

# Single-Access Retroperitoneoscopic Adrenalectomy (SARA) Versus Conventional Retroperitoneoscopic Adrenalectomy (CORA): A Case–Control Study

Martin K. Walz · Harald Groeben ·  
Piero F. Alesina

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## Abstract

**Background** Stimulated by the concept of Natural Orifice Transluminal Endoscopic Surgery (NOTES), minimizing the access even further has become a new trend in minimally invasive surgery. We compare our recently described new method of endoscopic single-access adrenalectomy with the conventional retroperitoneoscopic approach in a matched-pairs study.

**Methods** Fifty single-access retroperitoneoscopic adrenalectomies (SARA) were performed in 47 selected patients suffering from Conn's adenomas ( $n = 20$ ), pheochromocytomas ( $n = 15$ ), Cushing's adenomas ( $n = 6$ ), and other diseases ( $n = 6$ ). For SARA, a single 2-cm skin incision beneath the 12th rib was used. Following creation of the retroperitoneal space with the rigid endoscope, dissection was carried out single-handed. Another 47 patients served as control group; they were treated by the traditional retroperitoneoscopic three-port approach (CORA). Patients were matched with respect to gender, body mass index, diagnoses, tumor size, and tumor site.

**Results** Mortality was zero and no major complications occurred in both groups. SARA was completed in 41 cases

(86%). The overall complication rate was 8.5% in SARA and 6.4% in CORA. Operative time was longer for SARA ( $56 \pm 28$  min) than for CORA ( $40 \pm 12$  min) ( $P < 0.05$ ). Postoperatively, pain medication was administered in 47% of SARA patients and in 75% of CORA patients ( $P = 0.01$ ). Mean hospital stay was  $2.4 \pm 0.7$  days (SARA) and  $3.1 \pm 1.2$  days (CORA) ( $P < 0.01$ ).

**Conclusions** Because feasibility and safety of SARA could be demonstrated in a large group of selected patients, this surgical technique may represent a new milestone in minimally invasive endocrine surgery.

## Introduction

Since the first descriptions in 1992 [1, 2], minimally invasive adrenalectomy has become the gold standard in adrenal surgery [3]. In 1994 we started performing minimally invasive adrenalectomy using the posterior retroperitoneoscopic approach routinely using three ports [4]. Recently, we described a modification as a single-access procedure [5]. In a case-control study we compared the feasibility and safety of 50 single-access retroperitoneoscopic adrenalectomies (SARA) with 50 conventional (three-port) retroperitoneoscopic adrenalectomies.

## Patients and methods

### Patients

From July 22, 2008 to July 21, 2009, 47 patients (17 males, 30 females, age =  $43.3 \pm 14.4$  years, range = 12–73 years) with adrenal diseases were selected out of all patients who were admitted for retroperitoneoscopic

M. K. Walz (✉) · P. F. Alesina  
Klinik für Chirurgie und Zentrum für Minimal Invasive  
Chirurgie, Kliniken Essen-Mitte, Akademisches  
Lehrkrankenhaus der Universität Duisburg-Essen,  
Henricistrasse 92, 45136 Essen, Germany  
e-mail: mkwalz@kliniken-essen-mitte.de; mkwalz@mac.com

H. Groeben  
Klinik für Anästhesie, Intensivmedizin und Schmerztherapie,  
Kliniken Essen-Mitte, Akademisches Lehrkrankenhaus  
der Universität Duisburg-Essen, Henricistrasse 92,  
45136 Essen, Germany

adrenalectomy during one year ( $n = 130$ ; 36%). Main selection criteria were small and probably eccentric tumors and a minimal amount of periadrenal fatty tissue. These patients (SARA group) were operated on retroperitoneoscopically by a single-access approach. Patients suffered from Conn's syndrome ( $n = 20$ ), Cushing's syndrome ( $n = 6$ ), pheochromocytomas ( $n = 15$ ), nonfunctioning adrenal tumors ( $n = 4$ ), adrenal metastasis ( $n = 1$ ), and Cushing's disease ( $n = 1$ ). Forty-four patients underwent unilateral procedures (22 right, 22 left), and three patients received bilateral adrenalectomies (2 for pheochromocytomas, 1 for Cushing's disease). Altogether, 50 SARA procedures were performed: 31 as partial adrenalectomies and 19 as total adrenalectomies.

