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CASE STUDY

A Novel Use of Foley Catheters to Prevent Injury to the Pelvic Viscera During Stereotactic Radiosurgery for Undifferentiated Pleomorphic Sarcoma of the Sacrum

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Abstract

The use of a Foley catheter to protect the small and large bowel from radiation injury during stereotactic radiosurgery to the spine has not previously been described in the surgical literature. Many spine tumors should be treated with stereotactic radiosurgery as opposed to external beam therapy, yet the proximity of visceral organs may preclude adequate target delivery of radiation. We describe the novel use of Foley catheters placed intraoperatively to displace the bowel during stereotactic radiosurgery, allowing for a full radiation dose to be safely delivered to the tumor. The advantages of this technique are the low cost, the ability to place multiple catheters intraoperatively, and the ability to withdraw all the catheters after radiation without the need for reoperation.

Case Report

The patient was a 56-year-old woman with a history of T1N0M0 rectal adenocarcinoma treated with transanal excision followed by adjuvant chemoradiation 5 years before presentation. The patient had lymphovascular invasion, and she received 45.00 Gy to the whole pelvis and a boost of 55.60 Gy to the tumor bed, without subsequent local or distant recurrence. One year before presentation, she developed numbness of the lower left foot and leg; a magnetic resonance image (MRI) of the pelvis revealed a 4.2 cm × 1.8 cm mass compressing the left S1 nerve root, initially thought to represent a peripheral nerve sheath tumor (Figure 1). Fine needle aspiration of the mass demonstrated an unclassified spindle cell neoplasm but could not diagnose the mass as malignant, and a subsequent core needle biopsy again demonstrated a spindle cell neoplasm. Thus, the working diagnosis was nerve sheath tumor. The patient was very symptomatic from radiculopathy, and her treatment options included observation, radiation, or surgery. Conventional external beam radiation therapy was not possible because of the patient's history of radiation therapy, and the bowel had already received the maximal dose of radiation. The patient elected surgery and underwent a left S1 laminectomy for presumed schwannoma.

The pathology report demonstrated a grade 2 pleomorphic undifferentiated sarcoma with osteoclast-like giant cells, likely representing a radiation-induced tumor. The patient's new tumor was pathologically unrelated to the prior tumor, was located within the prior radiation field, and had evolved over an interval of several years after radiation. A postoperative MRI demonstrated a residual mass in the S1-S2 neural foramina with tumor extending into the pelvis, and resection for this

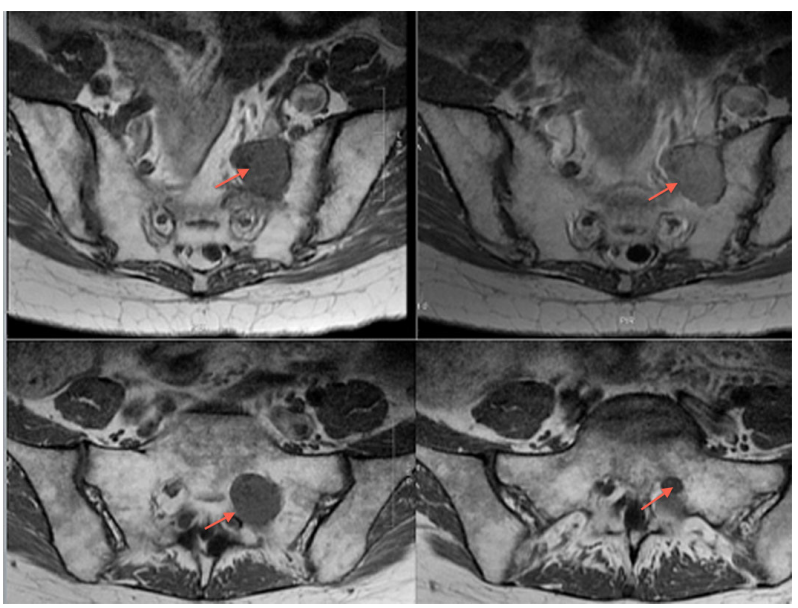

Figure 1. Axial images from the preoperative magnetic resonance imaging of the pelvis with gadolinium. Serial images define the superior-inferior extent of the tumor (arrow).

