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Retroperitoneal Liposarcoma: An Unusual Presentation of a Rare Cancer

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Abstract

Retroperitoneal liposarcomas (RLPS) are rare tumors that have variable clinical behavior and complex treatment strategies based on presentation, histopathology, and genomics. Early identification is critical, and complete surgical resection remains the primary treatment, although chemotherapy and radiation are used on individual bases. Presenting symptoms are often nonspecific; therefore, a high degree of suspicion is essential for early diagnosis. In this report, the management of a 37-year-old otherwise healthy male with a large RLPS causing right groin/testicular pain is presented. After three evaluations in the emergency department, the patient was diagnosed and received two cycles of doxorubicin/ifosfamide/mesna (AIM) neoadjuvant chemotherapy. His physical exam on presentation for second opinion demonstrated a large palpable abdominal mass and fullness around the right spermatic cord. There was no appreciable change in tumor size or distant metastases on repeat scanning. Given some obstructive symptoms, a multidisciplinary team advised neoadjuvant radiation followed by radical resection of RLPS. Final pathology demonstrated a 31-cm grade II well-differentiated (WD) liposarcoma with low-grade dedifferentiation. Scattered foci of microscopic positive WD margins were noted, and the remainder of margins were negative. Genomic evaluation showed amplification of *CDK4*, *MDM2*, and *FRS2*. A concise literature review of common presentations, histopathology, genomics, and treatment information is discussed herein. Thorough physical exams, attention to subtle findings, appropriate medical imaging studies, and a high index of suspicion when evaluating vague symptomatology can lead to earlier diagnosis and treatment of RLPS, and ultimately better patient outcomes.

CASE STUDY

Patient X is a 37-year-old otherwise healthy male who presented for a second opinion regarding treatment for his RLPS. According to the patient report, he initially visited his local emergency department (ED) with complaints of right groin and testicular pain. He had an ultrasound, which was normal, and was advised to use anti-inflammatories. Shortly thereafter he returned to the ED due to increasing right testicular pain. Blood work and scrotal ultrasound were again unrevealing. His third vis-

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it to the ED several days later prompted a CT scan of the abdomen and pelvis, which demonstrated a 25-cm retroperitoneal, heterogeneous, fat-containing mass that displaced his right kidney and intraperitoneal organs into the left hemiabdomen. He was admitted and CT-guided biopsy was performed. Pertinent pathologic and genetic results included presence of grade II dedifferentiated liposarcoma, no lymphovascular invasion, and fluorescence in situ hybridization (FISH) positive for mouse double minute 2 (*MDM2*) amplification. According to the report, follow-up staging CT scan showed no evidence for abdominopelvic lymphadenopathy or metastatic disease.

Patient X was evaluated at an outside facility by medical oncology and was started on neoadjuvant chemotherapy within 1 week of his staging CT scan. He received two doses of the AIM regimen (doxorubicin 25 mg/m^2 on days 1–3, ifosfamide 2,000 mg/m^2 on days 1–5, and mesna 2,000 mg/m^2 on days 1–5) with the last approximately 3 weeks prior to presenting to our facility. His intake physical examination was remarkable for a palpable mass causing distention throughout the entire abdomen, as well as fullness around the right spermatic cord compared to the left. Testes were normal to palpation bilaterally. The review of systems was positive for nausea with chemotherapy, constipation, intermittent difficulty voiding, and discomfort with deep breathing. Repeat CT scan was performed and demonstrated no appreciable change in the tumor size or interval development of lymphadenopathy or metastasis. His case was presented at our multidisciplinary cancer conference and the National Comprehensive Cancer Network (NCCN) Guidelines (2020) were reviewed.

