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Laparoscopic Adrenalectomy – A Year's Experience with a New Technique Compared with Conventional Open Adrenalectomy

Laparoskopowa adrenaektomia – pierwszy rok doświadczeń z nową techniką operacyjną, w porównaniu do zabiegu klasycznego, metodą otwartą

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Abstract

Objectives. The status of laparoscopic adrenalectomy has been well established in recent years. The aim of the study was to evaluate intraoperative and postoperative features of laparoscopic adrenalectomy and to compare the technique with the authors' previous experience with conventional open adrenalectomy.

Material and Methods. The study compared 32 laparoscopic adrenalectomies performed between October 2008 and August 2009 with 43 open adrenal resections performed from 2004 to 2008. The features analyzed included the basic characteristics of the patients in both groups, the size and type of adrenal tumors, the duration of the surgery, intraoperative and postoperative morbidity, the length of the hospital stay, the time to first oral intake and the amount of postoperative analgesic drugs taken.

Results. Laparoscopic adrenalectomy was successfully completed in 29 patients. In two cases, conversion to open surgery was necessary due to intraoperative bleeding in one case and iatrogenic injury of the colon in the other; and one patient was reoperated two weeks after the primary surgery due to postoperative hematoma. There was no significant difference in the duration of surgery with the two methods. There were, however, significant differences in time to first postoperative oral intake, the length of the postoperative hospital stay and the amount of postoperative analgesic drugs needed.

Conclusions. Laparoscopic adrenalectomy seems to be a safe, effective and minimally invasive method, the advantages of which include better visualization of the operative field, minimal morbidity and a rapid convalescence with a shorter hospital stay. In the authors' opinion, surgeons just beginning their experience with laparoscopic adrenalectomy should start from the transperitoneal approach; the retroperitoneal approach should be introduced later, after necessary experience has been gained (*Adv Clin Exp Med* 2010, 19, 5, 625–630).

Key words: laparoscopic adrenalectomy, open adrenalectomy, transperitoneal approach, retroperitoneal approach.

Streszczenie

Cel pracy. Obecnie laparoskopowa adrenaektomia jest standardem postępowania przy usuwaniu łagodnych zmian w nadnerczach. Celem pracy była ocena metody laparoskopowego usunięcia nadnerczy, rok po wprowadzeniu metody, w porównaniu z wcześniejszymi doświadczeniami autorów z klasyczną otwartą adrenaektomią.

Materiał i metody. W ciągu roku, od października 2008 r. wykonano 32 laparoskopowe adrenaektomie. Materiał ten porównano z wcześniejszymi zabiegami metodą otwartą w latach 2004–2008, przeprowadzonych u 43 chorych. Pod uwagę brano następujące czynniki: charakterystykę pacjentów, wielkość guza, czas zabiegu chirurgicznego, powikłania, czas hospitalizacji, czas do pierwszego posiłku, ilość użytych środków przeciwbólowych.

Wyniki. Laparoskopową adrenaektomię wykonano u 29 pacjentów. Dwóch pacjentów wymagało konwersji do metody otwartej z powodu śródoperacyjnego krwawienia, uszkodzenia okrężnicy. Jeden pacjent był reperowany 2 tygodnie po pierwotnym zabiegu z powodu pooperacyjnego krwiaka. Nie było znaczących statystycznie różnic w czasie trwania zabiegu chirurgicznego między porównywanymi metodami. Stwierdzono znaczące różnice w cza-

sie do pierwszego pooperacyjnego posiłku pacjenta, długości hospitalizacji i w ilości przyjętych leków przeciwbólowych.

Wnioski. Laparoskopowa adrenalectomia wydaje się bezpieczną metodą operacyjnego leczenia chorób nadnerczy. Wiąże się z mniejszym odsetkiem powikłań, krótszym czasem pobytu pacjenta w szpitalu oraz szybszą rekonwalecencją. Dla zespołów rozpoczynających zabiegi laparoskopowe na nadnerczach najlepszym dostępem operacyjnym jest droga przezotrzewnowa w bocznej ułożeniu pacjenta. Dostęp zaotrzewnowy powinien być wprowadzany w terminie późniejszym, po uzyskaniu niezbędnego doświadczenia (*Adv Clin Exp Med* 2010, 19, 5, 625–630).

