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Transperitoneal laparoscopic adrenalectomy for adrenal neoplasm: a report of 371 cases

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[Abstract] **Background and Objective:** Open adrenalectomy has been almost replaced by mini-invasive laparoscopic surgery. There are two popular mini-invasive laparoscopic adrenalectomy approaches: retroperitoneal and transperitoneal approaches. This study was to summarize our experience in transperitoneal laparoscopic adrenalectomy. **Methods:** In total 371 cases undergoing transperitoneal adrenalectomy in the First Affiliated Hospital of Zhengzhou University from February 2003 to August 2008 were reviewed retrospectively. There were 127 cases of primary hyperaldosteronism adenoma, 117 cases of Cushing's adenoma, 58 cases of pheochromocytoma, 37 cases of incidentoma and 32 cases of other types. The type of adrenal diseases, operating time, blood loss, complications and prognosis were summarized and the operating method was analyzed. **Results:** Three hundred and sixty-five out of 371 patients (98.4%) were successfully operated, five cases (1.4%) were transferred to open surgery, and one patient gave up surgery due to extensive invasion. The operating time was 40-240 min (average, 70 min). The blood loss was 20-1000 ml (average, 80 ml). Two patients suffered from diaphragm injuries, one patient had right renal vein injury and one had colon injury. The mean time of hospital stay was five days. **Conclusion:** Transperitoneal laparoscopic adrenalectomy is one of the favorable approaches for the treatment of adrenal neoplasm. **Key words:** adrenal gland, adrenal neoplasm, surgery, laparoscopic adrenalectomy

Surgery is a conventional method to treat adrenal tumors. Since Gagner et al.¹ reported laparoscopic adrenalectomy in 1992, open adrenalectomy has been gradually replaced by laparoscopic surgery due to the disadvantages of trauma and hemorrhage. There are two main approaches for laparoscopic surgery: retroperitoneal and transperitoneal approach. We adopted transperitoneal adrenalectomy to operate 371 patients with adrenal neoplasm from February 2003 to August 2008 and satisfactory clinical effects were acquired.

Data and Methods

General data. We reviewed and analyzed clinical data of patients with adrenal neoplasm who underwent surgery in the First Affiliated Hospital of Zhengzhou University from February 2003 to August 2008. All patients receiving transperitoneal adrenalectomy were enrolled. There were in total 371 cases, 174 males and 197 females, aged 2-72 years (average, 42 years). Pathological types of neoplasm are listed in Table 1. The average volume of the neoplasm was about 3.2 cm (0-13.0 cm). In total 375 times of operations were performed on 371 patients, 223 times were on the left side, the other 152 times were on the right side. Seventy-six cases received abdominal surgery previously, 45 of which underwent appendectomy, 10 received hysterectomy, and 21 were performed tubal ligation.

Operation methods. We adopted the clockwise method to resect the right adrenal gland. Patients were positioned in right lateral decubitus. At 2 cm below the costal margin and the outer edge of the rectus abdominis muscle, a needle was inserted to establish pneumoperitoneum; after placing a 10 mm trocar and giving a 15mmHg pressure, a 10 mm trocar and a 5 mm trocar were sequentially placed at the anterior axillary line under the costal margin and under the xiphoid. The retroperitoneal and the splenocolic ligament were incised from white line of Toldt at the flexura coli sinistra; at the level of the upper front of the kidney, the retromesenteric plane was slit to nearly the renal hilum; retromesenteric plane was pulled up; the adrenal gland was exposed in the surgical field. A electric hook or an ultrasonic scalpel was used to incise the vertical fiber between the capsula adiposa and adrenal gland; subsequently, the adrenal gland was freed from adipose tissue between the adrenal gland and kidney using an aspirator; the adrenal gland was dissociated along~ the clockwise direction; after use of a Hemoclip to deal with the adrenal artery and central vein, the left adrenal gland was freed and removed completely. The counterclockwise

