Endoscopic adrenalectomy in large adrenal tumors

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Background. *The purpose of this study was to evaluate the frequency of malignancy, oncologic outcome and perioperative morbidity between small (≤60 mm) and large (>60 mm) adrenal tumors treated by endoscopic adrenalectomy (EA).*

Methods. *EA was performed in 289 consecutive patients with a mean follow-up of 87.7 ± 45.1 months. Patients were divided in those with tumor size ≤60 mm (group 1;* n *= 252) and >60 mm (group 2;* n *= 37). Data on patient's age, gender, hormone function, tumor side, operation time, postoperative complications, conversion to open approach, and rate of malignancy were analyzed. Furthermore, disease-free survival in malignant tumors was estimated and compared between both groups.*

Results. *Patient age (*P *= .43), gender (*P *= .09), tumor side (*P *= .17), and operative time (*P *= .33) showed no difference in both groups. Functioning tumors were observed in 85% of patients in group 1 compared with 46% in group 2 (*P *= .0001). Seven (2.8%) patients in group 1 and 7 (18.9%) in group 2 had malignant tumors (*P *= .0001). Neither rate of conversion (*P *= .71) and postoperative complication (*P *= .27) nor recurrence of malignancy (*P *= .48) differed between both groups. Estimated disease-free survival after 5 years in malignant lesions was 87.5 ± 11.7% for group 1 and 62.5 ± 21.3% for group 2 (*P *= .49).*

Conclusion. *EA is a safe and feasible procedure in the majority of large adrenal tumors. Tumor size does not affect the outcome of surgery. In case of malignancy, it does not increase the rate of local recurrence. In experienced hands, tumor size should not influence the decision of surgical access (endoscopic versus open). (Surgery 2012;152:41-9.)*

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Endoscopic adrenalectomy (EA) has become the first choice for the treatment of small and benign adrenal lesions since its first introduction in 1992 by Gagner et al.[1,2] Reported advantages of endoscopic surgery are better patient's comfort owing to lesser pain, better cosmetic results, decreased operative blood loss, and faster recovery.[3-7] As experience with the endoscopic technique has increased, the indication for EA in large tumors has been extended. However, because of the technical difficulty and a greater risk of malignancy,[8-11] EA has not yet been accepted as appropriate for resection of large tumors in general. The technical difficulty has been overcome by increased experience in endoscopic surgery. Thus, malignancy is reported to be the only contraindication for EA,[3,12,13] so the appropriate surgical approach seems to be dependent on the ability to distinguish benign from malignant adrenal tumors, preoperatively.

Improved diagnostic imaging[14] offers the ability to identify tumors at greater risk for malignancy and sign of invasion to surrounding tissue, lymphadenopathy or distant metastasis.[15] Without evidence of these characteristics, malignancy of large adrenal tumors is difficult to diagnose before or even during surgery. The correlation between increasing tumor size and malignancy of the adrenal tumor is well described in the literature.[16] For that reason, some investigators regard large tumors as a contraindication for an endoscopic approach.[6,11,17-20] Although in the literature recommendations for the upper size limit for EA vary between 30 and 60 mm,[8,21-31] some investigators report of series with larger adrenal tumors treated successfully endoscopically.[10,12,32]

Data on EA and its outcome for large and, therefore, potentially malignant adrenal tumors are controversial.[8,12,13,19,31-34]

All patients provided informed consent to all diagnostic and therapeutic procedures. The prospective data collection and the retrospective analysis were approved by the ethics committee of the Medical University of Vienna (EK Nr:583/2011).

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The objective of the current analysis was to evaluate the frequency of malignancy, oncologic outcome and perioperative morbidity between small (≤60 mm) and large (>60 mm) adrenal tumors treated by EA.

MATERIALS AND METHODS

From 1997 to 2009, a series of 311 endoscopic adrenalectomies was performed in 289 consecutive patients. In this investigation clinicopathologic and radiologic data were collected and documented prospectively in a specific data base and analyzed retrospectively.

