

# Robotic Resection of Pheochromocytoma in the Second Trimester of Pregnancy

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## ABSTRACT

Pheochromocytoma is a rare neuroendocrine tumor diagnosed in 1:50 000 pregnancies. Normal physiologic changes associated with pregnancy often make early recognition difficult and diagnosis delayed. Treatment consists of medical followed by surgical intervention. This case of a 34-year-old African American female diagnosed with an adrenal pheochromocytoma during her second trimester of pregnancy is the first reported case of successful robotic resection. The robot provided advantages, such as enhanced visualization and freedom of dissection, within this confined space. These added benefits over traditional laparoscopy provide a means for performing difficult procedures within a decreased space possibly allowing for interventions in later or larger pregnancies.

**Key Words:** Pheochromocytoma, Pregnancy, da Vinci robot.

## INTRODUCTION

Pheochromocytoma is a rare tumor. When present, definitive treatment depends on surgical resection after adequate preoperative blood pressure control. Diagnosis during pregnancy poses unique issues in both timing and method of removal. Ideal timing for surgery is during the second trimester. At this point, organogenesis is complete, risk of miscarriage is low, and the uterus is still small enough to permit adequate visualization.<sup>1</sup> Laparoscopic removal is the most common method of resection, with robotic surgery reports emerging in the literature.<sup>2-4</sup> Robotic surgery has been applied to gynecology proving to be a feasible and successful preferred alternative to laparoscopy for complex operations.<sup>5</sup> We present the first case of robotic resection of pheochromocytoma during the second trimester of pregnancy. The robot offers unique advantages over laparoscopy in this situation. In this already complex case, the robot provides better visualization and facilitates easier dissection in a smaller operative space.

## CASE REPORT

A 34-year-old African American female (G1P0) with a history of appendectomy at 10 years of age and uncontrolled hypertension presented to an outpatient clinic complaining of headache and palpitations. One year earlier, she presented to a primary care physician with headaches and hypertension. At that time, she underwent an abdominal computed tomography (CT) which revealed a right adrenal mass. She was started on labetalol and hydrochlorothiazide and refused further evaluation or follow-up. On presentation to the clinic, she had not been taking any medications and was hypertensive (170-180/110-120). Unbeknownst to the patient, she was also found to be pregnant, at approximately 21 weeks gestation. An ultrasound was done at the clinic which revealed a normal fetal evaluation and a right adrenal mass approximately 5 cm in diameter. With a high suspicion of a catecholamine-producing tumor, blood screening and 24-urine collection was performed. The diagnosis of a pheochromocytoma was confirmed by concentrations of norepinephrine measuring 6109 pg/mL (reference range, 112 to 658) present in the blood with normal values of epinephrine and do-

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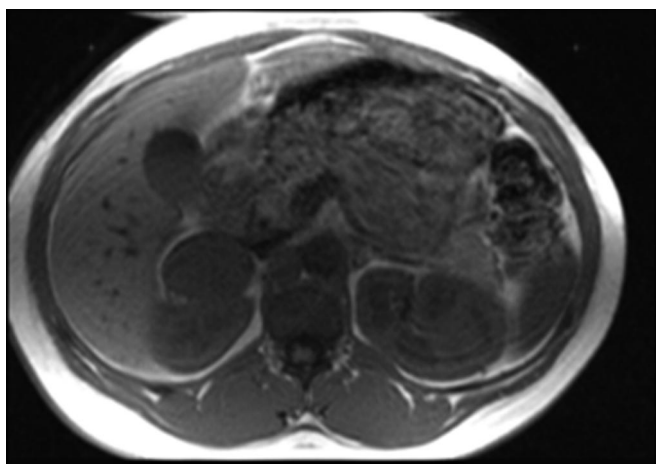
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pamine. The urine normetanephrine level was 8776 mcg/24h (reference range, 35 to 482). An MRI was also performed showing increased signal, T2 weighed, with a right adrenal tumor measuring 5 x 4 x 3.7 cm (**Figure 1**). No additional tumors were visualized.

The patient was transferred to a high-risk pregnancy clinic. Phenoxybenzamine, the nonselective  $\alpha$  (alpha) blocker, 20 mg 4 times a day was started. Labetalol 100mg 3 times a day was added as well. After 10 days of monitoring in the hospital, the patient was taken to the operating room. Normotensive blood pressure goals (120-130/70-80 mm Hg) were achieved after medication with an average blood pressure of 125-130/75-80 mm Hg preoperatively.

