

Robotic Surgery Assisted Staged En-Bloc Sacrectomy for Sacral Chordoma

A Case Report

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Abstract

Case: Two male patients aged 37 years and 39 years, diagnosed with sacral chordoma, underwent robotic-assisted preparatory adhesiolysis from the anterior aspect of the tumor, followed by posterior en-bloc partial sacrectomy. The average total operative time was 360 minutes (anterior docking + anterior console + posterior excision), and mean blood loss was 930 mL. Both patients were mobilized early, had no postoperative complications, and were free of local recurrence at 18 month of follow-up.

Conclusions: Robotic-assisted surgery is a novel, valid, safe, and minimally invasive technique which drastically reduces the associated surgical complications of single-staged posterior sacrectomy, resulting in excellent functional and oncological outcome.

Chordoma is the most common primary malignant tumor of the sacrum¹. Surgery is the mainstay management performed with a curative intent considering the long-term survival of patients after surgery². Obtaining a wide surgical margin is the most important predictor of survival and local recurrence in these tumors, and a combined

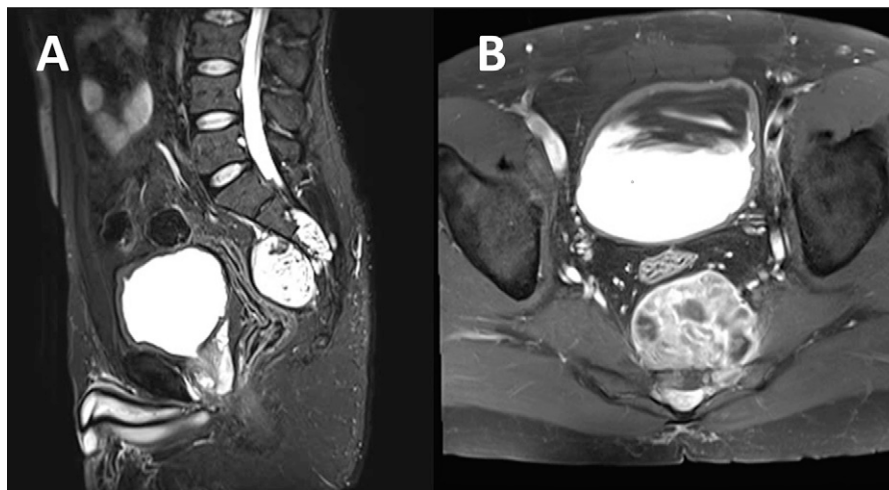


Fig. 1
Sagittal (**Fig. 1-A**) and axial (**Fig. 1-B**) views of pre-operative magnetic resonance imaging scan showing osteolytic heterogeneously enhancing lesion in the sacrum with prevertebral, postvertebral and intraspinal extension.

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TABLE 1 Characteristics of Operated Patients*

Characteristics	Patient 1	Patient 2
Total surgical time (minutes)	344	376
Anterior approach		
Docking	74	80
Procedure	124	140
Posterior approach	146	156
Total blood loss (milliliters)	870	990
Anterior approach	110	80
Posterior approach	760	910
Blood transfusion (units)		
Intra-operative	1	1
Post-operative	0	1
Age (yrs)/sex	37/male	39/male
BMI (kg/m ²)	23.86	24.67
Tumor volume (cm ³)	186	210
Pre-operative serum Hb (g/L)	10.4	11.3
Follow-up (mo)	19.3	18
MSTS score at final follow-up	29 (96.7%)	28 (93.3%)

*BMI = body mass index, Hb = hemoglobin, MSTS = Musculo-skeletal Tumor Society.

anterior and posterior approach increases the likelihood of securing wide margins³.

Posterior partial or total en-bloc sacrectomy (EBS) is a technically challenging procedure that requires multidisciplinary surgical expertise and depending upon the level of transection and the nerve root sacrificed, neurological dysfunctions can be encountered⁴. Preventing damage to the surrounding vital anatomical structures, thereby improving the quality of life after surgery has now become a part of the primary objective of operative procedures, apart from obscuring tumor free margin.

We report 2 cases of robotic surgery-assisted anterior adhesiolysis, coupled with a second-staged posterior en-bloc resection for sacral chordoma.

The patients being reported here were informed that the data concerning the cases would be submitted for publication and both the patients-provided consent.

