“Vaginal Delivery”: A Novel Extraction Route for Large Renal Calculi Encountered During Laparoscopic Pyeloplasty

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Key Words
Calculi treatment • Laparoscopy • Novel innovation • Endourology

Abstract
Background: To describe a simple, novel stone extraction technique using the transvaginal route for large renal calculi encountered during laparoscopic/robotic pyelolithotomy. Methods: After a standard approach laparoscopic pyelolithotomy in a patient with a large (42 × 36 mm) pelvic calculus, Anderson-Hynes pyeloplasty was performed. A transverse posterior colpotomy was performed laparoscopically with the assistance of the Colpassist Vaginal Positioning Device (Boston Scientific) and the calculus was extracted, intact, through the vagina with the aid of an endoscopic retrieval bag. The vaginal incision was then closed intra-corporeally. A systematic review on the topic was also performed. Results: The stone was removed in its entirety through an occult vaginal incision. There were no complications reported and the patient was stone free at follow-ups. Conclusions: This simple, novel technique is an easily reproducible method, for the removal of large urinary calculi during either traditional laparoscopic or robotically-assisted laparoscopic stone surgery in the appropriate female patient. It avoids the need for additional abdominal incisions or complex techniques involving lithotripsy which may be more complicated and time consuming. All previously published stone extraction techniques for large calculi (greater than 20 mm) within this systematic review are also critically appraised.

Introduction
Minimally invasive techniques for the management of ureteropelvic junction obstruction (UPJO) have long surpassed the open method, as the treatment gold standard [1]. However, the occasional stone burden encountered during either laparoscopy or robotic-assisted laparoscopy needs to be addressed as optimally as possible.

Although smaller stones are easily retrievable through pre-existing laparoscopic port incisions with traditional instruments, the surgeon is faced with a dilemma when it comes to the extraction of much larger calculi. Namely, the need for a larger abdominal incision purely for stone extraction or the need for intra-corporeal stone crushing, laser, or lithotripsy in order to render a patient stone-free.
We conducted a systematic review of the literature using the: Scopus, Web of Science and PubMed Databases with search terms: “laparoscopic pyeloplasty and stone” and “laparoscopic pyeloplasty and calculus”. Non-English articles were only considered if an accompanying English abstract mentioned the stone extraction technique performed in the respective article. Studies were excluded that described the removal of stones of less than 20 mm or where the size of stone was not specified (fig. 1).

We aimed to describe a novel, reproducible and safe method of large calculus extraction during laparoscopic pyelolithotomy via the transvaginal route. This extraction method avoids the use of lithotripsy or the need for extended or additional, abdominal incisions. This is a technique that can be performed in the same setting of laparoscopic pyeloplasty while still maintaining the requirements for minimally invasive surgery.

**Materials and Methods**

A 22-year-old female patient was found to have right-sided UPJO with ipsilateral urolithiasis (single 35 × 42 mm renal calculus) on computed tomography imaging of the renal tract. She was otherwise well with no other co-morbid disease. A double-J 6F ureteric stent was placed in the conventional manner via cystoscopy and fluoroscopic guidance prior to laparoscopic repair.

Human Research Ethics Committee (medical) Clearance Certificate No. M1710105 was obtained on the 20/12/2017 prior to commencement of this study.

The procedure (fig. 2) (fig. 3) was carried out under general anesthesia with endotracheal intubation. The operation was performed with the patient in the standard flank position with slight lithotomy.

A 12-mm optical port was first placed at the umbilicus via the Hasson open technique to prevent blind intraperitoneal organ injury. Pneumoperitoneum was initiated and maintained at 12–18 mmHg throughout the procedure. Three additional 5-mm ports were then inserted under direct vision. One supra-umbilically, and 2 in the lower abdomen on either side. The small bowel was reflected off the right kidney and dissection initiated to visualise and mobilise the right ureteropelvic junction. A cutaneous stay suture was looped around the proximal ureter to elevate the UPJ. An additional 5-mm port was required intra-operatively to reflect the left lobe of the liver and this was inserted in the sub-xiphoid region under direct vision.

After mobilisation, the ureteropelvic junction was excised to reveal a large pelvic calculus. The calculus was removed by blunt dissection and guided into the pelvis. An Anderson-Hynes pyeloplasty was then completed, ensuring complete closure of the UPJ incision with continuous suture. A posterior colpotomy was then performed. Amplatz type renal dilators (Boston Scientific, Marlborough, Massachusetts, USA) were used to increase the size of the incision until a 10 mm Endobag extraction bag (Endo Catch™ Gold 10 mm Specimen Pouch – Medtronic, Minneapolis, MN, USA) could be inserted to retrieve the stone intact.

