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Skull base chondroblastoma with aneurysmal bone cyst–like changes treated with percutaneous radiofrequency ablation and doxycycline sclerotherapy: illustrative case

*Madeline I. Foo, BS,[1] Kathleen Nicol, MD,[2] and James W. Murakami, MD[1]

Departments of [1]Radiology and [2]Pathology, Nationwide Children's Hospital, Columbus, Ohio

BACKGROUND Chondroblastomas (CBs) are rare benign bone tumors that are often difficult to treat because of their locations. CBs can be even more challenging to successfully manage when they present alongside aneurysmal bone cyst (ABC)-like changes. To minimize operative morbidity, especially in hard-to-reach lesions, percutaneous approaches for both lesions have been individually described. We present a skull base CB with associated ABC-like changes treated by combining two different previously described percutaneous modalities.

OBSERVATIONS The authors report successful percutaneous treatment of a skull base CB with adjacent ABC-like changes in a 17-year-old male. The CB was treated with radiofrequency ablation (RFA) and the adjacent ABC area with doxycycline sclerotherapy. After 3 years of follow-up, there has been no clinical or radiological evidence of recurrence.

LESSONS CBs occur in the skull base and, as elsewhere in the body, can be associated with ABC-like changes. Successful percutaneous treatment of such a CB with ABC-like changes is possible by combining previously described techniques of RFA and doxycycline sclerotherapy.

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KEYWORDS chondroblastoma; radiofrequency ablation; doxycycline; sclerotherapy; ABC

Chondroblastomas (CBs) are benign bone tumors that account for 1% of all primary bone neoplasms.[1,2] CBs of the skull are especially rare.[3] Aneurysmal bone cysts (ABCs) are benign, expansile, osteolytic lesions that constitute 1% of bone tumors.[4,5] Tumors with ABC-like changes, previously called "secondary ABCs," represent 30% of ABC cases and present with the radiological appearance of an ABC associated with a separate bone tumor.[4,5] CBs are one of the more common tumors associated with ABC-like changes (22%).[5]

Traditional treatment for CBs or ABCs is open surgical removal with or without adjuvants, bone grafting, and fixation, but it has a recurrence rate as high as 32%, especially in surgically complex locations.[6–9] With operative morbidity associated with resection of skull base lesions reported at 30.4%, open surgery carries significant risks that will only increase if repeated procedures become necessary due to recurrences.[9]

Within the last decade, percutaneous image-guided radiofrequency ablation (RFA) of CBs and doxycycline sclerotherapy of ABCs have proved to be safe and effective alternatives to open resection.[10–13] Percutaneous minimally invasive treatments can decrease procedural morbidity associated with more extensive open operative approaches.[6,9–12]

The purpose of this case report is to present a difficult skull base CB with ABC-like changes managed with a combination of RFA and doxycycline sclerotherapy. To our knowledge, this combination of percutaneous treatments has never been reported.

Illustrative Case

A 17-year-old, otherwise healthy, athletic boy presented with neck and shoulder pain leading first to non–contrast-enhanced magnetic resonance (MR) and noncontrast computed tomography (CT)

ABBREVIATIONS ABC = aneurysmal bone cyst; CB = chondroblastoma; CT = computed tomography; MR = magnetic resonance; RFA = radiofrequency ablation.

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* M.I.F., K.N., and J.W.M. contributed equally to this work.

scans, which demonstrated an expansile lytic bone tumor replacing the clivus and left occipital condyle (Fig. 1). The lesion was predominantly cystic with blood fluid levels on T2-weighted images but had an approximately 1-cm-diameter dark nodular area in the left side of the clivus, which was initially believed to be blood products within a cyst (Fig. 1). At this point, given the presumptive diagnosis of an ABC, the therapeutic options included surgical curettage with bone grafting and osseous fixation as needed, radiation therapy, medical therapy with denosumab, and percutaneous sclerotherapy. Radiation therapy and denosumab are usually reserved for ABCs untreatable by direct local therapies such as surgery or sclerotherapy.[12] To avoid the potential for significant morbidity associated with open resection and reconstruction, the patient was referred for percutaneous biopsy and doxycycline sclerotherapy. All procedures were performed after a full discussion of the risks, benefits, and treatment alternatives.

