Analysis of risk factors for conversion in laparoscopic adrenalectomy: a single-institution series of 256 patients

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Abstract

Introduction: *Although introduction of the laparoscopic approach for adrenal gland surgery revolutionized the strategy in management of adrenal gland tumors, open surgery is still a method of choice in some clinical scenarios. Moreover, laparoscopy may have limitations resulting in conversion.*
Aim: *To assess risk factors predisposing for conversion based on our own material, including 256 laparoscopic adrenalectomies performed in 2009–2016.*
Material and methods: *A retrospective analysis of patients who underwent adrenalectomies between 2009 and 2016 was conducted. Patients were analyzed for sex, body mass index (BMI), size of the adrenal gland lesion, final histopathological diagnosis and operated side of the adrenal gland, its impact on conversion rate.*
Results: *A total of 256 patients underwent laparoscopic adrenalectomy. The reported study comprised of 94 (36.7%) men and 162 (63.3%) women. The most common indication for adrenalectomy were adrenal cortex adenoma (n = 149; 58.2%) and pheochromocytoma (n = 48; 18.75%). The conversion rate was 3.91% (n = 10 patients). Mean BMI of patients without conversion was 27.6 kg/m^2, whereas in the group of patients with conversion, BMI was 29.7 kg/m^2 (p > 0.05). The conversion rate was precisely the same when comparing the right (5/126; 3.9%) and left (5/126; 3.9%) adrenal gland. There was no correlation between the size of the adrenal lesion and the risk of conversion.*
Conclusions: *The laparoscopic approach remains an efficient and safe procedure for adrenal gland tumors. Based on our study, obese patients and those with pheochromocytoma are associated with a higher risk of conversion but without any statistical significance. There was no difference in the conversion rate when analyzing the size of the adrenal gland tumor. No difference was also revealed in the conversion rate when comparing both sides of laparoscopic adrenalectomy.*

Key words: *conversion, laparoscopic adrenalectomy, adrenal gland tumor.*

Introduction

In 1889, the first adrenalectomy was performed by the British surgeon John Knowsley Thornton [1]. According to the detailed description of the surgery, a left adrenal tumor of a 36-year-old female was removed. However, due to the large size of the adrenal gland tumor, simultaneously, a left nephrectomy was needed. The patient lived 2 years after the index surgery.

Despite the first success in adrenalectomy, further outcomes of surgical management of the adrenal gland were not encouraging. The mortality rate

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was approximately 30% then, even in cases of subtotal resection of the adrenal gland [2]. A breakthrough factor in the strategy of surgical management was the perioperative supplementation of cortisol, as a result of discovery of this hormone in 1940. Since then, the mortality rate has decreased rapidly.

Over the past years, the selection of the surgical technique and approach of adrenalectomy depended mainly on the surgeons' preferences due to the lack of firm recommendations and anatomical considerations. The first description of trans-abdominal laparoscopic adrenalectomy performed by Gagner *et al.* in 1992 revolutionized the surgical management of the adrenal gland [3]. Two years later, a retroperitoneal approach for adrenalectomy in humans was described simultaneously in Japan, New Zealand and Sweden [4].

The introduction of minimally invasive techniques has resulted in a breakthrough in the surgical treatment of adrenal gland diseases. The laparoscopic approach was associated with advantages over open surgery and has immediately become the method of choice in many surgical indications and clinical scenarios.

Currently, due to the widely observed development of laparoscopy and improvement of surgeons' experience, the list of contraindications for laparoscopy is limited. However, traditional open surgery is still routinely used and includes locally advanced tumor, neoplastic metastases, intraoperative complications and others.

Moreover, in some surgical scenarios, conversion is still needed. In the literature, the most common reasons for conversion include the tumor size and histological type (adrenal gland cancer and pheochromocytoma). Others believe that a preoperative diagnosis of adrenal cancer does not increase the risk of conversion unless the tumor is more than 5 cm [5, 6].

According to various authors, conversion rates range from 1.4% to 7.7% in a high-risk group of patients [7–13]. An appropriate selection of surgical access and assessment of possible risk factors allows to minimize the risk of conversion. For high-risk surgeries, it seems to be reasonable to select a well-experienced laparoscopic team.