Case Report

Between July 2016 and November 2016, 2 patients with radiological diagnosis of sacral chordoma were considered for the procedure. Patient 1 was a 37-year-old male, presenting with complaints of chronic pain of the lower back with a recent history of aggravated pain with associated difficulty in walking, squatting, and passing stools. Radiologically, the lesion extended from the lower aspect of S2 vertebra to S5 vertebra (Fig. 1). Patient 2 was a 39-year-old gentleman who presented with pain in the sacral region along with difficulty in passing stools. Chordoma involved S2 to S5 vertebra and coccyx. S1 was spared in both patients. On examination, both patients had intact

sensory-motor neurological status and both patients underwent computed tomography (CT) scan-guided needle biopsy from the lesion for histological confirmation of the diagnosis. The mean body mass index (BMI) was 24.26 kg/m². The average preoperative serum hemoglobin was 10.85 g/L (Table I).

Surgical Technique

Same surgical procedure was performed for both patients, at a tertiary care specialty cancer center. Robotic surgery-assisted anterior adhesiolysis was performed by an uro-oncosurgeon with expertise in robotic surgery on day 1, and the posterior EBS was performed on day 2 by an experienced musculoskeletal oncosurgeon. On day 1, antibiotic prophylaxis was given, Foley urinary catheter was applied, general anesthesia administered, and the patient was positioned on the operating table. Da Vinci Si surgical system (Intuitive Surgical) was used for the procedure.

Anterior Approach

Patients were placed in the lithotomy position with limbs secured with side supports and straps. Pneumoperitoneum to 12 mm Hg was created using a transumbilical Verres needle. Twelve millimeter supra-umbilical camera port and three 8 mm working ports were used: Arm 1 on the right side, 3 cm lateral and 2 cm superior to the umbilicus; Arm 2 on the left side, 3 cm lateral and 2 cm superior to the umbilicus; and Arm 3, cranial to the anterior superior iliac spine lateral to the Arm 2 on the left side. Two assistant ports were used: 5 mm trocar on the right side below the lowest rib and a 12 mm trocar cranial to the right anterior superior iliac spine.

Abdominal pressure was maintained at 12 mm Hg and an abdominal examination was performed. Retroperitoneum was dissected and pararectal fossa on both sides were identified. Internal iliac vessels and the ureter were identified and protected. Bleeding from the presacral venous plexus was cauterized. Rectum was identified and mobilized after releasing the surrounding fascia, no lymphadenectomy was performed. The sacral tumor was separated from the inferior hypogastric plexus

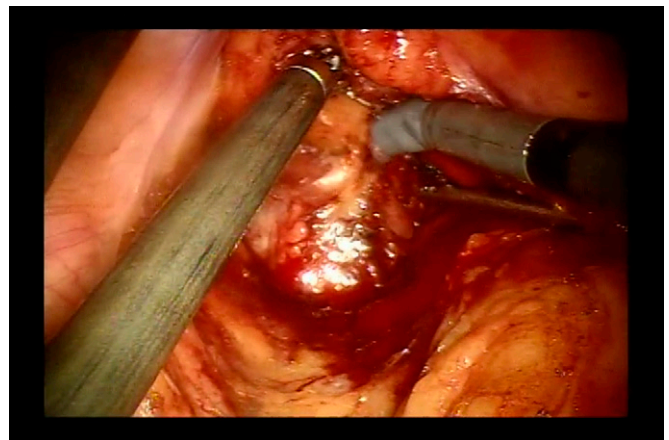


Fig. 2

Anterior aspect of the sacral chordoma through supraumbilical camera port during the robotic anterior preparatory approach.

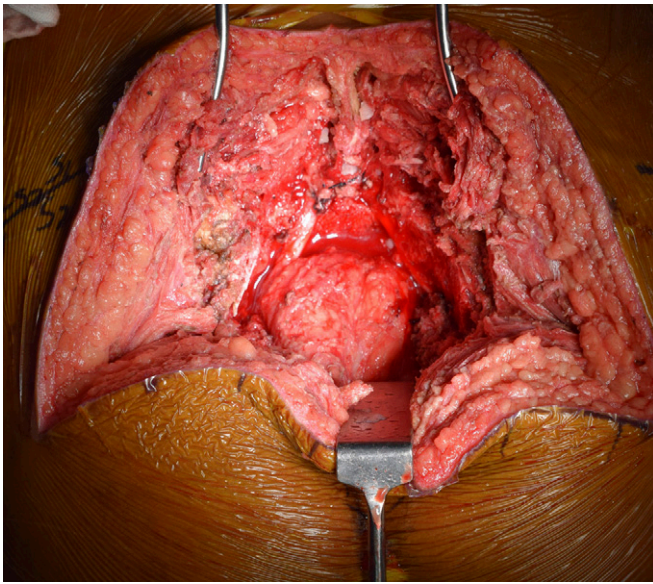


Fig. 3
Posterior aspect of the tumor bed (post resection) through the semilunar incision, with ligated and cut cauda equina.

and subsequently released of all the fascial adhesions (Video 1 and Fig. 2) and a Gore-Tex spacer was inserted anterior to the sacral mass. Both patients withstood the procedure well and were posted for posterior partial sacrectomy the following day.