### Surgical Technique

A robotic-assisted laparoscopic adrenalectomy was performed via transperitoneal endoscopic access with the patient under general anesthesia. The patient was placed in the left lateral decubitus position with the da Vinci Robotic System to her right. (Intuitive Surgical, Inc.) Five trocars were placed. A 12-mm trocar was placed 7 cm below the subcostal margin with anterior axillary line under direct visualization. Through this port, pneumoperitoneum was created. The abdominal cavity was inspected with no evidence of additional masses. The 21-week gravid uterus was visualized with no sign of abnormality (**Figure 2**). A 5-mm trocar was then placed in the subxiphoid region for retraction of the left lateral segment of the liver. Two 8-mm trocars were placed, one 7 cm below the subcostal margin in the midaxillary line and the second 4cm below the subcostal margin in the midclavicular line. Finally, a 5-mm assistant trocar was placed in the left



**Figure 1.** Right adrenal tumor magnetic resonance.

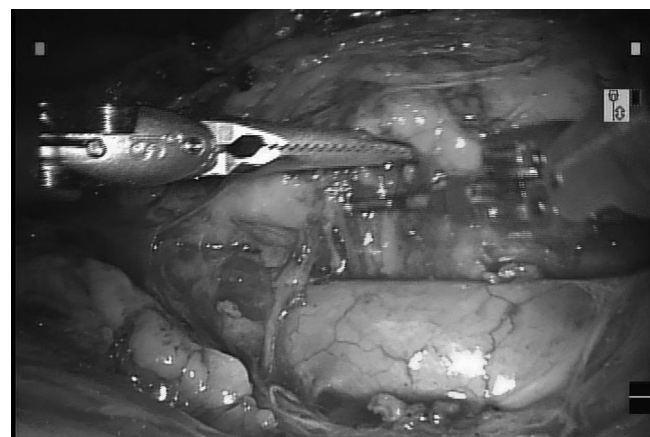
upper quadrant. The da Vinci Robotic System was then attached to the trocars.

The left lateral segment of the liver was retracted allowing division of the triangular ligament to facilitate tumor exposure. The retroperitoneum was dissected along the inferior edge of the liver until the mass was visible. The duodenum was then mobilized, exposing the mass and inferior vena cava (IVC) (**Figure 3**).

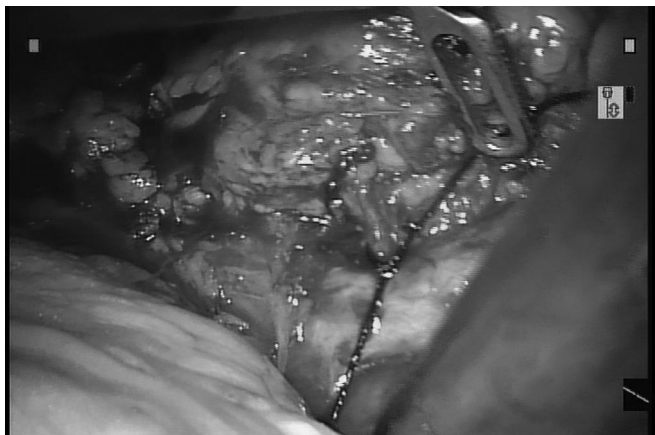
The adrenal vein was identified by dissecting along the medial aspect of the mass taking down small tributaries of the IVC with a combination of the Harmonic scalpel and suture ligation (**Figure 4**). Next, careful medial to lateral dissection of the tumor from the IVC and mobilization off the inferior pole of the kidney was performed. Finally, the upper pole of the mass occupying the retrohepatic space was dissected. During this dissection, an abnormal anatomical variation of the adrenal vein was found. A vascular



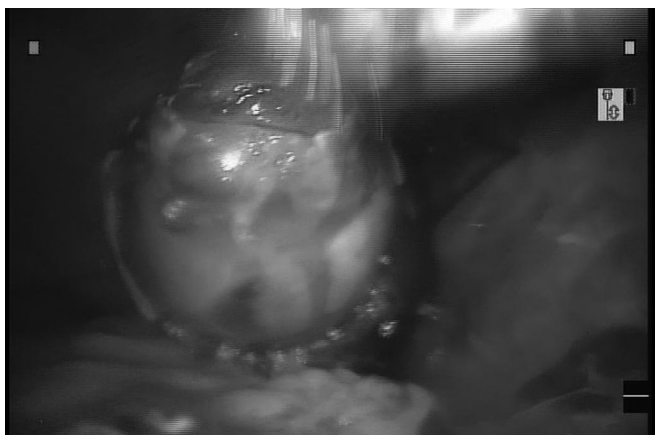
**Figure 2.** Uterus.



