Original Article

Five-year experience of peritoneal dialysis catheter placement

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Abstract

Background: Peritoneal dialysis (PD) is a widely used renal replacement therapy for end-stage renal disease (ESRD) patients. Using laparoscopic guidance for PD catheter placement, we have designed a safe method that resulted in a reduction in catheter migration.

Methods: We retrospectively reviewed 250 consecutive patients who underwent PD catheter placement from January 2005 to December 2009. The patients were divided into two groups: the conventional open surgery group and the laparoscopic group. All patients received Tenckhoff straight catheters. In the laparoscopic group, the catheter was additionally fixed to the ventral abdominal wall. Data were collected and a statistical analysis was performed to compare patient characteristics, surgical complications and catheter removal between the groups.

Results: Overall surgical complications in the laparoscopic group were lower than those in the conventional group (3.8% vs. 19.4%, p < 0.001), and the majority of catheter migrations and omental wraps occurred in the conventional group. Patients in the conventional group had higher American Society of Anesthesiologists scores than those in the laparoscopic group. There was no difference in the incidence of previous abdominal operation or follow-up periods in the groups.

Conclusion: Our laparoscopy-assisted PD catheter insertion method using an intraperitoneal fixation loop is safe and can be a valuable tool in prevention of catheter migration and omental wraps.

Keywords: end stage renal disease; laparoscopy; peritoneal dialysis

1. Introduction

Laparoscopic-assisted peritoneal dialysis (PD) catheter placement has proven beneficial for prolonging catheter outcome by preventing the causes of catheter dysfunction, such as catheter tip migration, omental wrap, and tissue entrapment. Unlike the conventional open method of Tenckhoff catheter placement, laparoscopy provides the benefits of allowing direct visualization and additional maintenance procedures, such as catheter fixation or omental resection.

Consequently, the use of laparoscopic-assisted PD catheter placement can help prevent viscus trauma and ensure better catheter function. Various laparoscopic approaches have been described, and these surgical designs are principally safe, efficient, and reproducible. However, there were still some patients who could not receive laparoscopic surgery clinically, because of severe cardiopulmonary distress or unsuitability for general anesthesia. There was still a need for catheter placement procedures through conventional open techniques. In the present study, we conducted an empirical review to understand...
the effectiveness of common catheter-placement methods, namely, the conventional open procedure and the laparoscopic technique.

2. Methods

2.1. Patient selection and perioperative preparation

Two hundred and fifty consecutive patients with end-stage renal disease (ESRD) who underwent PD catheter placement from January 2005 to December 2009 were retrospectively assessed. All patients were operated on by the same surgeon. Sixty-seven patients received conventional open surgery (conventional group) and the others (183 patients) received laparoscopic surgery (laparoscopic group). The patients were typically selected according to their general performance status and anesthesia risks; they gave complete informed consent. Patients with potential risks under general anesthesia, or those who had severe cardiopulmonary distress were placed in the conventional group. Each patient underwent abdominal KUB film assessment after surgery.

2.2. Surgical technique

All patients received standard double-cuff straight Tenckhoff peritoneal dialysis catheters (Sherwood Medical Company, St. Louis, MO, USA). Patients in the conventional group received either local or general anesthesia. Before incision, we preferred to draw a catheter map in order to create a better catheter path during the operation. The catheter map recorded the cuff position and the exit site position. Importantly, we measured 12 cm above the pubic symphysis as the inner cuff site. This allowed 5 cm spare length to the pelvic cavity due to the Tenckhoff catheter design (inner cuff to the catheter tip is 17 cm). A paramedian lower abdominal incision, 3–4 cm in length was given. The catheter was delivered after entering the peritoneal cavity using a catheter stylet without visual guidance along the ventral side of the peritoneum to the pelvic cavity. An additional catheter-fixation loop was placed at the lower end of the peritoneum, allowing a better catheter direction fixation. After closure of the peritoneal opening using a purse-string technique, we also fixed the inner cuff to the peritoneum in order to prevent catheter dropout. The external half of the catheter was delivered out through a subcutaneous tunnel to the skin opening, using a puncture needle guide. Finally, the superficial abdominal fascia and the skin were approximated.

