CLINICAL STUDY

Cryoablation of Osteoid Osteoma in the Pediatric and Adolescent Population

Morgan J. Whitmore, MD, C. Matthew Hawkins, MD, J. David Prologo, MD, Kelley W. Marshall, MD, Jorge A. Fabregas, MD, Douglas B. Yim, MD, David Monson, MD, Shervin V. Oskouei, MD, Nicholas D. Fletcher, MD, and Roger S. Williams, DO

ABSTRACT

Purpose: To evaluate the technical feasibility and clinical efficacy of osteoid osteoma (OO) cryoablation in a large, pediatric/adolescent cohort.

Materials and Methods: An electronic medical record and imaging archive review was performed to identify all cryoablations performed for OOs between 2011 and 2015 at a single tertiary care pediatric hospital. The subsequent analysis included 29 patients with suspected OOs treated by cryoablation (age range, 3–18 y; mean age, 11.3 y; 17 boys; 12 girls). Conventional CT guidance was used in 22 procedures; cone-beam CT guidance was used in 7 procedures. Follow-up data were obtained via a standardized telephone questionnaire (23/29 patients; 79.3%) and clinical notes (5/29 patients; 17.2%). One patient was lost to follow-up.

Results: Technical success was achieved in 100% of patients (29/29). Immediate clinical success (cessation of pain and nonsteroidal antiinflammatory drug [NSAID] use within 1 mo after the procedure) was achieved in 27/28 patients (96.4%). Short-term clinical success (cessation of pain and NSAID use for $>$ 3 mo after the procedure) was achieved in 24/25 patients (96%). Long-term clinical success (cessation of pain and NSAID use for $>$ 12 mo after the procedure) was achieved in 19/21 patients (90.5%). Median pain scale score before the procedure was 10 (range, 5–10); median pain scale score after the procedure was 0 (range, 0–8; $P < .0001$). There were 6 minor complications (21%) and no major complications.

Conclusion: Image-guided cryoablation is a technically feasible, clinically efficacious therapeutic option for children and adolescents with symptomatic OO.

ABBREVIATIONS

NSAID = nonsteroidal antiinflammatory drug, OO = osteoid osteoma

Osteoid osteomas (OOs) are benign, predominately cortically based bone tumors commonly found in the lower extremities (1–3). OOs have a 3:1 male-to-female preponderance and represent approximately 11% of all benign bone tumors in children (2,4). They classically cause nocturnal pain that is relieved by nonsteroidal antiinflammatory drugs (NSAIDs) (2–4). Treatment is often warranted because of the debilitating pain and potential clinical sequelae associated with these lesions as well as the side effects of frequent NSAID use. Image-guided cryoablation has emerged as a therapeutic option for patients with symptomatic OOs (5–7). Through a percutaneously inserted cryoprobe, cryoablation uses the Joule-Thompson effect, creating rapidly freezing temperatures within target tissues, followed by rapid active thawing within the same tissues, ultimately leading to cellular death through immediate and delayed mechanisms.

Data regarding cryoablation of OOs in the pediatric and adolescent population are sparse and mostly limited to small case series. A small case series performed by Wu et al (5) examined clinical outcomes of cryoablation in six pediatric patients and demonstrated complete

From the Department of Radiology and Imaging Sciences, Divisions of Interventional Radiology and Image-guided Medicine (M.J.W., C.M.H., J.D.P., R.S.W.) and Pediatric Radiology (C.M.H., K.W.M.), and Department of Orthopaedics (D.M., S.V.O., N.D.F.), Emory University School of Medicine, 1364 Clifton Road NE, Suite D112, Atlanta, GA 30322; Children's Orthopaedics of Atlanta (J.A.F.), Atlanta, Georgia; and Atlanta VA Medical Center (D.B.Y.), Atlanta, Georgia. Received August 6, 2015; final revision received October 6, 2015; accepted October 8, 2015. Address correspondence to C.M.H.; E-mail: Matt.hawkins@emory.edu

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technical and clinical success without complications. A study by Liu et al (6) examined two pediatric case reports of successful cryoablation of OOs. Coupal et al (7) demonstrated technical and clinical success of OO cyroablation in 10 adult patients without complications. The purpose of this study is to retrospectively evaluate the technical feasibility and clinical efficacy of OO cryoablation in a large pediatric and adolescent cohort.

