Unique Application of K-Y Jelly in Cryotherapy for Giant Cell Tumors of the Distal Femur - A Case Report

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Abstract

GCTs are a locally aggressive tumor that can result in significant pain and dysfunction through the disruption of bony and nearby soft tissue architecture. Although generally benign, these tumors have been shown to have 1-9% chance of metastasis and a local recurrence rate of up to 65%. For these reasons, appropriate treatment is essential to remove primary lesions as well as reduce the odds of metastatic disease and lower recurrence rates. Cryosurgery is a well-described technique used to achieve local control of primary GCTs. Modern cryoablation utilizes a cryoprobe to freeze surrounding tissues via release of a thermal conducting gas (argon-helium). The optimal technique for eradication of GCT is a widely debated topic rooted in rates of complications and tumor recurrence. Herein, we describe a case report of a 30-year-old female with a large distal femoral GCT that underwent intralesional curettage and adjunctive cryotherapy utilizing K-Y jelly as a semi-solid medium to transmit the freeze zone more evenly within the cavity. Following cryoablation, the cavity was filled with antibiotic loaded polymethyl methacrylate cement. This technique has scarcely been described in the literature and warrants further investigation.

Introduction

Giant cell tumors comprise approximately 5% of primary bone tumors and typically occur in the 3rd and 4th decade of life. Population studies have demonstrated the incidence of GCT to be 1.7 per million persons per year.¹ Although malignant transformation of GCT is rare, they are locally destructive and accordingly, warrant aggressive treatment strategies.² To date, there are several techniques employed in the management of these tumors, each with varying degrees of success and complications. Historically, methods of treatment include simple curettage with bone grafting, curettage and cementing with PMMA, wide resection with endoprosthesis, chemical adjuvants such as phenol/phenol-alcohol, and adjuvants with systemic therapy and cryosurgery. The most effective method is highly debatable with literature available to support nearly every method.³

The primary goal of treatment is eradication of disease. In conjunction with this, additional goals include eradication reducing the risk of local recurrence and complications. The most basic technique of simple curettage with graft and cementing has been demonstrated to have variable local recurrence rates from 0-65%.^{4,5,6} On the opposite end of the spectrum is total en bloc resection which is quite successful at minimizing local recurrence, but is destructive to native anatomy and requires the implantation of prosthetics.⁷ Accordingly, there is a great need for treatment modalities that are effective, reliable, and reduce morbidity.

Adjuvants to curettage such as chemical treatments, cementing, and cryosurgery are methods that have demonstrated great success in lowering recurrence rates with the optimal method being an area of contention.⁸ Cryosurgery has long been demonstrated to be amongst

Unique Application of K-Y Jelly in Cryotherapy for Giant Cell Tumors of the Distal Femur - A Case Report

the most successful at lowering recurrent rates.⁹ The technique originally described by Marcove involved pouring liquid nitrogen directly into the cavity of excised tumor, inducing apoptosis in cells exposed to extreme temperatures through several freeze-thaw cycles. To date, variations of this technique have been described including the freezing of ethanol and argon

gas ice balls to better control the biologic area of exposure with the goal to maximize the destruction of tumor cells while limiting damage to native tissue.^{9,10} Similarly, with the herein case report, we outline a cryosurgical technique utilizing K-Y jelly as a semi-solid freezing medium for argon based cryotherapy in the treatment of GCT in the distal femur of a 30 year old female.

Patient and Technique

Case

Figure 1: Pre-operative radiographic imaging and MRI scans demonstrating GCT comprising nearly the entire lateral femoral condyle

A 30 year old female initially presented to the office of her primary care with right knee pain after a slip and fall. X-rays were negative for fracture but demonstrated a large, well defined lucent lesion within the lateral femoral condyle. Subsequent MRI demonstrated a metaphyseal lesion of the distal femur extending to comprise the entire lateral condyle (Figure 1). The patient was subsequently referred to an orthopedic oncologist specialist for escalation of care. Upon initial examination, the patient was noted to have an antalgic gait favoring the right knee requiring assistance with a cane,

tenderness to palpation of the lateral knee, and difficulty with knee extension secondary to pain. Her lower extremity neurovascular status was fully intact.

