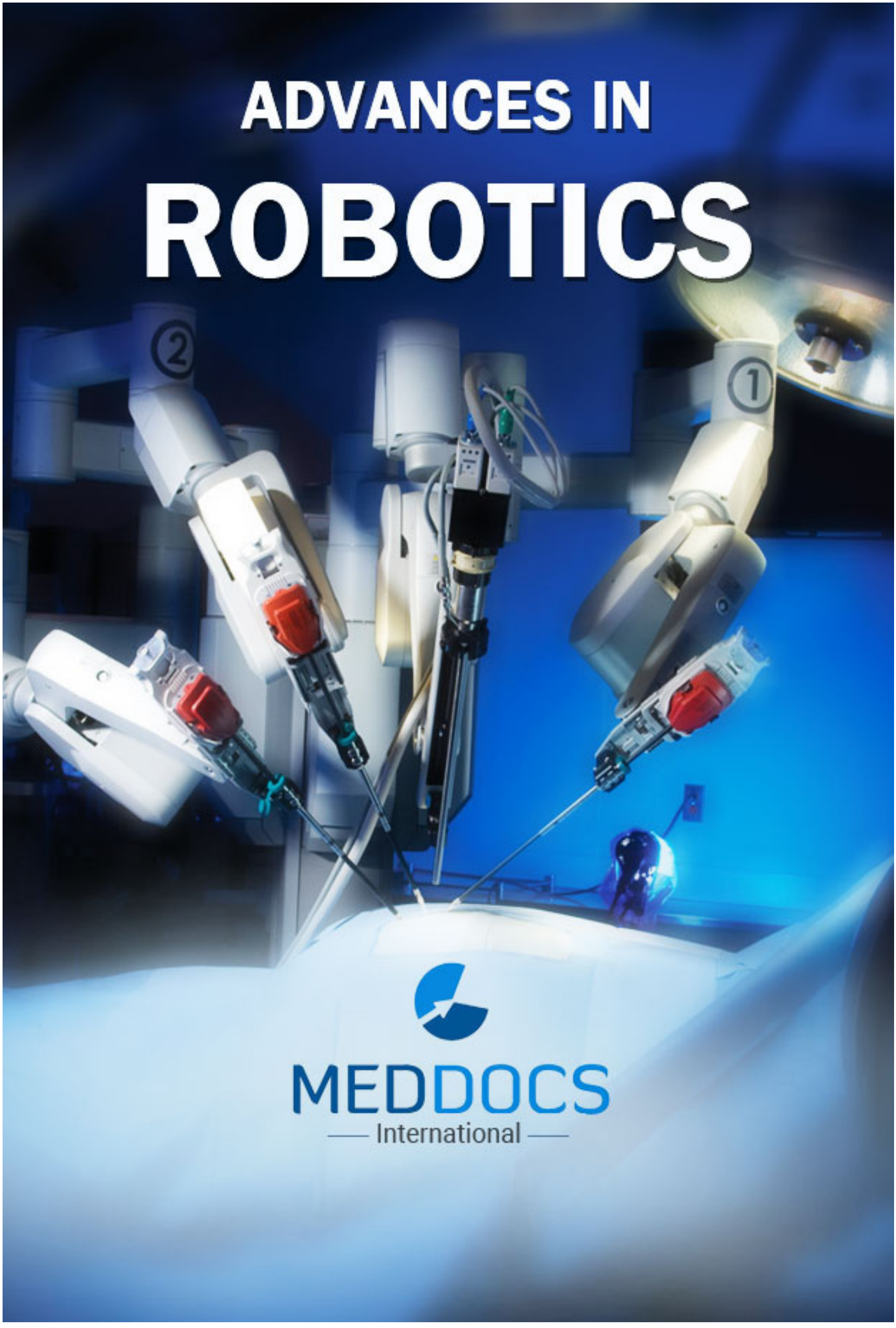
ADVANCES IN ROBOTICS



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The role of robotic assisted adrenalectomy in the minimally invasive era

Corresponding Author: Eugenia Yiannakopoulou

Department of Biomedical Sciences Faculty of Health Sciences, University of West Attica, Athens Greece.

