Clinical Utility of Musculoskeletal Ultrasound in Localizing Heterotopic Ossification of the Hip in a Patient with Chronic Burns: A Case Report

Lawrence G. Manalili, MD, Dorothy O. Dy Ching Bing-Agsaoay, MD and Carl Froilan D. Leochico, PTRP, MD

Department of Rehabilitation Medicine, Philippine General Hospital and College of Medicine, University of the Philippines Manila

ABSTRACT

Patients with burns are predisposed to heterotopic ossification and contracture formation. While radiographs and bone scans are used to detect heterotopic ossification, musculoskeletal ultrasound can be used to diagnose and localize the lesion in patients with contractures. A 14-year-old girl with multiple contractures of the limbs from thermal burn injury sustained three years ago underwent in-patient rehabilitation in a sub-acute burn rehabilitation unit. Despite close monitoring and daily therapy sessions, the patient had minimal improvement in the range of motion of bilateral hips. Musculoskeletal ultrasound demonstrated hyperechogenic focus on the posterolateral aspect of the bilateral hips. This report documents the advantage of diagnostic musculoskeletal ultrasound in localizing and guiding the treatment of heterotopic ossification in a burn patient with contractures.

Key Words: ultrasound, diagnostic imaging, heterotopic ossification, burns, rehabilitation, pediatrics

Corresponding author: Dorothy O. Dy Ching Bing-Agsaoay, MD
Department of Rehabilitation Medicine
Philippine General Hospital
University of the Philippines Manila
Taft Avenue, Ermita, Manila 1000, Philippines
Email: dorothydy@gmail.com

INTRODUCTION

The development and progression of ectopic bone in response to trauma remain to be a clinical dilemma, incurring significant cost and patient morbidity. Cases of heterotopic ossification (HO) are broadly classified into three etiological categories: 1) neurogenic (such as traumatic brain and spinal cord injury); 2) orthopedic (such as post-arthroscopy, fracture fixation, or joint replacement; and 3) traumatic (such as in severe burns and high-velocity blast injury).[1] Compounded by pre-morbid and/or new medical problems, cases of severe burns tend to have a slow course of rehabilitation. Such a complicated clinical course may delay the safe and adequate mobilization of burn patients, placing them at risk for the development of HO.

The incidence of HO differs among clinical populations. In spinal cord-injured patients, the incidence of HO ranges between 20% and 25%. In closed brain injury, 10%–20% of patients develop HO. Following open reduction and internal fixation of acetabular fractures, HO occurs in 18% to 90% of patients. Among people in extremes of age, such as children and elderly people, the incidence is significantly lower, however, this is contrary to those children with severe burn.[2]

Plain radiography, magnetic resonance imaging (MRI), and computed tomography scan (CT) have low specificity in detecting HO, especially in its early stage. In contrast, three-phase bone scintigraphy is used for confirmation and prognostication as it is the most sensitive imaging modality for early detection of HO. It can detect HO as early as

Table 1. Range of motion and strength of bilateral lower extremities of the patient on admission three years post-burn injury

Range of motion (in degrees) using standard goniometry			Strength based on manual muscle testing		
	Right	Left		Right	Left
Hip flexion	10-30	20-30	***Hip flexors***	3/5 (within available range)	3/5 (within available range)
Hip extension	10 (lag)	20 (lag)	***Hip extensors***	3/5 (within available range)	3/5 (within available range)
Hip abduction	0-20	0-20	***Hip abductors***	3/5 (within available range)	3/5 (within available range)
Hip adduction	0-10	0-10	***Hip adductors***	3+/5 (within available range)	3+/5 (within available range)
Knee flexion	0-60	30-50	***Knee flexors***	3/5 (within available range)	3/5 (within available range)
Knee extension	60-0	50-30	***Knee extensors***	3/5 (within available range)	3/5 (within available range)
Ankle dorsiflexion	20 (lag)	0-5	***Ankle dorsiflexors***	2/5 (within available range)	2/5 (within available range)
Ankle plantarflexion	20-50	0-40	***Ankle flexors***	2/5 (within available range)	2/5 (within available range)
Ankle eversion	0-10	0-10	***Ankle everters***	2/5 (within available range)	2/5 (within available range)
Ankle inversion	0-10	0-20	***Ankle inverters***	2/5 (within available range)	2/5 (within available range)

two to four weeks. Musculoskeletal ultrasound can detect HO as early as one week.[3] It is an emerging investigative modality not only for early identification of HO, but also to monitor its progression.[2]