Surgical Technique

A lateral approach to the right distal femur was utilized to expose the tumor and a biopsy was sent for frozen section. The pathology report confirmed giant cell tumor of bone without evidence of malignant transformation. Extensive curettage of the distal femur was then performed to excise as much tumor as possible (Figure 2).

Figure 2: The bony cavity that remains after extensive curettage of the GCT

Unique Application of K-Y Jelly in Cryotherapy for Giant Cell Tumors of the Distal Femur - A Case Report

The cavity was thoroughly washed with saline, peroxide, and filled with K-Y jelly. Four Galil ice FORCE probes were then inserted into the jelly and held in place for the initial 5 minute freeze-thaw cycle to -150°C (Figure 3). Simultaneously, an

arthroscopic canula was inserted into the knee and the joint irrigated with warm saline throughout the freeze cycle. After the initial cycle, the probes were re-positioned and a second 5 minute freeze-thaw cycle initiated. After the second thaw,

Figure 3: Positioning of the ice probes into the KY filled bony cavity for induction of cryotherapy

The K-Y jelly was removed from the cavity which was subsequently filled with antibiotic impregnated PMMA (Figure 4). A

six hole locking plate was then placed along the lateral distal femur for prophylactic internal fixation (Figure 5).

Figure 4: Antibiotic impregnated PMMA was placed into the residual cavity

Figure 5: Prophylactic fixation of the distal femur was performed with a laterally placed locking plate

Results

Follow-up: At 2 month follow-up, radiographs demonstrated intact hardware

without evidence of tumor recurrence or complication (Figure6). The patient was placed in an aggressive physical therapy program to focus on quadricep strengthening.

Figure 6: Radiograph obtained at 2 month post-op visit

Discussion

GCT of bone is a benign but locally aggressive tumor that if left untreated can cause severe damage to surrounding structures, resulting in debilitating pain and dysfunction. The success of treatment is measured based off the eradication of original tumor and the prevention of local recurrence. Cryosurgery has long been established as a successful methodology for treating GCT of bone, and in the aforementioned case, we outline a scarcely described technique utilizing K-Y Jelly as a freezing medium for adjuvant cryotherapy.

Curettage of tumor without adjuvant therapy has been demonstrated to result in GCT recurrence rates from 0-65%.¹¹ Consequently, more effective strategies have been employed to reduce these unfavorable outcomes. Gaston et al. conducted a retrospective review comparing curettage with bone grafting to curettage followed by cementing with PMMA and found recurrence rates to be 30% and 14%, respectively, concluding that adjuvant therapy with cementing resulted in lower recurrence rates.⁸ Interestingly, the authors also noted those patients PMMA

adjuvant had a higher rate of joint replacement. This seemed to be related to migration of cement through articular cartilage and into the joint, suggesting this to be a notable complication of this technique.

Although there are some studies reporting low levels of recurrence with techniques such as simple curettage, amongst the most consistent techniques in the literature reporting low recurrence rates with less morbidity than complete resection are cryosurgical adjuvants. In one of the larger case series reported in the literature, Malawer et al. treated 102 patients diagnosed with GCT with cryosurgery using the liquid nitrogen pour technique. The authors found a recurrence rate of 8% at average follow-up of 6.5 years. They further reported on their postoperative complications including fracture in 6%, partial skin necrosis (secondary to contact with liquid nitrogen) in 3%, and 0.02% with degenerative changes of the knee.¹² In another well described series, Abdelrahman et al. reported on a prospective analysis of 28 patients with GCT who underwent cryotherapy with liquid nitrogen and determined the local recurrence rate to be 3.5%.¹³