Four months later, the patient underwent a CT-guided biopsy of the nodular area in the left occipital condyle and walls of the cyst followed by doxycycline sclerotherapy of the cystic portions of the lesion. CT-guided biopsy was performed with two 14-gauge Bonopty needles (AprioMed) from retromastoid and transnasal approaches (Fig. 2). As is our routine practice when treating an ABC, during that same procedure, doxycycline was injected into the cystic areas under CT guidance using a double-needle technique previously described.[12] Doxycycline (40 mg/mL in normal saline) was mixed 50:50 with 25% human serum albumin (Grifols Therapeutics) and

FIG. 2. Axial CT image obtained during biopsy and first treatment, showing 14-gauge biopsy needles (*white arrows*) from transnasal and retromastoid approaches directed into the solid nodular area in the left side of the clivus shown in Fig. 1A. Injected dilute iodinated contrast can be seen opacifying the liquid portions of the lesion (*solid white areas*) and surrounding the solid nodule.

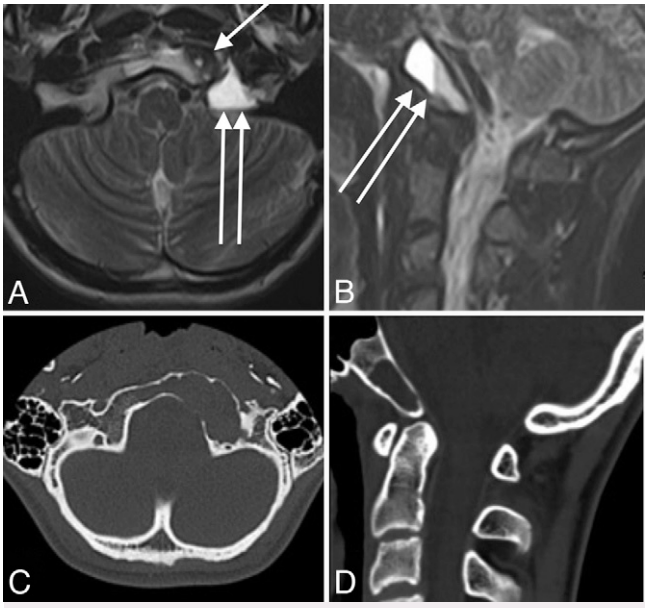

FIG. 1. Pretreatment skull base MR and CT images. **A:** Axial T2-weighted MR image shows the left side of the clivus filled with nodular low signal material (*single arrow*) and the left occipital condyle completely replaced with cystic disease containing a blood fluid level (*double arrows*). **B:** Midline sagittal short tau inversion recovery image showing an additional fluid portion replacing the clivus from the foramen magnum up to the basioccipital synchondrosis with blood fluid level (*double arrows*). **C:** Axial noncontrast CT image at the same level as in panel A, showing bone destruction of the clivus and left occipital condyle. **D:** Midline sagittal CT image at the same location as in panel B, showing midline clival bone destruction.

then agitated with an equal volume of air to generate a stable foam with a final doxycycline concentration of 10 mg/mL.

Pathology specimens later revealed that the solid area in the left side of the clivus was a CB and the adjacent cystic portions were ABC-like change (Fig. 3). At the beginning of the following year, after discussion with his referring neurosurgeon, we performed CT-guided RFA of the nodular area in the left side of the clivus and repeat doxycycline sclerotherapy of the remaining cystic areas, which were already decreasing in size since the first treatment 3 months earlier. For the RFA, a 14-gauge Bonopty needle was used to access the solid part of the lesion in the left side of the clivus from an