Table 1 Pathological types of 371 cases of adrenal neoplasms

Pathological type	Left (cases)	Right (cases)	Both (cases)	Total (cases)
Hyperaldosteronism adenoma	81	46	0	127
Cushing's adenoma	66	51	0	117
Phaeochromocytoma	30	25	3	58
Incidentoma	26	11	0	37
Othersa	17	13	2	32
Total	220	146	5	371

^aOther pathological types included five cases of malignant adrenal metastases, one of which was combined with bilateral adrenal metastases; one case of Medullaris hyperplasia with cystic degeneration; 16 cases of simple adrenal cysts; one case of adrenal acidophilic adenoma; six cases of ganglioneuroma; one case of bilateral lymphangioma, accompanied with spleen lymphangioma; and one case of adrenal tuberculosis which was preoperatively misdiagnosed as adrenal tumor.

method was adopted to resect the right adrenal gland. Patients were positioned in left lateral decubitus. Two 5-mm trocars and one 10-mm trocar were used for a right to perform adrenalectomy; a 5-mm trocar was placed on the midaxillary line, and the other on under the xiphoid, the 10-mm trocar was placed through the anterior axillary line; after determining the location of inferior cava vein and duodenum, the retroperitone was incised, turning upwards to the top of the diaphragm, and the med-tissue over the inferior cava vein was freed; after incision of the white line of Toldt along the hepatic flexure of colon, the colon was pushed down to left; the adrenal gland was exposed after the incision of prerenal fascia, the right adrenal gland was completed removed along the "counterclockwise" direction

Analyses were performed on the surgical methods, including operative time, blood loss and postoperative complications. All patients were followed up, and the survival of patients, blood pressure and the application of antihypertensive drugs were analyzed.

Results

Operation results. In total 365 surgeries (98.4%) were successfully performed. Five cases (1.4%) were changed to open surgery; one case

with left primary aldosteronism failed due to fat hardening, which was difficult to free; one case with the right primary aldosteronism failed because he had severe adhesions of the right upper quadrant due to chronic cholecystitis; two cases had difficulty to be exposed; one case had renal vein injury; and one case with right adrenal metastasis gave up operation due to wide-spread serious invasions. The average operative time was 70 min (range 40-240 min). The operative time was gradually shortened over the time. The average operative time for the later 200 case was shortened to 40-70 min. The average blood loss was 80 ml (range 20-1000ml). Gastrointestinal functions of all patients were recovered within 48 h after operation and patients started having liquid diet. Patients got up after the first day. Only 62 cases required analgesics after operation. The average length of stay in hospital was 5 d (3-8 d)

Complications. Two cases had pneumothorax due to diaphragmatic injury, left and right side each. The wound was sutured after reducing the pressure of pneumoperitoneum (<10mmhg) under laparoscopy. One of the cases appeared medium pleural effusion three days after operation, and was recovered by himself successfully seven days later. One case had colon injury (left phaeochromocytoma), after suturing the gap under endoscopy, the patient was successfully recovered after fasting for one week. One case had injury in the right kidney vein, who was transferred to open adrenalectomy. Severn case occurred incision infection, and they were recovered after conservative treatment. Twelve patients of Cushings adenoma appeared week, fever symptoms due to gland cortex dysfunction after six months of operation. These symptoms disappeared after Hormone therapy.

Prognosis. Patients were followed up for an average of 36 months (1-60 months). Blood pressure returned normal in 75 (59.1%) out of 127 cases of primary hyperaldosteronism adenoma after the operation, and that of the other 52 cases needed drug to control with a decrease in the drug dose. Eighty-six (72.9%) out of 118 cases of Cushings adenoma had normal pressure, and the other 32 (27.1%)

patients needed to take medication with a decrease in the dose. All patients of phaeochromocytoma had normal BP. After eight months of operation, patients with Cavernous lymphatic cyst recurred. The patient of liver cancer metastasizing to the right kidney died two months after giving up the operation, the other case with liver cancer metastasizing to the right adrenal gland died one year after the operation, two cases of lung cancer metastasizing to adrenal gland died 10 months and 16 months respectively after the operation. One case of the renal cell carcinoma was still alive eight months after operation.

