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RESEARCH ARTICLE

Anesthesia Considerations for Insertion of the Peritoneal Dialysis Catheter

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Abstract

Background: Laparoscopy is an effective method of implantation for Peritoneal Dialysis (PD) catheters. However, in many centers around the world, Peritoneal Dialysis Catheter (PDC) insertions are done using an open surgical method, associated with greater surgical trauma and longer duration of hospitalization. One of the major drawbacks to the acceptance of laparoscopic insertion is the perceived necessity for General Anesthesia (GA) for this procedure. In this study, we have examined methods of anesthesia for laparoscopic insertion of PD catheters at a major North American center.

Methods: This retrospective study includes 245 patients with laparoscopic PD catheter insertion from January 2008 to July 2013 at the University Health Network in Toronto. The patients were consigned to Local Anesthesia (LA) and General Anesthesia (GA) depending on their co-morbidity and risk assessment. The LA patients were given intravenous conscious sedation with midazolam, fentanyl and propofol. Hemodynamic fluctuations were managed with small doses of vasopressors or vasodilators during the procedure. Nitrous oxide and carbon dioxide pneumoperitoneum were used for LA group and GA group respectively.

Results: The age, the exit site position of the catheter, the history of abdominal surgery and co-morbidities such as diabetes and cardiovascular disease in the two groups were significantly different.

All patients tolerated the procedure well. Nearly 45% of the patients were given LA, there were more ASA grade IV patients in this group. Ten patients were converted to GA from LA. There were no significant differences in Systolic Blood Pressure (SBP) in the two groups at the beginning of the anesthesia, but during the surgery, the SBP of GA group decreased. There were no significant differences of SPO_2 between the two groups. The mean operating time and observation time in the Post-Anesthesia Care Unit (PACU) of the GA group was longer. After arrival in the PACU, the PACU score in GA group was lower than LA group, but there was no difference between the two groups at discharge.

Conclusions: Both local and general anesthesia for laparoscopic catheter implantation is safe and effective. Older patients, abdominal (as opposed to pre-sternal) exit sites, co-morbidity with diabetes mellitus, and those with higher ASA grade do well with local anesthesia.

Keywords

Laparoscopic insertion, Peritoneal dialysis catheter, Local anesthesia, General anesthesia, Conscious sedation

Introduction

Peritoneal Dialysis (PD) is becoming increasingly popular and different types of surgical techniques (open, percutaneous, and laparoscopic) have been developed for catheter placement [1]. Open surgery and especially the percutaneous technique are associated with poor outcomes and sometimes life-threatening complications. In fact, the incidence of omental wrapping, catheter displacement, and intra-abdominal complications, specifically bowel and bladder perforation, is higher with these two methods [2].

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Laparoscopic implantation of PD catheters has been shown to have advantages such as less surgical trauma and decreased formation of adhesions [3,4]. Catheters placed by laparoscopic methods have also been reported to have the best outcomes [5]. The keys to successful long-term PD catheter functioning after implantation are visual confirmation of proper catheter location and configuration during the implantation process [6]. Laparoscopy, in addition, provides a relatively noninvasive method to fully investigate the peritoneal cavity [7,8]. As a result, laparoscopy is becoming a preferential approach in a growing number of centers.

However, in China and many other countries, nearly all Peritoneal Dialysis Catheter (PDC) insertions are done using an open surgical method. One of the major drawbacks to the acceptance of laparoscopic insertion is the perceived necessity for General Anesthesia (GA), because insufflation of gas into the abdominal cavity produces peritoneal pain. Given that candidates for PD catheter implantation are patients with end-stage renal failure who often have severe coexisting medical problems that put them in a high-risk category for general anesthesia [9], the feasibility of laparoscopic implantation of PDC under local is worthy of investigation.

In order to promote acceptance of laparoscopy, we have examined anesthesia for laparoscopic insertion of PD catheters at a major North American center.

Patients and Methods

This is a retrospective analysis. Between January 2008 and July 2013, 245 consecutive adult patients with renal failure underwent laparoscopic placement of peritoneal dialysis catheters at Toronto General Hospital have been enrolled.

All the patients were referred from the nephrology clinic to an experienced surgeon in the general surgery clinic for careful examination before being decided whether they are the good candidates for laparoscopic placement of PDC. The choice of anesthetic technique (LA or GA) was determined in consultation with anesthesiologist upon looking at different factors including age of the patient, associated medical co-morbidity, patient cooperation, prior abdominal surgery and exit site location of the PDC.