Słowa kluczowe: laparoskopowa adrenalectomia, otwarta adrenalectomia, dostęp przezotrzewnowy, dostęp zaotrzewnowy.

In recent years minimally invasive techniques have been successfully adopted in many surgical procedures. One of them is laparoscopic adrenalectomy. Since the first report in 1992 from Gangner et al. [1], this approach has become a common technique and is now considered the „gold standard” for the resectioning of benign adrenal tumors [2, 3].

The advantages of this technique include minimization of tissue trauma, less postoperative pain and a shorter hospital stay when compared with the open technique [4, 5]. In selected cases it can even be performed as an outpatient procedure [6].

There are several laparoscopic approaches to the adrenal gland. Each of them has its unique advantages as well as limitations. Some authors advocate that surgical beginners in laparoscopic adrenalectomy ought to use the transperitoneal approach [7–9].

“Laparoscopic adrenalectomy is a safe and effective therapy for the management of pheochromocytoma, as compared with open surgery” [10, 11].

The first laparoscopic adrenalectomy at the 1st Department of General, Gastroenterological and Endocrine Surgery of Wrocław Medical University was performed in October 2008. Since then the laparoscopic approach has become the Department’s routine method for the removal of benign adrenal tumors. Between October 2008 and August 2009 a total of 32 laparoscopic adrenalectomies were performed. In this study, data on these procedures was collected and compared with data from 43 open adrenalectomies performed in the years 2004–2008. The results of the comparison clearly indicate the superiority of the less invasive laparoscopic procedure.

Material and Methods

All patients scheduled for an adrenal resection underwent a complete preoperative evaluation (biochemical tests and imaging studies, most of which were conducted at Wrocław Medical University’s Department of Endocrinology. The data concerning a total of 32 patients operated laparoscopically were compared with those of 43 patients

who underwent open surgery during the five years directly before the introduction of the laparoscopic technique (2004–2008). The data was obtained retrospectively, based on case histories.

In all the laparoscopic cases the diameter of the tumor was less than 6 cm (28 ± 9 mm), with no suspicion of malignancy. In the group that underwent open surgery the average size of the tumor was significantly larger (40 ± 25 mm), and in five cases postoperative histological examination revealed malignancy. In two cases a bilateral adrenalectomy was performed. The patients’ characteristics are presented in Table 1. There were no significant differences between the patients in the two groups apart from the larger average tumor in the open adrenalectomy group ($p < 0.001$).

All the laparoscopic adrenalectomies were performed by the same surgeon assisted by two colleagues. The open technique usually required four surgeons. In most cases the laparoscopic approach to the adrenal gland entailed the transperitoneal technique with the patient stabilized in the lateral decubitus position. In five cases the retroperitoneal lateral approach was chosen because of previous abdominal surgery. All patients were informed of the possibility of shifting to open surgery in case of any technical or anatomical intraoperative disturbances, and all signed informed consent forms.

All patients with adrenal tumors larger than 6 cm in diameter or with bilateral tumors were excluded from the laparoscopic approach, as were patients with suspected malignancy. The clinical charts of all the patients were reviewed, and all useful preoperative clinical parameters were recorded and evaluated, along with the surgical techniques used and intra- and postoperative morbidity.

