Radiation Therapy Clinical Training

Case Study on Leiomyosarcoma (LMS)

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Abstract

Leiomyosarcoma (LMS) is a malignant soft tissue sarcoma tumor of the muscle. Sarcomas are very vascular, with large internal and external tumor blood vessels that typically occurs in adults, especially women. (Chu et al., 2003) The majority of patients diagnosed with LMS are currently treated with surgical excision limb preserving surgery, radiation therapy or occasionally with chemotherapy or a combination of both. Almost 45% of all soft tissue sarcomas are located in the extremities, especially in the lower limb (Gomez ve Morcuende, 2004).
Introduction

In the previous six months, I had the pleasure of meeting and following a patient that I will refer to as Mrs. P. She was so generous to allow me to take part in her fight with LMS. I was involved in Mrs. P’s initial consultation to her final treatment and her clinic follow-ups. In this case study I will address the consultation, CT simulation, treatment planning, daily treatment and any side effects Mrs. P experienced during or after treatment. I will conclude with current treatment options that are available for this type of sarcoma.

Consultation

Mrs. P is an 83 year old female that was recently diagnosed with LMS of the right calf. She noticed an enlargement of her right calf with some tenderness while pressure was applied. The patient has a prior history of LMS of her pelvis, status post resection with positive margins. Mrs. P was treated with radiation therapy to the pelvic mass consisting of 5,400cGy in 30 treatment fractions, treatment was completed on (3/5/2008).

Due to her prior history of LMS the oncologist diagnostic testing done. Mrs. P was scheduled for a diagnostic Computer Tomography (CT), Magnetic Resonance Imaging (MRI), biopsy and a Computer Tomography Positron Emission Tomography (PET/CT) scans of the right lower extremity. On (1/9/2013) a CT with contrast was administered, results of this scan reviled a large 10cm soft
tissue mass that expands the soleus muscle. Her MRI scan on (1/15/2013) presented a 10.2cm x 6.6cm x 7.2cm heterogeneous, necrotic-appearing mass in the soleus muscle consistent with a tumor. On (1/17/2013) Mrs. P underwent a biopsy of the right calf mass, the biopsy reviled LMS. Mrs. P also underwent a PET/CT scan on (1/30/2013), the scan showed uptake of Flurorodeoxyglucose (FDG) in the mass in her right lower extremity of a SVU of (9.6).

The plan of action taken for Mrs. P was resection the right lower extremity calf mass, also a posterior tibial vessel resection with post-surgical radiation therapy.

**Detection and Diagnosis**

Pathology reviled a high grade LMS tumor measuring 13cm x 12cm x 9cm involving subcutaneous tissue, with sarcoma present at the posterior soft tissue edge adjacent to the skin. The anterior tibial artery was also grossly involved with tumor, the discovery of a secondary 5cm x 2cm x 2cm additional tumor was focused adjacent to posterior tibial artery with margins negative less than 1mm. There was no evidence of lymph node involvement. The pathological classification of this malignancy is a high grade LMS, stage: III (pT2b Nx M)

The oncologist and pathologist discovered upon examination of Mrs. P’s CT scan and PET/CT from (1/9 and 1/30/2013) there is a small right lung nodule. The
nodule did appear to present with minimal uptake of FDG. The oncologist elected to wait for any changes to appear due to an unclear significance.

**Simulation**

The simulation was performed with a Phillips big bore CT scanner equipped with LAP laser tumor localization technology. Mrs. P was positioned prone with one pillows under her abdomen, prone wedge under her hips and a prone pillow for head placement and comfort. *(See Image below)*

![Rt. Calf Patient Table Set-up for Treatment](image-url)

I constructed the custom Vac-Loc to position the right leg more superiorly to avoid any chance for the left leg/calf to be in the beams path, also formed the Vac-Loc around the lateral edges of Mrs. P’s ankle and upper thigh also formed the sides of the Vac-Loc below the calf. Due to the beams possible angles. I did not want any part of the vac-loc to attenuate the beams and possibly adding a bolus effect. For easy reproducibility I abutted the vac-loc to the prone wedge with a Styrofoam block under her ankle for support. *(See Image below)*
Mrs. P’s scar was marked with (CT-Spot) field outline, and (Y-Spot) or bee bees where placed on locations marked for tattoos. The superior and inferior tattoos are used for patient straightness and the center tattoo is the CAX (central access) with a shift of 2cm shift left from center of the scar. (See Images below)
Treatment Planning

After simulation of Mrs. P, I was able to partake in the treatment planning process. The oncologist expressed his intention of treatment fields consisting of two parallel opposed fields. Using the pinnacle treatment planning software in dosimetry, I constructed the Digital Reconstructed Radiograph (DRR) used for treatment, and outlined the regions of interest. The outlined regions consisted of the tumor bed and surgical scare. There wasn’t a need for a Dose Volume Histogram (DVH), due to the area of interest was located in the lower right calf and no critical structures where located in the treatment fields. Developing the treatment fields alongside the dosimetrist, physicist, and oncologist was a great experience.