Since Patient X demonstrated obstructive symptoms, the consensus of the conference was to halt chemotherapy and start neoadjuvant radiotherapy to assist with achieving negative margins, then proceed with resection. Patient X received 50 Gy intensity-modulated radiation therapy to the entire tumor volume (as per treatment guidelines by Baldini et al., 2015), ensuring the area where achieving negative margins could be potentially most challenging received the full dose (surgeon assisted in contouring). Figure 1 displays selected images from his post-chemotherapy and radiation preoperative CT scan that demonstrated no significant change in the tumor or interval development of lymphadenopathy or metastasis. His major vessels appeared to be compressed but uninvolved. Due to the significant displacement of the right kidney, ascending colon, and involvement of the right spermatic cord, the multidisciplinary surgical team consisted of a surgical oncologist, urologic oncologist, and surgical physician assistant.

Six weeks after the completion of radiation therapy, Patient X underwent a radical resection of retroperitoneal liposarcoma with en bloc right nephrectomy, right adrenalectomy, right orchiectomy, and right hemicolectomy. Special care was taken during the dissection of the medial margin to skeletonize the aorta and inferior vena cava and to transect the right renal vessels at their origin. In addition, the psoas fascia and lateral abdominal wall fascia were resected en bloc with the specimen to ensure adequate margins. The superior dissection involved adrenalectomy and dissection of Glisson's capsule off the inferior aspect of the liver, en bloc with the specimen. Figure 2 shows the resected specimen. Histopathologic examination demonstrated grade II well-differentiated liposarcoma with low-grade dedifferentiation and no lymphovascular invasion present. Final tumor size was 31 cm in the greatest dimension and lymph nodes (0/3) were negative giving a pathologic stage of T4N0M0. The tumor was grossly resected, but there were some scattered foci of microscopically positive well-differentiated margins posteriorly and at the point of adrenalectomy at the superior medial aspect of the dissection. Inferiorly, the tumor extended down around, but did not involve, the distal spermatic cord. All remaining margins were negative. The patient did well postoperatively, except for some intermittent pain control issues, and he ultimately discharged from the hospital on postoperative day 6.

Due to the small foci of microscopic positive well-differentiated margins, a boost dose of adjuvant radiation was considered. Ultimate-

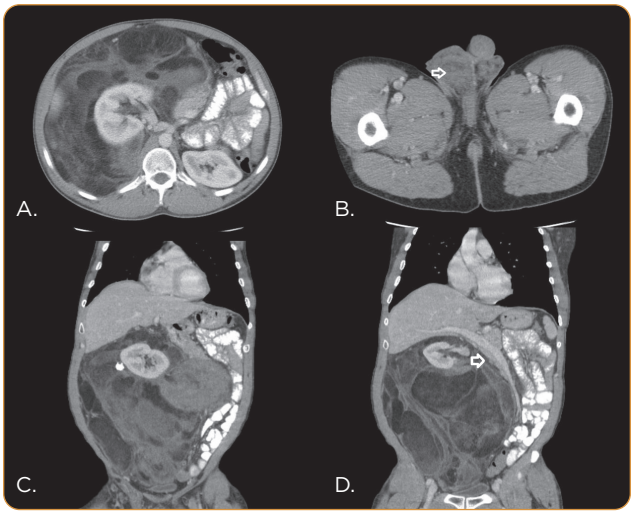

Figure 1. CT images prior to surgery. (A) Axial view of tumor surrounding the right kidney with displacement of intra-abdominal organs. (B) Axial view at level of the scrotum. Arrow identifies thickened fat that surrounds the spermatic cord. (C) Coronal view of tumor surrounding the right kidney with significant displacement of the intra-abdominal organs. (D) Coronal view of tumor. Arrow identifies displaced portal vein.