Email: nyiannak@teiath.gr & nyiannak@uniwa.gr

Published Online: May 25, 2019

eBook: Advances in Robotics

Publisher: MedDocs Publishers LLC

Online edition: http://meddocsonline.org/

Keywords: Robotic assisted adrenalectomy; Surgical technique; Benign adrenal disease

Abstract

Minimally invasive endocrine surgery has well been established, with minimally invasive adrenalectomy having a central role in the treatment of adrenal pathology. Robotic assisted adrenalectomy has become an alternative to conventional laparoscopic adrenalectomy. Although, worldwide, experience on robotic assisted adrenalectomy remains still limited, there is. evidence suggesting that robotic assisted adrenalectomy is feasible and safe. However, the number of patients submitted to robotic assisted adrenalectomy is still limited with the majority of them being operated for benign disease. Robotic assisted adrenalectomy for malignant disease i.e adrenocortical carcinoma, oncocytoma or metastasis has been performed in a limited number of patients. Robotic partial adrenalectomy seems to be a promising approach especially for the treatment of hereditary and familial adrenal benign neoplasms. The advantages of robotic assisted adrenalectomy in the era of laparoscopic adrenalectomy have not been clearly delineated. A possible advantage could be that robotic assisted surgery elicits a mild surgical response instead of the well described surgical response, Surgical response affects surgical morbidity and mortality as well as oncological outcome of malignant disease. If this hypothesis is proved correct, robotic assisted adrenalectomy could be possibly indicated in the treatment of disease. In conclusion, robotic assisted adrenalectomy is feasible and safe. Further research is needed on the oncological outcome of this minimally invasive technique as well as on its effect on surgical stress response.

Introduction

Nowadays, laparoscopic adrenalectomy first described in 1992, is the gold standard procedure for the treatment of benign adrenal tumors as well as for the treatment of metabolic disorders of the adrenal gland. In comparison with open surgery, laparoscopic adrenalectomy offers the advantages of less blood loss, less pain, fewer days of hospital stay as well as faster return to work and standard way of living [1-12]. There is still debate on the role of minimally invasive adrenalectomy in the treatment of malignant disease [7-9]. Despite of the above mentioned advantages, experience in laparoscopic adrenalectomy remains still limited and the technique is performed in a few number of high volume hospitals worldwide, due to the drawbacks of the technique and the difficulties in technique training. Laparoscopic adrenalectomy is an advanced procedure of minimally invasive surgery and requires the development of certain skills as well as training in the standardized step by step technique. Given that virtual models of training in laparoscopic adrenalectomy are quite limited in conjunction with the relatively restricted number of patients, experience in laparoscopic adrenalectomy is difficult to be obtained by a great number of surgeons. Robotic assisted adrenalectomy, first described in 2000, is an alternative option to laparoscopic adrenalectomy, that offers the advantages of improved dexterity and visualization due to stereoscopic view, greater magnification and greater range of motion. This chapter will provide a critical presentation of the current knowledge on the role of robotic adrenalectomy in the era of minimally invasive surgery.

Surgical technique

Robotic assisted adrenalectomy can be performed by either transperitoneal or retroperitoneal approach [13]. There are a few non randomized studies comparing the two approaches.

Both of them have pros and cons. The choice of the approach largely depends on surgeon and center experience and preference.

The advantages of the transperitoneal approach include greater working space, better orientation through identification of anatomical landmarks and better visualisation of surrounding anatomical structures as well as greater versatility in the angles of approach of laparoscopic trocars and instruments. In the lateral approach, peritoneal contents fall medially to give greater surgical exposure. In the supine position, both adrenal glands can be accessed without the need for intraoperative repositioning. The main advantage of the posterior retroperitoneal approach is the avoidance of the peritoneal cavity. However, the main disadvantage of this approach is the limited working space, that increases the technical difficulties of the procedure.