CASE

A 14-year-old female, right-handed, from Pangasinan, with unremarkable past medical history, was admitted in June 2018 at the Sub-Acute Burn Rehabili-tation Unit of the Philippine General Hospital due to multiple lower limb contractures. These contractures resulted from non-intentional thermal burn injuries in 22% of total body surface area involving the face, bilateral upper and lower extremities, and anterior trunk which she sustained three years ago. She had already undergone left knee contracture release with a split-thickness skin graft in March 2018.

The patient had an unremarkable systemic physical examination, except for the multiple mature hypertrophic scars on the face, and bilateral upper and lower extremities. She had limited range of motion on bilateral hips, knees, and ankles with tenderness on the lateral aspect of bilateral hips. The hips exhibited the most limitation in all ranges of motion, followed by the ankles. On manual muscle testing (MMT), the muscles of the hips and knees had a grade of 3/5 within available range (Table 1). She was bedridden and maximally assisted in performing all basic activities of daily living (ADLs).

After two weeks of in-patient rehabilitation which consisted of physical therapy and occupational therapy and focused on therapeutic modalities and stretching exercises, the range of motion of bilateral knees and ankles improved. However, the persistence of pain-limited range of motion of bilateral hips prompted further investigation. The course of succeeding evaluations and management are summarized in Table 2.

Bilateral hip radiographs showed a generalized decrease in density of the visualized osseous structures and non-specific soft tissue calcifications in bilateral femoral heads and neck. Due to hip pain and limitation of motion, it was technically difficult to appropriately position the patients' hips for the frog leg view and accurately localize the calcifications.

Clinical Findings and Management

In the attempt to further localize the calcifications, a bone scan was performed, revealing unusually increased tracer uptake in the area of the left acetabulum and greater trochanter of the left femur. Likewise, there was also

Table 2. Summary of patient's clinical course

April 2015	Burn injury Development of contractures Dependence in activities of daily living Inability to ambulate
March 2018	Underwent release of left knee contracture with a split-thickness skin graft Referred to subacute burn rehabilitation
June 2018: admission to rehabilitation unit	Admitted at the subacute burn rehabilitation unit Underwent daily physical therapy sessions, including therapeutic ultrasound, stretching, splinting, and exercises Given pain medications
After 2 weeks of rehabilitation	Non-improvement of bilateral hip pain and range of motion Bilateral hip radiographs revealed non-specific calcifications
Further investigation	A bone scan was requested to confirm the suspected heterotopic ossification Bone scan revealed increased tracer uptake of bilateral hips
Musculoskeletal ultrasound	Further investigation with musculoskeletal ultrasound was done to localize the lesion to the posterolateral aspect of bilateral femoral heads
Rehabilitation management updated	No aggressive stretching done Physical therapy focused on strengthening of hip extensors, ambulation training Pain medications Bilateral upper extremities were strengthened to prepare for walker ambulation
August 2018: discharged	The patient was discharged after two months of intensive rehabilitation Ambulatory with walker inside the home and used a wheelchair in the community

increased tracer uptake in the right periacetabular area and the greater trochanter of the right femur. On single-photon emission computed tomography (SPECT-CT), there were irregular calcific deposits adjacent to the inferomedial aspect of the left greater trochanter. Calcific densities were observed adjacent to the tip of the right greater trochanter extending to the acetabulum. The rest of the skeletal structures showed symmetrical physiologic tracer distribution.

Routine real-time sonologic evaluation of bilateral hips was performed to localize the site of the heterotopic ossifications. Static and selected dynamic views were obtained in orthogonal and non-orthogonal planes, with Doppler examination. Cortical irregularities were noted on the posterior aspect of the hips (Figure 1). The cortical irregularities were further localized to the posterior aspect of the greater tuberosity, and inferoposterior aspects of the femoral head (Figure 2). There was an absence of vascularity around the area, but there was pain on sonopalpation.