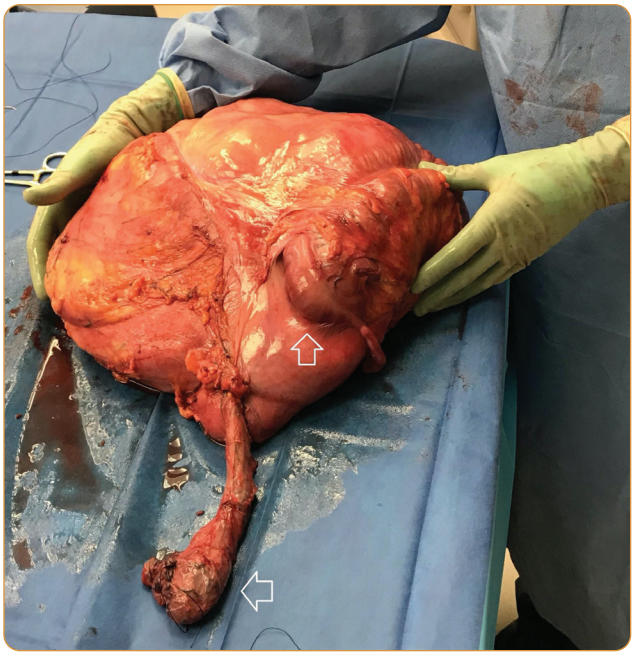

Figure 2. Surgical specimen. En bloc surgical specimen. Vertical arrow marks the ascending colon. Horizontal arrow marks the right testicle. Photo courtesy of Diego Muilenburg, MD.

ly, due to rehospitalization for severe narcotic-induced constipation despite an aggressive bowel regimen, and the fact he had neoadjuvant therapy, it was decided to forego the additional radiation, as the window to begin adjuvant therapy had passed with his prolonged postoperative course. In addition, part of the specimen was sent for genomic testing. The tumor showed amplification of cyclin-dependent kinase 4 (*CDK4*), *MDM2*, and fibroblast growth factor receptor substrate 2 (FRS2). Patient X is now over 2 years out from his surgery and continues to do well with no evidence of disease. He follows up with CT scans routinely to monitor for recurrence per the NCCN Guidelines (2020).

Soft tissue sarcomas (STS) are a heterogeneous mix of relatively rare tumors that can present in many ways. Estimates suggest there will be 13,460 new cases and 5,350 deaths from STS in the United States annually (Siegel et al., 2021). Liposarcoma is one type that accounts for approximately 20% of all STS, and 36% of these tumors occur in the retroperitoneum (Brennan et al., 2016). Porter and colleagues (2006) analyzed the Surveillance, Epidemiology, and End Results (SEER) database and identified that retroperitoneal liposarcoma (RLPS) has a mean annual incidence of 2.7 cases per 10^6 population and has been stable since 1973. In addition to being a rare form of cancer, the location of the tumors makes it difficult to identify in early stages; therefore, many patients present with large tumors, and depending on the histopathologic characteristics, often have a poor prognosis (Vijay & Ram, 2015).

The large potential space of the retroperitoneum can allow a primary RLPS to grow undetected for some time. Zhao and colleagues (2015) found 11.3% of RLPS are incidentally found on exams for other concerns, but the majority are identified only when the tumor has grown large enough for the patient to display symptoms. Common presenting complaints include palpable tumor, pain or fullness sensation in the abdomen or flank, early satiety, lower extremity pain or swelling, or obstructive urinary/bowel symptoms (Taguchi et al., 2016; Vijay & Ram, 2015). A smaller percent-

age of patients experience fever, emaciation, backache, or fatigue (Zhao et al., 2015). Since presenting symptoms are often nonspecific, it requires a high degree of suspicion to diagnose this disease.

The patient described is an example of an unusual presentation and successful management of RLPS. Patient X's complaint on presentation was mild right groin and right testicular pain without evidence for hernia, varicocele, or testes abnormality. He required multiple visits to the emergency department before his etiology was determined so he could begin his oncologic treatment. The goal of this report is to convey the importance of identifying the common presenting symptoms, review this unusual presentation, and discuss the complex treatment involved in the management of RLPS. A concise literature review of histopathologic, genomic, and treatment information pertinent to this patient will be discussed.