Aim

The aim of the study was to assess the risk factors predisposing for conversion based on our own material, including 256 laparoscopic adrenalectomies performed in 2009–2016.

Material and methods

A retrospective analysis of patients who underwent adrenal gland surgery between 2009 and 2016 at the tertiary reference center was conducted. A total of 346 patients underwent surgery due to varying pathologies of adrenal glands between 2009 and 2016. Ninety patients were excluded from the study due to either elective open adrenalectomy or not available data in medical records. Finally, a total of 256 patients were enrolled in the study.

Preoperatively, all patients were diagnosed with the standard endocrinological lab test panel for the exclusion of the functioning nature of the tumor. In case of pheochromocytoma, 2 weeks' preoperative preparation with α blocking drugs was administered. All patients were also diagnosed with computed tomography (CT) scan as a gold standard imaging study for adrenal gland pathologies.

The size of the adrenal gland lesion was assessed on the basis of the histopathological examination of the adrenal gland specimen. Data of 27 patients regarding the size of the adrenal gland tumor were not available. Regarding that anatomical feature, patients were divided into two groups – Group 1: patients with adrenal gland tumor $\leq$ 5 cm and Group 2: patients with adrenal gland tumor > 5 cm.

For the purpose of this study, conversion was termed for any incision of the abdominal wall longer than 5 cm and performed for other reasons than removal of the surgical specimen, as described by Vidal [9].

Regarding patients' body mass index (BMI), patients were divided into 4 groups according to the value of BMI – Group 1: BMI < 18.5 kg/m^2; Group 2: BMI 18.5–25 kg/m^2; Group 3: BMI 25–30 kg/m^2 and Group 4: BMI > 30 kg/m^2. Detailed data of patients' BMI were obtained only for patients operated between 2012 and 2016 (a total of 143 laparoscopies).

The trans-abdominal laparoscopic approach as described by Gagner *et al.* [3] was routinely used for adrenalectomy in our department. During the operation, the patient was placed on the side with the surgical table bent between the chest and the pelvis. As an antibiotic prophylaxis, cefazoline at a dose of 2.0 g was routinely used 1 h before skin incision.

Since the pneumoperitoneum was created using Hasson technique, four trocars were inserted along-

side the costal arch (2 ports 5 mm and 2 ports 10 mm on the left side adrenalectomy, and 3 ports 10 mm and 1 port 5 mm on the right side adrenalectomy). Depending on the anatomical conditions, the splenic flexure was mobilized on the left side with blunt dissection and by using a laparoscopic advanced energy device (ultrasonic or bipolar), usually the hepatic flexure mobilization was not necessary on the right side. After mobilization of the spleen on the left side and the liver on the right side, the visceral peritoneum was cut to enter the retroperitoneal space. After visualizing the adrenal gland, it was dissected from the kidney, and then separated from pancreas and from the liver, on the left and right side, respectively. Then dissection of the lower pole was performed and the adrenal gland vein was ligated. Further, by preparing the adhesions between the adrenal gland and the back wall of the abdominal cavity, the adrenal gland with the tumor was removed in the sterile plastic bag (endobag) using Hasson trocar site. Routinely, the abdominal drain was placed for 24 h. Abdominal fascia was closed using PGLA LACTIC 2 (Yavo Medical Supplies Manufacturer, Belchatow, Poland). The skin was cleansed with povidone iodine solution and closed primarily with interrupted Nylon 3/0 (Yavo Medical Supplies Manufacturer, Belchatow, Poland) in the standard manner.

Presented data were collected based on the available medical records. Patients' records were analyzed for sex, BMI, size of the adrenal gland lesion, final diagnosis based on the histopathological examination and operated side of the adrenal gland and its impact on the conversion rate.

Statistical analysis

Mann-Whitney test (Statistica v.13 Dell Inc. 2016) was used for statistical analyses. The coefficient $p \leq 0.05$ was considered statistically significant.

Results

A total of 256 patients underwent laparoscopic adrenalectomy. The reported study comprised of 94 (36.7%) men and 162 (63.3%) women.

The conversion rate was 3.9% (n = 10 patients). Six conversions (6/94; 6.4%) were done in men, whereas 4 conversions were performed in women (4/162; 2.5%).