Laparoscopic Adrenalectomy

For a left-side laparoscopic adrenalectomy, insufflation of the peritoneal cavity with carbon dioxide (12–15 mm Hg) was done with a Veress needle and the first 12-mm trocar was placed in mid-clavicular line, just below the costal margin. The next two trocars (10 mm) were placed at a distance of about 5 cm medially to the first one, also just below the costal line. The last trocar was

placed in the mid-axillary line 5–8 cm laterally to the first one. The 12-mm trocar was used to introduce the camera and to remove the tumor after the resection. The most medially placed trocar served to retract the spleen and for suction. The other two were used for manipulation. After gaining some experience, the authors started to use only three trocars for a left-side adrenalectomy. The lateral attachments to the spleen and splenorenal ligament were divided, which allowed the spleen and pancreatic tail to fall medially, thus exposing the retroperitoneal space and the vicinity of the adrenal gland. Sometimes the left flank of the colon was mobilized for better access. The medial side of the gland was dissected first; the kidney and adrenal veins were identified and the adrenal vessel was clipped and divided. The gland was freed and dissected using a vessel-sealing device (LigaSure). When the resection was completed, the gland was placed in a specimen bag and removed through the 12-mm trocar hole. A 5-mm suction drain was left at the operative site.

In right-side laparoscopic adrenalectomies, similar positioning of the trocars was used. The most medial one was used for a liver retractor, elevating the right lobe of the liver. The right triangular ligament of the liver was then dissected using electrocautery, exposing the inferior vena cava. The adrenal vein was identified, clipped and divided.

When necessary, conversion to an open procedure was performed by making a subcostal incision through the trocar line, without any need to change the patient's position.

Open Adrenalectomy

An open adrenalectomy was performed via an anterior subcostal incision; the gland was reached transperitoneally. For a bilateral adrenalectomy an initial incision on the right side was continued laterally to the left.

In the laparoscopic procedure, the duration of the operation was measured from the insertion of the Veress needle to skin closure; in the open tech-

Table 1. Patients characteristics

Tabela 1. Charakterystyka pacjentów

	Laparoscopic adrenalectomy (Adrenalektomia laparoskopowa)	Open adrenalectomy (Adrenalektomia metodą otwartą)	P-value (Wartość czynnika p)
Number of patients (Liczba pacjentów)	32	43	ns.
Age (Wiek)	58 ± 10 (35–72)	56 ± 12 (22–70)	ns.
Sex (Płeć)	M 12, F 20	M 12, F 31	ns.
Affected side (Strona ciała, po której znajdowała się zmiana)	R 15, L 17 (prawa, lewa)	R 22, L 19, both 2 (prawa, lewa)	ns.
Size of the tumor (Wiekść guza)	28 ± 9 (14–56) mm	40 ± 25 (25–125) mm	p < 0.001
Primary diagnosis (Wstępne rozpoznanie)			
Pheochromocytoma	9 (28%)	11 (25%)	ns.
Cushing Syndrome (Zespół Cushinga)	3 (12%)	2 (5%)	ns.
Primary aldosteronism, Conn's Syndrome (Pierwotny aldosteronizm, choroba Cohna)	14 (43%)	20 (47%)	ns.
Not secreting adrenal adenoma (Nieczynny gruczolak nadnerczy)	6 (18%)	6 (14%)	ns.
Carcinoma (Zmiana rakowa)	0	4 (9%)	

nique, it was measured from the first skin incision to its closure.

Statistical comparison analyses between the two groups were performed using the *t*-Student test. A two-tailed *p*-value of < 0.05 was considered statistically significant.

Results

Laparoscopic adrenalectomies were successfully completed in 29 patients. In three cases conversion to open technique was necessary. One patient needed emergency open surgery because of severe bleeding from the right adrenal vein. The second patient was opened because of iatrogenic injury to the left flexure of the colon. In the third case the original surgery was completed laparoscopically, but the patient had to be reoperated two weeks later in order to drain an intraabdominal hematoma (afterwards we considered this case a failure of the laparoscopic technique). In a fourth patient, following the laparoscopic procedure we observed a drop in the hemoglobin level and the formation of an intraabdominal hematoma that dissolved during prolonged drainage.

Blood transfusion was necessary in two cases in the laparoscopic adrenalectomy group. The overall amount of blood transfused was five units.