In the laparoscopic group, a 2 cm lower midline incision was used as both the catheter-insertion site and camera port. After the peritoneum was entered, we extended the entire catheter into the peritoneal cavity and tied a length of silk at the external end of the catheter in order to easily grasp the catheter after laparoscopic procedures. During laparoscopic procedures, fixation of the catheter to the ventral abdominal wall was performed (Fig. 1) using a Berci fascial closure instrument to create a fixation loop (Model 26173AM; Karl Storz, Tuttlingen, Germany). A 2-0 nylon line was delivered to and through the peritoneal cavity from the outside through different fascia openings. The distance between the two ends of the loop should be as small as possible in order to prevent intra-peritoneal hernia. With the aid of a grasper instrument from the other 3.5 mm trocar, we could easily put the catheter tip through the fixation loop to the pelvic cavity well. Then, the fixation loop was tied properly from the skin surface so that the notch would be located at the level of the abdominal fascia. The peritoneal opening of this 3.5 mm trocar site was

Fig. 1. The catheter insertion to the peritoneum site served as a 12 mm trocar site and a camera port. The 3.5 mm trocar site is a working port and ultimately served as a catheter exit site.
closed using the same Berci fascial closure instrument, and the skin opening of this site served as the exit site of the catheter (Fig. 2). Finally, the rest of the procedure including peritoneal closure and the delivering of the external catheter was the same as that of the conventional open method. The laparoscopic procedures were described in our previous literature where video recordation was utilized.8

2.3. Statistical analysis

We used Yates’ correction for continuity for the analysis of gender and surgical complications. The t test was performed for the analysis of age and follow-up period. Chi-square tests were utilized for the analysis of prior abdominal surgery. The Mann-Whitney U test was used for American Society of Anesthesia (ASA) score analysis.

A major surgical complication was defined as a significant catheter dysfunction which required reoperation. Blood clot obstruction was defined as obstruction of a catheter by a long segmental blood clot. Fixation site granulation was defined as inflammatory changes caused by stitch granulations at the catheter fixation sites. Incisional hernia was defined as the development of a hernia at either surgical incision site. Catheter migration was defined as transient or prolonged catheter malfunction during follow-up and by KUB films showing the catheter out of the pelvic cavity. Omental wrap was defined as catheter obstruction by an entrapped omentum. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS version 10.1; SPSS Inc., Chicago, IL, USA).

3. Results

A total of 183 patients received laparoscopic PD catheter placement and 67 patients received conventional open surgery. Patient demographics are listed in Table 1. In both groups, most of the patients were female. The patients’ ages ranged from 6 to 86 years, with a median age of 45 years. There was no statistical difference between the groups in terms of sex, age distribution, and the rate of previous abdominal surgery. Major surgical complications occurred in 8% of all patients and only 3.8% of the patients in the laparoscopic group. The conventional group had significantly higher ASA scores (p < 0.001), and more major surgical complications (p < 0.001) in comparison with the corresponding values in the laparoscopic group.

The incidence of major surgical complications in the conventional group was significantly greater than that in the laparoscopic group (Table 2). One patient in the laparoscopic group had a post-operative blood clot occlusion within the catheter and underwent a second operation. Another patient in the laparoscopic group showed granulation tissue formation in the subcutaneous layer of the lower abdominal catheter fixation site. These may have been stitch reactions, since they did not recur after the stitch material was changed from silk to nylon. One incisional hernia developed at the camera port site because of a technical error with a missing stitch carriage. In our study, the additional trocar incision did not cause an increase in abdominal wall hernia. In the laparoscopic group, no catheter migration was detected during follow-up. We did not routinely check the catheter position with abdominal plain radiographs during follow-up, because the patients with catheter migration also had catheter dysfunction and were therefore identified. All seven patients in the conventional group who had migrated catheters received adjustment surgeries after failure of medical laxative treatment and manual reduction. Omental wrap was the major cause of catheter dysfunction. Among the six patients in the conventional group who exhibited omental wrap, five were less than 18 years old. In these patients, widespread omentum filling of the pelvic cavity was the cause of this complication. In the laparoscopic group, all three patients had omental wrap because of inadequate lysis of adhesion.

