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Case Report

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Hybrid Robotic-Open Surgical Resection And Reconstruction For Pelvic Ewing's Sarcoma: Demonstrating Clinical Feasibility

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Abstract

Background: Excision and reconstruction of pelvic Ewing's sarcoma require in selected cases a combined anterior and posterior approach for complete and secure resection. The anterior approach involves a large retroperitoneal laparotomy for partial dissection and protection of major vessels, and the posterior approach enables the complete bone resection and reconstruction.

Purposes: Such double surgical approaches are physically demanding for patients, often resulting in a complex recovery process, mainly regarding postoperative pain. We aimed to demonstrate the clinical feasibility of a robotic-assisted anterior approach as part of a hybrid strategy, with the goal of facilitating a smoother clinical recovery of the patient.

Methods: We present a case of a pelvic Ewing's sarcoma classified as Enneking's type P Ia/b, IV, and S. A complete robotic-assisted procedure was used for the anterior approach. Tumor resection was finalized using cutting jigs via the posterior open approach, followed by reconstruction with a custom-made 3D prosthesis.

Results: The robotic procedure was performed in a retroperitoneal plane, facilitating posterior iliac vessels protection, dissection of the sciatic notch, and sectioning of the L5-S1 nerve roots and sciatic nerve. Partial sections of the psoas and piriformis muscles were also performed.

Conclusion: This robotic procedure was safely and successfully completed, demonstrating the feasibility of this technique for partial anterior pelvic tumor dissection, providing enhanced control and visibility in the restricted retroperitoneal pelvic surgical field. To our knowledge, this is the first reported description of this robotic procedure.

Introduction

Pelvic Ewing sarcoma is an aggressive malignancy that often presents as large, making its resection and reconstruction particularly challenging [1]. In cases involving the sacrum, sacroiliac joint, and posterior iliac wing, a combined anterior and posterior approach may be required for complete and secure resection. Indeed, Guder et al. identified iliac vessel injury as one of the main intraoperative complications [2]. The conventional technique involves an anterolateral retroperitoneal laparotomy being an extended surgical exposure between the rectus abdominis and the transverse and oblique muscles to access the retroperitoneal plane on the ipsilateral side of the tumor. This allows dissection of the major vessels including the aorto-iliac bifurcation, iliac vessels, superior and inferior gluteal vessels, as well as the nerve roots. This extensive exposure also facilitates the creation of a protective plane behind the median sacral artery, where sponges are strategically placed to shield critical structures from saw blades and osteotomes during the posterior osteotomies [2,3]. Although effective, this dual-approach strategy is highly invasive, primarily causing significant postoperative pain. So surgical technique is crucial, as pelvic resection is associated with significant postoperative morbidity, that must be carefully considered within the context of chemotherapy and radiation therapy [4-8].

In the present clinical case, we evaluated the feasibility of a robotic-assisted anterior approach as part of a hybrid surgical strategy. Our goal was to reduce the physiological impact of surgery, particularly postoperative pain, and to facilitate a faster and less complicated recovery.

Methods

A 22-year-old female was referred to our institution with a diagnosis of Ewing sarcoma involving the left sacroiliac joint, the sacrum and the sciatic notch, corresponding to a type P Ia/b, IV, and S according to Enneking's classification (Figure 1). Neoadjuvant chemotherapy, following the EuroEwing 2012 protocol, was initiated at another center and yielded an excellent radiological response. The patient was subsequently referred to our department for surgical management.