Another 47 patients (17 males, 30 females, age  $42.4 \pm 14.8$  years, range 18–69 years) served as a control group. These patients had had a CORA procedure (three ports) between February 2000 and June 2008 and were selected from a database that includes all retroperitoneoscopic adrenalectomies since 1994. All procedures were performed by two surgeons (MKW and PFA). SARA and CORA patients were matched with respect to surgeon, gender, diagnosis, tumor side and size, extent of resection (partial or total adrenalectomy), and dimension of para-adrenal fatty tissue. The latter was semiquantitatively characterized as “minimal” (1), “moderate” (2), or “extended” (3). Table 1 gives the demographic data of both groups.

## Operative technique

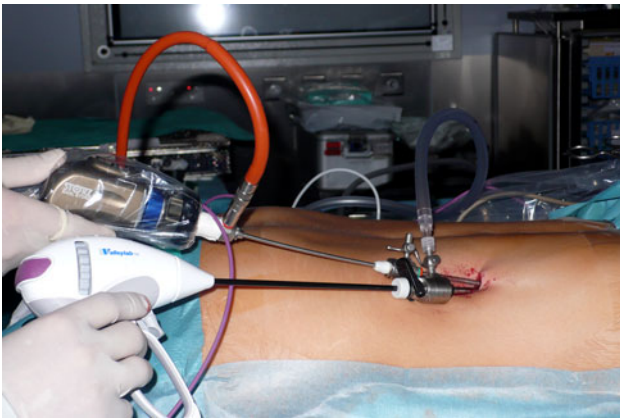
Since the first description of the technique, SARA has been modified and improved in a couple of ways. After induction of general anesthesia, the patient is placed in the same prone jack-knife position as for CORA. SARA starts with a 2.0-cm skin incision just beneath the tip of the 12th rib. The retroperitoneum is entered using a 10-mm cutting port (Visiport<sup>®</sup>, Covidian, Neustadt, Germany) under endoscopic view. The capnoretroperitoneum is created by CO<sub>2</sub> pressure of 20–30 mmHg. Retroperitoneoscopy is performed by a 5- or 10-mm 30° endoscope (Karl Storz Endoskope, Tuttlingen, Germany) which is introduced into the port. The endoscope itself allows step-by-step creation of a retroperitoneal space by disruption of Gerota's fascia and by pushing the retroperitoneal fatty tissue bluntly downward, thereby exposing the area of the adrenal gland and the upper renal pole.

The 10-mm port is removed and two 5-mm ports are inserted through the same incision in parallel (Fig. 1). Ports of different lengths are recommended as they minimize interaction. A 5-mm 30° endoscope connected to a 3-chip camera (Image 1 HD, Karl Storz Endoskope, Tuttlingen, Germany) and a 5-mm bipolar scissor (LigaSure<sup>®</sup>, Covidian, Neustadt, Germany) are introduced. The following steps of dissection are performed in a single-hand technique; the nondominant hand holds the camera. To start, the upper pole of the kidney is mobilized. Dissection of the

**Table 1** Data of patients who underwent single-access retroperitoneoscopic adrenalectomy (SARA) or conventional retroperitoneoscopic adrenalectomy (CORA)

	SARA	CORA
Patients ( $n$ )	47	47
Age (years)	$43.3 \pm 14.4$	$42.2 \pm 14.8$
Gender	17M, 30F	17M, 30F
Body mass index	$25.1 \pm 3.9$	$25.2 \pm 3.9$
Semiquantitative amount of periadrenal fatty tissue		
Minimal ( $n$ )	32	29
Moderate ( $n$ )	15	18
Extended ( $n$ )	3	3
Adrenalectomies ( $n$ )	50	50
Extent	19 complete, 31 partial	19 complete, 31 partial
Site	22 right, 22 left, 3 bilateral <sup>a</sup>	22 right, 22 left, 3 bilateral <sup>a</sup>
Diagnosis		
Conn's syndrome ( $n$ )	20	20
Cushing's syndrome ( $n$ )	6	6
Pheochromocytoma ( $n$ )	15	15
Others ( $n$ )	6	6
Tumor size (cm)	$2.3 \pm 1.2$	$2.6 \pm 1.4$

<sup>a</sup> Two patients with bilateral pheochromocytomas, one patient with Cushing's disease