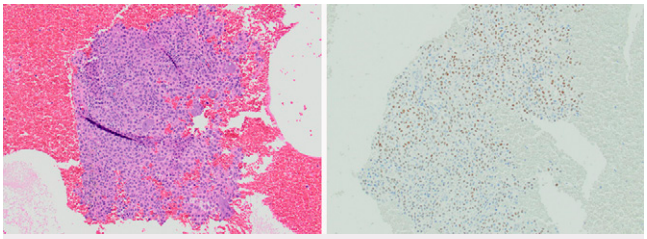

FIG. 3. Pathology specimens from the biopsy. **Left:** Stromal fragments composed of sheets of relatively uniform round-polygonal cells having well-defined cytoplasmic borders appear in a background of blood. Within the chondroblastic sheets are osteoclast-like giant cells that are randomly distributed. Some lesional nuclei have a longitudinal groove or cleft and variable numbers of nucleoli that are small or inconspicuous. Hematoxylin and eosin stain, original magnification ×200. **Right:** Immunohistochemical staining was performed: SATB2 nuclear positivity in the CB. Original magnification ×200.

infrazygomatic approach to deploy a 17-gauge Osteocool RF wand with a 7-mm long active tip (Medtronic) and to perform a 6-minute burn (Fig. 4). Within 24 hours, the patient developed paralysis of the left side of his tongue. He returned 3 months later for his last percutaneous doxycycline sclerotherapy session of all remaining cystic areas. He has been seen in follow-up closely with both CT and MR for 3 years with progressive ossification of all areas and no recurrent lytic or solid tumor (Fig. 5). He has had complete resolution of all symptoms, except that from his left hypoglossal nerve injury, and has returned to all activities, including collegiate athletics.

Discussion

Observations

CBs are painful benign primary bone tumors that typically develop in children and adolescents in the epiphyses of long bones.[1] Recent studies demonstrate successful treatment of appendicular CBs using RFA.[10,13] Rybak et al.[10] found that 12 (85.7%) of 14 patients did not require further intervention, with only one recurrence (6%) and no complications directly attributed to RFA. In addition, all patients demonstrated a full return to all pretreatment activities at a mean clinical follow-up of 41.3 months.[10] Kulkarni et al.[13] reported that out of 27 patients, only 2 patients (7.4%) experienced a complication related to RFA, which is less than that reported with open surgery. In that study, there were no recurrences, and all patients had a significant reduction in pain 6 weeks after treatment.[13] To the best of our knowledge, there is no literature on RFA of CBs in the skull.

ABCs are benign, locally aggressive bone tumors that commonly develop in the metaphyses of long bones.[4] Approximately 30% of these cases represent ABC-like changes associated with other primary bone tumors, such as a CB.[4,5] Percutaneous doxycycline sclerotherapy has been used to treat ABCs with proven safety and efficacy.[11,12] Shiels et al.[11] successfully treated 21 ABCs with a low recurrence rate of 5%. This approach was further analyzed in a recent study of 16 patients with cervical spine ABCs.[12] This paper reports that 86% of the patients were cured of their disease after percutaneous sclerotherapy with long-term follow-up, demonstrating that this technique is applicable in even anatomically challenging locations.