Although cryosurgery with the liquid nitrogen pour technique has been demonstrated to be successful, inherent properties of liquid nitrogen have been related to observed complications. Studies have demonstrated exposure to such extreme temperatures can decrease the strength of bone by 40% over a period of 8 weeks increasing risk for fracture.¹⁴ Additionally, liquid nitrogen's low viscosity can make the substance difficult to control when pouring into the surgical field rendering skin and nearby neurovascular structures susceptible to injury.¹⁴ With this in mind, Wu et al. investigated a variation of cryosurgery utilizing freezing nitrogen ethanol composite (FNEC), a more viscous medium, to induce cryoablation. This group of researchers demonstrated that FNEC could reach appropriate subzero temperatures to induce tumor cell apoptosis at 60°C warmer than traditional liquid nitrogen (-196°C) and inhibit neovascularization of GCT in ex vivo models. Additionally, the authors reported successful management of GCT with FNEC cryotherapy in a small case series including seven patients without local recurrence, skin necrosis, nerve injury, or fracture at a mean of 2 years. FNEC was effectively demonstrated to have similar tumor ablating properties as liquid nitrogen, with the additional advantage of utilizing a medium that offered less extreme temperatures and better control for targeted cryoablation.¹⁰

Similarly, we applied this principle to the utilization of K-Y jelly for cryoablation of GCT in the aforementioned case. One particular advantage to K-Y jelly is highly specific targeted cryoablation. Unlike previously described FNEC Liquid nitrogen, K-Y jelly exists at room temperature, is chemically inert, and therefore will only freeze when induced to do so by external stimulation. In this manner, K-Y jelly can be placed into the bony cavity without the risk of cold exposure to surrounding tissues if spilled. Argon gas based freeze probes may then be strategically arranged within the jelly and cryo then initiated in a highly controlled fashion. K-Y Temperatures of -150°C were reached which is lower than the threshold of -60°C required to induce

apoptosis. It should be noted that this technique has been similarly described by Bickel's et al. who used a gel-medium for cryoablation in a case series of 58 patients with bone tumors and noted a 3.4% fracture rate as well as a 3.4% recurrence rate.¹⁵

The management of GCT of bone is a highly debated topic in the literature with evidence supporting a myriad of strategies of management. The goals of treatment focus on eliminating tumor burden and preventing recurrence with as low a complication rate as possible. As evidenced in the literature, there are several techniques that have been demonstrated effective for treatment of this condition, each with their own set of benefits and complications to consider. Although we are not the first to describe this technique, there is a paucity of literature on this method of cryoablation which we believe deserves greater attention in the literature of orthopaedic oncology as the field continue the search for innovative ways of providing optimal outcomes for patient suffering from this disease. Accordingly, we believe the utilization of K-Y jelly houses several advantages that warrants further investigation and deserves consideration as one more method that adds to the armamentarium for the treatment for GCT of bone.

Conclusion

K-Y jelly appears to be a viable option as a semi-solid medium for inducing cryotherapy ablation of GCT while limiting the risk of damage to surrounding structures. We believe this method has potential to be a reliable technique for the application of argon based cryotherapy systems that has the possibility to reduce complication and recurrence rates. We look forward to future investigations of it's application in the treatment of GCT.

Highlights

- Optimal method of treatment for GCT of bone is a widely debated topic in the literature rooted in recurrence and complication rates that vary by technique
- Cryoablation therapy has been shown to be a successful method of treatment for

GCT tumors with consistently reported lower rates of recurrence than other adjuvant techniques

- Several techniques for cryoablation have been described in the literature, with the use of liquid nitrogen being the original and perhaps most widely described method
- The application of argon gas cryoablation with the use of metal probes for targeted therapy is modernizing cryotherapy and is a technique that has potential to consistently provide successful treatment with the lowest recurrence and complication rates
- The medium by which the argon based gas probes induce cryoablation is scarcely described in the literature, and is a key variable with the application of this technique to achieve adequate ablation of cancerous cells while minimizing damage to surrounding tissue structures
- This case reports describes the use of a common semi-solid gel, K-Y jelly, as a scarcely described method by which targeted and effective cryoablation of GCT can be performed