**Fig. 1** Single-access retroperitoneoscopic adrenalectomy (SARA). Patient in prone position. Procedure on the right side

adrenal gland begins from lateral to medial on the backside of the peritoneum, identifying the lower pole of the adrenal gland. On the right side, the adrenal arteries cross the vena cava medially-posteriorly. These vessels are separated with the bipolar scissors. By lifting up the adrenal gland, the inferior vena cava is visualized posteriorly in its retroperitoneal-cranial segment. Thus, the short suprarenal vein becomes clearly visible, running posterolaterally. This vessel has to be followed for 0.5–1 cm and divided with the bipolar scissors. As described previously, clips have not been used for the main adrenal vein for more than 4 years. Preparation of the right adrenal gland is completed by lateral and cranial dissection. For the left-sided adrenalectomy, an extended mobilization of the upper pole of the kidney is essential because the lower pole of the adrenal gland lies in front of the kidney. Thereafter, the inferior part of the gland can be visualized and dissected. In some cases the introduction of a retractor inserted directly through the incision may help expose the adrenal gland. The typical main left adrenal vein joins the diaphragmatic vein between the upper pole of the kidney and the spine. After dissection of the adrenal vein with bipolar scissors the gland is mobilized. In case of partial adrenalectomy, extent of dissection depends on the localization of the neoplasia. The parenchyma is divided with the bipolar scissors.

For removal of the specimen, the 5-mm port is replaced by a 10-mm port that allows the introduction of a retrieval bag. The bag is pulled through the skin incision after withdrawal of both ports. If the size of the specimen exceeds the size of the skin incision, the tissue is morcellated in the bag. Before closing the wound with absorbable sutures, the adrenal bed is inspected under endoscopic view and irrigated (after reinserting at least one 5-mm port). Drains are not used.

The conventional method of posterior retroperitoneoscopic adrenalectomy (CORA) and its modifications have

been described in detail elsewhere [6, 7]. In both groups, full mobilization and unlimited oral intake starts on the day of surgery. Pain medication is administered on request. Consistently, severe pain is treated with piritramide intravenously, and moderate or little pain with novaminesulfone orally.

### Statistics

Prospective documentation included age, gender, body mass index, extent of retroperitoneal fatty tissue, tumor size and side, operating time (from skin incision to skin closure), intraoperative blood loss, intraoperative and postoperative complications, and duration of hospitalization. Retrospectively, duration and dosages of pain medication were collected from the medical records. If possible, data were demonstrated as mean  $\pm$  standard deviation. For group comparison, Mann-Whitney *U* test and Fisher's exact test were performed as indicated. Significance was accepted for  $P < 0.05$ . Statistical analyses were performed by Prism 5 (GraphPad Software Inc., La Jolla, CA).

### Results

Mortality of SARA and CORA patients was zero. No major or minor complications occurred intraoperatively. Conversion to open surgery was not necessary but conversion from SARA to CORA (3 ports) was inevitable in four cases (2 right, 2 left). Reasons for conversion were the impossibility of safe dissection due to tumor size (6 cm) in one patient and large amounts of para-adrenal fatty tissue in three cases. In three other patients (all left side), a double-incision technique with an additional lateral port had to be used for retraction of the kidney. Thereby, full exposure of the adrenal gland could be achieved. Thus, altogether 43 of 50 SARA procedures (86%) were completed using a single-incision technique.

Operative time was  $56 \pm 28$  min (range = 20–155 min) for SARA and  $40 \pm 12$  min (range = 20–90 min) for CORA ( $P < 0.05$ ). Blood loss was negligible in both groups (<10 ml), without any blood transfusion in any case. Carbon dioxide pressures of greater than 20 mmHg (up to 30 mmHg) were used in 35 SARA patients and in 11 CORA patients ( $P < 0.01$ ) without any relevant side effects. Postoperative pain medication was needed significantly less in SARA patients (Table 2). Fifty-three percent of SARA patients did not request analgesics and 26% of CORA patients did not ask for analgesics ( $P = 0.01$ ); morphine derivatives (piritramide) were necessary in 0% (SARA) and 6% (CORA), respectively ( $P = 0.12$ ). More than 24 h after surgery, 13% of SARA patients and 34% of CORA patients asked for pain medication ( $P < 0.05$ ). In-hospital stay was

**Table 2** Pain medication following single-access retroperitoneoscopic adrenalectomy (SARA) and conventional retroperitoneoscopic adrenalectomy (CORA)

	SARA	CORA	<i>P</i>
None ( <i>n</i> )	25	12	0.01
Pirtramide ( <i>n</i> )	0	3	0.12
Novaminesulfone ( <i>n</i> )	22	32	0.02
After 24 h	6	16	0.03
After 48 h	4	6	0.74

$2.4 \pm 0.7$  days for the SARA group and  $3.1 \pm 1.2$  days for the CORA group ( $P < 0.01$ ). Postoperatively, three patients were readmitted: two SARA patients with assumed subclinical Cushing's syndrome suffered from hypocortisolism on day 8 and day 10, respectively; one CORA patient with supposed Conn's syndrome was also readmitted on day 12 for signs of an Addisonian crisis. For the latter case it was hypothesized that there was a preoperative misdiagnosis. Minor complications were seen in four patients with temporary segmental relaxation of the abdominal wall (2 SARA, 2 CORA). The overall complication rate was 8.5% (SARA) and 6.4% (CORA), respectively (n.s.).