LITERATURE REVIEW

Prognostic Factors

Several factors influence the prognosis of RLPS and are summarized in Table 1. It is commonly recognized that the two most important predictors of local recurrence (LR) and disease-specific survival (DSS) are complete surgical resection and histological grade (Amer et al., 2020; Matthyssens et al., 2015; Singer et al., 2003; Tyler et al., 2020; Vijay & Ram, 2015; Wu et al., 2018; Zhao et al., 2015). Complete resection with negative microscopic margins (R0) is the optimal surgical outcome (Keung et al., 2014; Vijay & Ram, 2015; Zhao et al., 2015). However, macroscopic complete resections with positive microscopic margins (R1) have been shown to have similar effects on DSS but can have increased incidence of LR compared with R0 (Brennan et al., 2016; Dalal et al., 2006; Wu et al., 2018; Zhao et al., 2015). R2 resection, incomplete macroscopic tumor removal (i.e., grossly positive margins), does have a significant negative impact on DSS and prognosis (Keung et al., 2014; Matthyssens et al., 2015; Singer et al., 2003; Taguchi et al., 2016; Wu et al., 2018; Zhao et al., 2015).

One prognostic factor that is debatable is the size of the tumor. Wu and colleagues (2018) demonstrated a statistically significant decrease in DSS related to increased tumor size. Other authors have stated that size does not directly correlate with DSS; however, larger dimension does lead to greater difficulty with surgical resection and obtaining negative margins; therefore, it does have an indirect effect (Singer et al., 2003; Taguchi et al., 2016; Zhao et al., 2015). Singer and colleagues (2003) concluded that as soon as the tumor grows beyond 10 cm, it exhibits high-risk behavior. Ad-

Table 1. Independent Prognostic Factors for Survival in Retroperitoneal Liposarcoma

Better prognosis	Worse prognosis
Complete resection with clear surgical margin (R0, R1)	Incomplete resection and/or grossly positive surgical margin (R2)
Histologic subtype: well-differentiated, myxoid (< 5% round cells)	Histologic subtype: dedifferentiated, myxoid (> 5% round cells), pleomorphic
Tumor grade: low	Tumor grade: high
No contiguous organ resection required	Contiguous organ resection
Age < 60 years	Age > 60 years
Incidentally found (asymptomatic)	Symptoms present at diagnosis[a]
Tumor size < 10 cm	Tumor size > 10 cm
Absence of distant metastasis	Presence of distant metastases
Minimal expression Ki-67 stain (immunohistochemical analysis)	High expression Ki-67 stain (immunohistochemical analysis)
Absence of ascites	Presence of ascites

Note. Information from Brennan et al. (2016); Dalal et al. (2006); Keung et al. (2014); Matthyssens et al. (2015); NCCN (2020); Singer et al. (2003); Taguchi et al. (2016); Vijay & Ram (2015); Wu et al. (2018); Zhao et al. (2015).
[a]Common symptoms may include palpability of the tumor, pain/fullness of the abdomen/flank, early satiety, lower extremity pain/swelling or obstructive urinary/bowel symptoms.

ditionally, contiguous organ resection had variable opinions with regards to DSS. In some cases, this suggested a more aggressive tumor biology and higher rates of disease-specific death due to morbidity (Singer et al., 2003). In other studies, it showed improved LR rates and DSS when the organs were resected en bloc to obtain negative margins (Wu et al., 2018; Zhao et al., 2015). Regardless, the most important prognostic factors are surgical resection status and histopathology.

Histopathology and Genomic Review

Retroperitoneal liposarcoma tumors are classified into subtypes based on histopathological findings. The World Health Organization (WHO) recognizes four subtypes: well-differentiated (WD), dedifferentiated (DD), myxoid, and pleomorphic (Doyle, 2014; Matthyssens et al., 2015). In the retroperitoneum, WD tumors are the most common (43%–46%), then myxoid (24%–28%), DD (18%–21%), and pleomorphic (8%; Brennan et al., 2016; Dalal et al., 2006). Well-differentiated and DD most commonly occur in the retroperitoneum and demonstrate similar morphologic and cytogenetic characteristics with prognosis dependent upon amount of dedifferentiation. Both types have supernumerary rings and giant rod chromosomes with amplification of the 12q13-15 gene segment (Brennan et al., 2016; Vijay & Ram, 2015). Abnormalities in *MDM2* and *CDK4* are the most common amplifications found in both WD and DD, although the quantity of aberrations is much higher in DD. Well-differentiated has a low grade and tends to be locally aggressive but has a low rate of distant metastasis (Brennan et al., 2016). Dedifferentiated has more complex chromosomal abnormalities, which makes it high grade, more aggressive, and more likely to metastasize, commonly to the lung or liver (Mullen & DeLaney, 2020; Singer et al., 2003; Tyler et al., 2020; Vijay & Ram, 2015). Other genes that have been implicated in these tumors are depicted in Table 2. Dedifferentiated can occur as a primary tumor, WD can dedifferentiate into a worse grade over time, or WD may recur as DD (Matthyssens et al., 2015). As shown in Table 2, lower-grade WD has better survival rates than the higher-grade DD.