The majority of patients had incidentally discovered adrenal masses. Preoperative evaluation for hormonal functioning included pheochromocytoma, hyperaldosteronism, hypercortisolism, and virilizing or feminizing adrenal tumors.[21] Imaging evaluation including gadolinium-enhanced magnetic resonance imaging (MRI) with chemical shift imaging as described in a former detailed study[14] and/or computed tomography (CT) were performed for all patients with an adrenal mass 4–6 weeks before surgery.

According to the National Institutes of Health and American Association of Endocrine Surgeons,[35,36] indications for operative treatment were either functional tumors irrespective of tumor size, or nonfunctional adrenal tumors >50 mm; hence, malignancy increases with tumor size significantly. Patients with tumors >50 mm or documented tumor growth during follow-up were candidates for operative intervention. Patients with tumors between 30 and 50 mm present a "relative indication" for surgery. Age, comorbidities, and patient's request influenced the therapeutic concept in these patients.[11,14,37-42] Patients with tumors <30 mm were generally monitored.

In most patients, EA was performed by the transperitoneal flank approach in the lateral decubitus position as it was first described by Gagner et al[3,43]; the endoscopic posterior retroperitoneal approach described by Mercan et al and Walz et al[44,45] was performed in 7 patients. When a conversion to an open approach was necessary, we performed a subcostal incision on the tumor side. In our first series,[2] EA was only performed in tumors <60 mm according to preoperative MRI or CT. With growing experience in endoscopic surgery and better preoperative radiologic prediction of malignancy, tumors >60 mm were operated endoscopically. Preoperative radiologic demonstration of peri-adrenal tissue infiltration or venous invasion remained an absolute contraindication for EA. All tumors were removed en bloc with the adrenal gland and the surrounding fatty tissue. No selective lymphadenectomy was performed. The specimen was always extracted in toto from the abdominal cavity in a plastic bag to avoid tumor spillage and to allow histomorphologic classification.

The tumor size was measured directly by the examining pathologist (O.K.) before formalin fixation. In case of adrenal cortical malignancy, specimens were classified according to the criteria proposed by Weiss and Aubert et al.[46-48]

Adrenocortical carcinomas were staged in accordance with the International Union against Cancer recommendations (UICC 2010) and the European Network for the Study of Adrenal Tumours (ENSAT 2010).[49-51]

According to size category, patients were divided in those with tumor size ≤60 (group 1) and tumor size >60 mm (group 2). Data on patient age, gender, hormone function, tumor side, operation time, rate of conversion to open procedures (because of technical difficulties or failure to progress with the dissection), postoperative complications, and rate of malignancy were analyzed. Furthermore, disease-free survival in malignant tumors was estimated and compared between both groups (see below).

Statistical analysis. Statistical analyzes were performed with a commercially available statistic software package (SPSS 18.0 for Windows; SPSS Inc, Chicago, IL).

The Pearson χ^2 test (Fisher's exact test, 2-tailed) was used for categorical variables and an unpaired t test was used for continuous variables. Survival was estimated for group 1 and 2 using Kaplan–Meier survival curves. All P values were calculated using 2-sided significance testing and the level of significance was set at $P \leq .05$.

RESULTS

The cohort consists of 186 female (64.4%) and 103 male (35.6%) patients leading to a female to male ratio of 1.5:1 with a mean age of 50.2 ± 13.6 years (range, 12–78; Table I). The preoperative biochemical work up and the histologic results showed 231 (79.9%) patients with functioning tumors, 36 (12.5%) patients had nonfunctioning adrenocortical tumors, 18 (6.2%) patients presented nonfunctioning nonadrenocortical tumors (detailed diagnosis is listed in Table II) and in 4 (1.4%) patients adrenalectomy was performed because of metastatic disease (metastasis of bronchus carcinoma, n = 2; melanoma, n = 1; colon carcinoma, n = 1). Overall, 252 (89.2%) patients had tumors ≤60 mm (group 1) and 37 (12.8%) patients tumors larger than 60 mm (group 2).

