# Robot-Assisted Resection of a Presacral Schwannoma: A Technical Note

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## ABSTRACT

Since the introduction of da Vinci robotic system in the 1990s, robot-assisted techniques have been applied to a wide variety of surgical specialties such as urology, obstetrics and gynecology, cardiac surgery, head and neck surgery, and more recently, spine surgery. Here we describe a technical description of the clinical application of robotic surgery to a 22-year-old female with a 7 x 6.2 x 5.8 cm presacral schwannoma originating from the right S2 neural foramen as well as a review of the treatment of presacral tumors and the current evidence supporting the use of robot-assisted surgical techniques.

**KEY WORDS:** Presacral tumor, robot-assisted, robotic, schwannoma

## INTRODUCTION

Since the introduction of da Vinci (Intuitive Surgical, Sunnyvale, California, USA) robotic system in the 1990s, robot-assisted techniques have been applied to a wide variety of surgical specialties such as urology, obstetrics and gynecology, cardiac surgery, head and neck surgery, and more recently, spine surgery (1, 5, 6, 21, 23). The robotic spine surgery was first described in the literature in 2006 by Barzilay et al. (2), where 15 patients underwent pedicle screw placement with the use of SpineAssist (Mazor Robotics, Caesarea, Israel). Following this, the first case of da Vinci-assisted tumor resection in the field of spine surgery was reported by Moskowitz et al in 2009, where a thoracolumbar neurofibroma was removed robotically via a retroperitoneoscopic laparoscopic approach (13). Since then, several articles related to robotic surgery such as cadaveric feasibility studies and clinical case series have been published (3, 9, 10, 18, 24). Based on the current literatures, the potential roles of robotic system in spine surgery include, but not limited to, minimizing invasiveness of the procedures, which could result in shorter length of stay, less pain, and optimal cosmetic outcomes, improving the visualization of tumors and surrounding vital structures such as ureter, rectum, nerves, and vessels, assisting precise spinal instrumentation, and reducing exposure to radiation (3, 9, 10, 18, 21, 24).

Meanwhile, a presacral (or retrorectal) tumor is a relatively rare entity, which is estimated to account for 1 in 40,000 hospital admissions (8). The true incidence is yet to be unknown, but there are several retrospective studies which indicated that one and six patients in the tertiary hospitals are annually diagnosed with presacral tumors (4, 7). The differential diagnoses include congenital lesions such as tailgut cyst and teratoma, neurogenic lesions such as schwannoma, neurofibroma, ependymoma, and neuroblastoma, osseous lesions such as giant cell tumor and aneurysmal bone cyst, and miscellaneous lesions, such as lipoma, leiomyoma, lymphoma, and metastatic tumors. Speaking of benign presacral tumors, overall survival rate is nearly 100% and local-recurrence is substantially rare in the literatures (14). However, given the proximity of presacral tumors to aforementioned critical structures, the surgical management is not infrequently challenging, especially in malignant tumors, which requires a large incision and a deep surgical field and might result in rectal fistula, ureteral damage, vessel damage, neurological deficit, and/or infection due to poor visualization. To prevent these potential complications, several techniques have been proposed, including an anterior-posterior combined approach and laparoscopic surgery (14, 19), but none of them has applied robotic surgery to presacral tumors. Considering the merits of robotic system addressed above, it is anticipated that it can overcome the drawbacks of open and laparoscopic surgeries and reduce the peri- and intraoperative complication rates in spine surgery just as it has done in the field of urology (22) and gastrointestinal surgery (17). Here we describe a technical description of the clinical application of robotic surgery to a presacral schwannoma with a case illustration.