Apart from the three cases mentioned above, we did not observe any major surgical complications in the laparoscopic adrenalectomy group. In the group of patients that underwent open adrenalectomies, blood transfusion was necessary in five cases (a total of 13 blood units used). Three patients had postoperative pneumonia, and we observed wound infection in four cases. The wound-infection cases required prolonged hospital stays and subsequent wound management on an outpatient basis. There were no other significant intraoperative or postoperative complications

in either group. The outcomes and complications are shown in Table 2.

The main intraoperative and postoperative clinical parameters of laparoscopic and open adrenalectomy were compared by statistical analysis. The results are shown in Table 3.

There were no significant differences in the duration of surgery in either group. A significant difference was noted in time to first oral intake. Patients who had undergone the laparoscopic procedure resumed oral intake sooner (1.7 days after surgery) than those who underwent open surgery (2.8 days) ($p = 0.002$). Another significant difference was in the length of the postoperative hospital stay, which was 6.8 days in the laparoscopy group as opposed to 10.2 days for the open procedure ($p < 0.0001$).

Patients who underwent the laparoscopic technique required fewer doses of analgesic drugs during the first post-operative day (1.2 vs. 3.4 for the open-surgery group; $p < 0.05$); likewise for the second postoperative day (0.7 vs. 2.8; $p < 0.05$). The analgesic drug (Ketoprofen 100 mg) was given intravenously or intramuscularly on the first postoperative day; on the second day it was mainly given orally.

Discussion

After the first laparoscopic adrenalectomy described by Ganger et al. [12], this method quickly gained popularity and finally became the procedure of choice for adrenal tumors as a result of its minimally invasive character.

For patients the advantages of laparoscopic surgery include a shorter operative time, reduced tissue trauma, less pain and postoperative discomfort, a shorter hospital stay, fewer wound complications and shorter convalescence [6, 9, 13–15]. The cosmetic advantage of the laparoscopic approach must also be borne in mind.

Table 2. The outcome and complications of the patients

Tabela 2. Przebieg leczenia u pacjentów

	Laparoscopic adrenalectomy (Laparoskopowa adrenalektomia)	Open adrenalectomy (Adrenalektomia metodą otwartą)
Conversion to open technique (Konwersja do metody otwartej)	3	–
Haematoma after operation (Krwiak po zabiegu chirurgicznym)	2	3
Wound infection (Infekcja rany operacyjnej)	–	4
Pneumonia (Zapalenie płuc)	–	3

Table 3. Comparison between patients in laparoscopic and open adrenalectomy**Tabela 3.** Porównanie pacjentów operowanych metodą laparoskopową i metodą otwartą

	Laparoscopic adrenalectomy (Laparoskopowa adrenalectomia)	Open adrenalectomy (Adrenalectomia metodą otwartą)	P-value (Wartość współczynnika p)
Number of patients (Liczba pacjentów)	32	43	
Time of operation (Czas zabiegu chirurgicznego)	117.6 ± 15.4	137.7 ± 27.6	ns.
Days to first oral intake (Liczba dni do pierwszego posiłku)	1.7 ± 0.9	2.8 ± 1.3	0.002
Postoperative hospital stay – days (Czas hospitalizacji – dni)	6.8 ± 2.4 (5–14)	10.2 ± 2.1 (8–16)	< 0.0001
Number of analgesics drugs (Ilość przyjętych leków przeciwbólowych)			
1 postoperative day (Pierwsza doba pooperacyjna)	1.2 ± 0.4	3.4 ± 0.7	< 0.05
2 postoperative day (Druga doba pooperacyjna)	0.7 ± 0.3	2.8 ± 0.4	< 0.05
Blond transfusion (Transfuzje krwi)	2 patients 5 blood units	5 patients 13 blood units	< 0.05

Different approaches to the adrenal gland can be used during a laparoscopic adrenalectomy. The lateral transperitoneal approach offers the best visualization of the intraabdominal organs, and relatively easy access to the retroperitoneal space on both sides, where the adrenal glands are situated. Lateral and lumbar retroperitoneal approaches are associated with poorer visibility, offer a smaller working space, and require more practical surgical experience and better orientation in the operating field [16].