Table I. Patient demographics

	Total, n (%)	*Group 1 (≤60 mm)*, n (%)	*Group 2 (>60 mm)*, n (%)	P *value*
Number of patients	289 (100)	252 (87.2)	37 (12.8)	—
Gender				
Female	186 (64.4)	167 (66.3)	19 (51.4)	.097
Male	103 (35.6)	85 (33.7)	18 (48.6)	
Mean age (y)	50.2 ± 13.6	50.7 ± 13.8	49.5 ± 12.1	.43
Hormone functioning				
Functioning	231 (79.9)	214 (84.9)	17 (45.9)	.0001
Nonfunctioning	58 (20.1)	38 (15.1)	20 (54.1)	
Tumor side				
Left	147 (50.9)	126 (50.0)	21 (56.8)	.169
Right	120 (41.5)	104 (41.3)	16 (43.2)	
Bilateral	22 (7.6)	22 (8.7)	0	
Tumor size				
Radiologic	34.2 ± 23.6	28.8 ± 16.9	70.8 ± 30.1	.0001
Histologic	37.1 ± 25.8	29.7 ± 16.0	87.2 ± 24.1	
Mean operative time	167.2 ± 72.7	165.6 ± 72.6	181.3 ± 74.5	.33
Conversion to open approach	11 (3.8)	10 (4.1)	1 (2.7)	.707
Postoperative complication	8 (2.8)	6 (2.4)	2 (5.4)	.273
Adrenal malignancy	14* (4.9)	7 (2.8)	7 (18.9)	.0001
Locoregional/distant recurrence of malignancy	3 (21.4)	1 (14.3)	2 (28.6)	.485

*Four adrenal metastases are excluded.

Excluding 4 patients with adrenal metastasis, 10 patients revealed adrenocortical carcinoma and 4 presented with malignant pheochromocytoma. According to the UICC and ENSAT classifications, 5 patients were classified in stage I and 5 patients in stage II. Weiss score was classified as a 4 in 5 adrenocortical carcinomas and a 5 in 3 tumors; 1 tumor presented a Weiss score of 6 and another, 8. There is a lack of consensus on defining malignant pheochromocytoma. In 4 patients, malignant pheochromocytoma was diagnosed regarding capsular and blood vessel invasion by tumor and a high proliferation and necrosis rate of tumor cells. Nevertheless, the diagnosis of malignant pheochromocytoma in these patients must be concerned with caution thus none of these patients have developed locoregional recurrence or metastasis, yet.[52] Postoperative complications occurred in 8 (2.8%) patients.

Group 1: Patients with tumors ≤60 mm. This group consisted of 252 patients (87.2%) including 167 females (66.3%) and 85 males (33.7%) with a total of 274 adrenal lesions; their mean age was 50.7 ± 13.8 years (range, 12–78). Demographics are listed in Table I.

There were 214 patients (84.9%) who presented with functioning and 38 patients (15.1%) with nonfunctioning tumors. The mean tumor size at the radiologic examination measured 31.5 ± 14.7 mm (range, 0–60) compared with the size at pathologic examination (30.2 ± 14.8 mm; range, 0–80 mm; $P = .31$) in this group.

In 126 patients (50.0%), EA was performed on the left side and in 104 patients (41.3%) on the right side. Twenty-two patients (8.7%) underwent bilateral adrenalectomy (16 patients with corticotropin-dependent Cushing disease [multiple nodules <10 mm], 4 patients with bilateral pheochromocytomas [multiple endocrine neoplasia type 2A, $n = 3$; Von Hipple Lindau syndrome, $n = 1$]). One patient presented with sporadic bilateral cortisol-producing tumors and 1 patient had Carney syndrome.

The mean operation time was 165.6 ± 72.6 minutes (range, 40–440). The endoscopic procedure was successful in 242 patients (95.9%). In 10 patients (4.1%), the approach had to be converted because of 6 cases of bleeding, 2 cases of severe tumor adhesions to surrounding structures, 1 tumor rupture and in 1 patient inability of establishing pneumoperitoneum (corticotropin-dependent Cushing disease).

