Subcostal Port Placement for Lateral Transperitoneoscopic Adrenalectomy: Assessment of Surgical Efficacy

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Abstract The purpose of this study was to evaluate the safety and efficacy of the modified lateral transperitoneal (MLTP) approach in comparison with the traditional lateral transperitoneal (LTP) and lateral retroperitoneal (LRP) approach. From January 2008 to December 2012, 287 patients underwent laparoscopic adrenalectomy, and the MLTP, LTP and LRP approaches were used in 93, 96 and 98 patients. The patients' demographics and surgical outcomes from the three approaches were reviewed and compared. There were no significant differences in the general demographic or postoperative recovery variables among the three groups. However, the average volume of blood lost was lower for the MLTP group than for the other two groups. Additionally, the average operative time was significantly shorter in the MLTP group than in the LTP group and slightly shorter than in the LRP group, but the differences were not statistically significant. This study shows that the MLTP approach is a safe and effective procedure which is associated with shorter operative time and lower volumes of blood loss.

Keywords Laparoscopic adrenalectomy · Transperitoneal · Retroperitoneal · Optical axis-to-target view

Introduction

Since laparoscopic adrenalectomy was first described in 1992 [1], several studies have demonstrated that this minimally invasive procedure can achieve the same results as open surgical procedures with less trauma and lower mortality [2–4]. At present, it has been considered the gold standard for the treatment of benign adrenal disease [5]. Various laparoscopic approaches to the adrenal gland have been described [6–8]; of these, the lateral transperitoneal (LTP) approach is the most frequently used because of the familiar operative field and wide working space. The literature shows that laparoscopic adrenalectomy is performed using the LTP route in approximately 80 % of published cases [9]. However, no standard lateral transperitoneal approach to the adrenal region has ever been defined. The approach varies among reports [10–13], as port placement is determined by the surgeon's preference based on individual experience. We first applied a triangular port configuration involving camera access just lateral to the edge of the rectus sheath at the level of the umbilicus; however, the visibility of the videoscope is less desirable, as it might be impaired by a sagging bowel. Then, we attempted a subcostal port placement that involved camera access subcostally at the level of the anterior axillary line; for the sake of simplicity, we called this procedure the modified lateral transperitoneal approach (MLTP). The purpose of this study is to evaluate the safety and efficacy of this modified technique compared with the traditional LTP and lateral retroperitoneal (LRP) approaches.

Patients and Methods

Patients Between January 2008 and December 2012, 287 patients with adrenal disease who underwent laparoscopic surgery were studied. The MLTP approach was used in 93, the

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LTP approach in 96 and the LRP approach in 98. Patient demographics and surgical outcomes were reviewed and compared among the three groups. Statistical analysis was performed using the chi-square test for qualitative variables and the Student's *t* test for quantitative variables. The level of significance was defined as $P < 0.05$. To allow for background matching of the three groups, the data from those patients who converted to open were excluded from the analyses.

Operation Methods

Modified Lateral Transperitoneal Approach The patient was placed in the semilateral decubitus position with the side of the lesion elevated 70°. General anaesthesia with endotracheal intubation was used in all cases. The operative bed was flexed just above the level of the iliac crest, and the lumbar bridge was elevated to maximally widen the space between the iliac crest and the costal margin. Typically, three trocars were used for the left adrenal gland, and four were used for the right adrenal gland. All trocars were inserted 2 cm from the subcostal margin, ensuring adequate clearance for the manoeuvres. The first skin incision was placed at the anterior axillary line and open technique needed to construct the access for the pneumoperitoneum. After a 12-mm trocar was placed at the first incision, two other trocars, 12 and 5-mm, were inserted under direct endoscopic visualisation. One was placed at the lateral border of the rectus sheath, and another was placed at the midaxillary line, such that the three trocars were equidistant from each other. For the right adrenal gland procedure only, an additional 5-mm trocar was placed below the xiphoid for liver traction. Most cases do not require mobilisation of the hepatic flexure and ascending colon on the right side, and the triangular ligaments of the liver are incised to facilitate a gentle retraction of the liver medially. The reflection of the posterior peritoneum along the edge of the liver was incised to enter the perirenal fat. Next, dissection along the anterior renal fascia was performed to expose the anterior aspect of the adrenal gland after the gland had been separated from the upper pole of the kidney. Dissection was also carried out along the lateral vena cava to identify the right adrenal vein, which was then divided among clips. Once the adrenal vein was secured, the remaining surrounding retroperitoneal attachments were divided. On the left side, the line of Toldt was incised from the splenic flexure to the sigmoid junction, and the left colon was then reflected medially. Subsequently, an incision into the lienorenal ligament was performed to expose the gland. The anterior renal fascia is always incised simultaneously, and dissection was carried out along the anterior renal fascia to expose the anterior aspect of the adrenal gland. Next, dissection along the lateral aspect of the gland was performed to identify the adrenal vein. Once the