## CASE ILLUSTRATION

A 22-year-old female presented to another hospital for the evaluation of her abnormal vaginal bleeding. An exploratory laparoscopy demonstrated presacral mass, which was consistent with the magnetic resonance imaging (MRI) at that time which revealed 6.4 x 5.7 x 5.1 cm encapsulated and heterogeneously T2 hyperintense presacral mass, extending to the right S2 neural foramen. She was then referred to our hospital and underwent computational tomographically guided biopsy which confirmed the diagnosis of a presacral schwannoma. Neurologically, she was completely asymptomatic. Given its pathology, size of the tumor, and her presentation, she was followed up conservatively. However, three years later, the annual MRI demonstrated that the tumor was gradually growing, measuring 7 x 6.2 x 5.8 cm (Figure 1A-C). Several treatment options, including the resection of the tumor via open laparotomy, via robotic surgery, or observation, were discussed with the patient. Considering that the robotic surgery can provide shorter length of stay and aesthetic advantages, she agreed with us to undergo robot-assisted resection of the tumor.

## SURGICAL TECHNIQUE

After general endotracheal anesthesia was obtained, the urologist placed a ureteral stent into the right ureter and then the patient was positioned in lithotomy position. To insufflate the peritoneal cavity with CO2, a Veress needle (Covidien, New Haven, CT, USA) was utilized. The initial 12 mm umbilical trocar was placed and the peritoneal cavity was then inspected and discovered to be free of any gross abnormalities other than the tumor itself. There was no significant adhesion from previous exploratory laparotomy. Subsequently, three additional 8 mm robotic ports as well as 12 mm and 5 mm ports were placed under direct vision. The patient was then placed in Trendelenburg position in order for the abdominal contents to fall rostrally away from the pelvis and the da Vinci robot Si was docked (Figure 2).

qFirst, the peritoneum covering the tumor (Figure 3A) was cautiously dissected and reflected both medially and laterally (Figure 3B). Reflecting the peritoneal flap laterally exposed the ureter, common iliac artery and vein, and obturator nerve (Figure 3C). Medial reflection mobilized the rectum away from the tumor and sacrum. The uterus and ovaries were retracted out of the field by reflecting the peritoneum and thereby indirectly retracting those structures. The outline of the tumor was identified at this point and it appeared to be well-circumscribed and yellow, which was consistent with the preoperative diagnosis of a schwannoma. There was no sign of invasion to surrounding structures (Figure 3D). Next, a bipolar stimulator was utilized to confirm that there should be no motor response from the

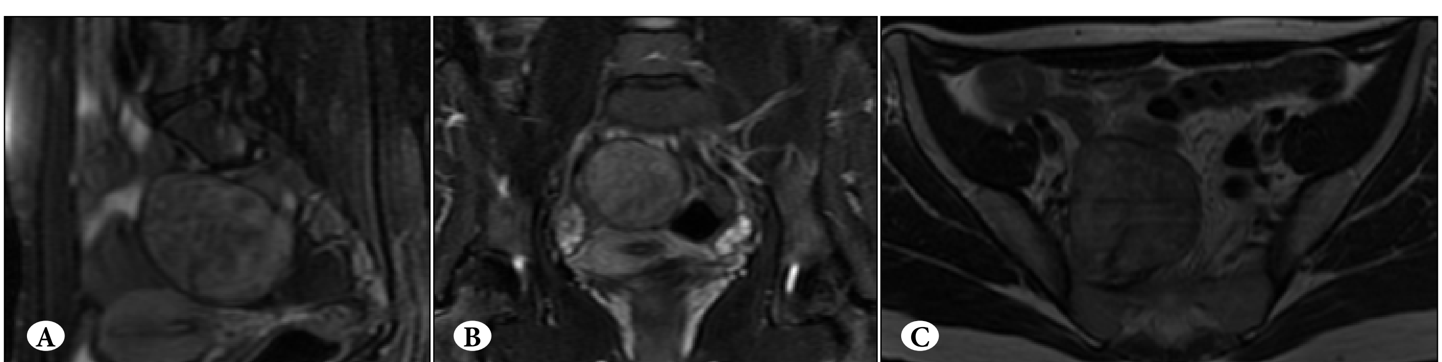


***Figure 1:*** *The encapsulated and heterogeneously T2 hyperintense presacral mass, extending to the right S2 neural foramen, measuring 7 x 6.2 x 5.8 cm* ***A)*** *T2 fat-suppression sagittal,* ***B)*** *T2 fat-suppression coronal,* ***C)*** *T2 axial.*