MATERIALS AND METHODS

Following institutional review board approval, an electronic medical record and imaging archive review was performed to identify all cryoablations for OOs performed between 2011 and 2015 at a single tertiary care pediatric hospital. Final inclusion criteria included all patients who underwent cryoablation for suspected OO based on clinical presentation and imaging characteristics, which have been described in the literature (2). All patients were referred by pediatric orthopedic surgeons or pediatric rheumatologists. Clinical presentation was subdivided into typical (n = 23; pain predominately in the evening, at night, or early in the morning pain relieved by NSAID use) and atypical (n = 6; not meeting the definition of typical) categories (2–4). Multiple additional parameters were assessed before the procedure (**Table 1**). The following information was unavailable for analysis pain scale score before the procedure in one patient, pain scale score after the procedure in one patient (a different patient), and NSAID use after the procedure in two patients.

Table 1. Patient Demographics and Data Gathered before Treatment (N = 29)

Characteristic	Value
Age (y)	
Mean	11.3
Range	3–18
SD	±4
Sex	
Male	17 (59%)
Female	12 (41%)
Race	
White	22 (76%)
African American	5 (17%)
Hispanic	2 (7%)
Clinical presentation*	
Classic	23 (79%)
Atypical	6 (21%)
Duration of pain (mo)	
Mean	13.4
Range	2-42
NSAID use†	29/29 (100%)
Location	
Proximal femur	12 (41.4%)
Midfemur	3 (10.3%)
Distal femur	2 (6.9%)
Proximal tibia	3 (10.3%)
Midtibia	4 (13.8%)
Talus	1 (3.4%)
Metatarsal	1 (3.4%)
Humerus	1 (3.4%)
Radius	1 (3.4%)
Vertebral body	1 (3.4%)
Nidus size (mm)	
Mean	6.7
Range	1–18
SD	±2.7

NSAID = nonsteroidal antiinflammatory drug; SD = standard deviation.
*Classic clinical presentation defined as pain predominately in the evening, at night, or early in the morning relieved with antiinflammatory medication.
†Use of NSAIDs before procedure.

Procedural Technique

Informed consent was obtained before any intervention. All patients received general anesthesia under the supervision of a pediatric anesthesiologist. Cone-beam computed tomography (CT) (Philips Healthcare, Andover, Maryland) (n = 7) or axial thin-section CT (n = 22) imaging guidance was used for OO and needle localization. Cone-beam CT was used in conjunction with XperGuide and XperCT tools (Philips Healthcare). Cone-beam CT parameters were source-detector distance, 1,200 mm; 18°/s rotation speed for 180°; 30 images/s; and automatic exposure control. Acquired cone-beam CT images were analyzed on a three-dimensional angiography workstation in the interventional radiology suite (Philips Interventional Tools 8.3.1). CT-guided procedures were performed on a 40-slice positron emission tomography/CT scanner (Siemens AG, Berlin, Germany) at 2.5-mm collimation, 120 kVp, and 160 mA.

In 21 cases, intralesional positioning of the cryoablation probe was obtained via an 11-gauge cortical drill (Teleflex, Morrisville, North Carolina), which was used to bore through the cortex and into the OO nidus. A 17-gauge cryoablation probe was placed through the introducer into the region of the nidus. In eight cases, the cryoablation probe was placed alongside the osseous cortex adjacent to the OO nidus (juxtacortical). The juxtacortical technique involves placement of the cryoprobe adjacent to the OO nidus without drilling through any cortex. This technique was previously described by Liu et al (6). If a biopsy was performed (n = 7), a 13-gauge bone biopsy device (Teleflex) was deployed through the introducer, and a 1-cm specimen was obtained.

Galil cryoablation systems (Galil Medical Inc, Arden Hills, Minnesota) were used in all procedures, employing either the SeedNet Gold (Model: FPRCH2024; before