Right robotic assisted lateral transabdominal adrenalectomy

Preoperative preparation, positioning of the patient, and creation of the port sites are performed following the same principles applied in the laparoscopic lateral transabdominal adrenalectomy. The patient is placed in the left lateral decubitus position. Four trocars are used. After creating pneumoperitoneum with the Verres needle, the first, 12-mm camera port, is placed midway between the umbilicus and the right costal margin. Through this first port, the robotic scope is inserted and the abdomen is carefully inspected to rule out any accidental injuries. Then the remaining ports are placed under vision. Two robotic instrument ports, both 8 mm, are placed along a line 2 fingerbreadths from the costal margin. A 10- mm liver retraction port is placed in the midline in the epigastrium. An accessory 10/12 mm auxiliary port is occasionally placed near the umbilicus.

The surgical steps are four, the same as in the laparoscopic right adrenalectomy and include (1) superomedial mobilization of the liver, (2) definition of the right adreno-caval junction, (3) division of the right adrenal vein and (4) dissection and removal of the adrenal gland circumferentially. At first, the procedure starts with laparoscopic exploration. Then the posterior peritoneum is incised high along the under surface of the liver. The triangular ligament as well as the anterior and posterior coronary ligaments are incised for the identification of the bare area of the liver. Vena cava is identified laterally and posteriorly to the gallbladder. Dissection proceeds laterally to medially until the identification of the lateral side of the inferior vena cava. The second portion of the duodenum is mobilized medially for the identification of the right kidney. The colon rarely needs significant mobilization in the case of right adrenalectomy. Dissection along the anterior wall of the vena cava in a cephalad direction will release the right lobe of the liver. Handling the robotic monopolar hook, the surgeon at the console precisely dissects the vena cava along its lateral edge between the inferior vena cava and the liver. Helpful landmarks that allow the surgeon to be oriented in the surgical field include superior pole of the right kidney laterally the and the psoas muscle posteriorly. In the next step, the right adrenal vein is isolated and divided between clips applied by the on-site assistant at the origin of the inferior cava vein. Special attention is needed for the unique anatomy of the right adrenal vein. The right adrenal vein inserts posteriorly and superiorly in the inferior vena cava necessitating meticulous dissection as bleeding may be difficult to be observed and controlled.

Then, the dissection of the periadrenal space is completed using the robotic hook as well as bipolar forceps that is introduced from the auxiliary trocar. The specimen is delivered in a specimen retrieval bag.

Left robotic assisted lateral transabdominal adrenalectomy

The patient is placed in the right lateral decubitus position for the performance of left robotic assisted lateral transabdominal adrenalectomy. Trocars are positioning following the mirror image of that applied in the case of right robotic assisted adrenalectomy as described above. The operative steps reproduce those of the laparoscopic technique and include:

1. the division of the spleno-colic and freno-lienal ligaments,

2. mobilization of the splenic flexure of the colon

3. medial rotation of the spleen and pancreas,

4. division of the left adrenal vein and

5. dissection and specimen extraction.

At first, the procedure starts with the exposure of the abdominal cavity and laparoscopic exploration. Then, the robotic hook diathermy is used for the division of the spleno-colic and freno-lienal ligaments. Following this, the splenic flexure of the colon is refracted downward, while the spleen and pancreas are rotated medially. Dissection continues into the periadrenal fat and the following landmarks are identified: laterally, the superior pole of the kidney; medially the tail of pancreas and the splenic vessels, posteriorly the psoas muscle. and inferiorly, the left renal vein; In the meantime, the robotic monopolar hook and the laparoscopic bipolar forceps that is introduced via the auxiliary trocar, are alternated for the achievement of hemostasis. After identification of the left adrenal vein, the vessel is divided between clips applied from the auxiliary trocar at the origin with the renal vein. Afterwards, dissection continues in the the adrenal space, and finally the specimen is captured in a specimen retrieval bag and delivered through the auxiliary port site.