There was no perioperative mortality. Postoperative complications occurred in 6 patients (2.4%). Complications required operative management included 1 trocar site bleeding and 1 incisional hernia. A "delayed postoperative complication" occurred in 1 patient with splenic rupture on postoperative day 9. Postoperative complications without operative intervention were observed in 1 patient necessitating a blood transfusion, 1 patient

Table II. Functional and histopathologic diagnoses

Diagnoses	*Total,* n *(%)*	*Group 1 (≤60 mm),* n *(%)*	*Group 2 (>60 mm),* n *(%)*
Functioning tumors	231 (79.9)	214 (92.6)	17 (7.4)
Pheochromocytoma	78 (33.8)	68 (87.2)	10 (12.8)
Hyperaldosteronism	70 (30.3)	70 (100)	0 (0)
Cushing syndrome	66 (28.6)	60 (90.9)	6 (9.1)
Corticotrophin-dependent Cushing	16 (6.9)	16 (100)	0 (0)
Androgen producing	1 (0.4)	0 (0)	1 (100)
Nonfunctioning adrenocortical tumors	36 (12.5)	25 (69.4)	11 (30.6)
Nonfunctioning nonadrenocortical tumors	18 (6.2)	12 (66.7)	6 (33.3)
Myelolipoma	7 (38.9)	4 (57.1)	3 (42.9)
Ganglioneuroma	3 (16.7)	2 (66.7)	1 (33.3)
Adrenal gland hematoma	3 (16.7)	3 (100)	0 (0)
Adrenal cyst	2 (11.1)	1 (50)	1 (50)
Schwannoma	2 (11.1)	1 (50)	1 (50)
Lymphangioma	1 (5.5)	1 (100)	0 (0)
Metastases	4 (1.4)	1 (25)	3 (75)

with subcutaneous hematoma, and pneumonia (after bilateral adrenalectomy for corticotropin-dependent Cushing disease) in another patient.

Histologic examination revealed 8 malignant tumors, including 5 adrenocortical carcinoma in UICC/ENSAT stage I (3 patients with cortisol-producing tumors [25, 45, and 50 mm in diameter on radiologic examination; all 3 tumors had a Weiss score of 4], 2 patients with nonfunctioning adrenocortical carcinomas [25 mm, Weiss score of 4; and 40 mm, Weiss score of 5]) and 2 patients with malignant pheochromocytoma (55 and 60 mm) (Table III). None of these tumors were "suspected malignant" in preoperative imaging (as defined by heterogenous tumor with irregular margin on CT and lipid depletion on MRI). In contrast, 3 (1.2%) of 252 patients presented tumors with radiologic signs of possible malignancy in preoperative imaging without conformation in histologic examination. Metastasis of colon carcinoma was diagnosed in histologic examination in 1 patient.

The patient with a 25-mm, nonfunctioning adrenocortical carcinoma developed lymph node metastasis 6.2 months after the initial operation (Weiss score of 4). All other patients have been free of disease during a mean follow-up of 77.2 ± 44.5 months (range, 14–159). The estimated disease-free survival in malignant tumors after 5 years according to Kaplan–Meier survival for group 1 was 87.5 ± 11.7% (4 patients at risk; Figure).