The angels I developed for the treatment plan was approved by the oncologist are as follow. Beam one was a left lateral (Lt. Lat) with a gantry angle
of 90°, a collimator angle of 73° with a couch kick of 5° to 185°. The (Lt. Lat) utilized Multi-leaf Collimation (MLC) blocking with an Electronic Dynamic Wedge (EDW) of 30°. Beam Two was a Right lateral (Rt. Lat) with a gantry angle of 270°, a collimator angle of 278° with a couch kick of 5° to 185°. The (Rt. Lat) also utilized Multi-leaf Collimation (MLC) blocking with an Electronic Dynamic Wedge (EDW) of 30°. The prescription for this treatment plan consisted of using 6MV photons of 200cGy per treatment fraction for 25 fractions totaling a dose of 5,000cGy. Treatment was administered from (6/4/2013-7/12/2013).

There was also additional plans for two treatment boosts. Boost one was planned with a cone down consisting of all the same angels as the main treatment plan with a prescription of 6MV photons of 200cGy per treatment fractions for 5 fractions totaling a dose of 1,000cGy. Treatment was administered for boost one from (7/15/2013-7/19/2013).

Boost two was planned with an additional cone down from boost one consisting of all the same angels as the main treatment plan with a prescription of 6MV photons of 200cGy per treatment fractions for 3 fractions totaling a dose of 600cGy. Treatment was administered for boost two from (7/30/2013-8/1/2013). The total number fractions for all treatments delivered was a total of 33 fractions with a total dose of 6,600cGy.
(Below are the treatment plans, boosts 1, and 2 also field block shapes)

**Plan Summary Sheet**

**Main Treatment Plan**

### Beam Setup

<table>
<thead>
<tr>
<th>Beam</th>
<th>Machine</th>
<th>Energy</th>
<th>Modality</th>
<th>Prescription</th>
<th>Isocenter</th>
<th>SSD (cm)</th>
<th>MU Per Fraction</th>
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<tbody>
<tr>
<td>12 L Lat R Cal...</td>
<td>21–23 EX</td>
<td>6 MV</td>
<td>Photons</td>
<td>Rt Lower Leg</td>
<td>ISO</td>
<td>95.40 / 95.40</td>
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<th>Wedge</th>
<th>Bolus</th>
<th>Comp</th>
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<tr>
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<td>90.0 / 90.0</td>
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<td>73.0 MLC</td>
<td>EDW</td>
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<tr>
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<td>270.0 / 270.0</td>
<td>185.0</td>
<td>287.0 MLC</td>
<td>EDW</td>
<td>No</td>
<td>No</td>
<td></td>
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### Prescriptions

**Rt Lower Leg**
Prescribe 200 cGy per fraction to 100% of point dose at "ISO" for 25 fractions.
Beam weights are proportional to point dose.
Actual point dose at "ISO" from all prescriptions/beam is 5015.08 cGy.
2 beams are assigned to this prescription.

### Isocenter

**ISO**
Position patient such that lasers line up with patient marks.
No left/right table adjustment is required.
Move the table UP 5.00 cm.
No in/out table adjustment is required.
Main Treatment Plan Field Block Shape for Rt. Lat
Main Treatment Plan Field Block Shape for Lt. Lat
Rt. Calf Block Check of (Lt. Lat) Treatment Field Outline from Main Plan
**Boost #1 Treatment Plan**

### Beam Setup

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<td>90.0 / 90.0</td>
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<td>MLC</td>
<td>EDW</td>
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### Prescriptions

**R Lower Leg Bst**

Prescribe 200 cGy per fraction to 100% of point dose at "ISO" for 5 fractions.

Beam weights are proportional to point dose.

Actual point dose at "ISO" from all prescriptions/beams is 996.196 cGy.

2 beams are assigned to this prescription.

