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ORIGINAL ARTICLE

Laparoscopic adrenalectomy for adrenal tumors: A 21-year single-institution experience

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Summary *Objective:* We have performed laparoscopic adrenalectomy including retroperitoneoscopic adrenalectomy via a single large port (RASLP) and conventional laparoscopic adrenalectomy (CLA) for adrenal tumors since 1992, and report our experience to date.
Methods: The study population consisted of 134 patients who underwent laparoscopic adrenalectomy from 1992 to 2012. Fifty-eight patients (18 aldosterone-producing adenomas, 13 adenomas with Cushing's syndrome, 1 adenoma with preclinical Cushing's syndrome, and 26 nonfunctioning tumors) were treated using RASLP, and 76 patients (33 aldosterone-producing adenomas, 17 adenomas with Cushing's syndrome, 6 adenomas with preclinical Cushing's syndrome, 17 pheochromocytomas, and 3 nonfunctioning tumors) were treated using CLA. Complications were graded according to the modified Clavien system.
Results: The majority of RASLPs were performed during the 1990s, whereas all patients underwent CLA after 2000. The mean operation times (166 vs. 205 minutes, $p < 0.01$) and intraoperative estimated blood loss (85 vs. 247 mL, $p < 0.01$) were significantly lower in the CLA group. Conversion to open surgery was required in three patients (5%) in the RASLP group and five patients (7%) in the CLA group ($p = 0.73$). Postoperative complications were grade

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1 in three patients and grades 4 and 5 in one patient each in the RASLP group, whereas grade 2 in one patient was observed in the CLA group ($p = 0.085$).
Conclusion: Although this study included biases such as different eras and indications, CLA resulted in decreased operative times, blood loss, and postoperative complications compared with RASLP. CLA has so far become our preferred procedure for patients with adrenal tumor in our experience.
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1. Introduction

In 1985, Buess et al[1] performed endoscopic surgery of the rectum using a rectoscope 4 cm in diameter and with a large working lumen. We first performed retroperitoneoscopic adrenalectomy via a single large port (RASLP) using this wide-lumen rectoscope to treat a small adrenal tumor without carbon dioxide insufflation in 1992.[2] We subsequently performed RASLP routinely, reporting the techniques involved and outcomes in 2005.[3] Our unique procedure introduced a template for the development of laparoendoscopic single-site surgery (LESS),[4] which has seen increasing uptake recently with advancements in surgical instruments, greater consideration of cosmetics, and the trend towards minimal invasiveness. Indeed, there has been a paradigm shift in the field of minimally invasive surgery, as laparoscopy progresses towards scar-free techniques. Although different techniques and devices have been reported in the published data on surgery with various terminologies and acronyms applied, natural orifice translumenal endoscopic surgery[5] and LESS[6] are emerging in an effort to duplicate standard laparoscopic procedures through a virtually scar-free approach.

By contrast, since the introduction of the laparoscopic approach to adrenalectomy in 1992 by Gagner et al,[7] this minimally invasive technique has gained worldwide acceptance and has become the gold standard for the removal of most small, benign lesions of the adrenal gland as conventional laparoscopic adrenalectomy (CLA) including lateral transperitoneal and retroperitoneal approaches. We have also performed CLA routinely for adrenal tumors including even relatively large tumors and pheochromocytoma since the year 2000. The purpose of this study was to evaluate our single-center experience with RASLP and CLA performed for a variety of adrenal tumors.

2. Materials and methods

We reviewed the records of all patients undergoing laparoscopic adrenalectomy at our institution (Nihon University Itabashi Hospital, Tokyo, Japan) from May 1992 to December 2012. Data were extracted from institutional review board-approved databases. Data extracted included patient age, sex, body mass index (BMI), operative history, tumor size, side effects of disease, and characteristics on imaging and clinical diagnosis. In addition, information relating to the perioperative course such as operative time, estimated blood loss, conversion to open surgery, perioperative mortality, complications, postoperative hormonal prognosis in functioning tumors, and tumor recurrence was extracted from the operative notes, anesthesia records, and inpatient and outpatient charts.

RASLP was indicated for unilateral and small benign adrenal tumors (<4.5 cm in diameter) excluding pheochromocytoma, whereas CLA was indicated for all benign adrenal tumors with the exception of those with malignant potential. Surgical indication of nonfunctioning adrenal tumors after 2003 was according to the consensus conference on the topic at the National Institute of Health in 2002.[8]

The surgical technique of RASLP has been previously described in detail.[3] Briefly, patients were placed in the lateral decubitus position with slight flexion, and a 4.5-cm skin incision was made below the 12th rib in the mid axillary line. The retroperitoneal space was dissected using index fingers and a balloon dilator. A rectoscope tube (4 cm in diameter) was inserted, and the adrenal glands were endoscopically removed via the single large port without carbon dioxide insufflation. Figure 1 shows an operating scene including a tube of rectoscope inserting into the retroperitoneal space and a retroperitoneoscopic finding, and postoperative scar.

CLA including transperitoneal lateral and retroperitoneal lateral approaches were performed using standard techniques with small modifications routinely using multiple ports and carbon dioxide insufflation.[9] In the transperitoneal approach, the primary port site was located at the lateral margin of the ipsilateral rectus muscle at the level of the umbilicusor several fingerbreadths above the umbilicus. Secondary ports were placed in the anterior axillary line/ipsilateral rectus near the costal margin. An auxiliary port was necessary for retraction of the liver on the right side (Figure 2). The abdominal cavity was insufflated to 8—12 mmHg using carbon dioxide. On the left side, the renal hilum was directly approached to expose the renal vein. The adrenal vein was identified on its cranial surface and ligated. On the right side, the inferior vena cava was identified and traced up to the gland that was dissected primarily prior to ligating the short adrenal vein as it enters the vena cava. All specimens were retrieved within an endoscopic pouch through the primary port. In the retroperitoneal approach, an initial port was made near the tip of the 12th rib under the 11th rib, and the retroperitoneal space was extended with balloon distension. After carbon dioxide insufflation of the retroperitoneum, the other trocars were placed at the angle of the paraspinal muscle and the origin of the 12th rib, and approximately

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