Myxoid and pleomorphic liposarcomas are more likely to occur in the extremities but can be found in the retroperitoneum (Singer et al., 2003). Myxoid has both a low- and high-grade form, depending on the percentage of round cells found in the tumor, and as such, respond differently to therapy. The genetic abnormality most associated with myxoid is *FUS-DDIT3* (previously recognized as *FUS-CHOP*) fusion gene (Singer et al., 2003; Tyler et al., 2020). Pleomorphic tumors are quite rare in the retroperitoneum and have complex cytogenetic abnormalities with no specific gene amplification. Investigations are underway examining the *p53* and *VEGF* genes in relation to these tumors (Tyler et al., 2020; Vijay & Ram, 2015). Early metastasis is common with pleomorphic, most often to the lung (Brennan et al., 2016).

Table 2. Retroperitoneal Liposarcoma Histopathologic and Genomic Associations with 5- and 10-Year Survival Rates

Histologic subtype	Commonly associated grade	Commonly associated genomic alterations	5- and 10-year survival rates
Well-differentiated	Low (grade 1)	*MDM2*, *CDK4*, HMGA2, TSPAN31 (SAS), YEATS4, miR-26a-2, PPARγ, RET, DDR2, **FRS2**	82% and 67%
Dedifferentiated	High (grade 2 or 3)	*MDM2*, *CDK4*, HMGA2, TSPAN31 (SAS), YEATS4, miR-26a-2, PPARγ, ASK1, JUN, TERT, ZIC1, **MAP3K12**, **GLI1**, **CDK2**, **ALX1**, **TBX5**, **FGFR3**, **CEBPA**, **RB1**	50% and 32%
Myxoid	Low (< 5% round cells) or high (> 5% round cells)	*FUS-DDIT3*, YAP1, RET	Low 76% and 64% High 55% and 47%
Pleomorphic	High	p53, VEGF	51% and 35%

Note. Italic indicates hallmark gene associated with subtype. Bold indicates exclusive to subtype. Information from Amer et al. (2020); Cancer Genome Atlas Research Network (2017); Creytens et al. (2015); Trautmann et al. (2019); Tyler et al. (2020).

Table 2 outlines the relationship between subtypes, grade, genomics, and survival rate. The differentiation of the tumors directly correlates with prognosis and survival. In general, a higher grade means increased risk for distant metastasis and a lower survival rate.

Available Treatment Modalities

As stated previously, complete surgical resection (R0/R1) is the most effective treatment modality for primary RLPS. In the case of an unresectable tumor, there has been no benefit to survival by performing a debulking surgery unless it will relieve symptoms (i.e., bowel obstruction) and thus is done for palliative measures (Mullen & DeLaney, 2020). These patients are mainly treated with chemotherapy and/or radiation depending on their histopathology. The use of chemotherapy and radiation therapy has been controversial and is often considered on a case-by-case basis. Some authors advocate using neoadjuvant chemotherapy and radiotherapy in cases where the ability to completely resect the tumor is a concern. This may assist to downgrade the tumor and improve the chances of complete resection (Livingston et al., 2017; Vijay & Ram, 2015). Chemotherapy has traditionally not been effective as a single therapy for WD, although Livingston and colleagues (2017) demonstrated that DD did show some response to combination therapy with doxorubicin and ifosfamide. Low-grade myxoid responds well to a combination of doxorubicin with ifosfamide (Livingston et al., 2017; Jones et al., 2005). Patients with tumors that are unresponsive to doxorubicin/ifosfamide may respond to gemcitabine, docetaxel, trabectedin, and pazopanib, which can be used as second- or third-line options (Brennan et al., 2016; Matthyssens et al., 2015).