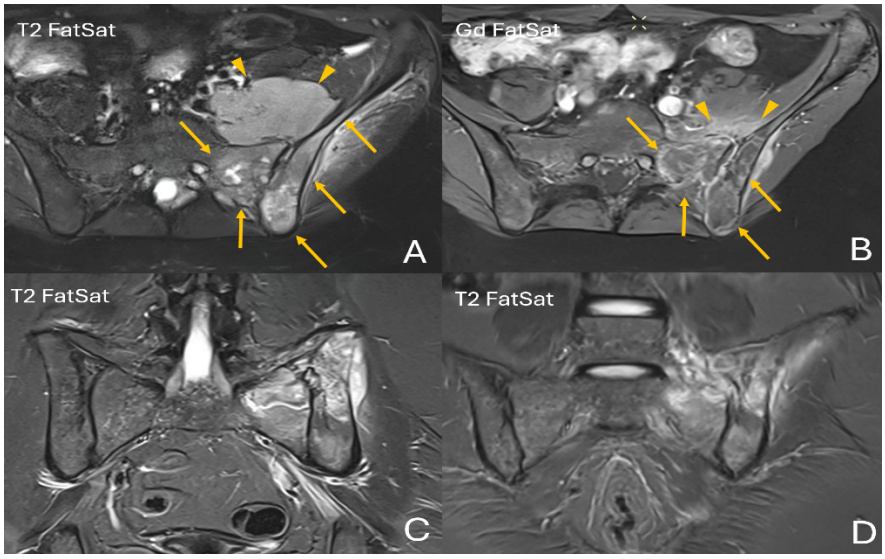

Figure 1: **A**: Baseline MRI prior to chemotherapy. Enneking type P Ia/b, IV, and S pelvic Ewing sarcoma in axial T2 FatSat view. Large intrapelvic soft tissue extension (arrowheads) and intraosseous extension (arrows). **B**: Shrinkage of the soft tissue mass (arrowheads) and necrosis of the osteomedullary infiltration on post-chemotherapy gadolinium-enhanced image (arrows). **C and D**: Coronal views of the post-chemotherapy status.

Given the involvement of the sacroiliac joint without extension to the hip joint, a limb-salvage procedure was planned that would replace the ilio-lumbar segment with a custom-made 3D-printed implant (Implantcast®, Buxtehude, Germany). In view of the patient's young age, we proposed a hybrid surgical strategy: a minimally invasive, robot-assisted anterior approach followed by a posterior resection using patient-specific cutting jigs and reconstruction.

Results

The robotic procedure was performed using the Da Vinci Xi robotic system (Intuitive Surgical). A three-arm technique was employed, taking into account the limited retroperitoneal space. The patient was positioned supine on a memory foam mattress with a slight Trendelenburg tilt and right lateral rotation to facilitate a left retroperitoneal approach. The robotic cart was docked on the left side of the patient. An initial 1.5 cm incision was made along the lateral border of the rectus abdominis muscle to access the retroperitoneal space. Through this first port, selective retroperitoneal CO_2 insufflation was initiated, maintaining a pneumoretroperitoneum pressure of 12 mmHg. Two additional 8 mm robotic ports were placed 7 cm apart one at the anterior border of the anterior superior iliac spine and the other in the supra-inguinal region (Figure 2). A 12 mm assistant port was placed medially to the central camera port. A 30-degree endoscope was used for visualization. The instruments utilized included a ProGrasp forceps and a fenestrated bipolar grasper. The bedside assistant utilized a suction-irrigation device and laparoscopic clip appliers.

Figure 2: Immediate post-operative view of the anterior retroperitoneal robotic approach.

To our knowledge, this robotic surgical technique has not yet been described in the literature for this type of procedure; however, the technical concept is comparable to that of retroperitoneal lymph node dissection, but extended in this indication down to the lower pelvis [9].

The dissection began at the level of the common iliac vessels and their major branches (Figure 3), with clipping of the median sacral artery (Figure 4). Dissection proceeded toward the sciatic notch, followed by transection of the L5-S1 nerve root and the sciatic nerve (Figure 5). Partial resections of the psoas and piriformis muscles were also performed. At the end of the robotic procedure, surgical sponges were strategically placed to protect the iliac vessels, allowing for a safe posterior bone resection in the subsequent stage (Figure 6).

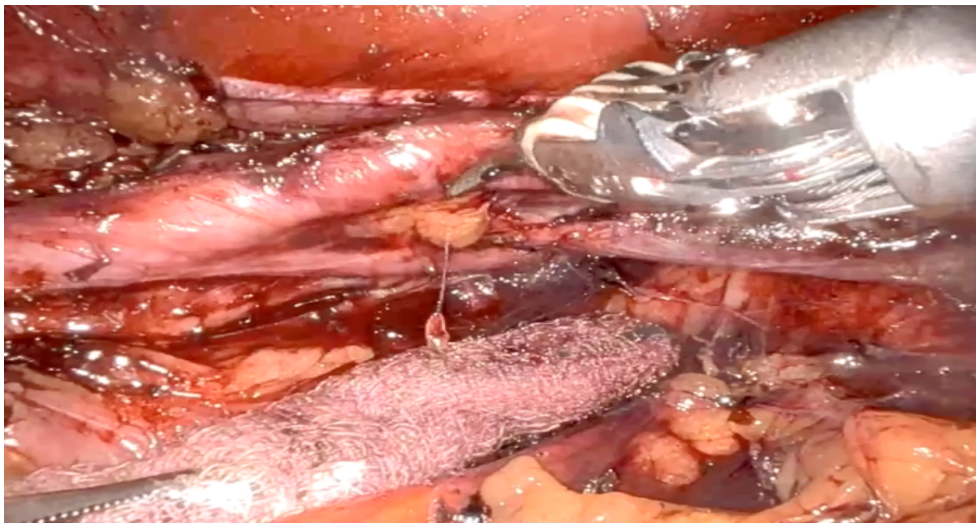

Figure 3: Dissection of the common iliac artery and its branch divisions.

