curve of the stent was placed into the renal pelvis, and the anterior wall



**Figure 3.** Diuretic renography examination with  $^{99m}\text{Tc}$ -DTPA.



**Figure 4.** Intraoperative confirmation of the presence of retrocaval ureter and whether additional stenosis was present by retrograde pyelography.

was anastomosed in a watertight manner. After the completion of the anastomosis, a suction drain was placed in the operation area. Double J stents were removed after six weeks after the surgery.

## Results

All operations were completed laparoscopically without conversion to open surgery. Mean operative time was  $168.5 \pm 9.89$  minutes (range: 155-180). The operation time of two patients in whom the 3D vision system used was shorter compared to others (155 and 165 minutes). The reason for this may be the visual advantage of the 3D system for making anastomosis and dissection procedure easier. No intraoperative vascular or digestive complications occurred. Blood loss was less than 50 mL in all patients. Obliterated ureteric segments were excised in four patients. Four patients were symptom-free after surgery and had regression of hydronephrosis in their kidneys. In one of the cases, there was no resolution of hydronephrosis postoperatively. Further investigations were carried out due to anastomotic stricture suspicion. After diuretic renography and retrograde pyelography, ureteral stricture of the anastomotic segment was diagnosed, followed by laparoscopic excision and reanastomosis of the ureteric segment.

None of the patients developed urinary leak postoperatively. Intravenous paracetamol was administered during the first postoperative day for pain control. No patient required opioid analgesia. All patients were discharged three to four days after the operation and the mean hospital stay was 3.4 days. None of the patients had significant symptoms related to stent placement. After removing the stent, patients were followed clinically and by ultrasound every

three months. There after the same follow-up protocol was used. Maximum follow-up was 6.5 years, and there were no long-term complications in any of the patients.

## Discussion

Retrocaval ureter is a rare congenital anomaly, with a reported incidence of 1/1000 live births [7, 8]. Retrocaval ureter mostly manifests itself in the third or fourth decade of life and occurs three times more frequently in men than women [9]. In normal embryologic development, the connection between the right subcardinal vein and the supracardinal vein regresses. The failure of the supracardinal vein to develop into the infrarenal inferior vena cava seems to be responsible for a retrocavally positioned right ureter [10].

Anderson and Hynes originally described the necessity of dismembering of the ureter in a patient with RCU in 1949 [3]. In true sense, as the ureter circumvents the vena cava, "circumcaval ureter" is the appropriate terminology to describe the course of the ureter. Many authors use the term "preureteral vena cava" because the root cause of the condition is actually a developmental anomaly of IVC and not ureter. Embryologically, 15 different types of periurethral vena cava are described by Huntington and McClure, twelve of which have been documented in animals [11]. Five different variants have been described in human beings [12].

Retrocaval ureter has been associated with different anatomical abnormalities in 21% of the cases. These can be horseshoe kidney, absent or ectopic opposite kidney, agenesis of vas or uterus, cardiovascular anomalies, Turner syndrome, and imperforate anus [13]. It mostly involves the right ureter. Two types of RCU were described. In type I (S-shaped), the ureter lies medial to lumbar vertebral process and the point of maximal obstruction is lateral to the lateral margin of inferior vena cava, whereas in type II (sickle-shaped), the ureter is less angulated, hydronephrosis is less severe, and the point of obstruction is the lateral border of inferior vena cava [9].

Surgery is indicated when the disease is associated with symptoms or related complications. Patients of RCU generally present clinically with symptoms in the third or fourth decade of life with dull aching right flank pain [14]. RCU is not always associated with symptomatic obstruction. However, in our case series, all the patients presented with symptoms like flank pain or fever. The degree of hydronephrosis was of grade 3-4 in our case series. The diuretic renograms showed delayed excretion and decreased function in the affected kidney of all patients. Therefore,

surgical treatment was offered.

Patients with RCU are mostly identified by IVP (sea-horse sign). In suspected cases, CT (preferably 3-dimension or reconstructed) or magnetic resonance imaging may be helpful. However, the diagnosis must be confirmed with an intraoperative RGP. The luminal obliteration or dysplasia of the ureteral segment beneath the inferior vena cava is not frequent. However, it may occur in some cases, such as the case reported by Chung and Gill. RGP may reveal different areas of stenosis or obstruction that have not been shown by preoperative radiological studies [15]. We think that doing an RGP on table aids in ruling out concurrent pathology of the lower ureter, ensures patency of the segment. Excision of the retrocaval segment is unnecessary unless found atretic on the table. Although operative intervention is the standard of care in these patients, there are certain reports of conservative management. Yen et al. [16] described two cases of RCU, which were managed conservatively as per patients' choice. Both cases had unobstructed drainage on renogram despite having a certain degree of hydronephrosis. Both of them did well in the follow-up of 6-8 months.