Robotic assisted posterior retroperitoneoscopic adrenalectomy

The patient is placed in a pronejack knife position. An optical trocar is introduced inferior to the 12th rib through an incision of 1 cm. Then the trocar is replaced with a dissecting balloon under direct view to generate a space. A 12 mm long trocar is placed in this space and carbon dioxide insufflation at 15 mmHg is maintained. Carbon dioxide pressure can be increased at 20 mmHg, if there is a problem with exposure. Two 5mm trocars are introduced medially and laterally, as far away as possible from each other, attempting to prevent instrument collision. Laparoscopic ultrasound is used for the identification of the adrenal gland. Superior, lateral, and inferior dissections are performed. Then the medial aspect and the vascular pedicle are dissected. The adrenal vein is divided either with the Harmonic scalpel or with clips via the

medial port. The specimen is removed in a specimen retrieval bag.

Robotic assisted adrenalectomy in benign disease

The indications for robotic assisted adrenalectomy include benign adrenal disease, i.e

- non functioning adrenal adenoma
- benign pheochromocytoma
- aldosteronoma
- Cushing syndrome
- myelolipoma

Experience is still limited on the performance of robotic assisted adrenalectomy in pregnant patients and women. However, there are case reports of successful performance of robotic assisted adrenalectomy in these special populations. For example , an uneventful robotic left transabdominal adrenalectomy for a right-sided pheochromocytoma has been described in a pregnant patient during second trimester of pregnancy [24]. In addition, robotic assisted radical adrenalectomy and lymph node dissection has been reported in a 15 month old infant.

Robotic assisted adrenalectomy in malignant disease

Although the role of robotic assisted adrenalectomy in malignant disease, is not clearly defined, there are also case reports of robotic assisted adrenalectomy performed for adrenal carcinoma, oncocytoma and adrenal metastasis [21,27]. Recently, a case report of robotic assisted thoracoscopic trandiaphragmatic adrenalectomy for metastatic renal cell carcinoma has been reported. In published case series of robotic assisted adrenalectomy, the number of patients being operated for malignant disease is quite limited. For expamle, D'Annibale et al. [14] in a series of 30 patients being submitted to robotic assisted adrenalectomy, reported three patients treated for metastasis, one from lung cancer and two from colorectal carcinoma. There was one cancer related death 37 months after the operation, while the other patients were alive with systematic disease at 8 and 29 months after the operation [14].

Intraoperative and postoperative complications complications

Robotic assisted adrenalectomy is safe in well experienced centers and surgeons. In a number of published case series, intraoperative and post-operative complications of the technique have been reported. In a series of 100 patients, Brunaud et al. [17], have reported three Clavien grade I complications including two patients presenting with wound infections, one case of facial edema and seven grade II complications including three patients presenting with pneumonia, two patients presenting with urinary tract infection, one case of postoperative anemia and one case of hematoma [17]. In another series of 100 patients, Nordenstrom et al. [15] reported that thirteen patients had at least one perioperative complication Clavien grade II, including bleeding in four patients, tachycardia in two patients, postoperative adrenal insufficiency in two patients, emphysema in one patient, confusion in one patient, hypotension in one patient, placement of urinary catheter in one patient, fever in one patient [15]. One case of capsular disruption in a patient with a 6 cm pheochromocytoma and one case of Clostridium difficile diarrhea were reported by Giullianotti et al. [16] in their series of 40 patients. Furthermore, a death due to myocardial infarction was reported in a patient treated for pheochromocytoma [16]. D'Annibale et al. [14] in a series of 30 patients have reported two intraoperative complications, one capsular distortion of a large right adrenal mass and marked arterial instability in patient with left pheochromocytoma. In addition, the authors have reported three postoperative complications, one case of abdominal hematoma, one case of pneumonia and one case of myocardial infarction [14]. Winter et al, in a series of 30 patients reported no intraoperative complication and two postoperative complications including one patient suffering from prolonged postoperative ileus; another patient suffering from a brief

episode of hypoxemia that was likely due to a combination of bronchitis and atelectasis.