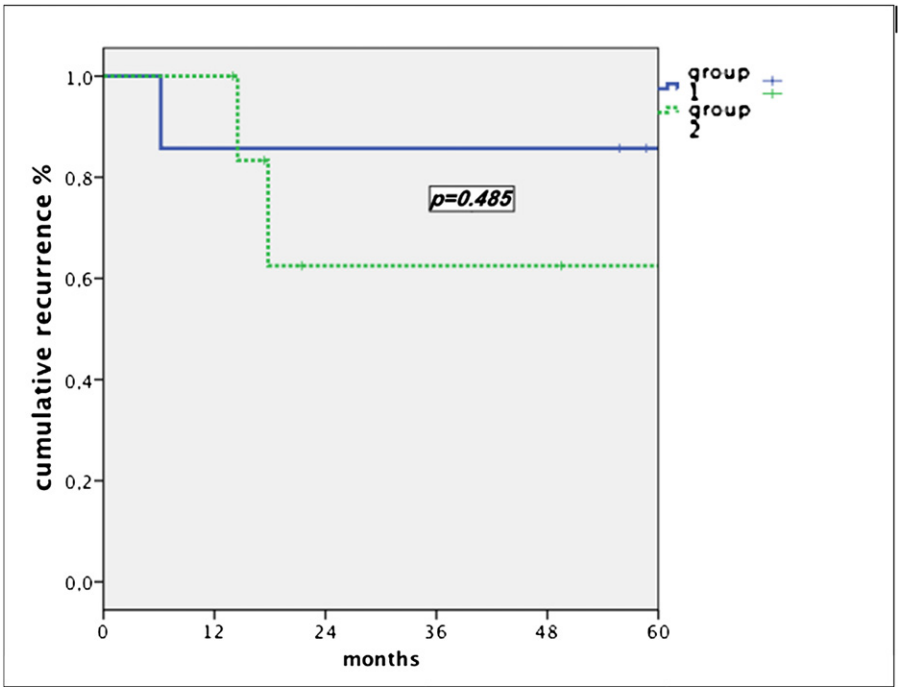
Group 2: Patients with tumors >60 mm. Out of 37 patients with a tumor size of >60 mm, there were 19 females (51.4%) and 18 males (48.6%) with a mean age of 49.5 ± 12.1 years (range, 27–71 years; Table I). Functional tumors were present in 17 patients (45.9%). The mean tumor size in radiologic imaging measured 70.8 ± 30.1 mm (range, 62–130). Radiologic tumor size was significantly smaller compared with histologic measurements 87.2 ± 24.1 mm (range, 40–150; $P = .03$). Twenty-seven patients presented benign adrenal tumors; in 22 (81%) of 27 patients, radiologic imaging underestimated the real tumor size measured by histologic measurements. In 3 patients, there was no difference between radiologic and histologic measurements and in 2 patients radiologic imaging showed larger tumor than its real size. In 6 (85%) of 7 patients with primary malignant tumors, radiologic measurements underestimated the histologic measurements of tumors; in 1 patient there was no difference. Three patients had metastasis of other origin in the adrenal gland, in 1 of them (33%) radiologic measurement showed smaller tumor diameter than the histologic measurements.

Twenty-one adrenal lesions (56.8%) were located on the left side and 16 lesions (43.2%) on the right side. The mean operation time was 181.3 ± 74.5 minutes (range, 65–300). In 1 of 37 patients, the approach had to be converted to an open procedure because of bleeding. There was no perioperative mortality and no tumor capsular rupture during tumor dissection. Delayed postoperative complication occurred in 1 patient on postoperative day 3 with colon perforation (most probably according to a lesion of colon serosa by the vascular sealing device during operation), which required reoperation. One patient showed postoperative subcapsular hematoma in left kidney without consequence.

Table III. Details and follow-up (recurrence, site, and time) of primary malignant tumors in groups 1 (≤60 mm) and 2 (>60 mm)

Group	*Patient no.*	*Endocrine status*	*Tumor size (mm)*	*Recurrence*	*Site of recurrence*	*Time to recurrence (mos)*
1	1	Non functioning	25	Yes	LN	6.2
	2	Non functioning	40	No	—	—
	3	Cushing syndrome	25	No	—	—
	4	Cushing syndrome	45	No	—	—
	5	Cushing syndrome	50	No	—	—
	6	Pheochromocytoma	55	No	—	—
	7	Pheochromocytoma	60	No	—	—
2	8	Non functioning	110	No	—	—
	9	Non functioning	150	No	—	—
	10	Cushing syndrome	92	No	—	—
	11	Cushing syndrome	120	Yes	LO/LI	17.8
	12	Cushing syndrome	140	Yes	LI	14.5
	13	Pheochromocytoma	70	No	—	—
	14	Pheochromocytoma	75	No	—	—

LI, Liver; *LN*, lymph node; *LO*, local recurrence.