Operative intervention progressed from open surgery carried out for the first time by Anderson and Hynes, followed by laparoscopic surgery carried out for the first time by Baba et al. [17] That operation took 9.3 h with 2.5 h for anastomosis. This pioneering work has given the direction to the current approach for RCU. Due to the improvements in techniques of hemostasis, intracorporeal suturing, and availability of newer energy sources, the operative and anastomosis time have significantly gone down. Regarding minimally invasive approaches, different authors have used either transperitoneal laparoscopic or retroperitoneoscopic or robotic or mini-laparotomy approach for RCU. All approaches have pros and cons when we compare them. Both the transperitoneal and the retroperitoneal approach can be used [18]. Considering the very few series of RCU reported, we aimed to compare our cases with the reported ones. Therefore, the numbers of patients involved in our series were considerable when compared with the other series.

Dogan et al. [19] operated on four patients using the transperitoneal approach. Mean operation time was 210 minutes. No intraoperative complications occurred. Simforoosh et al. [14] reported a series of six cases of RCU that were successfully treated with a transperitoneal laparoscopic approach. Mean operative time was 180 minutes (range 150 to 210), and patients were discharged home at a mean of four days (range 3 to 5). Ding et al. [20] reported

the largest series of transperitoneal approach in 2012. Nine patients underwent pure laparoscopic pyelopyelostomy or ureteroureterostomy. The mean operative time was 135 minutes (range, 70–250 minutes). No intraoperative complications or significant bleeding occurred. Some authors preferred the retroperitoneal approach. Xu et al.<sup>[21]</sup> used this way to treat RCU. In their series, seven patients underwent retroperitoneal repair. The mean operating time was 128 minutes. The mean blood loss was 20 mL. Li et al.<sup>[22]</sup> operated a total of 10 patients with the retroperitoneal approach. All operations were completed laparoscopically. The mean operative time was 82 minutes and the blood loss was minimal. Chen et al.<sup>[23]</sup> reported the largest series of retroperitoneal laparoscopic ureteroureterostomy for RCU with 12 patients. No open surgery conversion was needed. The mean operating time was 112 minutes, and the mean anastomosis time was 42 minutes. Ricciardulli et al.<sup>[24]</sup> have described the vast experience of retroperitoneal laparoscopic approach in 27 cases of RCU. In this approach, operative time is reduced as there is no need for colon mobilization and liver retraction. One can get early access to the urinary tract. They have a mean operative time of 131 min in 27 cases. Ji et al.<sup>[25]</sup> analyzed the results of 10 retroperitoneal and eight transperitoneal laparoscopic RCU repairs from the same center. Operative time was comparable (98 vs. 85 min). Both groups were comparable concerning success and complications related to surgery.

The approach performed frequently is the transperitoneal one because of a larger operation field and because urologists are more familiar with this approach<sup>[14, 26, 27]</sup>. In comparison, there is a risk of hemorrhage during the creation of working space in cases of retroperitoneoscopy<sup>[28]</sup>. The retroperitoneal approach was also described earlier because of the concerns of urine leaking into the peritoneum<sup>[29–31]</sup>. However, the surgical field is narrower in this approach, and we believe that a transperitoneal watertight anastomosis over an internal stent is straightforward and does not pose any postoperative problems. We believe that each technique (transperitoneal and retroperitoneal) has advantages and drawbacks.

Our results are comparable to these series. All operations were achieved with a transperitoneal approach and laparoscopically without conversion to open surgery. The mean operative time was 168 min (155–180). No intraoperative vascular or digestive complication occurred. Blood loss was less than 50 mL in all patients.