The colpotomy incision was then closed with 2-0 absorbable 15 mm V-Loc suture (Covidien, Medtronic Minimally Invasive Therapies, Minneapolis, Minnesota, USA) and the abdominal port incisions were closed in the conventional manner. A drain was placed next to the right kidney and transurethral catheter inserted. The double-J ureteric stent was left in situ.

**Results**

*Systematic Review Results*

The systematic review search revealed 18 previous studies (fig. 1), where removal was described under direct vision by one or a combination of the following methods during laparoscopic surgery: laparoscopic graspers, stone baskets, irrigation and suc-
tion with flexible nephroscopy or extraction through an abdominal incision using an endoscopic tissue retrieval bag for larger stones [4, 7–10, 15–27] (table 1).

Operative Results
No complications were reported intra-operatively. Post-operative recovery in the ward was uneventful. The abdominal drain was removed on the third post-operative day once the output was minimal. The patient was discharged 6 days after the procedure. First follow-up took place at 2 weeks with an acceptable cosmetic result (fig. 3d). The double J stent was removed 6 weeks post-operatively under fluoroscopic guidance. Retrograde studies showed no extravasation or attenuation of contrast.

Discussion
Stone presence is a significant complicating factor in patients presenting with UPJO, ranging from 20 [2] to 68% [3]. The management of which, can prove challenging to the surgeon, particularly in the preservation of the minimally invasive approach as we move away from the previous era of the “open” pyeloplasty.
### Table 1. The literature review of laparoscopic calculi extraction techniques performed for upper urinary tract stone disease larger than 20 mm