The role of radiation therapy is arguably to help improve local control or to treat metastatic lesions. As previously stated, WD has a high likelihood of local recurrence: 4% to 5% per year risk in some studies, and up to 40% return by 10 years (Haas et al., 2019; Heslin et al., 1997). Cause of death in WD is most often due to local recurrence unless the tumor dedifferentiates and then distant metastases becomes the main cause of death (Mullen & DeLaney, 2020). Consequently, initial treatment is aimed primarily at local control, and neoadjuvant radiation has been shown to significantly reduce the risk of LR (Heslin et al., 1997). Neoadjuvant intensity-modulated radiation therapy can be helpful because the exact edges of the tumor are known and the bulk of the mass often pushes radiosensitive organs (e.g., bowel, bladder, etc.) out of the field, so more specific and higher radiation doses can be utilized (Baldini et al., 2015; Tzeng et al., 2006). Adjuvant radiotherapy is often not performed due to toxicity to the radiosensitive organs filling the space and difficulty in identifying the margins; however, a small-field boost dose can be helpful in cases of R2 grossly positive margins if other organs are out of the way (Mullen & DeLaney, 2020). If the surgical team is concerned about achieving grossly negative margins, intraoperative radiotherapy may also be utilized either alone or in conjunction with neoadjuvant therapy to treat positive margins (Mullen & DeLaney, 2020). Generally, radiation can be used in certain circumstances to improve LR but has not been found to affect overall survival in RLPS (Heslin et al., 1997; Matthyssens et al., 2015; Mullen & DeLaney, 2020; Vijay & Ram, 2015).

Since the advent of genomic evaluation, directed molecular therapy has become a therapeutic option for many cancers. Considerable research is underway to identify additional genetic targets for RLPS and STS in general (Cancer Genome Atlas Research Network, 2017; Creytens et al., 2015; Matthyssens et al., 2015; Trautmann et al., 2019; Tyler et al., 2020). Table 2 lists some of the genes currently under investigation. At this time, palbociclib (Ibrance), a selective CDK4/CDK6 inhibitor that is U.S. Food & Drug Administration approved for treating breast cancer, has been shown to have a positive effect on progression-free survival in WD/DD disease (Dickson et al., 2016). Several other medications are currently in clinical trials and are providing RLPS patients with hope for future treatment options (Matthyssens et al., 2015; Tyler et al., 2020).

DISCUSSION

There are several factors in this case that affected the prognostic outcome of Patient X. First, his presentation of right groin/testicular pain was unusual and very subtle. In fact, he was seen in the emergency department three times before he was diag-

nosed. At each visit, he had medical imaging studies of the scrotum, but the ultrasound failed to identify the cause of his symptoms. At his third evaluation, his contrast-enhanced CT scan did identify the tumor, which incidentally is the diagnostic test of choice in RLPS. A staging CT scan should also include the chest to rule out distant metastasis to the lungs as that is the most common site in addition to the liver (Mullen & DeLaney, 2020; Singer et al., 2003; Tyler et al., 2020; Vijay & Ram, 2015). Magnetic resonance imaging with gadolinium can also be done for staging or surveillance if an iodine contrast allergy precludes CT, decreased renal function prohibits use of iodine contrast, or further soft tissue delineation is required when planning for surgery (Mullen & DeLaney, 2020).