Discussion

Adrenal gland locates deeply with many surrounding organs and is difficult to be exposed by traditional open surgery. Since Gagner et al.¹ carried out the first laparoscopic excision of adrenal tumors in 1992, it has gradually become the gold standard for adrenal surgery because of small injury, safety and reliability.² Rubinstein et al.³ carried out a prospective case-control study on these two approaches, excluding patients with bilateral disease, obesity, age of more than 80 years, and previous upper abdominal surgery, finding that the two groups had no significant difference in operative time, surgical blood loss, specimen weight, postoperative analgesic consumption, length of stay in hospital, complications and conversion to laparotomy. Guazzoni et al.⁴ reported 161 cases of adrenal surgery by transperitoneal approach and found three cases (1.86%) had hemorrhage due to injury of blood vessels and surrounding organs (one case on the left side, and two cases on the right side). Meraney et al.⁵ reported 404 cases of renal and adrenal surgery by retroperitoneal approach, and found seven cases (1.73%) of vascular injury (right adrenal vein in two cases, left renal vein in two cases, right renal vein in one case, right renal artery and inferior vena cava each in one case) and one case of intestinal injury. Both groups had similar injury risk of blood vessels and surrounding organs. In this group with 371 surgical cases, four cases had

injury of blood vessels and surrounding organs (diaphragmatic injury in two cases, colon injury in one case, and right renal vein injury in one case), with odds ratio of 1.08 %, which is lower than Guazzoni and Meraney reported. It is important that the transperitoneal approach has its unique advantages: (1) It is with big operating room, clear anatomical marks and easy to grasp. Suzuki et al.⁶ regards the transperitoneal approach by the lateral position is most appropriate for operators who have not mastered techniques of laparoscopic adrenal surgery. (2) For patients with obesity, the transperitoneal approach avoids excessive perirenal fat separation by the retroperitoneal approach, and is a more direct surgical approach especially in the right adrenal gland, which generally can be seen after raising liver. (3) It is adaptive in a wide range, especially for adrenal tumors larger than 5 cm. (4) Adrenal central veins can be controlled first by the transperitoneal approach, which effectively avoids catecholamine released into blood leading to severe fluctuation of blood pressure in patients with pheochromocytoma.⁷ It can effectively prevent the spread of tumors with the maximum diameter of greater than 5 cm with non-uniform density and obvious enhancement detected by CT scan and suspected malignant and metastasis.⁸ (5) Previous abdominal surgery is not a contraindication of transperitoneal laparoscopy. Parsons et al.⁹ reported 334 cases of urological laparoscopy with previous abdominal surgery, and found 229 cases in different parts had no difference in blood loss, complications and conversion to laparotomy, while 105 cases in the same parts had significantly longer operative time. They suggest previous surgery has no negative impact on abdominal urologic laparoscopic surgery. In this group, 76 cases with previous abdominal surgery were completed surgery successfully, including appendectomy in 45 cases, hysterectomy in 10 cases, tubal ligation in 21 cases. Therefore, there is no significant difference in adrenal gland surgery by transperitoneal and retroperitoneal approach in general cases, but transperitoneal laparoscopic adrenal surgery has more advantages in extensive and special cases (such as obesity, previous