adrenal vein had been secured, the remaining surrounding retroperitoneal attachments were divided. The specimen was placed in an entrapment sack and retrieved through the camera trocar port site.

Lateral Transperitoneal Approach The position and anaesthesia were similar to those of the MLTP group but with the side of the lesion elevated 90°. Usually, three trocars were used for the left adrenal gland, and four were used for the right adrenal gland. The first skin incision was placed just lateral to the edge of rectus sheath for pneumoperitoneum; the open technique was used at the level of the navel. After placing a 12-mm trocar at the first incision, two other trocars, 12 and 5-mm, were inserted 2 cm caudally from the subcostal margin under direct endoscopic visualisation, one at the lateral border of the rectus sheath and another at anterior axillary line. For the right adrenal gland procedure only, an additional 5-mm trocar was placed along the midaxillary lines between the costal margins and iliac crest to provide additional traction. The intraoperative procedure was similar to that of the MLTP approach.

Lateral Retroperitoneal Approach Patients were placed in a true lateral position, and the first skin incision was made above the iliac crest on the midaxillary line. The retroperitoneal space was dissected with the index finger. A balloon dissector was inserted through the port. Rapid distension of the retroperitoneal space was completed by inflating the balloon with 500–700 ml of air. After placing a 12-mm trocar at the first incision, 12 and 5-mm trocars were inserted below the costal margin, one was placed on the anterior axillary line and one was placed on the posterior axillary line. After opening Gerota's fascia, dissection was carried out between the perirenal fat and the anterior renal fascia, along with the posterior renal fascia, until the adrenal gland was identified. Then, the gland was separated from the upper pole of the kidney. The adrenal vein was clipped and transected, the remaining surrounding retroperitoneal attachments were divided, and the specimen was retrieved through the camera trocar port site.

Results

The three groups had comparable demographic data (Table 1). The postoperative data of the three groups are shown in Table 2. MLTP was associated with shorter operative time, less blood loss and more comfortable operating experiences. First oral intake, initial ambulation, days of hospitalisation, convention rates and postoperative complication rates were comparable among the groups ($P > 0.05$).

Table 1 Demographic data of the three groups

Parameters	MLTP	LTP	LRP	<i>P</i> value
No. of patients	93	96	98	
Mean age (years)	35.6 (21–67)	33.3 (18–65)	36.8 (19–72)	>0.05
M/F ratio	0.97	1.04	0.94	>0.05
R/L ratio	1.06	0.96	1.12	>0.05
BMI±SD	23.4±2.7	25.6±3.1	24.3±2.9	>0.05
Mean tumour size (cm) (range)	3.4 (1.6–9.5)	3.5 (1.5–8.7)	3.2 (1.4–8.0)	>0.05
Diagnosis				
Cushing's disease	28 (31.8 %)	31 (35.2 %)	29 (33.0 %)	>0.05
Aldosteronism	17 (34.0 %)	15 (30.0 %)	18 (36.0 %)	>0.05
Pheochromocytoma	22 (33.8 %)	22 (33.8 %)	21 (32.3 %)	>0.05
Nonfunctioning tumour	25 (29.8 %)	27 (32.1 %)	32 (38.1 %)	> 0.05

MLTP Modified lateral transperitoneal, LTP Lateral transperitoneal, LRP Lateral retroperitoneal, M/F male/female, R/L right/left

Operative time was defined as the duration of the surgical procedure, beginning with the insertion of the first trocar. The operating time of the MLTP group was 60.2±16.1 min, which was significantly shorter than that for the LTP group (66.4±18.3 min, $P<0.05$) but comparable with the LRP group (62.1±16.4 min, $P>0.05$). The average volume of blood loss for the MLTP group was lower than that for the LTP group or LRP group (37.5±17.7, 40.4±17.8 and 55.7±24.8 ml, respectively). $P<0.05$ when the MLTP group compared with the LRP group, but $P>0.05$ when MLTP group compared with LTP group. The failed procedures were not included in the above statistics.