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ventral component was not achievable by a posterior approach. The patient thus underwent an exploratory laparotomy for removal of this anterior component of the tumor. The pathology report from this procedure demonstrated a pleomorphic undifferentiated sarcoma with osteoclast-like giant cells and a lymph node with clear margins. Subtotal resection was achieved.

A postoperative MRI of the pelvis demonstrated a mass-like rind of enhancing material in the anterolateral margin of the left S1 neural foramen, suspected to be a residual tumor. Stereotactic radiosurgery (SRS) was planned to treat the residual tumor, but the patient was given time to recover from her surgical procedures. One month later, a repeat MRI demonstrated tumor progression. The patient's case was presented at tumor board, and it was felt that further anterior debulking was critical. However, it was not feasible to achieve this via an anterior laparotomy because of the sacral promontory obstructing the approach. Thus, a revision via the posterior approach would be necessary. However, a gross total resection would not be possible because of the previous subtotal resection, and SRS was critical for control of the residual tumor. Preoperative evaluation demonstrated that the adjacent bowel was too close to the tumor for safe delivery of adequate dosing to the tumor by SRS. Thus, the preoperative planning included a method to keep the bowel away from the sacrum during SRS and to subsequently allow the bowel to return to its normal anatomic position next to the sacrum after SRS.

The initial preoperative plan was to use aortic angioplasty catheters to create a space that would displace the bowel, which could subsequently be deflated and withdrawn easily. The patient underwent a revision via the posterior approach to remove the tumor and to attempt placement of the angioplasty catheters. Bilateral ureteral stents were placed, the small bowel and rectum were dissected off the anterior surface of the sacrum, and a revision S1-S2 laminectomy, partial resection of the sacrum, and resection of the left S1 nerve root were performed. The tumor that could be safely removed from a posterior approach was resected, but clearly the anatomic limitations precluded a gross, total resection. The stiff and relatively sharp tips of the angioplasty catheters prevented safe and accurate placement. In addition, upon inflation of the balloon, the construct was very stiff and not malleable, precluding proper placement of the balloons. Thus, the strategy of placing these angioplasty balloons was abandoned.

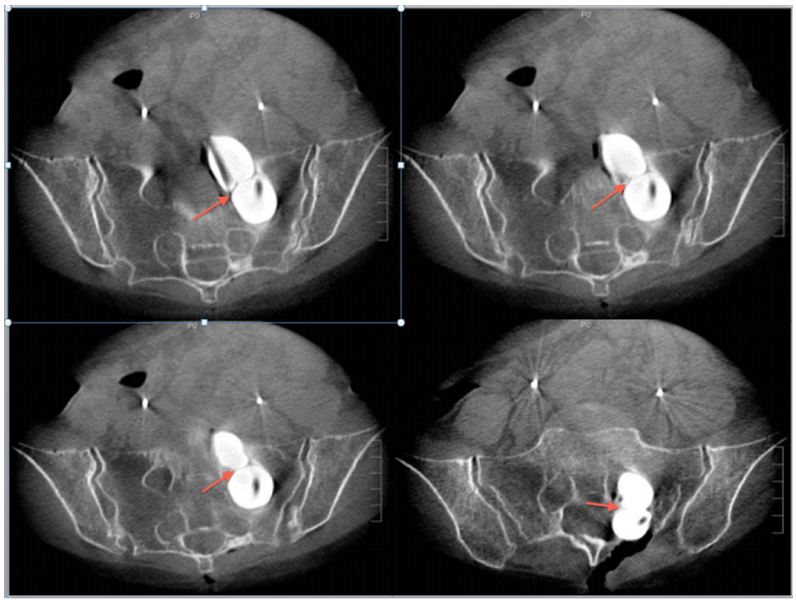

Figure 2. Intraoperative O-arm images with two large-volume Foley balloons (arrow) positioned adjacent to one another in the pelvis anterior to the sacrum.