Estimated recurrence after 5 years	DFS (%)	Patients at risk (n)
Group 1 (tumors ≤60mm)	87.5±11.7	4
Group 2 (tumors >60mm)	62.5±21.3	1

Figure. Estimated disease-free survival in malignant tumors in groups 1 and 2.

By definition, 2 patients with cortisol producing adrenocortical tumors (140 and 150 mm), 1 patient with pheochromocytoma (70 mm), and 1 patient with an androgen-producing tumor (90 mm) were "suspected malignant" in the preoperative radiologic imaging None of these tumors presented signs of invasion to the adjacent tissues or tumor thrombosis. Histologic examination confirmed malignancy in 3 tumors.

Overall, 10 malignant tumors were documented in this group (Table III). Five patients presented adrenocortical carcinoma in UICC/ENSAT stage II (3 patients with cortisol-producing tumors [92, 120, and 140], 2 patients with nonfunctioning

adrenal tumors [110 and 150 mm], and 2 patients with malignant pheochromocytoma [70 and 75]). Histopathologic examination revealed 3 adrenal metastases (bronchial carcinoma, $n = 2$; melanoma, $n = 1$).

Out of 7 patients with primary adrenal malignancy, 2 (28.6%) developed recurrence. One patient with a cortisol-producing tumor (120 mm; Weiss score of 6) showed local recurrence and liver metastasis 17.8 months after adrenalectomy and died 38.2 months after the operation. Another patient with a cortisol-producing malignant tumor (140 mm; Weiss score of 6) developed liver metastases 14.5 months after adrenalectomy and has still been in a stable disease under mitotane treatment. All other patients with malignant tumors have been free of disease during a follow-up of 34.3 ± 22.5 months (range, 11–75). The estimated disease-free survival after 5 years according to Kaplan–Meier survival for group 2 was 62.5 ± 21.3% (1 patient at risk). There was no statistical difference between the estimated disease-free survivals in both groups (log rank, $P = .485$; Figure).

DISCUSSION

Controversial data exist in the literature analyzing the role of EA in large adrenal tumors with potential malignancy.[19,30,31,53-57] Absolute contraindications for EA are described in tumors with peri-adrenal tissue invasion or venous tumor thrombus,[13] but there is no consensus regarding the maximum tumor size for EA because adrenal tumor size is a sensitive predictor for malignancy.[11]

The aim of this investigation was to evaluate the frequency of malignancy, oncologic outcome, perioperative morbidity, and long-term follow-up of EA in small (≤60 mm) and large (>60 mm) adrenal tumors.

To our knowledge, no randomized, prospective, controlled investigations comparing EA with open procedure have been conducted because of the rarity of malignant adrenal tumors, although the safety and efficacy of EA if performed by an experienced team is well documented in several studies.[4-7] According to the National Institutes of Health Consensus Development Program report,[16] adrenal cortical carcinoma account for 2% of tumors that are ≤40 mm, 6% of tumors that are 41–60 mm, and 25% of tumors >60 mm. Therefore, small tumor size does not guarantee that an adrenal tumor is benign and otherwise large size is not necessarily indicative of malignancy.

Bilimoria et al[58] reported a median tumor size of 130 mm (interquartile range, 80–290 mm) in 3982 patients diagnosed with adrenocortical cancer in The National Cancer Data Base. Belldegrun et al[24] found that 105 of the 114 (92.1%) adrenocortical carcinoma studied had tumor size >60 mm. He concluded that solid adrenal tumors >60 mm should be considered malignant until proven otherwise by exploration and adrenalectomy. Copeland[22] found 1 adrenocortical carcinoma for every 60 adrenalectomies performed for patients with adrenal tumors >60 mm. In contrast with these reports, Barnett et al[40] found 13.5% of adrenocortical carcinoma in tumors <50 mm.