Robotic assisted partial adrenalectomy

Partial adrenalectomy has been suggested for patients with functioning and non functioning benign adrenal tumors especially in the case of hereditary syndromes, like multiple endocrine neoplasia type 2, Von Hippel–Lindau disease and neurofibromatosis type I. Especially in patients with von Hippel Lindau multiple bilateral adrenal pheochromocytomas can develop.

Minimally invasive partial adrenalectomy is a therapeutic option especially in patients with heritable pheochromocytoma, given that tumors are often bilateral, tumors are commonly benign and severe morbidity and mortality may be associated with life-long steroid replacement therapy such as the possibly lethal Addisonian crisis . However, data are limited, follow up is not standardized and not appropriately reported and randomized controlled trials are difficult to be done due to the rarity of the disease. Current knowledge on robotic assisted adrenalectomy is derived from reported case series and case reports.

The first robot-assisted partial adrenalectomy has been reported by Julien et al. [44] in a patient with von Hippel-Lindau (VHL) disease treated for pheochromocytoma. Asher et al. [41] have published a series of 12 patients undergoing 15 cases of robotic partial adrenalectomy procedures for pheochromocytoma. Ten of the patients had VHL disease, one patient had neurofibromatosis type 1, and the other had bilateral pheochromocytomas without a known genetic disorder. There was one conversion to open partial adrenalectomy due to severe adhesions to the liver and repeated vena cava injuries. There was one Clavien grade 3 complication, one bile leak that required a temporary drain for 5 days. During a follow-up of 17.5 months, there were no recurrences and one patient required steroid supplementation [41]. Mannie et al. [40]. have reported a case series of three patients treated with robotic partial adrenalectomy for pheochromocytoma, lipoadenoma and follicular lymphoid hyperplasia [40]. In addition one case report of a pediatric patient with VHL treated with robotic partial adrenalectomy for pheochromocytoma has been published [43]. Kumar et al. [42] have published a case of robotic partial adrenalectomy for renal cell carcinoma adrenal metastasis in a patient previously treated with contralateral adrenalectomy for metastasis [42].

Drawbacks of the technique

Training in robotic assisted adrenalectomy as well as in robotic partial adrenalectomy is not well standardized. Both techniques demand thorough knowledge of anatomy and special skills that are difficult to be taught in the operating room. In addition the number of operations performed is not that large especially in hospitals that are not reference centers. In small countries reference centers in adrenal disease are difficult to be organized due to the limited number of patients. Thus, alternative methods of training are needed. Virtual reality simulators could be a useful alternative model for the shortness of the learning curve.

The cost of robotic assisted surgery is another issue, that could be balanced if morbidity of the procedure is proved to

be lower than the morbidity associated with the laparoscopic adrenalectomy as well as if duration of hospitalization could be shorter in comparison with laparoscopic adrenalectomy. However, at the moment, the advantages of the technique in relation to laparoscopic adrenalectomy have not been proved.

Conclusion

Robotic assisted adrenalectomy is feasible and safe. It is an alternative minimally invasive option for the treatment of benign adrenal disease. Further research is needed for defining the role of this approach in malignant disease as well as for delineating the possible advantages and limitations of the approach in comparison with the conventional laparoscopic adrenalectomy.