### Isocenter

**ISO**

Position patient such that lasers line up with patient marks.

No left/right table adjustment is required.

Move the table UP 5.00 cm.

No in/out table adjustment is required.
Boost #1 Treatment Plan Field Block Shape for Lt. Lat
Boost #1 Treatment Plan Field Block Shape for Rt. Lat
Rt. Calf Block Check of (Lt. Lat) Treatment Field Outline 1st Boost Plan
Plan Summary Sheet

Boost #2 Treatment Plan

Beam Setup

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<th>Prescription</th>
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Prescriptions

R Lower Leg Bst2
Prescribe 200 cGy per fraction to 99% of point dose at "ISO" for 3 fractions.
Beam weights are proportional to point dose.
Actual point dose at "ISO" from all prescriptions/beams is 606.874 cGy.
2 beams are assigned to this prescription.

Isocenter

ISO
Position patient such that lasers line up with patient marks.
No left/right table adjustment is required.
Move the table UP 5.00 cm.
No in/out table adjustment is required.
Boost #2 Treatment Plan Field Block Shape for Rt. Lat
Boost #2 Treatment Plan Field Block Shape Lt. Lat
Patient Treatment Follow-up

Mrs. P’s first treatment and block check went fairly well. She was setup with minimal discomfort and seemed to appear relaxed. The first port films were approved, we proceeded with her first treatment. During the duration of her treatments, Mrs. P experienced minimal discomfort or skin reaction. She did present with in the last week and half before end of treatment had expressed the feeling of pain in the right heel inferior to the treatment field and surgical scar.
On August 6\textsuperscript{th}, 2013 one week after her last treatment Mrs. P presented with mild erythema, pigmentation and a small opening at the inferior aspect of the scar with a small amount of drainage. Over the course of treatment she handled treatment better than expected.

On September 4\textsuperscript{th}, 2013 one month after her last treatment Mrs. P still complained of right heel pain that has been present since surgery. Within the prior radiation fields the skin is well healed, with some residual increased pigmentation and the absences of erythema, desquamation, or any evidence of infection. The inferior portion of the scar still demonstrates a small (4-5mm) opening with drainage of yellowish fluid without the presents of bleeding or infection. Also she is experiencing tenderness to palpation of the right calf in the location around the prior surgical and radiation therapy areas.

On October 23\textsuperscript{rd}, 2013 two and a half months after her last treatment. Mrs. P continues to report pain in her right heel, approximately with a level of 5 out of 10. She also underwent an MRI for her calf on (10/14/2013), which showed no evidence of infection at the surgical site or no obvious fistula at the small wound opening. Mrs. P on (10/14/213) underwent a CT of her chest that showed an increase number in size of the bilateral pulmonary nodules that were previously discovered on a prior scan before Radiation treatment.
On December 11th, 2013 four months after the completion of adjuvant radiation therapy of the right calf for resected leiomyosarcoma. The examination of the right calf showed posteriorly a small (3-4mm) unhealed opening and an additional tiny (1mm-2mm) opening just superiorly os scar. There was no evidence of erythema or infection. Mrs. P still has tenderness of the right calf which is noticeably less than prior exam. The oncologist presented Mrs. P with the findings from her (10/25/2013) CT guided biopsy of the lung. The results of the pathologic report showed metastatic LMS. Consultation with Mrs. P about palliative radiation therapy of her lung mass was addressed with Mrs. P. She expressed she was not going to proceed with any more radiation treatments or surgeries.

**Leiomyosarcoma (LMS)**

Leiomyosarcoma (LMS) is classified by their anatomical site of presentation, retroperitoneum, subcutaneous skin, blood vessels or extremities. (De Vita Jr Vt, 1997) In the case with Mrs. P, the location involved is the lower right extremity (right calf).

**Etiology**

Current researchers speculate a contributing role in causing LMS, is genetic changes that occur spontaneously or may be inherited. (De Vita Jr Vt, 1997) LMS malignancies may develop due to abnormal changes in the structure and orientation of certain cells known as oncogenes (tumor suppressor genes).
Oncogenes control cell growth and cell division and ensure that cells die at the appropriate time.

The specific cause of the changes is unknown. Research suggests that abnormalities of in DNA (deoxyribonucleic acid), is the underlying source of cellular malignant transformation. (Sarcoma, 2012) There aren't many known risk factors for LMS, but higher risk may be increased due to Age. LMS can occur at any age, but overall is more common in older adults. Chemical exposure of certain chemicals, such as vinyl chloride and dioxin, can increase the risk of soft tissue sarcomas. (Moynihan TJ, 2007) Radiation exposure of previous radiation treatment for other cancers can increase the risk of soft tissue sarcomas.