We accessed the electronic patient records, the patient charts, the operation records, the anesthetic records, and the PACU (Post-Anesthesia Care Unit) records. Collected data for this study included demographic data and clinical details, including the patients' age, gender, Body Mass Index (BMI), cause of renal disease, abdominal surgery history, co-morbidities such as Diabetes Mellitus (DM) and Cardiovascular Disease (CVD), physical status according to the American Society of Anesthesiologists (ASA) classification, type of anesthesia, vital signs of the procedure including at the beginning of the anesthesia, at the end of the surgery before discharge from the operating room, duration of operation, PACU scores at arrival and discharge respectively, and observation time in PACU. At the same time, the most recent laboratory blood tests before the surgery were also been collected (such as hemoglobin, serum albumin, creatinine and Creatinine Clearance (Ccr) as a measure of renal function. All the patients were divided into Local Anesthesia (LA) and General Anesthesia (GA) groups.

Anesthesia and surgical technique

All procedures were performed in the operating room with an anesthesiologist in attendance. After arrival in the operating room, an Intravenous (IV) catheter and all standard monitors (electrocardiogram, non invasive blood pressure, pulse oximetery) were applied to the patient. Patients undergoing general anesthesia were induced with IV propofol (1-2 $mg.kg^{-1}$), fentanyl (1-2 $\mu g.kg^{-1}$), and cisatracurium (0.15 $mg.kg^{-1}$) for tracheal intubation. The maintenance of anesthesia was with oxygen; air with either sevoflurane or desflurane (titrated to age adjusted Minimum Alveolar Concentration (MAC) 0.8-1.1). For patients undergoing procedure under LA, sedation was started after the application of the monitors. This consisted of midazolam 0.015 mg/kg, fentanyl 1-2 ug/kg (and/or) remifentanil (0.01-0.1 $\mu g.kg^{-1}.min^{-1}$) followed by propofol (intermittent bolus of 10-20 mg or continuous infusion at 25-150 $\mu g.kg^{-1}.min^{-1}$), titrated to titrated to the assessment of alertness/sedation (OAA/S) scale 3 or 4. All patients in the LA group received supplemental oxygen via facemask. Hemodynamic fluctuations were managed with small doses of vasopressors or vasodilators during the procedure.

All the laparoscopic PD catheter implantations were done by one designated experienced general surgeon, Local anesthesia was achieved by infiltrating the soft tissue and peritoneum with 1% lidocaine. Nitrous Oxide (N_2O) and Carbon Dioxide (CO_2) pneumoperitoneum were used for LA group and GA group respectively, inflating to a maximum pressure of 12 mmHg. After completion of the surgery, patients were transported first to the post-anesthesia care unit.

Statistics

Data are expressed as mean ± standard deviation or as number of patients. Parametric data were analyzed using the independent samples t-test. For categorical data analysis, the chi-square or Fisher exact test was used. A binary logistic regression model was used to identify the decisive factors of LA patient selection. Odds Ratios (ORs) and 95% Confidence Intervals (CI) were calculated. Statistical calculations were performed using the SPSS software version 17.0. Differences were considered significant at $p < 0.05$.

Results

All patients tolerated the procedure well. Mean age in

the study group was 60.60 ± 16.01 years (range 19 to 92), and 47.8% of the patients were male. The main causes of the renal failure were diabetic nephropathy in 71 patients, chronic glomerulonephritis in 42 and hypertension in 27 (Table 1). As shown in Table 2, nearly 45% of the patients were given local anesthesia with conscious sedation. There were more ASA grade IV patients in this group. There were no significant differences between two groups in gender, BMI, hemoglobin, serum albumin, Ccr, and the PACU scores when discharged. However, the age, presternal versus abdominal exit site position, history of previous abdominal surgery, co-morbidities such as DM and CVD, the mean surgery time and the PACU scores when arrival in two groups were significantly different.

At the same time, the vital signs during the procedure were compared between LA and GA groups (Table 3). There were no significant differences between GA group and LA group in systolic blood pressure at the beginning of the anesthesia (155.0 ± 26.2 mmHg versus 154.0 ± 22.5 mmHg). The systolic blood pressure at the end of the surgery decreased in both groups, but it was lower in GA group than LA group (120.2 ± 17.7 mmHg versus 128.9 ± 21.4 mmHg). However, before discharge from the operating room the systolic blood pressure increased more in GA group. The average oxygen saturation (SPO_2) which was more than 95% during the procedure was similar in both groups.