Due to the lack of data in medical records, BMI was only evaluated between 2012 and 2016. The mean BMI of the patients without conversion was 27.6 kg/m^2, whereas in a group of patients with conversion, BMI was 29.7 kg/m^2 ($p > 0.05$) and had no statistical significance.

Analyzing the diameter of the adrenal gland tumor, an adrenal gland tumor ≤ 5 cm was revealed in 175 patients, whereas in 54 patients an adrenal gland tumor was greater than 5 cm. No data of the tumor size were obtained for 27 patients due to incomplete or lack of medical records.

For the purpose of the study, adrenal gland patients were divided into two groups: 1) adrenal gland tumor ≤ 5 cm and 2) adrenal gland tumor > 5 cm.

In Group 1, a total of 175 laparoscopic adrenalectomies were performed (82.9%), whereas traditional open surgery was performed in 36 (17.1%) patients. In Group 2, a total of 54 patients underwent laparoscopic surgeries (54.5%) and 45 patients underwent traditional open surgeries (45.5%).

Analyzing the operated side of the adrenal gland, an equally distributed number of patients was operated on the right (n = 126) and left (n = 126) adrenal gland. The conversion rate was precisely the same when comparing the right (5/126; 3.9%) and left (5/126; 3.9%) adrenal gland.

Based on the final histopathological examination, the most common indication for adrenalectomy were adrenal cortex adenoma (n = 149; 58.2%), pheochromocytoma (n = 48; 18.75%) and nodular hyperplasia of the adrenal cortex (n = 20; 7.8%).

The remaining underlying pathologies of the adrenal gland were summarized in Table I.

Analyzing the patients' BMI and its influence on the conversion rate, there was no statistical significance ($p > 0.05$) (Table II).

Discussion

Since the first laparoscopic adrenalectomy was presented by Gagner *et al.*, the laparoscopic approach has become a method of choice for management of adrenal gland tumors [3, 7]. However, minimally invasive techniques have some limitations and may result in conversion to the traditional open surgery.

In clinical practice, it seems to be difficult to clearly specify and predict such clinical scenarios. According to some authors, any additional surgical incision unplanned preoperatively may be termed conversion [9]. Other authors stated that only the

Table I. Histopathologic characteristics and prevalence of adrenal gland tumors

Type of adrenal gland tumor	No. of patients	No. of conversion	Conversion rate (%)
Pheochromocytoma	48	3.00	6.2
Adrenal gland adenoma	149	3.00	2
Adrenal cortical hyperplasia	20	2.00	10
Myelolipoma	12	0.00	0
Other	15	1.00	6.7
Metastatic tumor	9	0.00	0
Adrenal cortex cancer	3	1.00	33
Total	256	10.00	3.9

Others referred to: angiolipoma, lymphangioma, cavernous hemangioma.

Table II. Prevalence of the conversion rate in a group of patients with various BMIs

BMI [kg/m^2]	No. of laparoscopic procedures without conversion (*n* – patients)	No. of laparoscopic procedures with conversion (*n* – patients)
< 18.5	N = 3	N = 0
18.5–25	N = 35	N = 0
25–30	N =52	N = 2
> 30	N = 47	N = 4

incision longer than 10 cm is considered as a conversion [8]. For the purpose of this study, conversion was termed for any incision of the abdominal wall longer than 5 cm and performed for other reasons than for removal of the surgical specimen [9].

According to previous publications, the conversion rate in adrenalectomy varied from 1.4% to 7.7% in a high-risk group of patients [9–13]. Preoperative assessment of risk factors and thus appropriate selection of the surgical approach may minimize the conversion rate.

It is well known that conversion is associated with a longer hospital stay, higher risk of surgical site infection, more intense postoperative pain, higher postoperative hernia rate and others [9, 10].

Laparoscopic adrenalectomy is quite demanding and requires the surgeon to be well experienced in laparoscopic techniques.

Recently, Pedziwiatr *et al.* stated that there are currently no absolute contraindications for laparoscopic adrenalectomy [11]. However, according to other authors, the laparoscopic approach is not recommended in the case of suspected primary adrenocortical malignancy [10, 12, 14]. In their opinion, the role of laparoscopy in the surgical management of adrenal gland cancer remains controversial [15]. Widely observed improvement in the field of minimally invasive techniques and data of well-experienced laparoscopic centers proved that the radical adrenal cancer resection is feasible laparoscopically and the outcomes are comparable to traditional open techniques in relation to adrenal gland malignancy [10, 16, 17]. Gaujoux *et al.* presented comparable long-term oncological outcomes in terms of overall survival and cancer-free survival rates analyzing open surgery and laparoscopic approaches [10].