## Discussion

Though only one prospective randomized trial comparing open and endoscopic adrenalectomy has been performed and was recently published in 2008 [8], the minimally invasive technique have become the method of choice in most cases of adrenal surgery for the past 15 years. The only generally accepted contraindication is obvious malignoma. As in open surgery, four approaches to the adrenal glands are endoscopically possible: laparoscopic with the patient in the supine or lateral position and retroperitoneoscopic with the patient in the lateral or prone position. Since 1994, we favor the latter technique and were able to demonstrate the feasibility, safety, wide applicability, and speed of the posterior retroperitoneoscopic access to the adrenal glands [6, 7, 9]. Based on these experiences and mainly triggered by the hype about natural orifice transluminal endoscopic surgery (NOTES), we developed and published the SARA method after having performed more than 800 adrenalectomies by the posterior retroperitoneoscopic approach [5]. Prior to using a single-access technique, we gathered additional experience with a two-port technique in five operations; this convinced us that a one-hand dissection is safely possible in selected cases. The step to single-access adrenalectomy was obvious. To minimize the approach, the cutting trocar was used to allow a shorter incision than in CORA in which the

access to the retroperitoneum is performed with the digit finger. The creation of a retroperitoneal space could always be achieved by the endoscope itself; this allows the separation of the abdominal wall structures from the retroperitoneal fatty tissue. In general, we have used this method for creation of an extraperitoneal space in endoscopic inguinal hernia repair for many years.

The single-access two-port technique for dissection of the adrenal gland is possible because the camera and working port are inserted through the same incision. No special instruments are necessary, but a 30° scope that allows variation of perspective of the surgical field is essential. The dissecting instrument and the para-adrenal tissue are always visualized from a side aspect. Our experiences show that SARA can be thought of as a two-handed, single-surgeon operation. We learned that preparation is significantly simplified by using bipolar scissors which allow safe dissection of all adrenal vessels, including the main adrenal vein. This way, we did not use clips in any of the SARA procedures. Also helpful is the increased CO<sub>2</sub> pressure of up to 30 mmHg. To our surprise, no relevant side effects were noticed when tidal volume was slightly increased. Ideal patients for SARA are slim and have only little para-adrenal fatty tissue. These patients should be selected carefully. Further developments will be very useful to improve this technique. A top priority is camera systems with varying angles of view that allow a more adjusted exposure and angulating instruments.

Compared to CORA, single-access retroperitoneoscopic adrenalectomy takes longer to perform (about 15 min longer) but causes less pain. Complications are rare and similar for both methods. The typical minor complication of CORA of temporary lesions of the subcostal nerve was also noticed after SARA. This shows that the incision and port insertion at the 12th rib causes that complication. There is presently no way to identify the location of that nerve preoperatively, but a modification of port insertion may decrease the number of lesions.

Minimally invasive single-access approaches have been used in endocrine surgery for many years, mainly for gasless thyroidectomy [10, 11] and parathyroidectomy [12, 13], and in one study also for gasless adrenalectomy [14]. Hirano et al. [14] used a 4-cm rectoscope tube to remove adrenal tumors in 54 patients. The average operating time was 203 min, the mean blood loss was 252 ml, and four patients received blood transfusions. Conversion was necessary in one case. Compared to SARA, feasibility, safety, and cosmesis of their technique seemed to be significantly poorer. Recently, Castellucci et al. [15] presented the first single-access laparoscopic transabdominal adrenalectomy in a 63-year-old patient. They used three ports introduced through a 2-cm supraumbilical incision and successfully removed a left-sided adrenal tumor. From our point of

view, transperitoneal single-access adrenalectomy seems to be more complex than SARA, especially with respect to the exposure of the adrenal gland.

In summary, we conclude that SARA is a feasible and safe procedure in selected patients with adrenal diseases. It has minimal perioperative morbidity and pain and may supersede NOTES in adrenal surgery.

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