There was no significant difference between the causes of catheter removal in the two groups (Table 3). Catheter removal was performed in 55.2% of the patients in the conventional group and 35% of the patients in the laparoscopic group. Patient dropout and a shift to hemodialysis were the major reasons for catheter removal.

4. Discussion

Although peritonitis is the major factor of PD catheter survival, an efficient, less-complicated PD catheter placement is important in this organ shortage to provide satisfactory bridge care for ESRD patients.9 Laparoscopic-assisted PD catheter placement using various surgical techniques, provides direct vision, allows for additional procedures for reducing complications, and is completely reproducible.10,11

Ogunc et al reported that a laparoscopic omental fixation technique could prevent the mechanical catheter failure rate.1 Oontrapornchai and Simapatanapong reported their experiences in intraperitoneal laparoscopic suturing of the catheter.12
The use of this technique afforded the advantage of preventing catheter migration; however, it did not provide better catheter survival. Both of the procedures reported above were complicated because of the multiple trocars setting and the requirement of intraperitoneal suturing techniques. Recently, simpler methods which require fewer trocars and no suturing have been developed. Harissis et al reported their minimally invasive laparoscopic PD catheter-placement technique, which uses only a single port and a needle-assisted intra-abdominal fixation.\(^6\) This method is simple and fewer trocars are used. Our procedure is similar to their design, although it differs in the emphasis on catheter manipulation using a suture delivery carrier and a laparoscopic grasper. We believe that the catheter placement procedure is easier with these instrument aids. Carrillo et al reported a method using two trocars without accompanying catheter management; their study showed good catheter outcome in a small patient group during a short follow-up period (median follow-up period \(=\) 1 year).\(^{13}\)

Laparoscopic PD catheter placement also allows for concomitant procedures during the operation. Adhesiolysis was the most commonly reported combined procedure in several series. In Ogunc’s series, they reported a case of combined trans-abdominal pre-peritoneal (TAPP) inguinal hernioplasty and PD catheter placement. They also reported combined operations involving a liver biopsy and an ovarian cystectomy. In our experience, only three adhesiolysis procedures were performed. With the aid of the laparoscopic grasper, the PD catheter could be placed at the proper position even when minor adhesion exists. We did not extensively dissect the existing omental adhesion, unless it blocked the entrance of the pelvic cavity. Therefore, three patients had recorded omental wrap. We then adjusted the procedure design and performed limited adhesiolysis around the catheter insertion site. No additional omental wrap was found after this modification. We also performed combined operations during catheter placement. One patient underwent an ovarian cystectomy, because a corpus luteum cyst rupture was found during laparoscopy. Another patient underwent a laparoscopic peritoneal biopsy for a rare peritoneal mesothelioma. Three patients had a bilateral inguinal hernia and underwent concomitant total extra-peritoneal hernioplasty (TEP). TEP is considered a reasonable technique in PD patients because the integrity of the peritoneum is preserved.\(^{14}\)