Once the mass was identified, a CT-guided biopsy was performed at his outside facility. Differential diagnosis of a retroperitoneal mass includes lymphoma, primary germ cell tumor, metastatic testicular cancer, other metastatic or advanced carcinomas, lymphangiomas, retroperitoneal fibrosis, schwannomas, and paragangliomas. At this time, there is no consensus in the literature on the need for a preoperative biopsy. Retroperitoneal liposarcoma has specific characteristics, so a CT scan can be diagnostic; however, the need for neoadjuvant therapy and/or the scope of surgery can depend on the histology (e.g., presence of dedifferentiation or myxoid type), so proceeding with a biopsy can guide the treatment plan (Mullen & DeLaney, 2020; Thomas, 2007, as cited in Matthyssens et al., 2015). A recent study by Parkes and colleagues (2020) demonstrated that PET/CT imaging can be utilized to identify potential areas of dedifferentiation in a WD tumor. This can provide guidance on the best location to biopsy and improve the sensitivity and specificity of a CT-guided biopsy. A biopsy should always be done if the diagnosis is uncertain or if neoadjuvant therapy is planned (Mullen & DeLaney, 2020). In this case, the biopsy result confirmed a focus of grade II dedifferentiated liposarcoma that was FISH positive for *MDM2* amplification. Since the patient was started on neoadjuvant chemotherapy, and we planned to do preoperative radiation, a biopsy would have been indicated in this situation.

Another prognostic factor that impacted this patient was that on presentation to our facility, he had a palpable abdominal mass, as well as fullness around the right spermatic cord compared with the left. As discussed above, symptoms at presentation are a negative prognostic factor. However, the confounding issue here is the fullness around the right spermatic cord. A retrospective study performed by Rhu and colleagues (2017) looked at RLPS vs. inguinoscrotal liposarcoma. They found that 4% of their liposarcoma patients had tumors that originated in the inguinoscrotal area around the spermatic cord. Out of all their RLPS patients, 3.6% had extension into the inguinal canal. Both groups had similar clinical presentations, and based on pathology alone, they were unable to differentiate if the tumor originated in the retroperitoneum or in the inguinoscrotum. Their findings also suggested that patients with RLPS that extends into the inguinal canal have a higher morbidity and mortality than patients who had inguinoscrotal liposarcoma. This is of particular importance to the prognosis of Patient X, but it is impossible to determine where his primary tumor was. Ultimately, the treatment is the same for both, and complete surgical excision of the retroperitoneal tumor and the right testes was performed.

His final pathology showed grade II well-differentiated liposarcoma with low-grade dedifferentiation, and genomic testing identified amplification of *CDK4*, *MDM2*, and *FRS2* consistent with WD with areas of dedifferentiation. He did have some foci of microscopic positive WD margins resulting in an R1 resection; however, those areas were the focus of his neoadjuvant radiation. A boost dose of adjuvant external beam radiation could have been given to these areas; however, his bowels were in the target field and given his significant narcotic-induced constipation, it was determined to avoid the additional toxicity of radiation to his bowels. He has been followed postoperatively with contrast-enhanced CT scans per NCCN Guidelines (2020) and continues to do well with no evidence of disease over 2 years after surgery. Since his genomics indicated *CDK4* amplification, he would be a candidate for palbociclib therapy in the event of a recurrence. Screening CT scans or MRIs should occur until at least 10 years postoperatively due to high risk of recurrence of these tumors (Brennan et al., 2016; Haas et al., 2019; NCCN, 2020).

CONCLUSION

Retroperitoneal liposarcomas are rare tumors that have variable clinical behavior and complicated treatment strategies depending on their presentation, histopathology, and genomics. Continued focus on molecular therapy options may lead to new avenues of treatment; however, early identification and complete surgical resection remain the mainstay of treatment. Chemotherapy and radiation therapy are used on a case-by-case basis. Thorough physical exams, attention to subtle findings, appropriate medical imaging studies, and a high index of suspicion when evaluating vague symptomatology can lead to earlier diagnosis and treatment, which can, in turn, lead to better patient outcomes. Once the tumor is diagnosed, due to its rare and complex nature, patients are best served by evaluation and management at a multidisciplinary center with experience in sarcoma care (Mullen & DeLaney, 2020).

Disclosure

The author has no conflicts of interest to disclose.

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