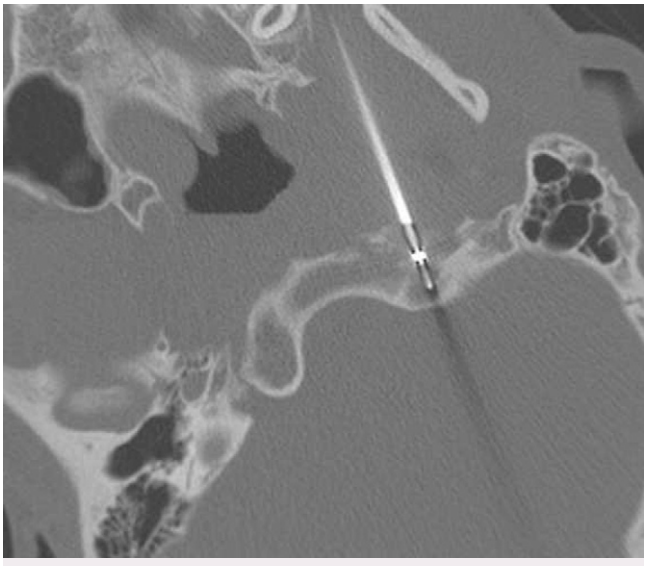

FIG. 4. Axial CT obtained during second treatment, showing infrazygomatic approach with RFA wand deployed coaxially through a 14-gauge needle into the CB. Note that the more medial cystic ABC-like area in the clivus is healing and ossifying because of the first doxycycline treatment.

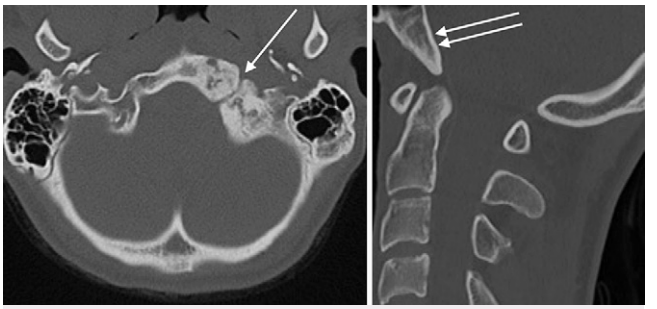

FIG. 5. Noncontrast CT images obtained 3 years after the last treatment with locations matching those shown in Fig. 1. **Left:** Axial image showing dense ossification of the treated left side of the clivus and occipital condyle. The small hypoglossal canal (*arrow*) can now be seen traversing the previously treated area. **Right:** Midline sagittal image showing complete ossification (*double arrows*) of the previously cystic fluid–filled ABC component.

This case report presents the successful combination of RFA to treat a CB and doxycycline sclerotherapy to treat an associated ABC. To our knowledge, this is the first report of using image-guided RFA and sclerotherapy to concurrently treat a bone lesion of this kind. It highlights how minimally invasive percutaneous techniques can be combined.

Open resection is currently the first treatment option for skull base tumors; however, lesions in this location are often difficult to completely resect without complications.[2,8] Hayhurst et al.[9] and Hanbali et al.[14] retrospectively reviewed the functional outcomes related to skull base surgery and reported that only 52% and 63.6% of their cases, respectively, achieved gross total resection. Our report presents an alternative, less invasive, percutaneous treatment for a skull base CB with ABC-like changes. Although our patient did sustain a permanent hypoglossal nerve injury, this may also have occurred with resection because the CB encased the hypoglossal canal (Fig. 5). The requirement for a straight needle path from the skin to the center of the CB, avoiding all critical neck structures, left only one viable option, which was the one chosen (Fig. 4). Although it cannot be completely known which of the components of the treatment caused the nerve injury, RFA is the most likely choice because nerve injury is a known complication of this technique. In this case, the inability to accurately see the hypoglossal canal's proximity to the CB, the lack of an insulating cortex around the hypoglossal nerve, and the needle position required to ablate the CB all likely contributed to the injury.

At the most recent follow-up (3 years after the cessation of treatment), our patient had dense ossification of both lesions and was clinically well and engaged in all of life's activities including collegiate sports.

Lessons

Image-guided percutaneous RFA and doxycycline sclerotherapy can be combined in the treatment of a CB with ABC-like changes,

respectively. If benign bone lesions such as CBs and ABCs occur in surgically difficult areas such as the skull base, they can be percutaneously treated with the minimally invasive approaches described in this report.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Murakami. Acquisition of data: Murakami, Nicol. Analysis and interpretation of data: Murakami, Nicol. Drafting the article: Murakami, Foo. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Murakami. Administrative/technical/material support: Murakami. Study supervision: Murakami.

Correspondence

James W. Murakami: Nationwide Children's Hospital, Columbus, OH. james.murakami@nationwidechildrens.org.