| No. | Ref.          | Age | n | Stone location | Stone size mean/No. (range) | Stone extraction method                                                                 | Equipment utilized                                           | Lap/ RALP | Complication                                      | MFU (month) | Authors’ conclusion(s)                                                                 |
|-----|---------------|-----|---|----------------|-----------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------|-----------|-----------------------------------------------|-------------|----------------------------------------------------------------------------------------|
| 1   | Van Cangh     | A   | 1 | calyceal       | 20                          | crushing forceps, irrigation and suction                                                | N/S                                                        | Lap       | N/D                                          | 8           | laparoscopic ultrasound-assisted nephrolithotomy is a safe and useful procedure        |
| 2   | Micali        | A   | 17| ureteral, renal | 15.6 (2–60)                | four-pronged grasping, basket, spoon, forceps                                          | FL flat wire basket                                          | Lap       | one patient with prolonged ileus and 2 with post-operative sepsis                    | 1.5         | laparoscopic ureterolithotomy and pyelolithotomy offer a safe and effective alternative to open stone surgery |
| 3   | Goel          | A   | 19| pelvicalyceal  | 36 (32–45)                  | extraction bag through initial port site, stones fragmented in bag                     | Stone crusher                                               | Lap       | two conversions to open: stone misplaced in calyx and difficult dissection due to adhesions | 3           | laparoscopic pyelolithotomy took longer to perform, was more invasive, less cosmetic and required more skill to perform compared to PCNL |
| 4   | Ariag         | A   | 8 | N/S            | 10.7 (2–35)                 | basket, laparoscopic grasping, specimen bag                                           | N/S                                                        | RALP      | none                                         | 12.3        | RALP with concomitant stone removal can be performed safely. The addition of stone extraction via flexible nephroscopy or robotic pyelolithotomy might prolong operative times |
| 5   | Nambirajan    | A   | 18| renal, pelvicalyceal 1 | 13 (5–45)                 | basket laparoscopic grasping, partial nephrectomy for multiple renal stones            | N/S                                                        | Lap       | urinary leak, late colonic perforation requiring colostomy                        | 18          | laparoscopic surgery effective for complex renal stones and allows for adjunctive procedures and as an alternative to PCNL |
| 6   | Gupta         | A   | 2 | pelvic         | 55                          | self-made extraction bag through extended incision of suprapubic port                 | N/S                                                        | Lap       | one patient required conversion to open surgery due to difficulty removing the stone and bleeding | N/S         | the laparoscopic approach is suitable for the management of ectopic pelvic kidneys    |
| 7   | Srivastava    | A/C | 20| pelvicalyceal 3 | 15 (9–25)                  | laparoscope and rigid graspers, semi-rigid stone grasping forceps, tailor-made specimen retrieval bag through 11 mm port | Retrieval bag: finger of dismembered latex glove            | Lap       | two patients required conversion to open: large stone lost in abdomen and uncontrollable bleeding in hemophiliac patient | 6          | laparoscopic pyeloplasty with concomitant pyeloplasty is feasible and effective, however some cases may need ancillary procedures to achieve complete stone clearance |
| 8   | Nada          | A   | 13| calyceal, pelvic, staghorn calculus | 80 (70–90)                | laparoscopic grasping, irrigation and suction after lithotripsy, staghorn stone removed with endobag – site N/S | Holmium:YAG laser for lithotripsy                           | Lap       | two patients with lost stones in the abdomen and 1 patient had urinary leak - managed with ureteric stent | N/S         | laparoscopic and endourological techniques can be combined in one procedure to effectively manage UPJO and stone disease |
| 9   | Salvadó       | A   | 9 | pelvicalyceal  Min. 3 per patient | 29                      | basket via flexible cystoscope, laparoscopic grasping, retrieval bag                  | N/S                                                        | RALP      | two cases required extension of port incision for stone extraction via retrieval bag | 1           | this technique can be considered in cases of a large stone burden in different locations in the kidney |
| 10  | Sotelo        | A   | 2 | staghorn       | 80 (70–90)                 | specimen retrieval bag, removed through additional abdominal incision                  | N/S                                                        | RALP      | N/D                                          | 1.5         | feasible, reproducible technique, lower incidence of stone fragmentation              |
| 11  | Singh         | C   | 1 | pelvic stone, single | 20                      | laparoscopic grasping                                                                | N/S                                                        | Lap       | N/D                                          | 6           | laparoscopic technique should be kept as the first option for the management of retrocausal ureter even if it is complicated by the presence of a renal calculus |
| 12  | Nouralizadeh  | A   | 13| staghorn, calyceal | 51 (40–66)                | laparoscopic grasping, surgical glove                                                  | Curve grasping, Babcock grasping                            | Lap       | residual stones in 2 patients requiring extracorporeal shockwave lithotripsy | 0.5         | this procedure is performed with acceptable results and negligible complications in skillful hands |
| 13  | Naitoh        | A/C | 4 | pelvicalyceal 2 | 6 (6–22)                   | laparoscopic grasping or basket through 2.5 cm umbilical incision for SILS port     | SILS Port (Medtronic, Minneapolis, MN, USA)           | Lap       | N/D                                          | N/S         | a safe and effective procedure with good success for patients with UPJO and renal stones |
| No. | Ref. | Age | n | Stone location mean No. (range) | Stone size mean/ (range) mm | Stone extraction method | Equipment utilized | Lap/ RALP | Complication | MFU (month) | Authors’ conclusion(s) |
|-----|------|-----|---|--------------------------------|----------------------------|--------------------------|-------------------|-----------|-------------|-------------|------------------------|
| 14  | Qin [23] 2014 | A/C  | 75 | staghorn and large calyceal | 21 (15–35) | laparoscopic grasper, intracorporeal lithotripsy and basket, irrigation/suction | Holmium laser | Lap | 2 conversions to open; difficulty extracting stones | N/S | the described method is an effective and less invasive alternative for intra-renal pelvic stones, but not for large staghorn stones |
| 15  | Zheng [24] 2014 | A/C  | 9 | pelvicalyceal | (3–21) | rigid grasper or stone basket through rigid nephroscope or ureteroscope; fragmentation and suction/irrigation | Holmium laser, pneumatic lithotriptor, Electrical Medical System (EMS; Swiss Litho-Clast Master 9.8F rigid ureteroscope (Karl Storz Endoscopy-America, Inc., Culver City, CA) | RALP | incomplete stone removal in 1 patient. Postoperative retroperitoneal urine leak in 2 patients | 12 | the use of concomitant technique is a safe and feasible option for the treatment of UPJO complicated with renal calculi |
| 16  | Pastore [25] 2016 | A | 9 | staghorn | 72.4 (62–90) | intracorporeal lithotripsy, laparoscopic suction/irrigation system and/or grasping forceps | Holmium-YAG laser, 400 µm fiber (Medilas H20, Dornier Medical Systems, Inc., Marietta, GA, USA) | Lap | N/D | 6 | combined technique is feasible and repeatable, with a stone-free rate similar to open surgery |
| 17  | Jensen [26] 2017 | A | 18 | pelvicalyceal | 15 (10–100) | basket, specimen retrieval bag | N/S | RALP | 1 patient with polyuria and 2 with sepsis. 3 patients had residual stones | 6 | RALP can safely be offered to patients with UPJO and renal stones, with acceptable stone-free rates |
| 18  | Kouriefs [27] 2017 | A | 6 | calyceal stones (1–6) | (1–20) | basket via flexible nephroscope 2 cases required fragmentation with Holmium laser prior to extraction | 1.9F zero-tipped basket | Lap | N/D | 18 | use of flexible video-cystoscope to locate calyceal stones and use of gas to distend the renal pelvis-calyceal system allows for complete stone clearance |
| 19  | Novel current vaginal extraction method (2018) | A | 1 | pelvic (single) | 35 × 42 | vaginal extraction with endoscopic retrieval bag | Colpassist vaginal positioning device (Boston Scientific, Marlborough, Massachusetts, USA) 10 mm endobag extraction bag (Endo Catch™ Gold 10 mm Specimen Pouch – Medtronic) | Lap | None | 3 | novel, reproducible and safe method of larger calculus extraction while preserving the minimally invasive surgical approach, in an appropriate female patient |