Baba et al. [17] concluded that a posterior lumbar approach is faster than other laparoscopic techniques and is associated with a lower risk of injury to the intraabdominal organs. However, this method requires more experience, and therefore in our opinion it should not be recommended for surgeons beginning their experience with laparoscopic adrenalectomy. The safest method to use while gaining experience seems to be the transperitoneal lateral approach. Later of course the more demanding techniques can also be utilized.

Simforoosh et al. [18] emphasize the role of the surgeon's experience. They started to operate tumors larger than 6 cm in diameter after their first 20 successful cases.

Ichikawa et al. [19] adopted the posterior lumbar approach in 1997, but before that they used the transperitoneal anterior approach.

In the five cases of left-side adrenal tumors in which the authors of the current study chose a retroperitoneal lateral approach, it was because of

previous abdominal operations. When using this more demanding method we were supervised by a visiting laparoscopic specialist with more experience.

In the present study no significant difference was observed in the duration of laparoscopic and open adrenalectomy. The same finding was reported by Wang et al. [20]. Other authors have noted a significant difference in the length of operations using the two methods [19], with laparoscopic adrenalectomy being obviously faster. The authors of the present study think that in our case the longer duration of laparoscopic adrenalectomy reflects the learning curve of a relatively difficult surgical technique, and that in the near future the duration of laparoscopic procedures should shorten considerably. During all the laparoscopic adrenalectomies performed, a vessel-sealing device (LigaSure) was used, which allowed good tumor mobilization with effective hemostasis and significantly shortened the time needed for tumor resection.

During the past year the authors did not have patients with adrenal tumors larger than 6 cm; the average size of the tumor in the laparoscopic procedures performed was 28 ± 9 mm. This probably results from the widespread use of high-quality ultrasound facilitating the diagnosis of adrenal tumors in the early stages. The widely publicized dramatic rise in the number of newly diagnosed incidentalomas further justifies the use of minimally invasive laparoscopic techniques for their safe removal [10]. During the earlier years covered

by the present study (2004–2008), the resected tumors were significantly larger (40 ± 25 mm). The patients in this period included a 22-year-old male with bilateral adrenal metastases (6 and 12 cm).

The authors' first year of experience with laparoscopic adrenalectomy has confirmed it as a safe and an effective procedure for the treatment of benign adrenal tumors, offering excellent visualization of the operating field and associated with minimal morbidity.

A comparison of laparoscopic adrenalectomy with open surgery proves the superiority of the laparoscopic technique in terms of duration of

hospital stay, postoperative analgesic drug intake and time to first postoperative oral intake. Patients recover quickly and require shorter hospital stays; their convalescence is faster with significantly better cosmetic outcomes.

The similar duration of laparoscopic and open adrenalectomy in our study most probably reflects the learning curve for a more demanding surgical technique.

The authors' experience suggests that the lateral transperitoneal approach should be the method of choice for beginners in laparoscopic adrenalectomy.