Seven cases were recorded conversion to open surgery. The causes in the LTP group were uncontrolled bleeding from the adrenal gland ($n=1$), extensive adherence of the tumour to adjacent organs ($n=1$) and iatrogenic liver injury ($n=1$); the causes in the LRP group were irreversible adherence of the tumour to the retroperitoneum ($n=1$) and obscured operative field caused by haemorrhage ($n=2$). Only one case required conversion in the MLTP group, which was due to an iatrogenic injury of the spleen. Postoperative complications occurred

in seven patients; two patients in each group experienced post-operative distension of the abdomen, and subcutaneous emphysema occurred in another patient in the LRP group. All of the patients settled for conservative management, and there were no significant differences in the rate of postoperative complications among the three groups.

Discussion

Since laparoscopic adrenalectomy was first described in 1992 by Gagner et al. [1], this minimally invasive procedure has replaced open adrenalectomy as the standard operation for benign adrenal disease over the last two decades [2–4]. Although less invasive approaches, such as single-site access, natural orifice transluminal endoscopic surgery (NOTES) and robotic-assisted surgery, have been developed, several limitations, including further refinements in instrumentation and operative techniques, hamper the broad acceptance of these new techniques [14–16]. Standard laparoscopy is still

Table 2 Summarised postoperative data of the three groups

Parameters	MLTP	LTP	LRP
Mean operation time (min)±SD (range)	60.2±16.1 32–118	66.4±18.3* 43–122	62.1±16.4 41–127
Blood loss (ml)±SD (range)	37.5±17.7 15–70	40.4±17.8 15–70	55.7±24.8* 25–110
First oral intake (hours)±SD	22.2±8.1	24.3±9.7	22.7±6.9
First ambulation (hours)±SD	25.8±10.7	25.3±11.4	24.7±10.1
Postoperative hospital stay (days)±SD	6.9±1.3	6.9±1.4	6.7±1.1
Conversion to open rate	1 (1.1 %)	3 (3.1 %)	3 (3.1 %)
Postoperative complications	2 (2.2 %)	2 (2.1 %)	3 (3.1 %)

* $P<0.05$ (significantly different from MLTP)

the most widely used technique for the treatment of adrenal masses.

Several approaches have been developed to reach and remove the adrenal glands [6–8]; of these, the LTP approach is the most popular technique for laparoscopic adrenalectomy [9]. However, as neither a standard approach to the adrenal region nor reliable criteria to select the most suitable route have been defined, a consensus has not been reached regarding the appropriate port placements for the previously reported LTP approach [10–13]. Because a model has shown the optical axis-to-target view (OATV) angle [17], alteration in angle of vision or the angle between the optical axis of the endoscope and the instruments' plane can influence surgical performance and altering the port configuration may possibly affect the outcomes [18, 19]. However, no consensus on the OATV angle selection has been reached. Harper and colleagues recently reported that the placement of a laparoscope outside the working field can separate the camera holder and surgeon in space and avoid the need for the camera operator to cross hands with the surgeon [20]. Ng and associates suggested that a laparoscope placed between, instead of outside, the two working axes is ergonomically more favourable [21]. Port placement to achieve the perfect OATV angle should not only meet operational needs but also conform to the ergonomic requirements.