Intraoperatively, the discussion turned to identifying alternate catheters that were soft, malleable, and already equipped with a balloon, leading to the selection of a large-volume-balloon Foley catheter. Two Foley catheters, with balloon volumes of 30 cc each, were obtained and placed ventral to the sacral defect. The tips of the Foley catheters were trimmed to prevent iatrogenic injury or erosion into native structures during postoperative radiation therapy. Because a single catheter would not stay in place, a second catheter was placed dorsal to the first to prevent it from migrating (Figure 2). They were placed manually and then inflated with barium mixed with saline. An intraoperative O-arm image (lower-resolution intraoperative computed tomography) confirmed satisfactory position of the catheters and adequate distance between the sacrum and the bowel (Figure 2). Because the manufacturer's instructions recommend saline as the appropriate fluid for balloon inflation, two new Foley catheters were then placed directly through the sacral wound and inflated with saline. The two drains were placed adjacent to each other in a buttressing manner and were not secured to each other. They were then tunneled laterally through the subcutaneous tissues and secured to the skin exit sites with nonabsorbable sutures. The skin was closed primarily over the surgical incision, and the sacrum provided the barrier to prevent Foley catheter migration posteriorly. The patient was discharged on postoperative day 4 and subsequently received an SRS boost totaling 30.00 Gy in 5 fractions, with minimal dose to the adjacent bowel. The Foley catheters remained in situ for the duration of radiation therapy. They were removed in the outpatient clinic in the standard manner, as with other intraabdominal drains, after premedication with oral narcotics on the final day of radiation treatment, 3 weeks postoperatively. The balloons were inspected and were without leakage.

The final pathology report was of a grade 2 pleomorphic undifferentiated sarcoma with osteoclast-like giant cells.

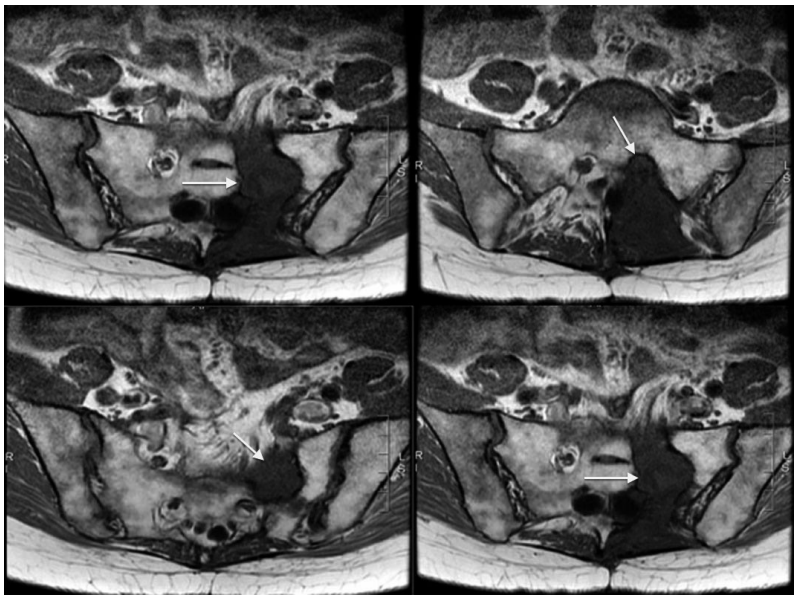

Figure 3. Postoperative axial magnetic resonance imaging with gadolinium demonstrating near complete tumor response (arrow) in the resection bed after radiation therapy.

Immunohistochemical staining revealed a moderate to high mitotic index with an MIB-1 labeling index of 15%. Patchy CD31 staining of the tumor raised the remote possibility of an atypical angiosarcoma, but staining for vascular markers including Fli1, thrombomodulin, and factor VIIIa was negative. The tumor was negative for melanoma markers (S-100, HMB-45, and Melan-A), as well as keratin, arguing against sarcomatoid carcinoma (which is the more common presentation of recurrence of a rectal carcinoma). The staging classification was T1N0M0.