**Epidemiology**

Soft tissue sarcomas account for 1% of all adult cancers in the U.S. According to one estimate, Leiomyosarcomas account for 7-11% of all cases of soft tissue sarcomas. (American Cancer Society, 2012) Leiomyosarcoma is primarily a disease of middle-aged people, presenting between the years 50-60, especially women. (Gomez ve Morcuende, 2004) Individuals diagnosed with LMS have an 8% chance of developing local recurrence also a 45% of LMA metastases. (Washington, Leaver, 2010) The American Cancer Society's estimates about (12,020) new soft tissue sarcomas will be diagnosed this year (6,550 cases in males and 5,470 cases in females) and 4,740 in Americans (2,550 males and 2,190
females) are expected to die of soft tissue sarcomas in the United States for 2014. (American Cancer Society, 2012)

**Diagnostic methods**

General symptoms with patients diagnosed with LMS is pain located in the affected area. Swelling and a mass is commonly detected. Mrs. P was experiencing pain and numbness in her right lower extremity, and was also noticing the right calf was significantly larger with a hard mass palpable under her skin. The oncologist performed a complete physical exam. After completion of the exam he ordered standard imaging tests.

The tests ordered was a diagnostic X-ray, Computerized Tomography (CT) scans, Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET), also a CT guided biopsy. The battery of test ordered appeared to be excusive, but due to Mrs. P’s history with prior Leiomyosarcoma of her pelvis. Out of all the diagnostic procedures completed, the most important test was the full body PET/CT scan preformed on (10/30/2013). The scan revealed there was an increase of Flurorodeoxyglucose (FDG) uptake in the lung nodules and increase in size, with an additional noticeable uptake in the thyroid. This was conclusive of metastatic disease.
Pathology

Leiomyosarcoma is classified as a soft tissue sarcoma. Sarcomas are malignant tumors that arise from the connective tissue, this connects, supports and surrounds various structures and organs in the body. (Moynihan TJ, 2007) Most forms of LMS are aggressive tumors that may spread (metastasize) to other areas within the body. Because LMS typically spreads via the bloodstream and soft tissues is found all over the body, LMS can form almost anywhere where there are blood vessels. This includes the lungs the most prevalent site of metastases, heart, liver, pancreas, muscle, nerves, tendons the genitourinary and gastrointestinal tract and the abdominal cavity, uterus, skin. The lungs or liver, potentially causing life-threatening complications, if not diagnosed early. The 5-year relative survival rates for Leiomyosarcoma is: Stage I - 60%, Stage II - 35%, Stage III - 28% and Stage IV - 15%. (Washington, Leaver, 2010)

The pathologist evaluates the scans and determines how far the cancer has metastasizes. This is called staging. The evaluation of the appearance of the biopsied tissues under the microscope and judge how fast the cancer seems to be growing. When examining the biopsy sample accounts for the number of cells actively dividing and how closely the cancer cells resembles normal tissue. This determines the cell type and grade and estimates how rapidly the tumor will grow and spread. (Gomez ve Morcuende, 2004) After evaluation of Mrs. P’s biopsy and
scans the prior pathological classification of a high grade LMS, stage: III (pT2b Nx M) was updated to a high grade spindle cell neoplasm LMS, stage: IV (pT2b Nx M1)

**Current Treatment Options**

There are currently three treatment modalities available for LMS: surgery, radiation therapy and chemotherapy. The specific procedures and interventions is dependent upon several pathological factors. (NCCN, 2011) The factors for a specific treatment options for Mrs. P was the location of the primary tumor, extent of the primary tumor (stage), and degree of malignancy (grade). Also taken in to consideration is whether the tumor has metastasized to distant sites, her age and overall general health.

**Surgery**

Surgery is the most common treatment for soft tissue sarcomas, especially if malignant cells haven't spread to other parts of the body. Surgery for LMC generally involves removing the tumor and some surrounding healthy tissues, as with Mrs. P. If the sarcoma has spread, surgical removal of the primary and secondary tumors may be possible. Surgical amputation was previously a common treatment for soft tissue sarcomas in the arms or legs. (Washington, Leaver, 2010) Currently advancements in surgical techniques with the combination of chemotherapy and radiation therapy before or after surgery has allowed for the
possibility for limb-sparing surgery. In rare cases amputation is still required if LMS has invaded underlining nerves, arteries or muscle. (Moynihan TJ, 2007) This allow for the complete removal of all malignant tissue and tumor cells in the arms or legs. If initial surgery is not an option due to the specific location or progression of the malignancy, radiation therapy maybe include alone.