Many surgeons choose a triangle port configuration in which the camera port is placed at or near the umbilicus with working ports around the adrenal region [10–12]. In such cases, if a patient is placed in the supine position, the abdominal organs must be widely mobilised to reach the area of the adrenal gland. If the patient is placed in the lateral decubitus position, visualisation of the operative field may be impaired by the sagging bowel. In addition, the laparoscope should be inserted far enough to approach the lesions, which may cause the camera operator to become easily fatigued. The friction between the instrument and the bowel may increase the risk of intestinal wall oedema. However, in a subcostal port configuration that involves subcostal camera access at the level of the anterior axillary line, the camera port is at the top of abdominal cavity, and the patient is in the semilateral decubitus position at 70° to allow for a more direct field of visualisation that is no longer interrupted by the bowel. The superior position of the laparoscope in this setup prevented its contact with the bowel, thus potentially reducing the risk of bowel injury. In addition, a shorter length of the laparoscope in the abdominal cavity results in the camera operator being more relaxed. The other two working ports were placed below the costal margin to provide direct access to the adrenal gland and facilitate dissection of the posterior of the adrenal gland compared to the LTP approach, and the interaction between the camera holder and the surgeon's working envelope could be reduced by the short distance of the cavity portions. Furthermore, because of the suitable OATV angle, the optical axis approximately parallel

to the plane of the instruments improved the intuitiveness of the surgeon's perspective.

The present study was the first study that compared the clinical curative effect of three common port placements for laparoscopic adrenalectomy. We found that some outcome characteristics, such as first oral intake, initial ambulation, days of hospitalisation, conversion rates and postoperative complication rates, were not significantly different among the three techniques. Although the LRP approach was beneficial in decreasing the intraoperative intestinal irritation, there was no advantage to shortening the time of first oral intake and initial ambulation. However, the volume of blood lost in the LRP group was significantly higher than that of the two transperitoneal groups. A concern that the retroperitoneal fat, which contains multiple small veins, requires dissection in the transperitoneal approach was less prevalent than in the retroperitoneal approach [19]. In the MLTP or LTP approach, once the spleen or liver has been moved from the front of the gland, the adrenal region is well exposed. Only a portion of the former layer of the perirenal fascia and periadrenal fats is dissected. However, in the LRP approach, identifying the adrenal gland is relatively difficult due to its location buried in the retroperitoneal fat. Gaining access to the deeper gland involves the manipulation of abundant retroperitoneal fat tissues, especially in obese patients. Another reason for the increased difficulty of the LRP approach may be related to the fact that the adrenal vein is easier to clarify and dissect using transperitoneal approaches, while gland mobilisation is mandatory prior to reaching the vein using the retroperitoneal approach [8, 22]. Although the MLTP and LTP approaches shared the same operative space, differences in the operative time were found in the present study. Benefiting from direct and intuitive OATV angles, the MLTP approach achieved a superior surgical view that allowed a faster and more accurate dissection, which is essential to reducing operative time. However, the difference in the mean operative time between the MLTP and LRP was small, even though the LRP approach required moving more fat to reach the operative region.

The main criticism of the transperitoneal approach is that it involves invasion of the intraperitoneal space; thus, intraperitoneal organ injury or irritation is possible. In the present study, conversion to an open procedure was required in one patient in the MLTP group and one patient in the LTP group due to visceral injury. In the LRP approach, no visceral injury occurred; instead of invasion into the abdominal cavity, the LRP approach provided a more direct approach to the retroperitoneal organs without handling the bowel and without interference from the intraperitoneal organs. Due to the operating space within Gerota's fascia using this approach, complication rates are potentially reduced. However, considering the narrowness of the retroperitoneal space, the identification of marks is limited and dissection in obese patients with large amounts of retroperitoneal fat can be quite difficult, and once

the operative field becomes obscured by haemorrhage, surgeons will soon become disoriented [13]. Other concerns include the small working space, which may limit the size of the lesion that can be safely removed laparoscopically [6, 13, 23]. Therefore, although no specific indications for LTP or LRP have been defined, many surgeons, including us, prefer the transperitoneal approach for patients with high BMI or large tumours. The LRP approach, on the other hand, appears to be the procedure of choice for patients with small tumours, those with non-obese physiques and those who have undergone previous upper abdominal surgery.

Conclusion

According to our initial experiences, the MLTP is technically a feasible and safe approach, it has shorter operative times and better OATV angle than the traditional LTP approach. When compared with the LRP approach, MLTP can achieve similar surgical outcomes with lower volumes of blood loss. However, as mentioned previously, for patients with non-obese physiques, small tumour sizes or prior abdominal surgeries, the retroperitoneal approach is certainly a viable alternative.

Conflict of Interest None to declare.

Ethical Approval For this type of study, formal consent is not required.

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