SKILL AND TALENT

Nephroscopy with carbon dioxide in combination with laparoscopy in the treatment of urinary stones

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Abstract

Objective: Laparoscopy in combination with nephroscopy is rarely used for the treatment of complex urinary stones or anatomical abnormalities with difficult access to stones. During the nephroscopy, in an opened renal pelvis, large amount of fluid leaks and collects in the peritoneal cavity and can be a drawback. In these cases, the nephroscopy with use of carbon dioxide (CO₂) can be an alternative. We present our experience in this technique.

Material and method: We performed surgeries using the 3-port transperitoneal technique. Five patients with urolithiasis were included. Three patients had concomitant ureteropelvic junction (UPJ) stenosis, one with stones in ectopic kidney, and the third had a large stone impacted in the proximal ureter. Patients were treated by pyelolithotomy or ureterolithotomy combined with flexible nephroscopy using CO₂ and dismembered pyeloplasty was performed in appropriate cases. A flexible cystoscope was passed through a port and guided laparoscopically through the opening in the renal pelvis. The gas cannula was connected to the irrigation channel of the endoscope to insufflate CO₂ and calculi were extracted with a nitinol basket.

Results: Median age was 45 years (24–58). Mean operative time of nephroscopy was 22.4 minutes (range 15–48). Mean intra-operative blood loss was inestimable. There were no complications or conversion. Residual lithiasis requiring ureteroscopy was present in one patient.

Conclusions: Flexible nephroscopy using CO₂ in combination with laparoscopy is a feasible and effective technique for the treatment of urinary stones in selected cases to avoid accumulation of fluid in the peritoneal cavity.

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Nephroscopy con uso de dióxido de carbono en combinación con laparoscopia para el manejo de la litiasis urinaria

Resumen

Objetivos: La laparoscopia en combinación con nefroscopia se ha usado en raras ocasiones para el tratamiento de litiasis urinarias complejas o con anomalías anatómicas que presentan cálculos de difícil acceso. Con la pelvis renal abierta, la fuga del líquido de irrigación hacia cavidad peritoneal puede ser inconveniente. La nefroscopia empleando dióxido de carbono (CO₂) es una alternativa en estos casos. Nuestro objetivo es presentar nuestra experiencia con dicha técnica.

Material y métodos: Empleamos abordaje transperitoneal con tres trócares. Cinco pacientes con litiasis urinaria fueron incluidos. Tres casos presentaban estenosis de la unión pieloureteral, un caso tenía riñón pélvico y un último caso tenía un cálido grande impactado en el uréter proximal. Se les realizó pielolitotomía o ureterolitotomía laparoscópica en combinación con nefroscopia flexible empleando CO₂ y pieloplastia laparoscópica en los casos correspondientes. Se insertó un cistoscopio flexible a través de un trócar y se dirigió hasta las cavidades renales. La manguera del gas se conectó al canal de irrigación del endoscopio para insuflar el CO₂ y se realizó la extracción de los cálculos con cesta.

Resultados: La edad promedio de los pacientes fue 45 años (24-58). El tiempo operatorio promedio de la nefroscopía fue 22,4 minutos (15-48) y el sangrado intraoperatorio fue inestimable. No se presentaron complicaciones ni conversión. Un paciente presentó litiasis residual que precisó ureteroscopia.

Conclusiones: La nefroscopia flexible empleando CO₂ en combinación de laparoscopia es factible y efectiva para el tratamiento de la litiasis urinaria en casos seleccionados, ya que evita la acumulación de líquido en la cavidad peritoneal.

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Introduction

In current clinical practice, laparoscopic surgery is rarely used to treat urinary stones, because most of the calculi are eliminated successfully using endourological techniques or by shock waves. The combination of laparoscopic procedures with endourological techniques has been described, and it offers significant benefits for the management of complex lithiasis with anatomical abnormalities. The removal of the stones during laparoscopic pyelolithotomy can be performed with laparoscopic atraumatic forceps; however, it can be difficult and traumatic to reach some calyceal stones with rigid instruments. Inserting a flexible nephroscope guided by laparoscopic assistance allows for a systematic inspection of all renal cavities and the stones can be removed in their entirety.

Flexible nephroscopy combined with laparoscopy may have some disadvantages because of irrigation with saline solution. The problem occurs because the renal pelvis is open, as the fluid may leak into the peritoneal cavity. Furthermore, the interface between the liquid and gas from the pneumoperitoneum can alter intrarenal vision. Mason and Hoenig described the technique of flexible nephroscopy using CO₂ in combination with laparoscopy in the treatment of urinary stones in order to avoid irrigation with saline solution.6

We present our experience on the feasibility and effectiveness of nephroscopy with use of CO₂ in combination with laparoscopy for the management of the urolithiasis.