**Radiation**

Radiation therapy is also used to treat LMC. Oncologists likely will recommend using radiation therapy before surgery (neoadjuvant radiation therapy) or after surgery (adjuvant radiation therapy). The postoperative radiation helps treat known or possible residual disease and preoperative radiation administered halts the growth of tumor and reduces the size for possible surgical resection (Sarcoma, 2012).

Radiation and chemotherapy are also used before surgery (neoadjuvant chemo radiation therapy) or after surgery (adjuvant chemo radiation therapy). (Moynihan TJ, 2007) Chemotherapy administered alongside with radiation allows for the radiation to be more effective in destroying cancer cells (Sarcoma, 2012).

Treatment recommendations for patients with a surgical resectable disease, followed by radiation therapy is recommended for high-grade LMS. The benefits is a smaller treatment field and potentially less chance for tumor seeding during resection. The normal prescribed dose for radiation for LMS is 5,000cGy. (NCCN,
2011) Mrs. P was prescribed the normal radiation dosage for LMS treatment of 200cGy per day for 25 treatment fraction for a total dose of 5,000cGy, but she also was prescribed two treatment boosts. Boost one was administered 200cGy per day for 5 treatment fraction for a total dose of 1,000cGy and boost two was administered 200cGy per day for 3 treatment fraction for a total dose of 600cGy. The total dose given for her LMS treatment was 6,600cGy. The only negative aspect of such a high dose is significant wound healing complications. (NCCN, 2011)

**Chemotherapy**

Chemotherapy uses medications to kill rapidly dividing cells. These cells include cancer cells, which continuously divide to form more cells, and healthy cells that divide quickly, such as those in your bone marrow, gastrointestinal tract, reproductive system and hair follicles. (Sarcoma, 2012) Unlike radiation therapy, which treats only the part of your body exposed to the radiation, chemotherapy treats your body as a whole (systemically). Due to LMS spreads throughout the bloodstream. (Chemotherapy treats cells that passably have spread beyond where the cancer originated.

In Mrs. P case the oncologist felt that she wouldn’t benefit from chemotherapy alongside radiation. His choice was for radiation alone was due to the possible side effects from chemotherapy, her daily regimen of insulin for
diabetes and pain medications could cause extreme nausea, vomiting, fatigue, increased risk of infection, weakness and increased bleeding. (Washington, Leaver, 2010)

**Conclusion**

I have had the privilege to follow Mrs. P’s course of treatment for six months, from her initial consultation, final treatment until her last follow up in December of 2013. The treatment Mrs. P received was in accordance with the standard plan of treating LMS. She did receive two boosts to the initial treatment area, that the oncologist procived as beneficial for no possible reoccurrence of Mrs. P’s LMS.

The prognosis for Mrs. P unfortunately isn’t good. As mentioned in the follow up portion of the case study. Mrs. P on (10/14/2013) underwent a CT of her chest and a PET/CT full bod scan on (10/30/2013) that showed an increase number in size and uptake of FDG in the bilateral pulmonary lung nodules as well an additional noticeable uptake in the thyroid. This is pathologically decisive of metastatic LMS.

On December 11th, 2013 four months after the completion of adjuvant radiation therapy of the right calf for resected leiomyosarcoma. The oncologist presented Mrs. P with the pathological findings from her (10/25/2013) CT guided biopsy from her lung. The results of the report showed metastatic LMS. After Mrs.
P was presented with the finding from pathologist, the oncologist consulted with Mrs. P about her choices of treatment options. He discussed about surgery although there was a slim chance her lesions were resectable. He also discussed palliative radiation therapy of her bilateral pulmonary nodules. After some questions from Mrs. P on the likelihood of curability. She expressed that she wasn’t going to proceed with any more surgeries or radiation treatments.

Mrs. P indicated that she has lived and has a great life and was tired of all the surgeries, radiation and just wanted to enjoy the time she has left with her husband, children and grandchildren. She did express she knew this was coming after LMS of her pelvis and calf and now lungs. I knew before the biopsy was preformed what the outcome would be.
References