The frequency of adrenal malignancy was clearly related to the size of the tumor in our series: 18.9% of tumors >60 mm in contrast with 2.8% malignancy in tumors ≤60 mm ($P = .0001$). On the other hand, 50% of primary malignant adrenal tumors had a tumor size of ≤60 mm and 81.1% of tumors >60 mm were classified as benign. Therefore, if size would be the criterion on which the operative approach should be based, 81% of benign large adrenal tumors would have an unnecessary open adrenalectomy, which might increase their morbidity. radiologic signs of malignancy were not justified for small tumors in group 1 and had a limited value in large tumors in group 2. Only 4 (28.6%) of 14 patients with malignancy in the final histopathologic result were "suspected malignant" on preoperative imaging.

Without taking into account the risk of malignancy, it has been demonstrated that in experience hands EA in large adrenal tumors is technically feasible and safe.[12,59]

As expected, demographic data in this series showed that age, gender, and tumor side did not differ between endoscopically treated patients with small or large adrenal tumors. The number of functioning tumors was significantly higher in the small tumor group compared with the large tumor group ($P = .0001$). Interestingly, preoperative radiologic imaging underestimated the size of tumors significantly comparing to the histologic measurements ($P = .0001$). One explanation could be that CT/MRI measure the transverse dimension of an adrenal lesion alone however the largest diameter of adrenal tumors may occur in oblique or craniocaudal dimensions. Another explanation could be the ligation of adrenal vein as the first step of operation and therefore venous blood accumulation in adrenal gland; this finding was also documented by other authors.[42,60]

Some authors suggest that patients with adrenal lesions >60 mm should not be treated endoscopically because of the longer operation time and higher complications[8-11]; in contrast with these findings, we could not observe longer operation time in

patients with larger tumor size (mean, 181.3 ± 74.5 minutes) compared with patients with smaller tumor size with a mean operation time of 165.6 ± 72.6 minutes (P = .33; bilateral adrenelectomies are excluded in this analysis), similar results according to operative time in large and small tumors was also reported by other investigators.[27,28,61]

Henry et al[61] added that large (benign) tumors involving the whole gland are sometimes easier to dissect from surrounding structures than small tumors, which require dissection of the gland itself.

The rate of complications did not differ significantly in both groups: 2.4% in group 1 and 5.4% in group 2 (P = .273). The total rate of complications (2.8%) is in accordance or even lower compared with the results of meta-analysis published by Brunt et al,[62] in which adrenalectomy related complication rate was reported with 10.9% in 1522 patients.

The role of oncologic outcome after EA in patients with malignancy is controversial. Whereas some authors[63] report a 100% rate of recurrence and peritoneal carcinomatosis according to laparoscopically treated malignant adrenal lesions, others see no difference in outcome in long-term follow-up.[27,31,34,64-69]

All 14 malignant tumors were staged UICC/ENSAT I and II. During the follow-up for primary malignant adrenal lesions (34.3 ± 22.5; range, 11–75 months) in this study, no patient showed port site metastasis. In 3 (21.4%) of 14 patients with primary adrenal malignancy, locoregional recurrence (n = 1), distant metastasis (n = 1), or both (n = 1) were observed. The estimated disease-free survival after 5 years was 87.5 ± 11.7% in group 1 (UICC and ENSAT stage I) and 62.5 ± 21.3% in group 2 (UICC and ENSAT stage II). There was no difference between the estimated disease-free survival between groups 1 and 2.

These data show the feasibility of EA for en bloc resection for even large tumors, which lack invasion to surrounding tissue even though the prevalence of malignancy is higher. When performing EA, the possibility of malignancy should be always considered. Avoiding tumor capsule rupture and radical resection including peri-adrenal fatty tissue is mandatory. Once encountering any difficulty in dissection, the laparoscopic procedure should be converted to an open procedure.

In conclusion, the present results demonstrate that EA is a safe and feasible procedure in the majority of large (>60 mm) adrenal tumors once local invasion is excluded. Tumor size does not affect the outcome of surgery and, in cases of malignancy, it does not increase the rate of local recurrence. The size of tumor should not influence the decision for an endoscopic or open procedure. Moreover, the choice of approach should depend on the surgeon's experience in endoscopic surgery.

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