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Percutaneous Image-Guided Cryoablation of Recurrent Myxofibrosarcoma in the Forearm: A Case Report and Review of Literature

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Abstract

Myxofibrosarcoma (MFS) is a rare, aggressive soft tissue sarcoma with high recurrence rates. Conventional treatment involves wide surgical resection and radiotherapy, but the infiltrative nature of MFS often complicates complete resection. This case highlights an 81-year-old patient with recurrent MFS in the left forearm, initially treated with surgery and radiation therapy. Due to surgical limitations and desire for a minimally invasive approach after recurrence, cryoablation was performed. The patient underwent the procedure successfully, and postoperative imaging indicated effective ablation. This case demonstrates cryoablation as a feasible, minimally invasive alternative for managing recurrent MFS, particularly in anatomically challenging cases.

Keywords
- cryoablation
- myxofibrosarcoma
- interventional radiology

Introduction

Myxofibrosarcoma (MFS) is a soft tissue sarcoma that commonly presents in the extremities of adults.[1] MFS tends to be superficially located, however, can exhibit infiltrative growth leading to greater recurrence. Clinically, MFS manifests as slowly enlarging and painless mass and is often mistaken for a benign tumor. Due to the challenging growth pattern, it becomes difficult to evaluate the true extent of the tumor, ultimately preventing adequate surgical resection.[2] The invasive nature of MFS is associated with a higher tumor grade, increased risk of multiple recurrences, and other comorbidities such as cardiovascular diseases.[1–3]

Conventional treatment of MFS is surgical excision along with the use of radiotherapy.[4] However, the wide surgical margins and anatomical presentation of the tumor can pose great challenges. Cryoablation is a minimally invasive technique that uses cryoprobes to deliver compressed gas (argon) to cool tumor tissue for purposes of necrosis to less than −20°C.[5] Using cryoablation for the management of MFS allows for a minimally invasive procedure with potential for greater accuracy to target the tumor.

In this case report, we highlight the use of percutaneous image-guided cryoablation in a patient with MFS of the forearm.

Case Report

An 81-year-old male with a history of MFS in the left forearm, initially treated with surgical resection and subsequent radiation therapy in 2013, presented with local recurrence in 2017, necessitating repeat surgical resection. The postoperative course was complicated by infection. After multiple negative yearly surveillance MRIs of the left forearm, the patient unfortunately presented in June 2020 demonstrating a collection at the previous site of the surgical bed. Ultrasound-guided biopsy was performed and pathological results indicated low- to intermediate-grade, recurrent, MFS.

On physical examination, the patient presented with a well-healed free flap over the dorsal aspect of the forearm, accompanied by noticeable radiation changes indicative of previous treatment. There were no signs of open wounds, and the forearm and elbow were free of palpable masses or tenderness. Mobility in the elbow was preserved, allowing full range of

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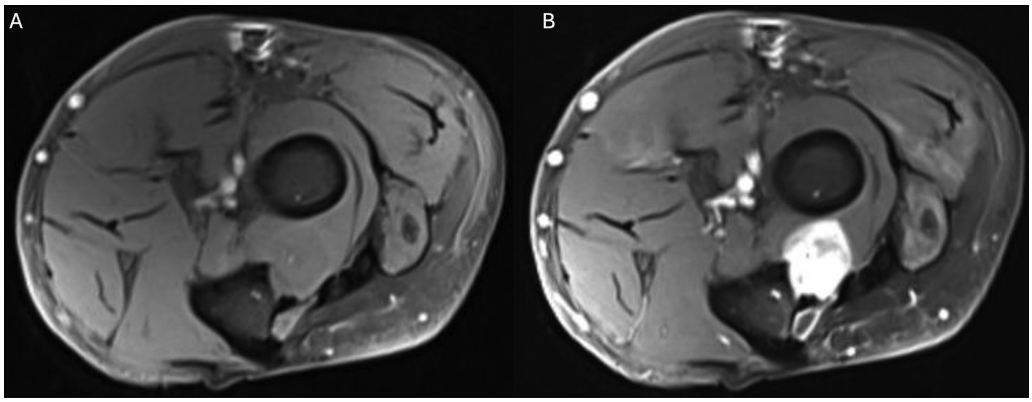

Fig. 1 Preprocedure MRI. (**A**) Axial T1 fat-saturated pre-contrast MRI image showing a soft tissue mass within the supinator muscle belly. (**B**) Corresponding postcontrast image demonstrates enhancement of the mass. MRI, magnetic resonance imaging.

motion without any pain. However, the patient exhibited a chronic contracture at the left wrist, significantly limiting the ability to fully extend the wrist and digits. Notably, there was observed weakness in the extensor pollicis longus and the flexor digitorum muscles, both deep and superficial.