Patients and methods

A total of 5 patients with urolithiasis underwent laparoscopic surgery in combination with nephroscopy using CO₂. Of these, three had multiple pyelic lithiasis together with stenosis of the UPJ with indication for surgical treatment. They underwent laparoscopic pyelolithotomy, flexible nephroscopy with use of CO₂ and Anderson–Hynes laparoscopic pyeloplasty. The fourth case is a patient with calyceal stones in a pelvic kidney who underwent laparoscopic pyelolithotomy and flexible nephroscopy with CO₂. The last case is a patient with a large calculus impacted in at the level of the proximal ureter, which during laparoscopic ureterolithotomy shifted to the renal pelvis and required CO₂ ureteronephroscopy. In all the patients, informed consent was obtained for the surgical procedures suggested. All the patients underwent preoperative imaging studies (intravenous urography and/or computerized axial tomography).

The indications for laparoscopic surgery for urinary tract stone disease are well established and are as follows: when both calculi with anatomical abnormalities coexist (ectopic kidney, horseshoe kidney, renal malrotation, etc., or in situations with anatomical changes following a surgical procedure such as renal transplantation); symptomatic stones in diverticula of the renal pelvis that cannot be managed by endoscopic techniques; very hard, impacted, and large calculi (>15 mm) mainly in children; when both nephrolithiasis with another renal disease that requires laparoscopic surgery, such as laparoscopic pyeloplasty in the stenosis of the UPJ, coexist; and when there is an economic
or social need to remove the stones in a single surgical intervention.¹

Surgical technique

The patient is placed in lateral decubitus position. Transperitoneal approach with placement of three trocars was used. A laparoscopic tower using a 30° laparoscope, and another endourological tower with flexible cystoscope were available in the operating room to perform laparoscopic surgery and nephroscopy simultaneously. The first 10-mm trocar was inserted at the level of the umbilicus, through a transumbilical incision with open technique. The other two ports were placed on the anterior axillary line, maintaining the proper triangulation with the umbilical trocar (Fig. 1).

The first 4 patients underwent the same procedure of laparoscopic pyelolithotomy. Once the renal pelvis and the proximal ureter were dissected, a pyelic incision was performed. The calculi visible through the opening in the renal pelvis were removed using an atraumatic laparoscopic piece, and they were deposited in a laparoscopic extraction bag. We proceeded to perform nephroscopy, for which we introduced the flexible cystoscope through the 10-mm trocar, and under laparoscopic assistance it was directed towards the interior of the renal pelvis inserting it through the pyelic incision (Fig. 2). On the irrigation line of the endoscope, the CO₂ hose which was used previously for the pneumoperitoneum was connected (Fig. 3).

Through there, the gas was insufflated, and with an atraumatic laparoscopic forceps, the pyelotomy edges were confronted to prevent gas leakage and manage to distend the renal cavities (Fig. 4). Flexible nephroscopy was performed 'without liquid' running a systematic inspection of the calyces (Fig. 5). Using a nitinol basket, the calculi were progressively removed and deposited in a laparoscopic extraction bag (Fig. 6). Upon completion of litoextraction we proceeded to reconstruction according to the corresponding procedure.

In all the cases of stenosis of the UPJ, we performed Anderson–Hynes laparoscopic pyeloplasty, and in the case of the pelvic kidney, closure of the renal pelvis with intracorporeal suturing was performed. In the latter case, laparoscopic ureterolithotomy was prescribed, and then the cystoscope was introduced through the incision of the ureter and advanced in a retrograde manner to reach the renal cavities. The calculus is located in the renal pelvis and extracted with laparoscopic forceps. Finally, ureteral closure is performed with intracorporeal suture. In all patients, double J ureteral catheter was inserted anterogradely, and a Jackson–Pratt drain was left exteriorized through one of the holes of the trocars.

Results

All the cases were successfully completed laparoscopically without conversion. The average age of the patients was 45
years (38–62), and 4 were male. The average operative time of the nephroscopy was 22.44 minutes (15–48 minutes). The intraoperative bleeding was invaluable. The average hospital stay was 3.2 days (3–5). There were no complications. One of the patients with stenosis of the UPJ had a great amount of kidney stones; therefore, the nephroscopy was the longest (48 minutes), managing to remove a total of 18 calculi. Despite this, it was the only case in our series that showed residual stones and it required additional ureteroscopy.

**Discussion**

Percutaneous, retrograde, or through shock wave techniques are the main approaches to the treatment of urinary stones for their good results and low morbidity. Laparoscopic surgery is a complement for those cases that may have a lower success rate and an increased risk of morbidities, like when both anatomical abnormalities or very bulky calculi coexist. 1–5,7,8

Many authors have reported that the endourological and laparoscopic procedures can be combined successfully in a single intervention to improve the rates of residual stones and resolve synchronous anomalies. 3 Fariña Pérez et al. 4 described a case of lithiasis in a pelvic kidney treated with laparoscopic pyelolithotomy combined with flexible nephroscopy. These authors conclude that the use of the endoscope allowed them to perform a more limited pyelic incision to remove the calculus, which meant less surgical time and lower risk of fistula. El-Kappany et al. 7 described the benefits of the combination of laparoscopy with nephroscopy for patients with ectopic kidney, both to assist in the performance of percutaneous nephrolithotomy and to carry out nephroscopy through pyelotomy. Ramakumar et al., 9 and Whelan and Wiesenthal, 5 point the fact that the optimal treatment for patients with stenosis of the UPJ, in conjunction with renal lithiasis, is laparoscopic pyeloplasty combined with flexible nephroscopy, which includes simultaneous radiological assistance through fluoroscopy.