References

1. Conzo G, Musella M, Corcione F, De Palma M, Avenia N, et al. Santini, Laparoscopic treatment of pheochromocytomas smaller or larger than 6 cm A clinical retrospective study on 44 patients. Laparoscopic adrenalectomy for pheochromocytoma. Ann Ital Chir. 2012; 13: 417-422.
2. Toniato A, Boschin IM, Opocher G, Guolo A, Pelizzo M, et al. Is the laparoscopic adrenalectomy for pheochromocytoma the best treatment? Surgery. 2007; 13: 723-727.
3. Shen WT, Grogan R, Vriens M, Clark OH, Duh QY. One hundred two patients with pheochromocytoma treated at a single institution since the introduction of laparoscopic adrenalectomy. Arch Surg. 2010; 13: 893-897.
4. Bittner JGIV, Gershuni VM, Matthews BD, Moley JF, Brunt LM. Risk factors affecting operative approach, conversion, and morbidity for adrenalectomy: a single-institution series of 402 patients. Surg Endosc. 2013; 13: 2342-2350.
5. Sharma R, Ganpule A, Veeramani M, Sabnis RB, Desai M. Laparoscopic management of adrenal lesions larger than 5 cm in diameter. Urol J. 2009; 13: 254-259.
6. Conzo G, Pasquali D, Della Pietra C, Napolitano S, Esposito D, et al. Laparoscopic adrenal surgery: ten-year experience in a single institution. BMC Surg. 2013; 13.
7. Prager G, Heinz-Peer G, Passler C, Kaczirek K, Scheuba C, et al. Applicability of laparoscopic adrenalectomy in a prospective study in 150 consecutive patients. Arch Surg. 2004; 13: 46-49.
8. Lombardi CP, Raffaelli M, De Crea C, Boniardi M, De Toma G, et al. Open versus endoscopic adrenalectomy in the treatment of localized (stage I/II) adrenocortical carcinoma: results of a multiinstitutional Italian survey. Surgery. 2012; 13: 1158-1164.
9. Lombardi CP, Raffaelli M, Boniardi M, De Toma G, Marzano LA, et al. Adrenocortical carcinoma: effect of hospital volume on patient outcome. Langenbecks Arch Surg. 2012; 13: 201-207.
10. Pedulla G, Crocetti D, Paliotta A, Tarallo MR, De Gori A, et al. Surgical treatment of pheochromocytoma in MEN 2. Ann Ital Chir. 2014; 85.
11. Walther MM, Herring J, Choyke PL, Linehan WM. Laparoscopic partial adrenalectomy in patients with hereditary forms of pheochromocytoma. J Urol. 2000; 164: 14-17.
12. Walz MK. Adrenalectomy for preservation of adrenocortical function. Indic Results Chir. 2009; 80: 99-104.
13. Yiannakopoulou E. Robotic assisted adrenalectomy: Surgical techniques, feasibility, indications, oncological outcome and safety. nt J Surg. 2016; 28:169-172.
14. D'Annibale A, Lucandri G, Monsellato I, De Angelis M, Pernazza G, et al. Robotic adrenalectomy: technical aspects, early results and learning curve. Int J Med Robot. 2012; 8: 483-490.
15. Nordenstr€om E, Westerdahl J, Hallgrimsson P, Bergenfelz A. A prospective study of 100 robotically assisted laparoscopic adrenalectomies. J Robot Surg. 2011; 5: 127-131.
16. Guillianotti PC, Buchs NC, Addeo P, Bianco FM, Ayloo SM, et al. Robot assisted adrenalectomy: a technical option for the surgeon? Int J Med Robot Comput Assist Surg. 2011; 7: 27-32.
17. Brunaud L, Ayav A, Zarnegar R, Rouers A, Klein M, et al. Prospective evaluation of 100 robotic-assisted unilateral adrenalectomies. Surgery. 2008; 144: 995-1001.
18. Winter JM, Talamini MA, Stanfield CL, Chang DC, Hundt JD, et al. Thirty robotic adrenalectomies: a single institution's experience. Surg Endosc. 2006; 20: 119-124.