For diagnostic assessment, a magnetic resonance imaging (MRI) with IV contrast was performed. The results of the MRI showed a heterogeneous T2 hyperintense mass lesion within the supinator muscle belly, which showed heterogeneous enhancement on the postcontrast imaging. This structure measured up to 2.6 cm in craniocaudal dimension and 1.3×1.1 cm in axial dimension (previously $2.1 \times 1.0 \times 0.8$ cm). Axial T1 fat-saturated pre- and postcontrast images demonstrated avid heterogeneous enhancement of the mass within the supinator muscle belly (►**Fig. 1**).

The patient ultimately refused a third surgical resection and opted for a cryoablation procedure using ultrasound and computed tomography (CT) guidance. A positron emission tomography-CT was performed to exclude any distant metastasis. The cryoablation procedure was performed under general anesthesia. The patient was placed on the CT table and axial CT images were obtained. An isodense lesion was identified within the proximal forearm. Initially, the tumor was targeted with real-time ultrasound guidance (►**Fig. 2A**). Subsequently, two cryoablation probes were advanced under real-time ultrasound guidance into the tumor (►**Fig. 2B**). The planned intralesional points of insertions were along the long axis of the lesion to maximize coverage and symmetry of the ice ball. Given the lesion's orientation within the forearm, the probe insertion was performed to achieve the shallowest possible trajectory while maintaining safe distance from critical structures. The position was verified by limited CT (►**Fig. 3**). An ablation margin of 5 mm beyond the visible tumor boundary was planned to ensure adequate coverage. Two cycles of freeze–thaw–freeze–thaw ablation was performed at this location for a total of 8-minute freeze, 10-minute passive thaw, 8-minute freeze, and active thaw. CT was performed at approximately 2-minute intervals during the freeze–thaw cycles to ensure appropriate coverage of the ice ball surrounding the left forearm mass (►**Fig. 4**). Additionally, the CT demonstrated no significant hemorrhage or other complications. Patient tolerated the procedure well and was transferred to the recovery unit.

Postoperative T1 pre- and post-gadolinium magnetic resonance images at 3 months following ablation demonstrated no significant enhancement (►**Fig. 5**). The lesion appeared similar in size but was likely necrotic, indicating treatment-related effects.

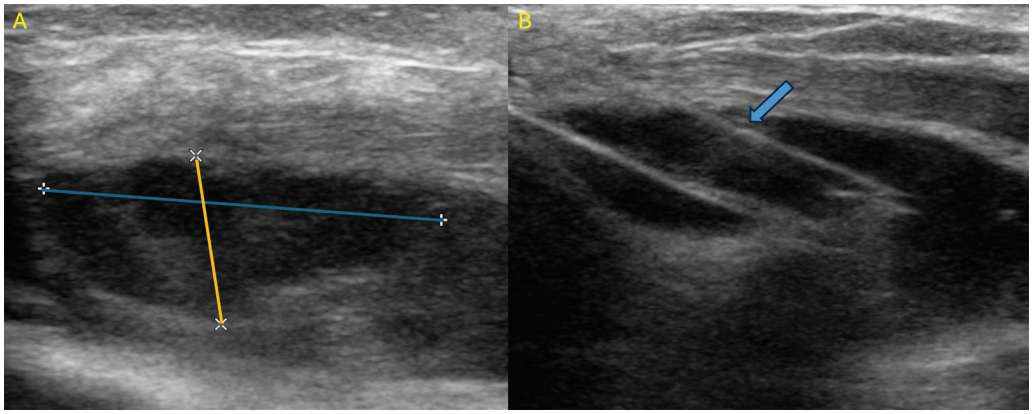

Fig. 2 Ultrasound-guided probe placement. (**A**) Transverse ultrasound image of the lesion with caliper measurements. The "X" crosshairs denote the long axis (2.32 cm), and the "+" crosshairs denote the short axis (0.991 cm). (**B**) Longitudinal ultrasound image demonstrating in-plane placement of cryoablation probes (*arrow*) within the lesion.

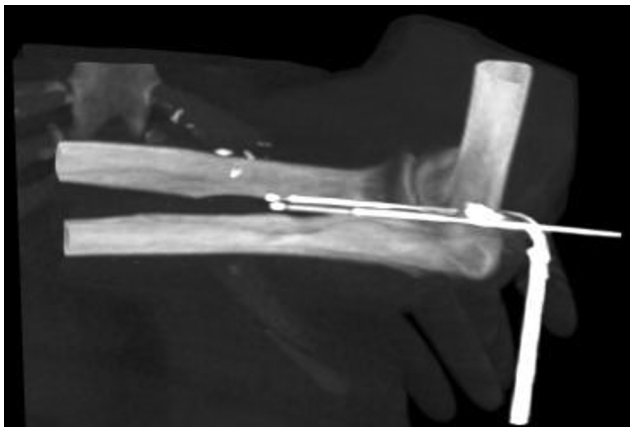

Fig. 3 Probe placement on CT. Anteroposterior (AP) view of intraprocedural CT 3D reconstruction showing cryoablation probe placement. Two cryoablation probes in place, with warm saline-filled sterile gloves applied to skin for dermal protection. CT, computed tomography.