The performance of the laparoscopic pyelolithotomy in combination with conventional nephroscopy implies that much of the saline solution for irrigation leaks into the peritoneal cavity. This liquid which accumulates in varying amounts can be difficult to extract from the bowel loops and cause some problems. 3,6,10 Nadu et al. 3 observed that during the laparoscopic procedure, the saline solution accumulated in the abdominal cavity occupies the space of pneumoperitoneum, and it may affect the quality of the vision and work space. It has also been observed that the small stones can be dragged by the irrigation fluid outside the renal pelvis 9 and lost in the abdominal cavity. 3 Although the relevance of this issue has not been sufficiently treated in the literature, it is clear that the search for these missing calculi in the abdomen is difficult and time consuming. However, the complications of loss of calculi in the abdomen after laparoscopic cholecystectomy are well described, including intra-abdominal abscesses, fistulas, and prolonged fever. 11

Additionally, in our opinion, we consider that the saline solution that leaks from the renal pelvis, where the
potentially infected calculi are present, can spread foci of infection. Schatloff et al. point that this fluid accumulated in the abdomen complicates the postoperative period, because it predisposes the ileus and it generates doubts about a false sensation of anastomotic leakage during the first few days after the surgery, for showing an output increased by the drain.\textsuperscript{10}

Mason and Hoening\textsuperscript{6} were the first authors to describe the usefulness of nephroscopy with use of CO\textsubscript{2} in combination with laparoscopy. The technique was applied in a patient with pelvic kidney who had 4 caliceal stones of 10 and 12 mm, treated with laparoscopic pyelolithotomy combined with the mentioned innovative nephroscopy. They reported that the intrarenal vision obtained with CO\textsubscript{2} insufflation is excellent, because the distension of the renal cavities is particularly good, which facilitates the systematic and thorough inspection of the calyces, adding avoidance of the use of irrigation. In our series, we had the same perception and our results were satisfactory.

Schatloff et al.,\textsuperscript{10} also described an excellent view when they performed nephroscopy with use of CO\textsubscript{2} in combination with laparoscopic pyeloplasty in a patient with multiple kidney stones and stenosis of the UPJ. These authors point that the calculi located in the calyces, which do not drain naturally into the renal pelvis because of the patient’s side position, were difficult to inspect clearly, due to the air–water interface that is created in the calyces that do not drain the urine that they produce. They suggest a maneuver to overcome this deficiency, consisting in suspending the gas insufflation and administering a minimum irrigation with a 50-ml syringe in small amounts of solution applied in short ‘pulses’. In one of our patients, we had to apply this maneuver and we checked its effectiveness.

At present, most patients with urinary lithiasis who are treated with laparoscopic surgery are due to the need for concomitant laparoscopic pyeloplasty due to UPJ stenosis. Our series confirms this postulate. The limitations of our research are due to the fact that this is a retrospective study, and the number of patients is limited, due to the low current indication for the laparoscopic treatment of urolithiasis. An obvious disadvantage of nephroscopy with use of CO\textsubscript{2} is the inability to implement technologies for stone fragmentation or laser vaporization.\textsuperscript{9} In our last patient with ureteral lithiasis, it was intended to exclusively perform laparoscopic ureterolithotomy; however, the displacement of the calculus to the renal pelvis forced us to perform the ureteronephroscopy. The latter procedure could have been avoided if we had performed a maneuver of proximal and distal occlusion on the ureter to prevent dislocation of the stone.\textsuperscript{1,2} However, we could solve the problem without complications using the resource of the nephroscopy with use of CO\textsubscript{2} that we had used previously. The effectiveness obtained with the technique of insufflating gas to perform endourological procedures changes the paradigm that all urological endoscopies are performed with irrigation fluid, and it raises the idea of its potential usefulness in other endoscopic cases of the upper or lower urinary tract, where the vision is affected by active bleeding or turbidity of the internal environment.

Conclusion

Flexible nephroscopy with use of CO\textsubscript{2} in combination with laparoscopy is a feasible and effective procedure for the treatment of urinary stones in selected cases with anatomical abnormalities, complex calculi, or those susceptible to a concomitant laparoscopic treatment. This technique is definitely an excellent resource to reduce the rate of residual stones during laparoscopic pyelolithotomy, which avoids the complications of accumulation of irrigation fluid during nephroscopy.

Conflict of interest

The authors declare that they have no conflict of interest.

References