Some authors consider the adrenal cortex cancer as an indication for laparotomy surgery [18].

Based on our experience, we agree with Donatini *et al.* and preferably qualified patients with tumor suspected of adrenocortical cancer to traditional open surgery. However, there are no available reports in the literature indicating adrenocortical carcinoma as a risk factor for conversion. This applies to both clinical scenarios, either to tumors preoperatively defined as an adrenocortical carcinoma based on imaging studies, or to tumors diagnosed postoperatively as malignant ones based on histopathological examination and such a scenario is more likely found in general practice.

Moreover, in some cases, preoperative differentiation of the primary malignant lesion from benign

lesion of the adrenal glands is demanding. Thus, the rational selection of patients qualified for laparoscopy or laparotomy regarding this pathology is ambiguous [15].

Based on our analysis, from all patients undergoing laparoscopic surgery, 3 patients were finally diagnosed with adrenocortical carcinoma (n = 3; 1.1%). There was one laparoscopy converted to open surgery due to technical problems with dissection of the tumor. Thus, 3 patients were incorrectly diagnosed preoperatively, what may confirm the difficulties with the differentiation of the nature of the adrenal gland tumor in preoperative imaging studies.

Another potential risk factor for laparotomy was the tumor size. Based on our experience, the role of laparoscopic adrenalectomy for tumors of 6 cm or greater is still debatable. However, it is worth noting that the size criterion for laparoscopy is systematically shifting towards greater tumors [19–21].

On the one hand, there are some recommendations indicating the use of laparoscopy in adrenal lesion no greater than 5 cm [10, 12]. This is justified by the higher risk of conversion due to technical difficulties in dissection and a significant percentage of malignant lesions [7].

On the other hand, some authors reported a technically feasible laparoscopic procedure in large adrenal tumors [11, 22]. Moreover, some reports proved laparoscopic adrenalectomy for tumors with a diameter of 10 cm, 12 cm or even 15 cm [23]. Large adrenal tumors, especially malignant, are usually hard, immovable, rich in pathological vascularization and infiltrate surrounded structures. In such clinical situations, embolization of the tumor may be an option to make the procedure safe. It may reduce the volume of the tumor and decrease the amount of pathological vessels resulting in a decrease of intraoperative bleeding [24]. It may also be helpful in case of borderline tumors. Utility of preoperative adrenal artery embolization may facilitate surgical excision.

Moreover, laparoscopy is the method of choice for the exploratory procedure with taking samples for histopathological examination. In cases of a non-resectable large tumor diagnosed finally with adrenocortical carcinoma, mitotane treatment may be administered [25]. Such a strategy may minimize the perioperative trauma and increase the chance for the final success of surgical treatment as a second-look operation. Analyzing our data, there was no correlation between the size of the adrenal lesion and the risk of conversion. The mean diameter of the tumor in the group of patients undergoing laparoscopic surgery was 3.9 cm, whereas in the group of patients requiring conversion was 3.7 cm. The explanation for such a small discrepancy may be associated with the fact that the majority of patients with large-sized tumors were qualified for traditional open surgery. However, we have observed a gradual tendency to operate laparoscopically larger adrenal gland tumors in the time intervals. The mean diameter of tumors qualified for laparoscopy increased from 3.8 cm in 2009–2012 to 3.9 cm in 2013–2016. Moreover, in the same time intervals, a trend was found to qualify adrenal tumor larger than 5 cm for laparoscopic surgery.

Based on our study, a total of 48 patients underwent laparoscopic adrenalectomy due to pheochromocytoma. A conversion rate was 6.3% (3 of 48 patients) that is a comparable outcome to other publications analyzing the efficiency of laparoscopy in pheochromocytomas [13]. Comparing conversion rates in pheochromocytoma patients (6.3%) and adrenocortical adenoma patients (2%), there were no statistically significant differences (p = 0.16). Our outcome is consistent with the observations by other authors. Vidal *et al.* and Shen *et al*. independently confirmed diagnosis of pheochromocytoma as an independent risk factor for conversion [9, 16]. Firstly, intraoperative maintenance of hemodynamic stability was revealed as a crucial element explaining such a correlation. Secondly, presence of the pathological vascularization within pheochromocytoma tumor is a source of intraoperative bleeding.