Discussion

This case demonstrates the use of cryoablation for the treatment of MFS in the forearm. Due to the recurrent nature of MFS, the condition poses challenges in adequate treatment. Our patient presented with a history of recurrent MFS, despite management with surgical resection and radiation therapy twice. Cryoablation offers an alternative therapeutic method to precisely target the tumor while ensuring preservation of local tissues.

Cryoablation techniques use the precision of imaging modalities such as ultrasound and CT for real-time guidance of probe placement and monitoring of the ablation zone. This allows for preservation of healthy tissue and decreased morbidity. As seen in our patient, the use of intra-procedural imaging indicated no significant hemorrhage or other adverse events during the procedure while achieving an adequate zone of ablation for complete tumor necrosis. In addition, the postprocedural MRI findings showed no internal enhancement of the mass and no continued growth, further supporting the efficacy of cryoablation in controlling the tumor.

There is generally a low complication rate in patients who undergo percutaneous cryoablation (2–5%).[6–8] However, in superficial tumors such as those in the forearm, complications can arise. Skin necrosis is a serious complication that can occur as a result of cryotherapy due to freezing of the superficial surface.[9] In addition, damage to adjacent structures such as nerves is a well-documented risk of cryoablation in musculoskeletal interventions.[10] To mitigate these adverse risks, precautionary measures can be taken. In our case, we used warm saline gloves to prevent skin necrosis. Thermal protection of the skin reduces the risk of skin necrosis from the cryoprobe. Furthermore, maintaining a safe distance from neurovascular structures also further prevents complications. A study by Lippa et al documented a distance to skin >5 mm and a distance to neurovascular structures >3 mm as precautionary measures for cryoablation in their patients with recurrence of soft tissue sarcomas.[11] Techniques such as hydrodissection and CO_2 pneumodissection have also been described in the literature.[12,13] This offers enhanced protection of the skin due to the decreased thermal conductivity in comparison to saline. While our patient tolerated the procedure well without complications, it is important to recognize precautionary measures such as thermal protection, adequate intraprocedural monitoring, and close follow-up to prevent long-term complications with cryoablation.

Literature comparing cryoablation to radiofrequency ablation in the treatment of renal masses suggests cryoablation results in lower retreatments, and improved local tumor control.[14] The greater precision in cryoablation may be attributed to the visible ice-ball formation, allowing for real-time monitoring and adjustment intraoperatively. Using

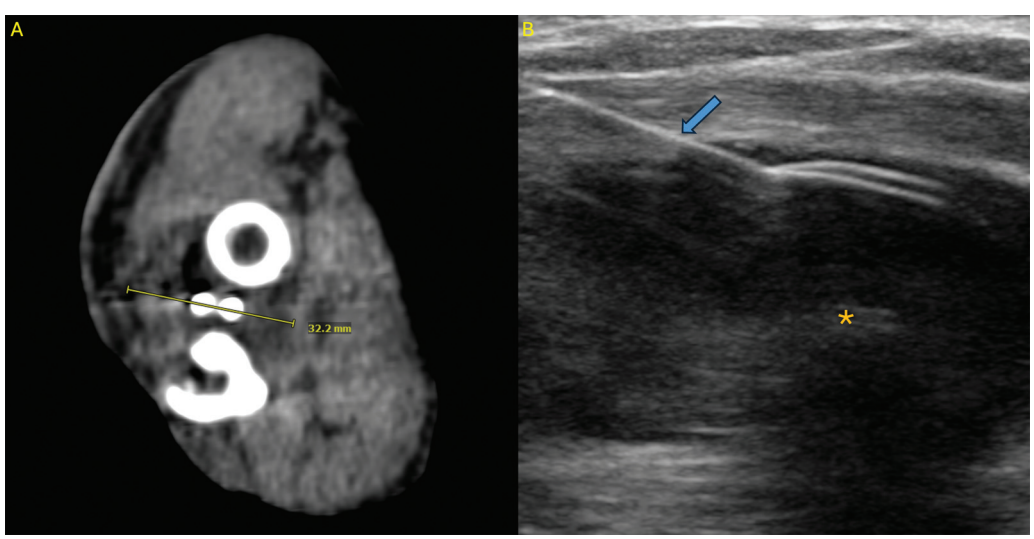

Fig. 4 Intraprocedural images of ice ball formation. (**A**) Axial CT image at 8 minutes demonstrating ice ball formation surrounding the cryoablation probes. The ice ball measures approximately 32.2 mm in maximum diameter. (**B**) Ultrasound image showing longitudinal view of the cryoprobe (*arrow*) entering the hypoechoic mass (*), with posterior acoustic shadowing indicative of early ice ball formation. CT, computed tomography.