The authors have modified certain techniques for a successful outcome. Expertise is required in the critical step of

mobilization of the retrocaval segment in the interaortocaval region. Chung and Gill have demonstrated the use of vessel loop around ureter for better dissection of interaortocaval portion<sup>[16]</sup>. Fidalgo et al.<sup>[32]</sup> described the technique of suspending the pelvis with monofilament suture from the abdominal wall for the ease of suturing, eliminating the need for extra hand. Unnecessary dissection can be avoided. After opening the peritoneum and Gerota's fascia, dissecting the anteromedial lower pole of the kidney is sufficient to expose the renal pelvis and upper ureter. In two of our cases, we used suture to lift up the pelvis and make manipulations comfortable as reported by Fidalgo et al.<sup>[32]</sup>

Regarding the excision of the retrocaval segment, Simforoosh et al.<sup>[14]</sup> demonstrated that the retrocaval segment might not be excised without compromising long-term patency rates. After that, multiple studies have omitted the excision of the retrocaval segment<sup>[21, 28, 33]</sup>. El Harrech et al.<sup>[28]</sup> did not excise the ureter in all of their cases. The reason was the posterior part of the ureter that was behind the cava, not being atretic. Also, they thought that probable excision would apply high tension on the anastomosis. Regarding the anastomosis type, either pyeloplasty<sup>[15, 28, 32]</sup> or pyelo-ureterostomy<sup>[14, 21]</sup> or uretero-ureterostomy<sup>[21, 32]</sup> can be done. All have shown good results in follow-up. Nayak et al.<sup>[33]</sup> shared their experience in three cases of uretero-ureterostomy and two cases of pyelopyelostomy, which had comparable results. Fidalgo et al.<sup>[32]</sup> have stated that dilated ureter has a long redundant segment. Hence, the uretero-ureterostomy, if conducted, would require excision of a longer segment of the normal ureter to give more functional and anatomical outcomes. Pyelopyelostomy is easier because it enables more space for grasping and passing the needle. However, this approach is not compatible with the aim and principle of laparoscopy. In our series, ureteric excision was performed after the ureteric dissection in all of the cases. We share the opinion that the length of the ureter and the excision of the ureteric segment are of crucial importance for the healthy ureter. We performed tension-free uretero-ureterostomy in three and pyelo-ureterostomy in two of our patients. In one of the uretero-ureterostomy patients, postoperative stricture occurred. The second laparoscopic session with excision of the narrow fibrotic segment and re-uretero-ureterostomy was carried out.

Many authors consider laparoscopic suture as the most difficult and time-consuming step of the procedure. Ishitoya et al.<sup>[34]</sup> and Tobias-Machado et al.<sup>[35]</sup> proposed retroperitoneoscopy for dissection followed by mini-laparotomy for extracorporeal anastomosis, which had the compara-

ble operative time and hospital stay. The 3D vision system can be of use for making easier the laparoscopic suture. In many laparoscopic series, including ours, also, the 3D vision system was associated with shorter operation time and a shorter learning curve for the surgeons [36]. To our knowledge, no previous results reported on the 3D vision system used in RCU repair. We used the 3D vision system in two of our patients. Operation times of these two cases were shorter than the other group, which the 2D vision system was used. This system was found to have an advantage on dissection and anastomosis part of the operation making its time shorter. Because of the small number of cases, we were not able to carry out comparable statistical analysis of the two systems.

Kang et al. [37] used the laparoendoscopic single-site surgery (LESS) procedure with retroperitoneal approach to operating four patients with RCU. The single-port device was made with a surgical glove and Foley catheter and allowed the introduction of three trocars. The mean operating time was 105 min (range, 90–135 min). None of the patients required blood transfusion. These results are encouraging, but the real place of LEES remains debated. Also, no benefit concerning recovery has been demonstrated when comparing LESS nephrectomy and LESS pyeloplasty with the classic laparoscopy [38, 39].

More recently, some observations reported the application of robotic laparoscopy to the management of RCU. Obviously, due to ergonomic benefit and 3D vision, this technology may improve surgeon dexterity and quality of dissection, but the problem of high procedure cost may be an obstacle, especially in emerging countries [40, 41]. The authors stated that robotic assistance eases the dissection and intracorporeal suturing. However, it is not available in every institute, and robotic technology is not widely used in our country.

## Conclusion

Careful dissection along the planes with good tissue respect, and good hemostasis during each step are the key to success for minimally invasive surgery for the RCU repair. Pure laparoscopic treatment of the RCU seems feasible and technically reliable. It should be proposed as a first-line treatment for the RCU. Transperitoneal or retroperitoneal approach can be considered equivalent, as parameters like operative time and results are comparable for these two modalities. The choice of transperitoneal or retroperitoneal approach depends on the preferences of the surgeon. At the same time, using a 3D vision system, if available would

be preferable because of the dissection and intracorporeal suturing advantages. We preferred the transperitoneal approach as it provides good working space for intracorporeal suturing. Especially we suggest a transperitoneal approach together with the 3D vision system for surgeons with less experience.

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