surface of the tumor (Figure 3D, F). The capsule of the tumor was cautiously dissected to preserve any viable nerve rootlets. There was one attachment of the tumor inferiorly coming off the S2 foramen. Again, this part of the tumor was stimulated and it was sharply dissected after confirming lack of motor response. Then, the entire tumor was completely mobilized (Figure 3G), placed into an EndoCatch bag (Covidien, New Haven, CT, USA) (Figure 3H), and then delivered through the umbilical incision (Figure 3I). All of the fascial incision and skin incision were closed layer-by-layer. The ureteral stent inserted preoperatively was removed, since there was no invasion of the tumor and it was successfully resected. The operation time was 377 minutes, including ureteral stent placement and removal. Estimated blood loss was less than 75 cubic centimeters. Urine output was 250 ml. There were no complications during the procedure. The patient was neurologically intact, moving all four extremities with 5/5 strength throughout.

***Figure 2:*** *The placement of a 12 mm umbilical trocar, a 12 mm port, three 8 mm ports, and a 5 mm port.*

## POSTOPERATIVE CLINICAL COURSE

Postoperatively, she stayed in the intensive care unit for one day and was transferred to the general neurosurgical floor. Since there was no sign of bowel obstruction, full liquid diet was initiated postoperative day 1. Foley catheter was removed postoperative day 2 with the urine output of 900 ml/day. Also, the surgical JP drain was removed postoperative day 2 with the total output of 160 ml, mostly serosanguinous. She was discharged postoperative day 3 without any complications. The pain level at that time was 3 out of 10 on the numeric scale, but was easily controllable by oral pain medications. She returned to work in one week and was evaluated in clinic four weeks post-operatively when she was noted to be doing well without any complications.

## DISCUSSION

With the advent of da Vinci robotic surgery, minimally invasive approaches have been emphasized extensively in the field of surgery in this modern era. Aside from minimal invasiveness, it offers several advantages such as clear and three-dimensional visualization of organs, improved dexterity, and increased freedom of motion (21). As far as we know, six case reports regarding da-Vinci-assisted spine surgery are currently available in the literature: neurofibroma resection by Moskowitz et al. (13), transoral odontoidectomy by Lee et al. (10), paraspinal schwannoma resection by Yang et al. (24) and Perez-Cruet et al. (18), and anterior lumbar interbody fusion by Lee et al. (9) and Beutler et al. (3). To the best of our knowledge, this is the first technical description of the clinical application of robotic surgery to a presacral schwannoma. In this case, the robot-assisted surgery was successfully performed with excellent clinical outcomes such as complete excision of the tumor, minimal blood loss and pain score, and short length of stay without any complications. Here we will review some of the literature regarding treatment options for presacral tumors, clinical outcomes, and current evidence supporting the use of robot-assisted surgical techniques.

First, in terms of surgical approaches, there are generally three options to consider for presacral tumors, namely, transabdominal (anterior) approach, transperineal (posterior) approach, and combined approach, depending on the three-dimensional relationship between a tumor and surrounding structures. Usually, a transabdominal approach or a combined approach will be necessary for the tumors above the level of midbody of S3 as in this case (19).