MFU = Mean follow-up; Lap = laparoscopy; RALP = robot-assisted laparoscopy; FURS = flexible ureteroscopy; UPJO = ureteropelvic junction obstruction; N/S = not specified; N/D = none documented; A = adult; C = child; SILS = single incision laparoscopy surgery; PCNL = percutaneous nephrolithotomy.
Small stone burden management has not proven to be difficult with conventional laparoscopic instruments readily available in most urological centres. The use of the laparoscopic grasping and stone basket under direct vision has been well described in the literature, while some studies have shown excellent stone-free rates with laparoscopic graspers alone [2, 4, 5].

Although the Anderson-Hynes pyeloplasty has undergone various unintended modifications from its inception [28], the stone extraction technique may always prove to be a challenge to the attending urologist.

There has, however, not been much published about the management of larger calculi during laparoscopic procedures. The use of percutaneous nephrolithotomy prior to or intracorporeal lithotripsy during laparoscopic surgery for UPJO has been reported [6]. The disadvantage of this however, is that this often requires more than one procedure or a lengthier procedure. Sotelo et al. [7] described success with extraction of large staghorn calculi in 2 patients with the aid of a specimen retrieval bag through an abdominal incision. Nadu et al. [8] described a case of a patient with a 9 cm staghorn calculus, on whom they performed laparoscopic anatomic nephrolithotomy and used an endobag for removal of the stone, again, through an extended abdominal incision. A larger (55 mm) stone was extracted through an extension of the supraumbilical port excision in another study [9].

Goel et al. [10] described another solution of large stone removal. They included extraction of larger stones (3 cm and larger) by placement of the stone into a retrieval bag and using stone-crushing forceps, reducing the stone into a size that was then able to be easily removed through one of the 12-mm laparoscopic insertion ports [10], and thus obviating the need for an additional incision or extension of a port incision. This method does carry the risk of intra-corporeal bag rupture and potential iatrogenic abdominal injuries.

Although transvaginal extraction during minimally invasive surgery is not a new concept, its employment in the extraction of large renal calculi is however a novel technique. It has been used with some success, for example, during laparoscopic nephrectomy [11–14]. Based on our current systematic review, the first description and successful performance of stone extraction via transverse posterior colpotomy for upper tract urolithiasis. We have now shown this to be an alternative extraction “route of passage” in the select patient. This may be more relevant in resource limiting environments where percutaneous nephrolithotomy equipment or expertise are not available.

**Conclusion**

We have described a novel extraction method of large upper tract calculus extraction following laparoscopic pyelolithotomy and pyeloplasty for UPJO associated with renal stones in an appropriate female patient. We believe that this is a safe, easily reproducible and simple technique to perform by a surgeon with laparoscopic experience. There is no reason to specifically confine the advantages of this technique to patients with UPJO; it can be utilised for any appropriate female patient with a high stone burden where laparoscopic surgery is a viable option. This method is of great use in the ever-growing movement toward minimally invasive surgery and has very few functional and cosmetic complications and very low post-operative morbidity.
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