Application of Real – Time Imaging with the O-arm for Management of Osteomyelitis in the Tibia following a Pediatric Crush-Injury

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Statement of Purpose

The O-arm (Medtronic Inc., Louisville, Colo., USA), is a CT-like, surgical, mobile 2D/3D X-ray imaging system optimised for spinal and orthopedic surgery in the intra-operative setting in the axial, coronal, and sagittal planes. This imaging modality is also extremely useful in accurately triangulating the location of the pathology in question. The O-arm has mainly been reported in spine and neurosurgery as an intra-operative imaging technique to appropriately detect osteoid osteomas, osteoblastomas, and spinal bone infections. The purpose of this study was to present the importance role the O-arm can have in lower extremity surgery.

Literature Review

Osteomyelitis is primarily a bacterial, or sometimes fungal, infection of bone and bone marrow, while suppuration of the bone cortex without extension into the bone marrow is referred to as infectious osteitis (1). While osteomyelitis is frequently seen within immunocompromised individuals, osteomyelitis affecting young, healthy patients most commonly occurs following a traumatic incident. The most common presentation of osteomyelitis in the lower extremity is through direct extension (1). Treatment options usually include surgical debridement of the infected bone, along with antibiotic therapy. However, the management of open fractures of the tibia in a pediatric population continues to represent a challenge to healthcare providers. Factors in the pediatric population biologically differ from those in adults due to the presence of a thickened periosteum, and therefore increased vascularity, greater healing ability, and improved potential to remodel (2,3). It is imperative to obtain functional anatomical results while achieving desirable long-term outcomes in the treatment of osteomyelitis in the pediatric population. However, the challenge lies in the complications of increased pressure from parents and the desire for children to return to activity quicker (4).

There have been several case series in literature describing the results of treating open tibia fractures in the pediatric population experiencing post-operative osteomyelitis. The initial protocol focuses on obtaining serial radiographs of the affected area. Imaging such as an MRI or CT imaging may be obtained for further advanced imaging. Intraoperative determination of osteomyelitis can be performed using an O-arm, which has been commonly employed for management of bone infections, neurological tumors, and other osseous pathologies. The O-arm (Medtronic Inc., Louisville, CO, USA) is a CT-like, surgical, mobile 2D/3D X-ray imaging system that is optimized for spinal and orthopedic surgery in the intraoperative setting for visualization in the axial, coronal, and sagittal planes (5). To our knowledge, there is no current literature describing the usage of the O-arm imaging modality in the treatment of lower extremity osteomyelitis.

Case Study

Case Summary: We present a 5-year old female patient who sustained a crush-type fracture of the right distal tibia and fibula, status post medial and lateral fasciotomies of the right lower extremity. Primary wound closure by Plastic Surgery and application of TLI Hex 6H fixator by our team was performed in April 2019 after transfer to our facility. Neurovascular status and muscle strength was maintained to the right lower extremity following appropriate management which included bone grafting, resection of the infected malunion of tibia, intravenous antibiotics, aggressive Physical Therapy and Occupational Therapy. At the patient’s 17 month follow-up, there was noted to be possible development of tibial bone infection with a central 1.2cm area of lucency, resembling a possible Brody’s Abscess. Following discussion with the Infectious Disease team the decision was made to aspirate the nidus and determine whether the area of delayed union was due to osteomyelitis or delayed healing. Our team employed the use of the O-arm (Medtronic Inc., Louisville, CO, USA) to accurately locate the osseous pathology in the intra-operative setting for aspiration and debridement. Cultures and a bone biopsy was sent to pathology and microbiology to guide treatment. The decision was made to remove the external fixator and primarily close all wounds of the right lower extremity.

History of Present Illness: SF presented on 4/24/2019 status post right leg. 2 incision 4 compartment plantar fasciotomy with distal tibia and fibular fracture from another hospital. The patient then underwent four subsequent procedures which included reduction of the right leg tibia and fibula fractures with application of an external fixator, wound debridement and closure, and tibia and fibula osteotomies with external fixator application. At 17 months follow up the patient developed a 1.2cm area of lucency in the right tibia resembling a possible Brody’s abscess. A review of systems was negative.

Past Medical History: None

Physical Exam:

Vascular: DP and PT pulses palpable 2/4 bilaterally. Capillary refill time brisk to all digits.

Dermatology: Pyogenic granuloma formation at pin sites on right leg. No erythema or ascending cellulitis.

Neurologic: Protective and vibratory sensation intact. Orthopedic: External fixation intact to right lower extremity.

4/02/2019

Right tibia/fibula osteotomy

04/20/2019

• 2 incision 4 compartment right leg fasciotomy

04/27/2019

• Right tibial fracture reduction and fixation

• Right leg wound debridement

• External fixation

05/01/2019

• Right lateral leg wound debridement and closure

05/06/2019

• Right medial leg wound debridement and closure

05/29/2019

• Right tibia/fibula osteotomy

• External fixation

• Left sublavian Broviac catheter insertion

• Right leg complex wound closure

10/19/2020

• O-arm guided incision and drainage of Right tibia bone cortex

• Removal of external fixation

• Right leg wound closure

Analysis & Discussion

The O-arm is a powerful imaging modality that can be highly useful in the intraoperative setting. It provides mobile 2D/3D imaging in all three surgical planes. In turn, osseous pathology such as bone tumors and infections can be accurately located during surgery. Currently, this system is mainly in use during spinal surgery, neurosurgery, and orthopedic surgery of the upper extremity. To our knowledge, this is the first use of the O-arm in lower extremity surgery. This case outlined the use of the O-arm to pinpoint a Brody’s abscess within the tibial shaft of a pediatric patient. We were able to precisely drill the bone cortex once the pathology was identified and were also able to send accurate specimens to help guide postoperative treatment.

As we report here, the O-arm does have place during surgical procedures of the lower extremity. This imaging modality may be used to give real time 2D/3D images of the lower extremity especially when trying to pinpoint the exact location of bony pathology. Additionally, future studies should focus on O-arm use in lower extremity surgery.

References


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