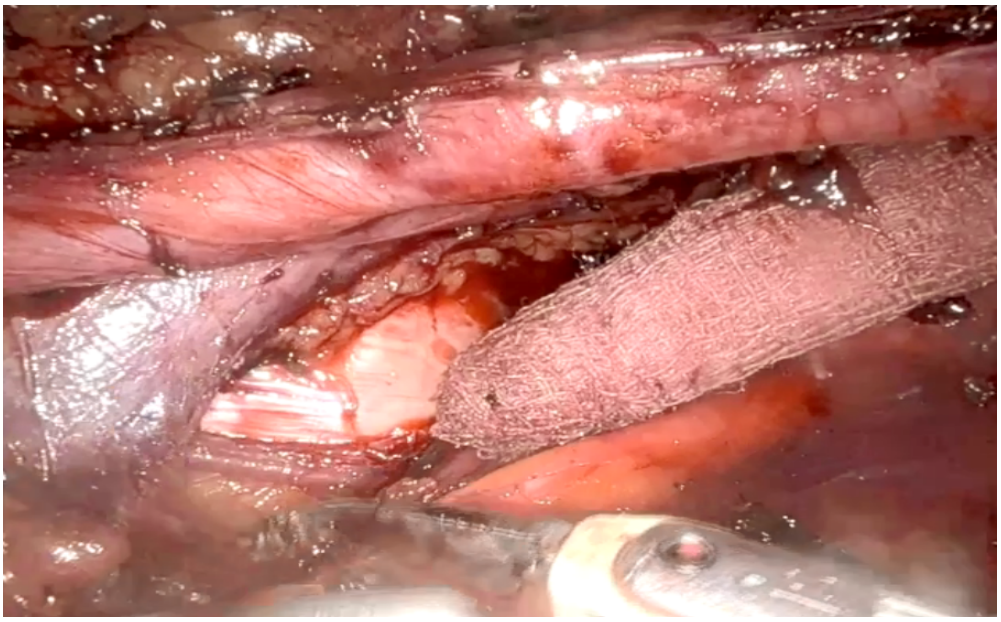

Figure 4: View of the common iliac artery and vein, with dissection of the median sacral artery, allowing exposure of the sacral promontory.

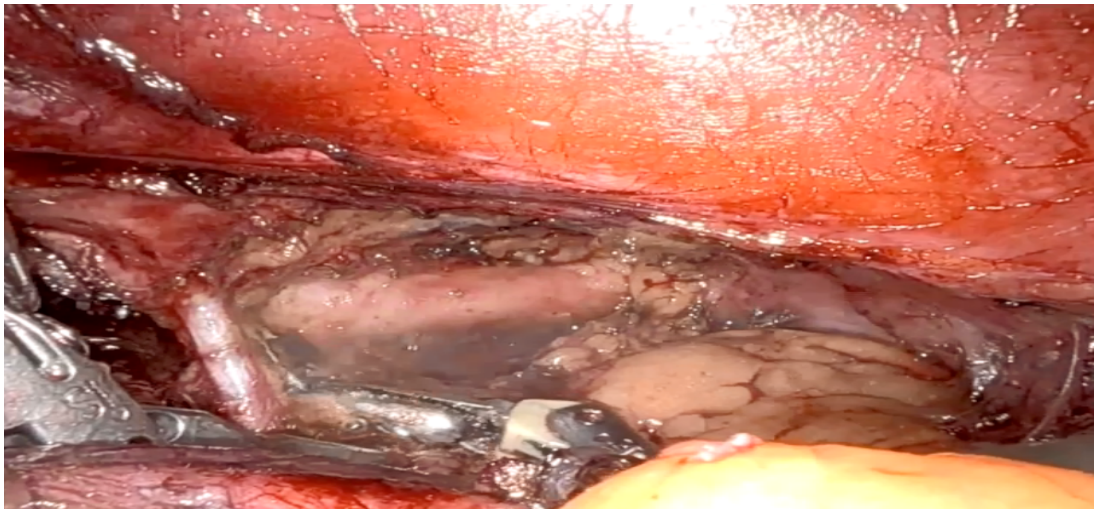

Figure 5: Exposure of the L5-S1 nerve root.