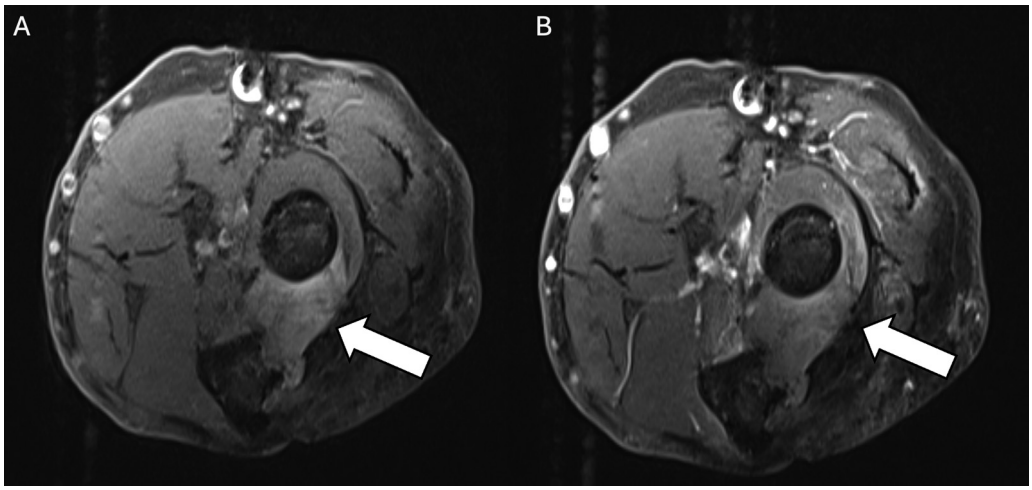

Fig. 5 Post-op MRI. (**A**) Postoperative T1-weighted pre-contrast MRI image demonstrating a soft tissue lesion with no significant intrinsic enhancement. (**B**) Corresponding post-gadolinium T1-weighted MRI image showing no significant enhancement and overall similar lesion size. Peripheral T2 hyperintensity (not pictured) was noted and suggested to represent posttreatment changes. MRI, magnetic resonance imaging.

real-time guidance of ultrasound and CT, we were accurately able to position the probe and maximize the localization of the tumor while minimizing any complications to adjacent critical structures. In our case, CT guidance was used for intraprocedural ice-ball monitoring to ensure precise visualization and confirmation of ablation margins. CT imaging provides high-resolution images that clearly delineate the margins of the ice ball, allowing for assessment of tumor coverage and proximity to adjacent structures.[5] While ultrasound offers the advantage of real-time imaging without radiation exposure, its utility remains limited due to its limited tissue penetration, operator dependence, and significant acoustic shadowing.[15] Ultrasound has been used in the literature for intraprocedural monitoring of ice-ball formation in cryoablation; however, CT provides greater reliability for comprehensive ice-ball evaluation.[15–18]

Our case supports the integration of cryoablation in the treatment for recurrent and anatomically complex MFS cases. For patients with recurrent disease or patients who are not suitable for surgery, cryoablation guided by radiologic imaging provides a safe, effective alternative.

Recent literature has demonstrated the expanding role of cryoablation in the management of both benign and malignant soft tissue tumors. A recent study by Pal et al highlighted the effectiveness of cryoablation in patients with recurrent or metastatic soft tissue sarcomas, indicating a progression-free survival rate of 86% at 1 year and 80% at 2 years.[6] To expand on this, a recent review reported an overall disease control rate of 85% in cryoablation of soft tissue tumors.[7] These positive outcomes of cryoablation are only paralleled in the treatment of desmoid fibromatosis, which shares similar infiltrative behavior and recurrence risk with MFS. Patients who underwent cryoablation for extra-abdominal desmoid-type fibromatosis demonstrated a 2-year disease control of 85% upon therapy.[19,20] Clinical evidence from studies in recent years has demonstrated enhanced patient outcomes upon cryoablation for soft tissue tumors. As the field of interventional radiology continues to advance, minimally invasive therapeutic techniques such as cryoablation will only expand in its applications.

Conclusion

This case underscores the technically successful utility of cryoablation for the clinical management of a soft tissue MFS. Cryoablation offers a potential minimally invasive intervention for adequate localization of the tumor while preserving adjacent critical anatomical structures. This case further emphasizes the potential of cryoablation to be used for soft tissue sarcomas over conventional surgical methods in surgical beds with recurrent disease.

Ethical Approval

Research Ethics Board approval was waived per standard policy for case reports and/or series.

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Conflict of Interest

None declared.

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