### Table 1
Patient demography comparison between the conventional and laparoscopic group.

<table>
<thead>
<tr>
<th></th>
<th>Conventional (n = 67)</th>
<th>Laparoscopic (n = 183)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>49.9 ± 21.97</td>
<td>48.5 ± 15.92</td>
<td>0.563</td>
</tr>
<tr>
<td>ASA score</td>
<td>3.46 ± 0.5</td>
<td>3 ± 0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Follow-up months</td>
<td>16.9 ± 17.04</td>
<td>17.8 ± 13.92</td>
<td>0.672</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>29 (43.3%)</td>
<td>83 (45.4%)</td>
<td>0.882</td>
</tr>
<tr>
<td>F</td>
<td>38 (56.7%)</td>
<td>100 (54.6%)</td>
<td></td>
</tr>
<tr>
<td>Previous Abdominal surgery</td>
<td>15 (22.4%)</td>
<td>36 (19.7%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Major surgical complication</td>
<td>13 (19.4%)</td>
<td>7 (3.8%)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

\(^a\) t test.  
\(^b\) Mann-Whitney U test.  
\(^c\) Yate’s correction of contingency.  
\(^d\) Chi-square test.  

### Table 2
Major surgical complication comparison between the conventional and laparoscopic group.

<table>
<thead>
<tr>
<th>Operation methods</th>
<th>Conventional (n = 67)</th>
<th>Laparoscopic (n = 183)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>54 (80.6%)</td>
<td>176 (96.2%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Blood-clot obstruction</td>
<td>0 (0.5%)</td>
<td>1 (0.5%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Fix-site granulation</td>
<td>0 (0.5%)</td>
<td>2 (1.1%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Incisional hernia</td>
<td>0 (0.5%)</td>
<td>1 (0.5%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Migration</td>
<td>7 (10.4%)</td>
<td>0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Omental wrap</td>
<td>6 (9.0%)</td>
<td>3 (1.6%)</td>
<td>0.013</td>
</tr>
</tbody>
</table>

\(^a\) Yates’ correction.  
\(^b\) Fisher’s exact test.

### Table 3
Catheter removal analysis in the conventional and laparoscopic group.

<table>
<thead>
<tr>
<th>Operation methods</th>
<th>Conventional n (%)</th>
<th>Laparoscopic n (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause of catheter removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transplantation</td>
<td>8 (21.6%)</td>
<td>15 (23.5%)</td>
<td>0.955</td>
</tr>
<tr>
<td>Patient death</td>
<td>8 (21.6%)</td>
<td>11 (17.2%)</td>
<td></td>
</tr>
<tr>
<td>Peritonitis</td>
<td>6 (16.2%)</td>
<td>10 (15.6%)</td>
<td></td>
</tr>
<tr>
<td>Shift to HD</td>
<td>10 (27.0%)</td>
<td>21 (32.8%)</td>
<td></td>
</tr>
<tr>
<td>Insufficient PD</td>
<td>5 (13.6%)</td>
<td>7 (10.9%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>37 (100.0%)</td>
<td>64 (100.0%)</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Yates’ correction.
Crabtree reviewed the trends in PD catheter placement in the last 3 decades and found that laparoscopic access is more commonly used and generally considered effective. He found that the most frequently reported benefits of using laparoscopy are the prevention of catheter-related dysfunction and prolonged catheter survival. In contrast, in a small prospective randomized series, Jwo et al reported that laparoscopic access did not result in superior catheter survival compared to that of the conventional method. In their study, laparoscopic access with a fixation procedure did show a benefit in the prevention of catheter migration (2.7% vs. 15.0%) and improved the omental wrap rate; however, the cost and operative times also increased.

Nephrologists have performed successful PD catheter placement using blind percutaneous access or video endoscopy. The reported benefits of this technique are that it is less invasive, costs less, and has a lower anesthesia-related risk. In our experience, some patients had severe cardiopulmonary distress, not suitable for receiving general anesthesia and may benefit from these procedures using local anesthesia. However, the potential risk of viscus trauma, catheter migration and omental wrap were still significant, owing to the lack of accompanying procedures which could help prevent complications.

In conclusion, laparoscopic PD catheter placement reduced surgical complications after PD catheter placement. It is recommended for patients who are preparing to receive PD catheter placement and can receive general anesthesia and pneumoperitoneum.

Acknowledgments

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References