Posterior Approach

With patient in the prone position, semilunar incision with caudal concavity centered over S2 was applied and subcutaneous tissue was dissected in line with the incision. Adequate thickness of the flaps on either side of the incisions was maintained to prevent vascular insult to the skin. Posterior S1 and S2 laminectomy were performed, cauda equina identified and ligated. Exiting nerve roots of S1 were identified, protected and nerve roots of S2 were cut on both sides. Under fluoroscopic

guidance, S1-S2 junction was identified and cut with an osteotome (Video 2). On the posterior aspect of the sacrum, insertion of erector spinae and multifidus superiorly and origin of gluteus maximus inferiorly, were cut, along with short and long posterior iliosacral ligaments to expose the sacrum and sacroiliac joints. Lateral sacral cuts were performed just medial to the sacroiliac joint on both sides, with an osteotome, under fluoroscopic guidance. Gore-Tex spacer positioned anterior to the sacral tumor the previous day was identified as the anterior limit for sacral cuts. Inferiorly, in patient 1 since coccyx was spared sacrococcygeal joint was identified and cut, thereby preserving the musculoligamentous attachments of coccyx; in patient 2 coccyx was removed along with the sacral tumor. Once circumferential sacral bone cuts were completed, Gore-Tex spacer placed anteriorly was palpated, laterally sacral origin of the piriformis muscle, sacrotuberous and sacrospinous ligaments were cut till the spacer was visualized. The tumor was removed en-bloc (Video 3), hemostasis achieved, and the sacral bed (Fig. 3) thoroughly washed with saline and hydrogen peroxide. No reconstruction was performed. Wound was closed in layers over suction drain and primary closure achieved. Both the resected specimens had all margins free of tumor.

Post-operative period was uneventful. CT and magnetic resonance imaging scans showed no residual lesions (Fig. 4). The operated patients were followed up for 19.3 months and 18 months; both patients were independently ambulant and showed no signs of local recurrence. Patient 1 had achieved bowel control and was on non-catheter postural and pressure-induced bladder voiding, and patient 2 had no bowel function and was on self-intermittent catheterization for voiding urine. Neither of the patients had sexual functions.

Discussion

From 2012 to 2016, 17 partial or total EBSs were performed at our institution, and since July 2016, anterior preparatory robotic surgery is being routinely performed prior to all resection procedures for the sacrum (4 cases until now). Though the robotic surgery is not performed by the surgeon who performs

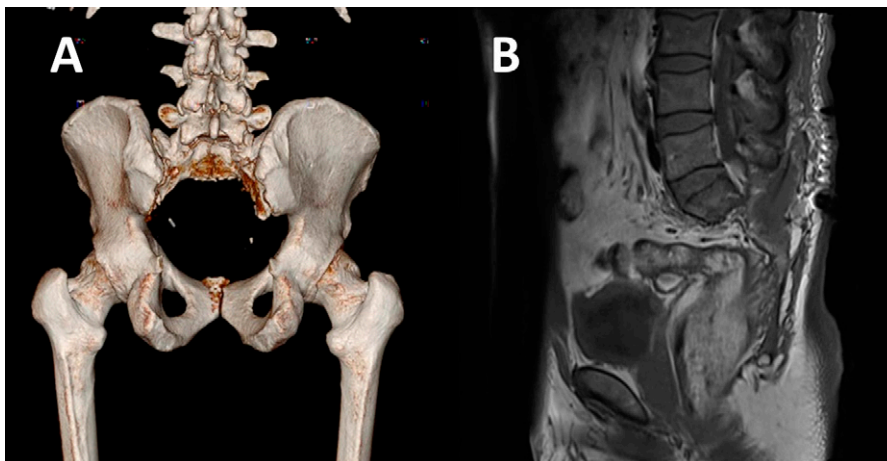


Fig. 4
Post-operative computed tomography scan (Fig. 4-A) and sagittal view of magnetic resonance imaging scan (Fig. 4-B) of the pelvis.

the posterior sacrectomy, his assistance is essential to guide the robotic surgeon to delineate the margins and assist with complex dissection, which may be slightly different from routine robotic surgeries of the pelvis⁵.