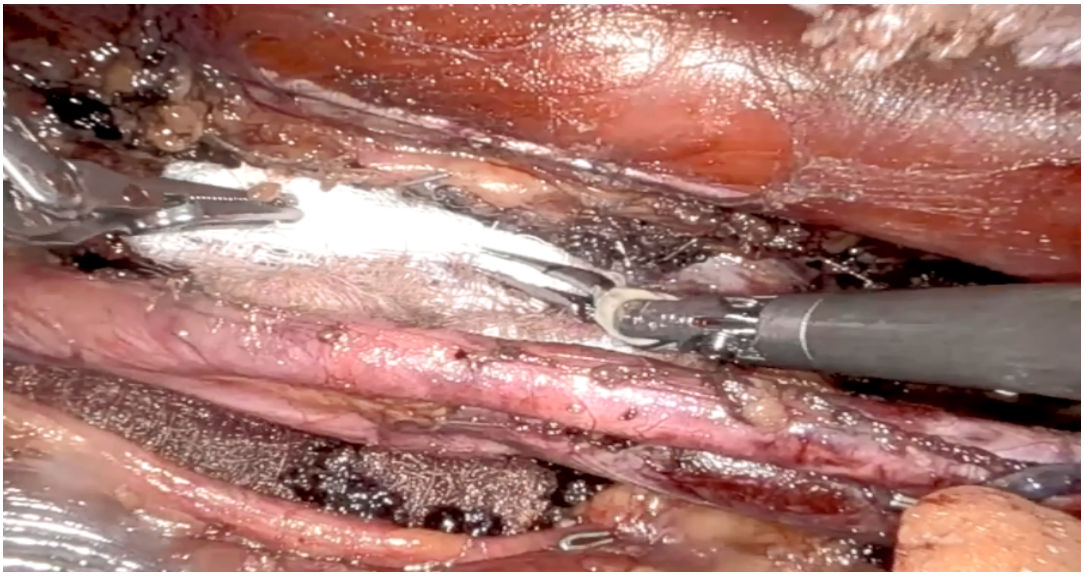

Figure 6: Surgical sponges placed behind the iliac vessels to protect them during posterior bone sectioning.

Postoperative care was managed in the intensive care unit, following a standardized analgesic protocol consisting of patient-controlled intravenous morphine, acetaminophen, and non-steroidal anti-inflammatory drugs.

In the second stage scheduled on the next day, tumor resection was completed via a posterior approach using cutting jigs, followed by reconstruction with a custom-made 3D-printed implant (Implantcast®, Buxtehude, Germany) (Figures 7, 8).

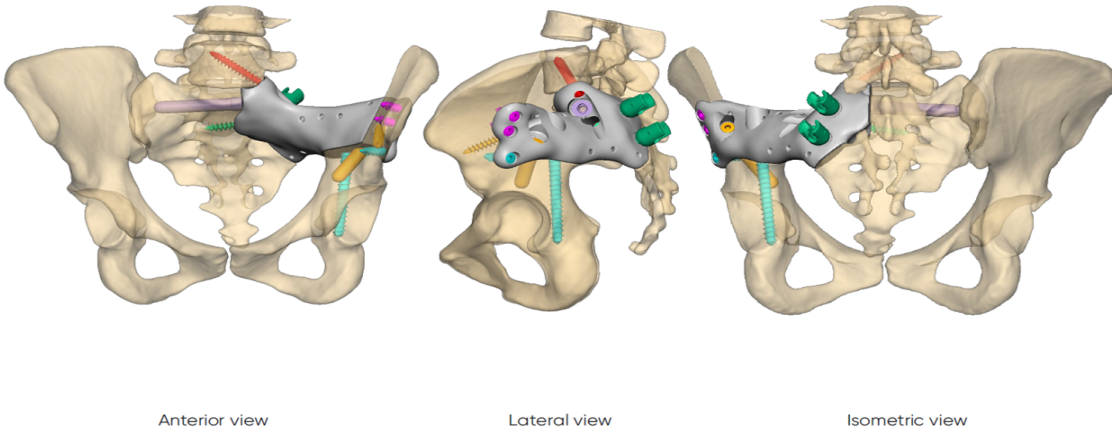

Figure 7: Reconstructive planning of the custom-made 3D-printed prosthesis (Implantcast®, Buxtehude, Germany).

Figure 8: Post-operative X-ray of the reconstruction.

The robotic procedure was completed safely and successfully, demonstrating the feasibility of this technique for such pelvic tumors. This robotic-assisted approach provided enhanced control and visualization within the confined retroperitoneal pelvic space, contributing significantly to the effectiveness and safety of both the resection and reconstruction, while offering a far less invasive approach to the patient.

Discussion

Robotic procedures have become established minimally invasive approaches for a wide range of clinical indications. These advanced systems provide three-dimensional visualization, enhanced magnification, and wristed instruments. They are currently applied across many disciplines. We report a first-described hybrid surgical resection of a pelvic Ewing sarcoma using both robotic and open approaches. The robotic procedure, performed within a two-stage surgical strategy, was safe and successful, aiding postoperative recovery in our young patient.

The author certifies that there are no funding or commercial associations (consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article related to the author or any immediate family members.

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