References

- [1] Verschoor AJ, Bovée JVMG, Mastboom MJL, Sander Dijkstra PD, Van De Sande MAJ, Gelderblom H. Incidence and demographics of giant cell tumor of bone in The Netherlands: First nationwide Pathology Registry Study. *Acta Orthop*. 2018; 89(5):570-574. doi:10.1080/ 1745 3674.2018.1490987
- [2] Raskin KA, Schwab JH, Mankin HJ, Springfield DS, Hornicek FJ. Giant cell tumor of bone. *J Am Acad Orthop Surg*. 2013;21(2):118-126. doi:10.5435/JAAOS-21-02-118
- [3] Errani C, Tsukamoto S, Ciani G, Donati DM. Present day controversies and consensus in curettage for giant cell tumor of bone. *J Clin Orthop Trauma*. 2019;10(6):1015-1020. doi:10.1016/j.jcot.2019. 09.017
- [4] Rigollino AV, Fernando TS, Tanaka MH, Souza MM. Giant cell tumor locally advanced around the knee: treatment and literature review. *Rev Bras Ortop (English Ed)*. 2017;52(4):473-478. doi:10.1016/ j.rboe.2017.06.009
- [5] Balke M, Schremper L, Gebert C, et al. Giant cell tumor of bone: Treatment and outcome of 214 cases. *J Cancer Res Clin Oncol*. 2008;134(9):969-978. doi:10.1007/s00432-008-0370-x
- [6] Kito M, Matsumoto S, Ae K, et al. Giant cell tumor of the distal femur: Outcome beyond 20 years of follow-up after curettage with polymethylmethacrylate. *J Orthop Sci*. 2018;23(6):1051-1055. doi:10.1016 /j.jos. 2018.06.013
- [7] Jamshidi K, Zandrahimi F, Haji Agha Bozorgi M, et al. Extended curettage versus en bloc resection for the treatment of grade 3 giant cell tumour of the knee with pathologic fracture: a retrospective study. *Int Orthop*. 2020. doi:10.1007/s00264-020-04836-y
- [8] Gaston CL, Bhumbra R, Watanuki M, et al. Does the addition of cement improve the rate of local recurrence after curettage of giant cell tumours in bone? *J Bone Jt Surg - Ser B*. 2011;93 B(12):1665-1669. doi:10. 1302/0301-620X.93B12.27663
- [9] Meller I, Weinbroum A, Bickels J, et al. Fifteen years of bone tumor cryosurgery: A single-center experience of 440 procedures and long-term follow-up. *Eur J Surg Oncol*. 2008;34(8):921-927. doi:10.1016/ j.ejso. 2007.11.001
- [10] Wu PK, Chen CF, Wang JY, et al. Freezing Nitrogen Ethanol Composite May be a Viable Approach for Cryotherapy of Human Giant Cell Tumor of Bone. *Clin Orthop Relat Res*. 2017;475(6):1650-1663. doi:10.1007/ s11999-017-5239-3
- [11] Heijden L, Dijkstra PDS, Sande MAJ, et al. The Clinical Approach Toward Giant Cell Tumor of Bone. *Oncologist*. 2014; 19(5): 550-561. doi:10.1634/theoncologist.2013-0432
- [12] Malawer MM, Bickels J, Meller I, Buch RG, Henshaw RM, Kollender Y. Cryosurgery in the treatment of giant cell tumor: A long term followup study. *Clin Orthop Relat Res*. 1999;(359):176-188. doi:10.1097/ 000030 86-199902000-00019
- [13] Abdelrahman M, Bassiony AA, Shalaby H, Assal MK. Cryosurgery and impaction subchondral bone graft for the treatment of giant cell tumor around the knee. *HSS J*.

Unique Application of K-Y Jelly in Cryotherapy for Giant Cell Tumors of the Distal Femur - A Case Report

- 2009; 5(2):123-128. doi:10.1007/s11420-009-9125-8
- [14] Fisher AD, Williams DF, Bradley PF. The effect of cryosurgery on the strength of bone. Br J Oral Surg. 1978; 15(3):215-222. doi:10.1016/0007-117X(78)90003-3
- [15] Bickels J, Kollender Y, Merimsky O, Isaakov J, Petyan-Brand R, Meller I. Closed argon-based cryoablation of bone tumours. J Bone Jt Surg - Ser B. 2004;86(5):714-718. doi:10.1302/0301-620X.86B5.14416

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