Ten patients in whom surgery was initiated with LA were converted to GA. Reasons for conversion included visceral perforation (gall bladder) in 1 patient, agitation and significant involuntary shivering in 4 patients, extensive adhesions in 1 patient, poor oxygenation in 1 patient, abdominal breathing in 1 patient, high pressure and abdominal guarding in 1 patient, and coughing in another two patients.

In two patients the insertion of the PDC was aborted because of the complication of the surgery, one with gall bladder injury mentioned above because of a very tiny abdomen and an extremely thin abdominal wall which would produce the possibility of an infected field, and the other due to extensive adhesions and injury to the transverse colon during the surgery.

Table 1: The primary disease of the study subjects.

Primary disease	N, %
Diabetic nephropathy	71 (29.0%)
Chronic glomerulonephritis	42 (17.1%)
Hypertension	27 (11.0%)
Obstructive nephropathy	14 (5.7%)
Polycystic kidney disease	12 (4.9%)
Lupus nephritis	11 (4.5%)
Calcineurin inhibitor toxicity	9 (3.7%)
Hereditary Nephritis	8 (3.3%)
Failed kidney transplantation	7 (2.9%)
Amyloidosis	5 (2.0%)
Vasculitis	4 (1.6%)
Acute kidney injury	3 (1.2%)
Tumor of urinary system	3 (1.2%)
Vascular disease	3 (1.2%)
Unknown	15 (6.1%)
Others	11 (4.5%)

Table 3: Comparison of the variation of vital signs between two groups during the procedure.

Variable		Point 1	Point 2	Point 3
SBP (mmHg)	LA	155.0 ± 26.2	128.9 ± 21.4	135.8 ± 25.9
	GA	154.0 ± 22.5	120.2 ± 17.7	146.0 ± 25.7
P value		0.746	0.001	0.003
SPO_2 (%)	LA	98.6 ± 1.2	98.8 ± 1.1	97.7 ± 1.6
	GA	98.8 ± 1.0	98.5 ± 1.0	98.0 ± 1.6
P value		0.272	0.055	0.194

Point 1: The beginning of the anesthesia; Point 2: The end of the surgery; Point 3: The post-operation before discharge from the operating room; SBP: Systolic Blood Pressure; SPO_2: Oxygen Saturation; LA: Local Anesthesia; GA: General Anesthesia.

Table 2: Comparison of demographic features and clinical details of two study groups.

Parameter	GA	LA	P Value
N	140 (57.1%)	105 (42.9%)	
Age (years; mean ± SD)	57.0 ± 16.9	65.4 ± 13.3	0.001
Gender (Male/Female)	63/77	54/51	0.319
BMI (kg/m^2)	27.7 ± 7.5	26.4 ± 5.6	0.121
Exit site position (pre-sternal %)	48 (34.8%)	4 (3.8%)	0.001
Abdominal surgery history (yes %)	80 (57.1%)	46 (43.8%)	0.039
DM (yes %)	49 (35.0%)	56 (53.3%)	0.004
CVD (yes %)	42 (30.0%)	48 (45.7%)	0.012
Renal CrCl (mL/min)	13.9 ± 5.8	13.8 ± 7.9	0.910
Hemoglobin (g/L)	103.8 ± 15.4	104.8 ± 16.6	0.632
Serum albumin (g/L)	35.8 ± 4.8	34.7 ± 5.1	0.097
ASA (III/IV) (IV%)	98/26 (21.0%)	56/35 (38.5%)	0.005
Mean operating time (min)	72.1 ± 50.5	50.5 ± 21.2	0.001
PACU score (arrival)	9.15 ± 1.14	9.72 ± 0.60	0.001
PACU score (discharge)	9.98 ± 0.15	9.98 ± 0.14	0.851
Observation time in PACU (min)	72.1 ± 50.5	50.5 ± 21.2	0.001

LA: Local Anesthesia; GA: General Anesthesia; SD: Standard Deviation; BMI: Body Mass Index; DM: Diabetes Mellitus; CVD: Cardiovascular Disease; Ccr: Creatinine Clearance Rate; ASA: American Society of Anesthesiologists; PACU: Post-Anesthesia Care Unit.

Table 4: Logistic Regression Analysis of the selected factors for LA patients.

Variables	Adjusted OR	95% CI	p value
Age	1.034	1.015, 1.053	0.001
Exit site position	9.341	3.948, 22.103	0.001
DM	0.531	0.305, 0.925	0.025
ASA Grade	0.566	0.311, 1.028	0.062

LA: Local Anesthesia; OR: Odds Ratio; CI: Confidence Interval; DM: Diabetes Mellitus; ASA: American Society of Anesthesiologists.