**Figure 3.** Medial dissection of mass from inferior vena cava.



**Figure 4.** Suture ligation of right adrenal vein.



**Figure 5.** Dissected mass.

stapler was used accomplishing complete tumor mobilization (**Figure 5**). The tumor was extracted through the 12-mm trocar.

## RESULTS

During the procedure, blood pressure was controlled with consistent values between 120-130/80 mm Hg and a heart rate of 85 to 95 beats per minute. Operative time was 270 minutes. The estimated blood loss was 350 mL. Blood gases were monitored via arterial line, ensuring acceptable carbon dioxide levels. The patient was extubated upon completion of the surgery without difficulty. Pathologic examination reported histological features compatible with benign pheochromocytoma of 5.3 x 4.2 x 3.7 cm (**Figure 6**).

The postoperative course was uneventful. The patient was ambulatory on the night of surgery reporting minimal



**Figure 6.** Dissected mass.

pain. Her diet was advanced beginning postoperative day number one. A fetal ultrasound was performed reassuring the presence of a healthy fetus. The patient was discharged on postoperative day 4. Postoperative follow-up at days 5, 30, and 60 were uneventful. Her blood pressure and heart rate were within normal limits, and the patient remained symptom free.

The patient was followed at the outpatient obstetrics clinic after discharge. All fetal ultrasounds were normal along with normal blood pressure readings. Induction at 39 weeks for oligohydramnios failed and a cesarean delivery was performed. A healthy baby boy was delivered without complication. One month postpartum, the patient's blood pressure remained stable without medication.

## DISCUSSION

Pheochromocytoma is a rare neuroendocrine tumor, affecting 0.2% of hypertensive individuals. These tumors most commonly arise from neuroectodermal chromaffin cells in the adrenal glands. Production of catecholamines and vasoactive peptides results in hypertension, headaches, and palpitations. Diagnosis is confirmed by elevated plasma and urine catecholamine levels along with radiologic tumor identification by CT or MRI. Although definitive treatment is surgical, blood pressure control with alpha- followed by beta-blockade must be achieved preoperatively.

Rarely, this uncommon tumor presents in pregnancy,

further complicating diagnosis and treatment. Although pheochromocytoma occurs only once in 50 000 pregnancies, it carries a high risk of fetal and maternal morbidity and mortality. Early recognition is crucial but often difficult, because presenting symptoms may vary from minor hypertension to cardiovascular collapse. Delayed diagnosis significantly increases undesired outcomes. Fortunately, increased suspicion, utility of screening laboratory tests, and prompt initiation of treatment has decreased maternal mortality from 46% to 4% and fetal mortality from 55% to 15% over the last 15 years.<sup>6</sup>

Biochemical diagnosis is the same as in nonpregnant patients. MRI is the preferred modality of choice for tumor localization, avoiding ionizing radiation to the fetus. Initial treatment is to control the blood pressure, first with alpha-blockers, such as phenoxybenzamine. Preoperative beta-blockade preferably with a selective beta-1 antagonist is initiated several days before surgery.

Timing of surgical resection is controversial. Maternal morbidity increases with progression of the pregnancy as uterine position and/or contraction, or fetal movement results in abrupt catecholamine release provoking lethal consequences, such as myocardial infarction or cerebral hemorrhage. The placenta metabolizes maternal catecholamines, protecting the fetus. Fetal demise results from uncontrolled hypertension, not directly from catecholamine surges.<sup>7</sup> If diagnosed early in the first trimester, termination should be offered. Late first trimester or early second trimester resection may be ideal. Diagnosis in the late second trimester or third trimester may require delay in resection until fetal lung maturity is attained, often combining cesarean delivery and resection.

Pregnancy was previously a contraindication to laparoscopy. The already present physiologic changes were thought to be increased by the pneumoperitoneum. Increased abdominal tension could compress the vena cava further reducing flow. Additionally, there was concern regarding the effect of the carbon dioxide on the developing fetus. Safe entry into the abdominal cavity was also a concern due to the displacement of anatomy by the gravid uterus.

Fortunately, it was realized that the known advantages of laparoscopic surgery may be expanded to this high-risk population.<sup>8</sup> Faster recovery results in earlier ambulation, decreasing the risk of thromboembolism in this hypercoagulable group of patients. Return of gastrointestinal function is also more rapid than with an open procedure. Decreased narcotic requirements limit potentially damaging effects on the developing fetus. Small incisions de-

crease the potential for herniation with the increased pressure of the uterus. Laparoscopy also offers enhanced visualization without manipulating the uterus, resulting in decreased incidence of preterm labor.