19. Hanly EJ, Talamini MA. Robotic abdominal surgery. Am J Surg. 2004; 188: 19-26.
20. Raman SR, Shakov E, Carnevale N, Yiengpruksawan A. Robotic adrenalectomy by an open surgeon: are outcomes different? J. Robot. Surg. 2012: 6; 207-212.
21. Alguraan Z, Agcaoglu O, Aliyev S, Berber E, A rare case of merkel cell carcinoma metastasis to the adrenal resected robotically, Surg. Laparosc. Endosc. Percutan Tech. 2013; 23.
22 Podolsky ER, Feo L, Brooks AD, Castellanos A, Robotic resection of pheochromocytoma in the second trimester of pregnancy, JSLS.2010; 14: 303-308.
23. Zafar SS, Abaz R, Robot-assisted laparoscopic adrenalectomy for adrenocortical carcinoma: initial report and review of the literature, J. Endourol. 2008; 22: 985-989.
24. Horgan S, Vanuno D, Robots in laparoscopic surgery, J. Laparoendosc. Adv. Surg. Tech. 2001; 11: 415-419.
25. Ludwig AT, Wagner KR, Lowry PS, Papaconstantinou HT, Lairmore TC, Robot-assisted posterior retroperitoneoscopic adrenalectomy, J. Endourol. 2010; 24: 1307-1314.
26. Manny TB, Pompeo AS, Hemal AK, Robotic partial adrenalectomy using indocyanine green dye with near-infrared imaging: the initial clinical experience, Urology. 2013; 82: 738-742.
27. Asher KP, Gupta GNH, Boris RS, Pinto PA, Linehan WM, Bratslavsky G, Robot-assisted laparoscopic partial adrenalectomy for pheochromocytoma: the National Cancer Institute technique, Eur. Urol. 201; 60; 118-124.
28. Kumar A, Hyams ES, Stifelman, Robot-assisted partial adrenalectomy for isolated adrenal metastasis, J. Endourol. 2009; 23; 651-654.
29. Rogers CG, Blatt AM, Miles GE, Linehan WM, Pinto PA. Concurrent robotic partial adrenalectomy and extra-adrenal pheochromocytoma resection in a pediatric patient with von Hippel-Lindau disease, J. Endourol. 2008; 22; 1501-1503.
30. St Julien J, Ball D, Schulick R, Robot-assisted cortical-sparing adrenalectomy in a patient with Von Hippel-Lindau disease and bilateral pheochromocytomas separated by 9 years, J. Laparoendosc. Adv. Surg. Tech. 2006; 16: 473-477.
31. You JY, Lee HY, Son GS, Lee JB, Bae JW, et al, Comparison of robotic adrenalectomy with traditional laparoscopic adrenalectomy with a lateral transperitoneal approach: a single-surgeon experience, Int. J. Med. Robot. 2013; 9: 345-350.
32. Wu JC, Wu HS, Lin MS, Chou da, Huang mh, Comparison of robot assisted laparoscopic adrenalectomy with traditional laparo-

scopic adrenalectomy- 1 year follow-up, Surg. Endosc. 2008; 22: 463-466.

33. Morino m, Beninca G, Giraudo G, Del Genio GM, Rebecchi F, Garrone C. Robot-assisted vs laparoscopic adrenalectomy: a prospective randomized controlled trial, Surg. Endosc. 2004; 18: 1742-1746.

34. Karabulut K, Agcaoglu O, Aliyev S, Siperstein A, Berber E. Comparison of intraoperative time use and perioperative outcomes for robotic versus laparoscopic adrenalectomy, Surgery. 2012; 151; 537-542.

35. Agcaoglu O, Aliyev S, Karabulut K, Siperstein A, Berber E. Robotic vs laparoscopic posterior retroperitoneal adrenalectomy, Arch. Surg. 2012; 147; 272-275.

36. Raffaelli M, Brunaud L, De Crea C, Hoche G, Oragano L, et al. Synchronous bilateral adrenalectomy for Cushing's syndrome: laparoscopic versus posterior retroperitoneoscopic versus robotic approach, World J. Surg. 2014; 38; 709-715.