Sedation administered to the patients included midazolam in 85%, fentanyl in 79% and propofol in 91%. Remifentanil was administered in 38% of those undergoing insertion.

Binary logistic regression analysis found that older age, abdominal exit site, co-morbidity with DM, and those with higher ASA grade were the decisive factors for LA patient selection (Table 4). Therefore, the choice of LA versus GA was not random, but informed by the risk factors carried by the patients.

Discussion

One of the major impediments to acceptance of surgical laparoscopy as a means for PD catheter implantation has been the necessity for a general anesthetic [10-12]. Laparoscopy is routinely performed with CO_2 abdominal insufflation to create the pneumoperitoneum in the peritoneal cavity. The insufflated CO_2 reacts with the peritoneal surface to produce carbonic acid. The resulting irritation causes pain [10,13]. In addition, CO_2 is rapidly absorbed across the peritoneal membrane and may contribute to significant metabolic acidosis and cardiac arrhythmias [14,15], disturbances that are not well tolerated by high-risk renal failure patients [10].

Alternatively, N_2O is an inert gas and better tolerated as an insufflation agent [16], because it produces neither peritoneal irritation nor the metabolic effects, offering a plausible explanation for absence of pain and thus enabling laparoscopy with the patient under local anesthesia [9,12]. Combined with the mild conscious sedation which is appropriate to alleviate undue fear and anxiety, the procedure can be tolerated well without GA [10].

Our study shows that the age in LA group is older than the GA group. One explanation is that the younger patients have more abdominal musculature than the older patients, leading to significant guarding when the pneumoperitoneum was given. In order to relax the abdominal muscle, the GA is more suitable for the procedure. In addition, local anesthesia may pose less of a risk compared to general anesthesia in the older patient with co-morbidity.

The patients with exit site position located pre-sternally need a longer tunnel, and have more tissue trauma incumbent in the subcutaneous tunneling. Because of the associated pain, the GA is indicated.

In our study, the GA group has more patients with the history of previous abdominal surgery included appendectomy, Cesarean section, hysterectomy, oophorectomy, hemicolectomy, cholecystectomy, laparotomy, nephrectomy, previous PDC implantation, hernia repair, and renal and liver transplantations. Previous abdominal surgery may result in intra-abdominal adhesions [17], which may need added procedures during the surgery such as adhesiolysis and omentectomy. Hence, the GA should be given to these patients in order to better tolerate the surgery. Indeed, we found that there were 9 patients who underwent extensive adhesiolysis during the surgery, all under GA.

There was more co-morbidity in the LA group, a result of confounding by indication, since it was elected to use LA because of the higher risk for GA [9].

Patients in the study are classified as ASA grade III or IV according to the American Society of Anesthesiologists Physical Status Classification. Unfortunately there were 30 missing classifications, due to no note in the anesthesia record. There are more grade IV patients in LA group; however the GA group have more grade III patients, the ASA classification evaluates the general health status focused on the perioperative risk [18], the higher grade the more severe systemic disturbances the patients have, making them high-risk candidates for GA [19].

Our results showed that the patients vital signs expressed as the systolic blood pressure and the SPO_2 were all at normal range, which indicates the procedure is safe.

The duration of the procedure was shorter in LA group than the GA group, because the patients needed to be intubated and ventilated when given GA, and needed to return to the recovery room after surgery.

The LA group had higher PACU scores than GA group upon arrival and was similar in two groups (all nearly 10) when discharged from the PACU, which conform to the criteria for discharge. The PACU scores are assessed by 5 items including respiration, circulation, consciousness, muscle strength, color. The observation time in the PACU was shorter in LA group, because the patients in LA group were only given a mild sedation. There were only a small number of patients in the study group who initiated LA and were converted to GA in order to make the surgery go well, so the two anesthesia methods are complementary.

In conclusion, the present study, although not randomized, shows that both local and general anesthesia for laparoscopic catheter implantation is safe and effective. Nearly 45% of the patients are suitable for local anesthesia with conscious sedation. Older patients, those with more severe systemic disturbances (with higher ASA grade), having more co-morbidities, abdominal (as opposed to pre-sternal) exit site, and those without previous abdominal surgery do well with local anesthesia.

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Disclosures

The authors declare that no financial conflict of interest exists.

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