

IMRT Case Studies

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At our institution, we routinely use IMRT to treat prostate cancer and head and neck malignancies, but in several situations we have employed IMRT in novel ways. The following case studies demonstrate how IMRT can work for patients for whom radiotherapy would not otherwise be possible or would be suboptimal due to critical structures within the radiotherapy field. Some of the limitations of the technique are also explored.

CASE 1: A 65-year-old white female underwent a LEEP procedure with clear margins for cervical intraepithelial neoplasia, grade III, in 1999. Routine follow-up Pap smears were normal. One year ago, she developed postmenopausal bleeding. Two attempts at D&C were unsuccessful due to severe stenosis of the upper vaginal region that precluded visualization of the cervical os. A pelvic ultrasound and an MRI of the pelvis revealed an enlarged uterus with fluid in the endometrial cavity. No pelvic masses, ascites, or pelvic lymphadenopathy were found.

The patient developed abdominal pain and was admitted to Trinity Hospital for consideration of surgery. Examination under anesthesia revealed an enlarged uterus and confirmed the above physical findings. The parametria could not be fully evaluated due to the foreshortened vaginal vault. The patient was taken to surgery and underwent a supracervical hysterectomy with bilateral salpingo-oophorectomy. Intraoperative pathology revealed a squamous cell carcinoma of the cervix. During the procedure a gynecological oncology opinion regarding further surgery was obtained from the Mayo Clinic. The advice was to leave the remaining cervical stump and refer the patient to radiotherapy. The final pathology specimen revealed that the cervical tumor extended into the right parametrium.

The patient was subsequently evaluated at the Trinity CancerCare Center, and chemoradiotherapy was recommended. The initial pelvic exam revealed complete obstruction of the posterior vaginal vault, making brachytherapy impossible. The patient underwent radiotherapy planning to evaluate how much external radiotherapy could be used. We planned to treat the whole

pelvis followed by a 3D or IMRT boost. Comparison of the plans and review of the dose volume histograms revealed that the IMRT technique would expose the rectum, bladder, small bowel, and femoral heads to significantly less radiation. Consultation with radiology showed that the cervical stump could be visualized on ultrasonography, so our BAT localization device could be used. The patient received 4,500 cGy to the whole pelvis followed by an IMRT cone-down to 7,560 cGy with concurrent chemotherapy. The patient tolerated the therapy with the expected acute toxicities we have seen with conventional radiotherapy, brachytherapy, and chemotherapy.

CASE 2: Due to the resource-intensive nature of IMRT for both planning and treatment delivery, we have not routinely used it to treat breast cancer, one of the most frequently seen malignancies in our clinic. Recently, however, this new technology was applied to the care of a 50-year-old white female diagnosed with Stage I left breast cancer who was anxious to receive breast-conserving therapy. Review of her history revealed that she had been diagnosed with interstitial lung disease four years ago, etiology unknown. Follow-up pulmonary function tests at our institution were normal for spirometry and total lung volume, but an isolated diffusion defect—again of uncertain etiology—was found and her diffusion capacity had decreased slightly since diagnosis. Given her lung condition, I felt that it was prudent to minimize the dose of radiotherapy to her lungs. We performed a comparison of 3D conformal radiotherapy and IMRT, and IMRT was clearly superior with respect to the homogeneity of the dose that would be delivered to the affected breast and the reduced amount of radiotherapy the left lung and heart would receive. The patient is currently completing chemotherapy and will start radiotherapy in the near future.

CASE 3: All too often radiation oncologists are faced with recurrent or metastatic disease within a previously treated field. If one considers the patient's performance status, the burden of disease, the impact of uncontrolled disease on the patient's quality of life, and the natural history of the particular malignancy, circumstances may exist when IMRT is a reasonable treatment choice in this setting.

Two years ago, an 85-year-old man returned to Trinity with recurrent renal cell carcinoma within a previously treated field. The history of his malignancy

dated back to 1979, when he underwent a right radical nephrectomy followed by radiotherapy to the tumor bed and draining nodes.

He did well until the summer of 1997, when he developed biopsy-proven metastatic renal cell carcinoma to the pleura abutting the right side of the T3 vertebral body. The extent of disease evaluation revealed that the recurrence was isolated. He was treated with external beam radiotherapy and received 3,500 cGy in 250 cGy fractions using AP/PA fields, followed by 1,500 cGy in 250 cGy fractions using off-cord oblique fields. The total dose delivered to the spinal cord was 3,500 cGy in 20 fractions. He received systemic therapy with interferon, which was discontinued after a few treatments due to poor tolerance. Follow-up evaluations revealed a complete radiographic response to therapy.