Case reports and series of laparoscopic appendectomy and cholecystectomy proved the minimally invasive approach to be a viable alternative during pregnancy.<sup>9,10</sup> From the collective reviews of these reports, SAGES published guidelines for laparoscopy in pregnancy. The first trimester should be avoided as organogenesis is incomplete and miscarriage is likely. The third trimester is often too late for intervention. By this point, the gravid uterus precludes adequate visualization. Attempts of insufflation may stimulate premature contractions resulting in premature labor before fetal lung maturity is complete. The second trimester is recommended as the ideal time for surgical intervention.<sup>11</sup> Spontaneous miscarriage rates decrease from approximately 15% in the first trimester to approximately 0% in the second trimester with a 5% risk of preterm labor.<sup>12</sup> Medical therapy should be initiated at least 10 days before surgery to obtain normal blood pressure values and adequate volume reconstitution.<sup>12</sup> The optimal surgical candidate should have a supine arterial pressure <160/90 mm Hg, orthostatic hypotension not exceeding 80/45 mm Hg, and an electrocardiogram free of ST-segment, T-wave changes for at least 2 weeks with no more than one premature ventricular contraction every 5 minutes.<sup>11</sup>

Immediate preoperative preparation should focus on maximal abdominal decompression and visualization. A nasogastric tube and Foley catheter are placed. The patient ideally should be positioned in the left lateral decubitus position. This position can increase maternal cardiac output by up to 20% and maximize blood flow to the uterus and placenta.<sup>13</sup> The first trocar should be placed in the left upper quadrant or subxiphoid area under direct visualization. After insufflation and inspection of the abdominal cavity, subsequent trocars may be placed. Pneumoperitoneum should be maintained at a decreased pressure of 10 mm Hg to 12 mm Hg. Continuous monitoring for acidosis is also recommended.

The first successful report of laparoscopic adrenalectomy for pheochromocytoma in pregnancy was published in 1999.<sup>14</sup> Laparoscopic techniques for this type of tumor are known to be technically demanding, because these tumors are well vascularized.<sup>15</sup> Although laparoscopic resection has become the preferred method of removal, reports of robotic adrenalectomy have emerged. In a prospective study of 109 patients, robotic adrenalectomy re-

sulted in lower blood loss than the laparoscopic cases.<sup>2</sup> After an initial learning curve, operative times were comparable between the 2 groups. With comparable results, robotic resection proved to be an available method of removal. Robotic surgery has been proven feasible in gynecologic oncology proving better initial outcomes in complex operations than with laparoscopy.<sup>5</sup>

We present the first report of robotic resection of pheochromocytoma in pregnancy. The robot offers advantages including a 3-dimensional view, accurate and precise dissection, and enhanced freedom of motion within reduced space.<sup>3,4,16</sup> Visualization is steady and allows depth perception that is lacking in traditional laparoscopy. Additionally, this technology provides adaptive downscaling of the surgeon's movement, eliminating tremor. Intraabdominal articulation provides safer and more efficient dissection. The degrees of freedom of each instrument permit virtually every angle desired for retraction, dissection, and resection. Optimal visualization and manipulation coupled with a more ergonomic operation provide a safe and comfortable option for this difficult case. These benefits outweigh any disadvantages of using the robot. Cost is always of concern as the initial price of the robotic system is high. With every subsequent use, the cost of the individual procedure decreases. The system is not amenable to use for every surgical procedure due to its size and time-consuming setup. Rare cases such as this one justify these disadvantages.

This case also demonstrates the potential to push the current recommendations for surgery during pregnancy. Current guidelines state the second trimester is ideal. Once the third trimester is reached, the uterus is too large to permit adequate visualization and room for dissection. These recommendations are for laparoscopic procedures. The robot provides superior 3-dimensional visualization and articulating instruments for dissection. This allows performing the operation within a smaller space under decreased pneumoperitoneum. This offers a unique advantage in this population. Using minimal insufflation decreases intraabdominal pressure maximizing blood flow to the uterus. Additionally, these advantages provided by the robot may enable later interventions. Third trimester procedures may be possible using the robot.

## CONCLUSION

Robotic resection of pheochromocytoma during pregnancy has not previously been reported. This case has proved that the da Vinci Robotic System is a feasible and safe procedure in the pregnant patient, providing unique

advantages in this difficult operation. It is important to individualize surgical timing based in the features previously described. Based on this, pregnant patients within the second trimester are the best candidates due to the low risk for maternal-fetal death during this period compared with the first or third trimester.

Finally, these cases should be treated by multidisciplinary teams to achieve the best outcome and minimize the probabilities of complications. The da Vinci robotic-assisted laparoscopic procedure plays an invaluable role in the achievement of this goal in the surgical field.

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