References

- [1] **Ganger M, Lacroix, Bolte E:** Laparoscopic adrenalectomy in Cushing's Syndrome and pheochromocytoma. *New Eng J Med* 1992, 327, 1033.
- [2] **Smith CD, Weber CJ, Amerson JR:** Laparoscopic adrenalectomy: new gold standard. *World J Surg* 1999, 23, 389–396.
- [3] **Lubikowski J, Umiński M, Andrysiak-Mamos E, Pynka S, Fuchs H, Wójcicki M, Szajko M, Moleda P, Post M, Zochowska E, Kiedrowicz B, Safranow K, Syrenicz A:** From open to laparoscopic adrenalectomy: thirty years' experience of one medical centre. *Endokrynol Pol.* 2010, 61(1), 94–101.
- [4] **Prinz R:** A comparison of laparoscopic and open adrenalectomies. *Arch Surg* 1995, 130, 489–494.
- [5] **Imai T, Kikumori T, Ohiwa M:** A case-controlled study of laparoscopic compared with open lateraladrenalectomy. *Am J Surg* 1999, 178, 50–53.
- [6] **Karanikola E, Tsigris C, Kontzoglou K, Nikiteas N Tohoku:** Laparoscopic adrenalectomy: where do we stand now? *J Exp Med* 2010, 220(4), 259–265.
- [7] **Zografos GN, Vasiliadis George K, Zagouri F, Aggeli C, Korkolis D, Vogiatzi S, Pagoni MK, Kaltsas G, Piaditis G:** Pheochromocytoma associated with neurofibromatosis type 1: concepts and current trends. *World J Surg Oncol* 2010, 8, 14, 1–4.
- [8] **Matsuda T, Murota T, Kawakita M:** Transperitoneal anterior laparoscopic adrenalectomy. The easiest technique. *Biomed Pharmacother* 2000, 54, Suppl 1, 157–160.
- [9] **Terachi T, Matsuda T, Terai A:** Transperitoneal laparoscopic adrenalectomy: experience in 100 patients. *J Endourol* 1997, 11, 361–365.
- [10] **Henneman D, Chang Y, Hodin RA, Berger DL:** Effect of laparoscopy on the indications for adrenalectomy. *Arch Surg* 2009, 144(3), 255–259.
- [11] **Humphrey R, Gray D, Pautler S, Davies W:** Laparoscopic compared with open adrenalectomy for resection of pheochromocytoma: a review of 47 case. *Can J Surg* 2008, 51(4), 276–280.
- [12] **Go H, Takeda M, Takahashi H, Imai T, Tsutsui T, Mizusawa T:** Laparoscopic adrenalectomy for primary aldosteronism: a new operative method. *J Laparoendosc Surg* 1993, 3, 455–459.
- [13] **Gagner M, Pomp A, Heniford BT:** Laparoscopic adrenalectomy: lessons learned from 100 consecutive procedures. *Ann Surg* 1997, 226, 238–247.
- [14] **Dudley NE, Harrison BJ:** Comparison of open posterior versus transperitoneal laparoscopic adrenalectomy. *Br J Surg* 1999, 86, 656–660.
- [15] **Assalia A, Gagner M:** Laparoscopic adrenalectomy. *Br J Surg* 2004, 91, 1259–1274.
- [16] **Thompson GB, Grant CS, van Heerden JA et al.:** Laparoscopic versus open posterior adrenalectomy: a case-control study of 100 patients. *Surgery* 1997, 122, 1132–1136.
- [17] **Baba S, Miyajima A, Uchida A, Asanuma H, Miyakawa A, Murai M:** A posterior lumbar approach for retroperitoneoscopic adrenalectomy: assessment of surgical efficacy. *Urology* 1997, 50, (1), 19–24.
- [18] **Simforoosh N, Majidpour HS, Basiri A, Ziaee S.A.M, Behjati S, Beigi FM A, Aminsharifi A:** Laparoscopic Adrenalectomy Ten-Year Experience, 67 Procedures. *Urol J* 2008, 5(1), 50–54.
- [19] **Ichikawa T, Mikami K, Komiya H, Suzuki H, Shimizu A, Akakura K, Igarashi T, Ito H:** Laparoscopic adrenalectomy for functioning adrenal tumors: clinical experiences with 38 cases and comparison with open adrenalectomy. *Biomed Pharmacother* 2000, 54, 178–182.
- [20] **Wang H-S, Chia C, Chou Y-H, Wang Ch-J, Wu W-J, Huang C-H:** Comparison of laparoscopic adrenalectomy with open surgery for adrenal tumors. *Kaohsiung J Med Sci* 2009, 25, 8, 438–443.

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