He did well until January 2000, when he developed a recurrence in the right side of the T3 vertebral body. Surgical stabilization was performed at M.D. Anderson Cancer Center in Houston, Tex., followed by chemotherapy with gemcitabine and 5-FU over several months. In August 2000 his disease progressed, and we used IMRT to treat the recurrent paraspinal mass. He received 3,800 cGy in 19 fractions using 58 segments. The maximum dose delivered to the spinal cord with IMRT was 1,600 cGy. He did well post-treatment, with a fair to good performance status.

Fourteen months later he developed brain metastases which were treated with whole brain external radiotherapy, but he died two months after therapy was completed. His upper back was symptom free until his death.

CASE 4: Unfortunately, IMRT is not suitable for every patient. Earlier this year, we evaluated a 65-year-old Native American male for radiotherapeutic treatment of a malignant mesothelioma in the pleura of his right chest. The neoplasm had been diagnosed eight months earlier at the Mayo Clinic. Four cycles of neoadjuvant chemotherapy with cisplatin and gemcitabine had been administered prior to possible surgical resection, and had produced a partial response.

After chemotherapy was completed, a thoracoscopy revealed that his disease was unresectable, and the patient was referred to Trinity for possible radiotherapy. After three weeks of exhaustive IMRT planning, we reluctantly concluded that his tall stature (6'6") created a field length that was too long for our machine. He received conventional radiotherapy with chemotherapy in an attempt to achieve local control, and is alive with evidence of disease at the current time.

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Retroperitoneal sarcomas represent about 10 to 15 percent of all soft tissue sarcomas. Complete surgical resection is the only potentially curative treatment, but many patients are not eligible for this procedure

because they present late in their disease course with large masses involving nearby critical structures. Even those patients who undergo gross complete resection will develop recurrences in the tumor bed about 50 percent of the time.

Although postoperative external beam radiation therapy may modestly decrease the rate of local recurrence, postoperative radiotherapy is not particularly efficient because the small bowel and other sensitive structures in the abdomen move into the surgical site after resection and have a low tolerance for radiation. Radiation therapy may be given during surgery when the small bowel can be physically retracted away from the tumor bed, but the dose is limited since only a single fraction can be delivered.

Administering radiotherapy preoperatively has several advantages, including using the tumor mass as a tissue expander to minimize the amount of normal tissue exposed to the radiation beam, sterilizing tumor clones that can be spilled at the time of surgery or exist at the margins of resection, and making treatment planning more accurate.

To date, 14 patients with retroperitoneal sarcomas have been treated with preoperative IMRT at the University of Alabama-Birmingham. Tolerance has been excellent with only mild to moderate nausea and vomiting. At early follow-up, only one patient has developed a local recurrence. Future trials will evaluate higher doses of preoperative IMRT and possibly add adjuvant chemotherapy for high-grade tumors.

We present a novel use of preoperative IMRT for retroperitoneal sarcomas, where the radiation dose is increased only to the portion of the tumor at risk for positive margins. Treatment time was the same as for conventional radiation therapy (Monday through Friday for 25 fractions), but the amount given per day to the margins at risk was escalated.

CASE 5: A 60-year-old white female presented with increasing abdominal pain and a 25-pound weight loss. Her referring physician palpated a mass in the pelvis and obtained a diagnostic CT scan, which showed a right-sided retroperitoneal mass with hydronephrosis. The tumor was encroaching on the superior vena cava. A core needle biopsy revealed a poorly differentiated mesenchymal sarcoma. Because of the proximity of critical structures, she was treated with neoadjuvant IMRT. The entire tumor received 45 cGy in 25 fractions at 1.8 cGy per fraction, but the volume judged to be at risk for microscopically positive margins was escalated to 57.5 cGy in 2.3 cGy fractions. During treatment the patient had only mild nausea that was controlled with oral medication. Approximately six weeks after her radiotherapy was completed, the patient underwent resection, which included removal of the right kidney. Pathology demonstrated residual scar and necrotic debris, but no remaining viable tumor. Postoperatively, the patient did well and regained weight. Eight months after surgery she developed an isolated recurrence in the lungs and is now being evaluated for surgical resection of pulmonary metastases. CT scans of the abdomen and pelvis show no evidence of local failure. ■