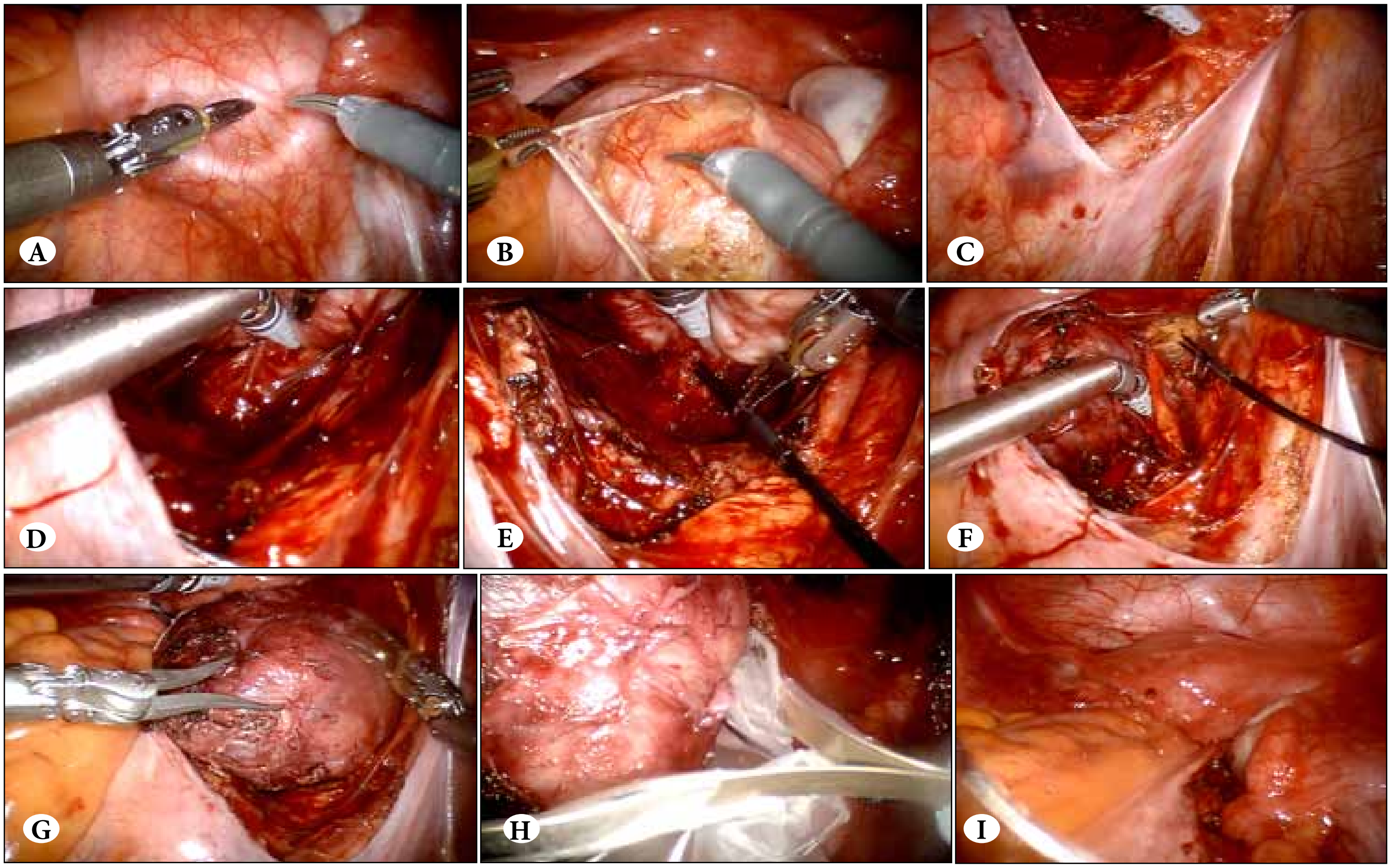


***Figure 3:* *A)*** *Peritoneum covering tumor and iliac bifurcation. To the left of tumor, the rectum comes into view. To the right of the tumor, the right fimbriae of the ovary can be seen draped over the peritoneum.* ***B)*** *Initial dissection and reflection of the peritoneum away from the tumor. The right ovary comes into view draped over the tumor. The rectum can be visualized to the left. The uterus and fallopian tubes can be seen anterior to the tumor.* ***C)*** *Reflection of the peritoneum and exposure of the right common iliac artery.* ***D)*** *Dissection of tumor away from the ventral aspect of the sacrum.* ***E)*** *Bipolar stimulation of the nerve fascicle contribution from S2.* ***F)*** *Bipolar stimulation of the sciatic nerve in the sciatic notch.* ***G)*** *Complete mobilization of the tumor.* ***H)*** *Placement of the en bloc specimen in the EndoCatch bag.* ***I)*** *Abdominal view after complete resection of tumor.*

Da Vinci system is usually applicable to a transabdominal approach, whose surgical anatomy is essentially similar to prostatectomy, hysterectomy and rectectomy.