Vidal *et al.* in a recent retrospective cohort study presented a 14.5% conversion rate in a group of patients diagnosed with pheochromocytoma [9]. The authors indicated traditional open surgery as a method of choice in pheochromocytomas greater than 5 cm.

In our study, in the pheochromocytoma patients qualified for laparotomy, the mean dimension of the tumor was 6.5 cm. Pheochromocytoma tumors qualified for laparoscopy were significantly smaller in size with the mean dimension of 4.1 cm. Comparing the outcomes of the presented study and other authors, our previous strategy seemed to be more conservative.

Currently, in authors' department, the strategy has been changed and the indications for traditional open surgery was limited to tumors with infiltra-

tion of adjacent structures or tumors greater than 8–10 cm but every patient requires an individual approach.

Kalady *et al.* and Kim *et al.* reported high efficacy in the use of laparoscopy in the surgical treatment of catecholamine-secreting adrenal tumors [26, 27]. Thus, despite the tendency to more frequent conversions, laparoscopy is beneficial in the surgical treatment of pheochromocytomas.

BMI is one of the basic elements of anthropometric measurements. It was widely recognized that obesity is an independent risk factor for various surgical complications. It has been proven to extend the operative time and a risk factor for intraoperative complications including conversion [9, 10, 16].

Overweight and obesity are also well-acknowledged risk factors for increased surgical site infection, deep vein thrombosis, pulmonary embolism or myocardial infarction [28].

In our study, the mean BMI was higher in the group where conversion was needed when comparing to the group without conversion (29.7 vs. 27.6, respectively; $p > 0.05$).

However, the higher risk of conversion in overweight and obese patients should not change the strategy in patients' selection. Moreover, laparoscopy is highly recommended in surgical treatment of adrenal gland diseases in obese patients [29, 30]. The use of the laparoscopic approach minimizes the risk of surgical complications, shortens hospital stays and reduces the time of recovery.

Various anatomical considerations of the right and left adrenal gland make the surgery of each adrenal gland different. In some surgeons' opinion, removal of the right adrenal gland is technically more difficult. Firstly, the adrenal gland is located posteriorly to the inferior vena cava. Secondly, the short right adrenal vein, drained directly to the inferior vena cava may result in some problems with safe dissection [31].

Thirdly, surrounding organs such as liver or duodenum may be susceptible to mechanical and thermal injuries. On the left side, the tail of the pancreas and spleen may be a source of complications. However, according to the available reports, the operated side does not have a significant impact on the incidence of surgical complications, including the prevalence of conversion [32].

Comparing sides of adrenal gland surgery, there were no differences revealed in terms of operative time, intraoperative blood loss, and length of hospital stay [9, 10, 11, 31]. However, according to previous studies, greater intraoperative blood loss was noticed at the time of learning laparoscopic right-sided adrenalectomy [32]. In the presented study, intraoperative bleeding was revealed as a cause of conversion in 4 patients when analyzing the right adrenal gland laparoscopy. In our opinion, that seems to be reflected in the anatomical considerations mentioned above, what is in the line with other reports [9–13]. On the left side, the dominant complication leading to conversion was injury of surrounding structures such as the pancreas tail, spleen vessels and hilum of the kidney. Varkarakis *et al.* reported intraoperative injury of the tail of the pancreas in 8% of left adrenalectomies [33].

Based on our study, no difference was found in the incidence of the conversion comparing right and left adrenal gland laparoscopy. There are no reports in the literature confirming the higher conversion rate when comparing both sides of laparoscopic adrenalectomy [34].

Conclusions

The laparoscopic approach remains an efficient and safe procedure for adrenal gland tumors. Based on our study, obese patients and those diagnosed with pheochromocytoma are associated with the higher risk of conversion but without any statistical significance. There was no difference in the conversion rate when analyzing the size of the adrenal gland tumor.

No difference was also revealed in the conversion rate when comparing both sides of laparoscopic adrenalectomy.

Conflict of interest

The authors declare no conflict of interest.

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