The patient subsequently completed an electron boost dose of 12.50 Gy in 5 fractions with 6 MV electrons directed to the postoperative bed and 5 cycles of adjuvant chemotherapy with ifosfamide and epirubicin. She presented with symptoms of a possible closed-loop small bowel obstruction 10 months after her last operation. She was brought to the operating room promptly and no closed-loop obstruction was found, but she did undergo lysis of adhesions with no requirement for bowel resection, and she recovered uneventfully. At the time of surgery for the bowel obstruction, the area of adhesion was remote from where the previous radiation had been delivered. There were no significant findings of inflammation or adhesions in the area of the previous Foley catheter placement. The most recent imaging, at 14-month follow-up, demonstrated no evidence of an active tumor after subtotal resection and SRS (Figure 3).

Discussion

External beam radiation therapy and SRS are important adjunctive therapies in the field of surgical oncology and in the treatment of sarcomas. Although radiotherapy has a significant role in the management of pelvic malignancies, the small intestine is the main dose-limiting organ. A variety of pelvic partitioning methods (both invasive and noninvasive) to exclude bowel from radiation fields using both native and prosthetic materials have been described previously. An early study of 60 patients with rectal and gynecologic malignancies reported the benefit of using a polyglycolic acid mesh to create an absorbable intestinal sling and suspend the loops above the pelvic radiation field.[1] MRI was used to confirm the mesh position and its complete resorption at the third to fifth postoperative month. The authors concluded that this approach is safe in select patients with high recurrence risk after surgery, for residual disease after debulking surgery, or at the time of exploration for unresectable pelvic tumors.

Authors of subsequent reports modified that approach by using laparoscopy to place an absorbable pelvic sling in patients requiring pelvic radiotherapy.[2] Another more recent novel strategy is the use of an air-filled breast prosthesis to exclude small bowel from the pelvis; this was performed following resection of recurrent adenocarcinoma of the ascending bowel.[3] The disadvantage of this approach is the need for reoperation to remove the prosthesis once the radiation therapy has been completed. Katsoulakis et al[4] reported a similar technique using saline bags placed by interventional radiology, but a standard Foley catheter was not used in these ten cases. Sezeur et al[5] also described a similar technique, but again, they used prosthetics, not standard Foley catheters.

In patients such as ours with a previous history of external beam radiation, SRS is an important option, but it carries an increased risk of injury to the adjacent small bowel and rectum. For those patients who have exceeded the normal-tissue maximum tolerated dose of external beam therapy in the treatment of unrelated malignancies, alternate treatment strategies are necessary. In the current case, because of anatomic constraints, interventional radiology to either place a physical barrier or to infiltrate the presacral space with saline to displace the bowel anteriorly before radiation treatments was deemed unsuitable. We initially considered an operative approach involving the use of an angioplasty catheter but intraoperatively chose not to proceed with that strategy when we recognized that we could not orient the inflexible catheters in the presacral space without risking injury to the intestine.

The only other therapeutic alternative would have been to use intraoperative radiation therapy. However, because the sacral nerve roots had already received maximal radiation, intraoperative radiation therapy could not be safely delivered. Ultimately, the novel use of a Foley catheter enabled the patient to undergo successful treatment, with successful removal at the completion of treatment.

Conclusion

To reduce the risk of radiation injury to the small bowel and rectum during stereotactic radiosurgery for tumors of the sacrum, a large-volume Foley catheter can be positioned intraoperatively in the pelvis to temporarily displace the visceral organs. The advantages of this approach are the low cost, the ability to place multiple catheters to displace the bowel, and the ability to remove the catheters without the need for reoperation. ❖

Disclosure Statement

Dr Chou reported receiving honoraria from Medtronic and Depuy; he is also a consultant for Globus and Orthofix. Dr Maa is on the Board of Directors of the American Heart Association and the San Francisco Medical Society. Dr Jahan reported receiving grant support from Pfizer, Aduro Pharmaceuticals, Morphotek, OSI/Roche, and Medimmune; he is also a consultant for Clovis Pharmaceuticals and Novartix. No other conflicts of interest were disclosed.

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