Speaking of surgical outcomes, Lev-chelouche et al. (11) reported the complete resection of 21 benign presacral tumors via open surgeries and with the median follow-up period of 54 months there was no local recurrence. They also addressed that 14 out of 21 patients with malignant presacral tumors underwent complete resection, and the overall survival rate and the local recurrence with the median follow-up period of 22 months were 67% and 57%, respectively. The complete resection was associated with the better overall survival. The overall complication rate was 36%, which included one case with neurogenic bladder dysfunction which required intermittent catheterization and one case with neurological deficit in the lower extremities. Other reported complications included rectal fistula, ureteral damage, vessel damage, wound breakdown, and infection (14). These results indicate the potential benefit of robotic surgery since it can provide better operative fields, which allow surgeons to achieve complete resection and prevent damages to normal structures. However, none of the current literatures directly compared the clinical outcomes of presacral tumors amongst open surgery, laparoscopic surgery, and robotic surgery. Hence, some of the articles regarding those comparisons in other surgical fields will be discussed further.

The population-based comparison conducted by Sugihara et al. (22), which included 7202 open, 2483 laparoscopic, 1181 minimal incision endoscopic, and 2126 robot-assisted radical prostatectomies, demonstrated that robotic surgery was independently associated with a significantly lower complication rate, autologous transfusion rate, homologous transfusion rate, lower cost excluding operation cost, and shorter postoperative length of stay. The shortcoming reported in the article was a 42.6% increase in anesthesia time and a 52.4% increase in total health care cost. The comparative study regarding robotic versus laparoscopic hysterectomy by Rosero et al. (20) demonstrated the same trend. In the treatment of rectal cancer, Park JS et al. (17) reported that mean operative time was 233.8 minutes in open surgery group (OS), 158.1 minutes in laparoscopic surgery group (LS), and 232.6 minutes in robot-assisted surgery group (RS) ($p < 0.001$). The difference in sphincter preservation was also significantly different: 93.2 % in OS, 98.4% in LS, and 100% in RS. The average maximal pain score was 6.4 in OS, 5.5 in LS, and 5.2 in RS ($p < 0.001$). They concluded that in terms of short-term outcomes, LS and RS were similar and better than OS. However, the superiority of one technique over the others is still controversial because some reported non-inferiority of open surgery to robotic surgery in radical cystectomy in terms of 90-day complication rates, hospital stay, pathologic outcomes, and 3- and 6-months quality of life outcomes (16) or non-inferiority of laparoscopic surgery to robotic surgery in liver resection measured by blood loss, hospital stay, pathological outcomes, and mortality (12). Particularly speaking of robot-assisted presacral neurectomy, which potentially resembles the resection of presacral tumor most, Nezhat et al. (15) reported no added risk of complications and advocated the advantages of robotic surgery since it provided a better angle, three dimensional visualization with sufficient magnification, and efficient elimination of hand tremor.

In summary, robot-assisted surgery in other surgical fields has been well-established and discovered to be safe and feasible with several benefits in clinical outcomes. It has been gradually applied to the field of spine surgery as well and robotic resection of a presacral tumor was also feasible. However, in order to prove its advantages over the other techniques, comparative, prospective studies regarding short-term and long-term outcomes, learning curves of surgeons, and health care cost are warranted.

## CONCLUSIONS

This is the first technique paper with a case illustration of the clinical application of robotic surgery to a presacral schwannoma, which was safe and feasible and addressed several advantages. As in other surgical fields such as urology, gynecology, and gastrointestinal surgery, the importance of robot assistance in spine surgery will definitely increase. Further studies will be needed to demonstrate its efficacy.

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