EBS for aggressive and malignant tumors of the sacrum is technically challenging due to the close proximity of vital structures and complexity of the surgical approach⁶⁻⁸. Achieving wide surgical margins in these patients, significantly reduces incidence of local recurrence and distant metastasis, and also attributes to higher 5-year survival⁹⁻¹². Regardless of the tumor histology, EBS is associated with substantial functional impairment, neurological dysfunction, damage to nearby anatomical structures, wound complications, local recurrence, gait disturbances and numerous other complications^{13,14}.

Posterior-only approach has been successful for EBS with tumors not extending beyond lumbosacral junction, but at the cost of extensive surgical dissection and related complications^{15,16}. Adaptive staged procedures involving sequential, abdominal and posterior approach have reported better outcomes. But preparatory anterior approach involving vigorous tissue handling and mobilization of rectum can end up needing end-sigmoid colostomy and suprapubic cystostomy; which can be prevented by minimally invasive procedures like laparoscopic or robotic-assisted procedures¹⁷⁻¹⁹. Robotic procedures, compared to conventional laparoscopic surgery, have resulted in reduced operative time, better accuracy, enhanced dexterity, lesser blood loss, and shorter hospital stay^{20,21}. The average BMI of the patients operated in our report was 24.265 kg/m². As long as the patient can be positioned properly on the robotic operating table, patient size is not a contraindication and robotic surgery can be safely performed in these patients, although the operating time has been reported to be longer in obese patients^{22,23}.

Sacrectomy, like other pelvic surgeries, is associated with extensive intra-operative bleeding^{24,25}. Fourney et al.⁷ reported a median blood loss of 3.9 L in their series of 29 patients undergoing partial or total sacrectomy. Tumor volume more than 200 cm³ is an independent risk factor for increased bleeding during sacrectomy and such large tumors are common, as patients with sacral lesions often present late^{26,27}. Bleeding from large sacral lesions can be reduced by preparatory minimally invasive approach, as it involves only adhesiolysis, and delineating the tumor without handling the tumor itself or sacrificing large veins that drain the epidural plexus²⁶. Anterior adhesiolysis can be performed even for large tumors of the sacrum, and tumor size is not a limiting factor in performing robotic anterior dissection. However, it cannot be used for tumors extending cephalad to body of L5 vertebra because above this level, mobilizing the common iliac vessels is difficult without dissecting the investing fascia off the psoas fascia.

Bederman et al.²⁸, in their systematic review of patients undergoing total sacrectomy from 23 publications, reported

that 90% of the operated patients were ambulant at final follow-up. The functional outcome following EBS depends mainly upon the level of resection and the nerve roots sacrificed, and most of the patients with total sacrectomy will be able to walk even without spinopelvic reconstruction²⁹. Patients undergoing sacral amputations above S2 are bound to have bowel, bladder and sexual dysfunctions. None of our patients had intact sexual or bladder functions at final follow-up, as S2 was sacrificed in both. Zoccali et al.³⁰ reported that normal bladder function was seen in 40% of the patients when both the S2 nerve roots were spared, and in 83% when both S3 nerve roots were spared.

Robotic technology is becoming dominant for major oncological procedures. Apart from technical difficulties, increased economic burden and steep learning curve are the 2 most salient drawbacks of the robotic procedures^{31,32}. Though the expenses for the procedure are high, overall hospital and health care cost can be less when compared to open and laparoscopic procedures^{33,34}.

Anterior preparatory robotic surgery assisting posterior staged sacrectomy is a relatively new technique and has only been recently reported in the literature³⁵. It allows for effective, safe anterior dissection with minimal blood loss and complications besides numerous other advantages over conventional open procedures³⁶⁻³⁸, resulting in excellent oncological and functional outcome. However, longer follow-up is warranted as late local recurrence is not unusual in en-bloc resections for sacral chordoma³⁹. With mentored training and experience, robotic surgery can routinely be used for pelvic surgeries. Even without a robot, EBS is a complex procedure which can lead to dreadful outcomes and such procedures should be attempted at specialized sarcoma centers equipped with experienced surgeons and support care. ■

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