retroperitoneal surgery, big or bilateral tumors). As to lateral transperitoneal laparoscopic adrenalectomy for adrenal tumors, we have accumulated a large number of cases in a short time and experienced some unique surgical techniques with very good results, using a unique "Clock method". Firstly, the left adrenal gland was removed by the "clockwise method": entering into the abdominal cavity and opening retroperitoneal space, incising pre-renal fascia at front top of the kidney to renal hilum, raising pre-renal fascia and separating inside along the avascular zone below it, and exposing the entire adrenal gland in the surgical field; using an electricity hook or ultrasonic scalpel incising vertical fiber between the adrenal gland and perirenal fat along outside of the adrenal gland, and separating fat between the adrenal gland and kidney to diaphragm bluntly by a aspirator; isolating the adrenal gland "clockwise", and cutting off the adrenal lower artery near 5 o'clock; in the process of isolating clockwise, finding the central adrenal vein below the inside middle of adrenal gland, and cutting it after occlusion by the hemoclip, with reservation of the proximal two hemoclips; raising stump of central adrenal vein, and continuing electrocoagulating adrenal upper and middle artery and peripheral vessels as well as connective tissue clockwise, and then completely resecting the left adrenal gland. Secondly, the right adrenal gland was removed by the anti-clockwise method: incising the Toldt white line along hepatic flexure to push colon to the left bottom in favor of exposure; incising pre-renal fascia and separating fully close to the bottom to expose the front of the adrenal gland, and then isolating the adrenal gland along outside the top of the adrenal gland "anti-clockwise"; Electrocoagulating or clipping the adrenal lower and middle artery; pushing the adrenal gland lateral upward; continuing separating upward along the inferior vena cava to find the central adrenal vein, and then cutting it after occlusion by hemoclip, with reservation of the proximal two hemoclips; raising stump of the central adrenal vein, and continuing to separate the adrenal gland and surrounding connective tissue

anti-clockwise by an electrocoagulation or ultrasonic scalpel, and then completely resecting the adrenal gland.

Different from the retroperitoneal approach, the transperitoneal approach opens pre-renal fascia after retroperitoneal incision, and then incises the fascia longitudinal to fully expose the front of the adrenal gland. No matter how obese the patient is, there is only loose connective tissue without blood vessels between pre-renal fascia and adrenal gland, so the adrenal gland or the tumor can be found quickly making use of the clear intra-abdominal anatomy marker and placed in the center of the surgical field. The "clock method" is used to isolate the adrenal gland, from the top along the lateral border of the adrenal gland downward, using the border of the adrenal gland or the tumor as the anatomical landmark to incise the vertical fiber outside the adrenal gland firstly, and separating backside to the diaphragm. Then the diaphragm was used as another important marker to separate the adrenal gland in left clockwise and right anti-clockwise, and the central adrenal vein was encounter naturally. The surgical field was clean and clear, effectively avoiding adrenal laceration and blurred vision by oozing if seeking adrenal gland in the center of fat sac blindly.

Although transperitoneal laparoscopic surgery has no significant difference with retroperitoneal approach in complications, there are still some complications. In this group, diaphragmatic thermal injury occurred in two cases under adrenal surgery, which was caused by "jump hook" when separating adrenal tissue. Pneumothorax was caused by diaphragmatic injury and perforation, whose typical performance was diaphragm collapsing into a "wavy", and patients airway resistance increasing. Discovering in time is the key for the complication, or high pressure of pneumoperitoneum would endanger patients life. The pressure was lowered below 8 mmHg, and diaphragm was sutured under the laparoscope with suture tightened after exclusion of pulmonary gas by anesthesiologists. Patients had smooth postoperative recovery. Right renal vein injury occurred in one case when separating the renal vessel and adrenal tissue, and was repaired

by conversion to laparotomy. Colon injury occurred in one case of left adrenal pheochromocytoma resection when incising the Toldt white line to push colon to left bottom, and was sutured under the laparoscope. Summing up experience, we have to effectively prevent organs and vascular injury, and ensure good insulation of equipment preoperatively to prevent arc mediated organ injury outside the field of vision. All operations should be at the center of vision. Adrenal gland and tumor should be raised lateral upward when separating the inner bottom of adrenal gland to avoid injury of renal vein and inferior vena cava. Be away from organs when separating tissues to prevent "jump hook" phenomenon. Keep electrocoagulation at a low power of less than 50W. Check any abdominal injury and bleeding after surgery. Transperitoneal laparoscopic adrenalectomy by "Clock method" uses adrenal gland itself as anatomical landmark, which is simple, safe and reliable, and is an ideal adrenal surgery method.

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