Follow-up and Outcomes

After careful localization of the heterotopic ossification in the posterolateral aspects of the hips using musculoskeletal ultrasound, rehabilitation management was modified accordingly. Since the heterotopic ossification was located underneath the gluteus maximus, along the femoral head, the ranges of motion of the hips were not expected to increase rapidly.

On admission, aggressive stretching of the bilateral lower extremities and management of the scars were the priority. The patient underwent physical therapy sessions twice a day and was prescribed bi-valve knee splints to maintain the stretch on the knees. Upon re-evaluation, the focus was shifted to pain control, gentle stretching of the hips, and strengthening of the bilateral crutch-bearing muscles and lower extremities. Therapeutic ultrasound, transcutaneous electrical nerve stimulation and pain medications were used to control the pain. Therapeutic exercises through gentle stretching of the hips, strengthening of bilateral upper extremities, and gait re-training with a walker were initiated. Furthermore, the patient was trained to propel the wheelchair for long-distance community mobility. The patient was discharged after two months of intensive rehabilitation with improvements noted in right hip flexion range of motion from 10°–30° to 10°–60° (improvement of 30°) and left hip flexion from 20°–30° to 20°–60° (improvement of 30°).

On follow-up after two months, the patient was ambulatory using a walker inside the home and was able to perform community ambulation using a wheelchair. She had modified independence on lower garment dressing, independent in upper garment dressing, modified independence in transitions and transfers. She was able to return to school and resume studying.

DISCUSSION

The exact pathophysiology of HO is still not known due to the low incidence and limited literature. Animal models and observations supply the knowledge that is missing from larger studies. The cellular pathways that are most implicated in the formation of pathological ectopic tissue, and the definitive mechanism driving HO deposition, have not yet been established. Reviews of the pathophysiology of HO implicate the inflammatory process and systemic responses to trauma as contributors to HO, particularly in burns. The formation of HO in burn injuries is understood to be brought about by inflammation and immune cascade.

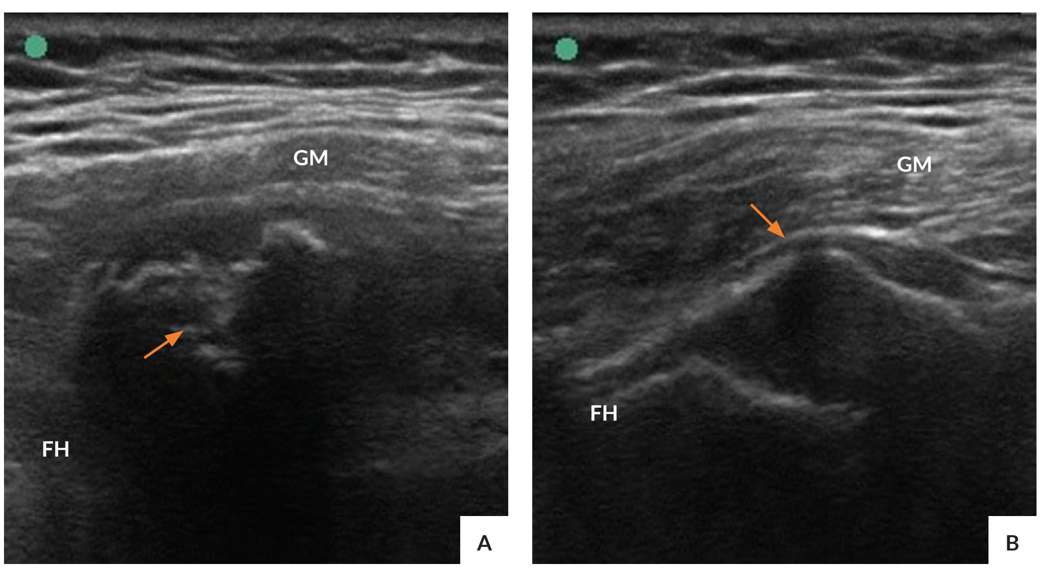

Figure 1. Short-axis sonologic images of right **(A)** and left **(B)** posterior hips showing calcific densities *(orange arrows)* along the femoral head (FH) underneath the gluteus maximus (GM).

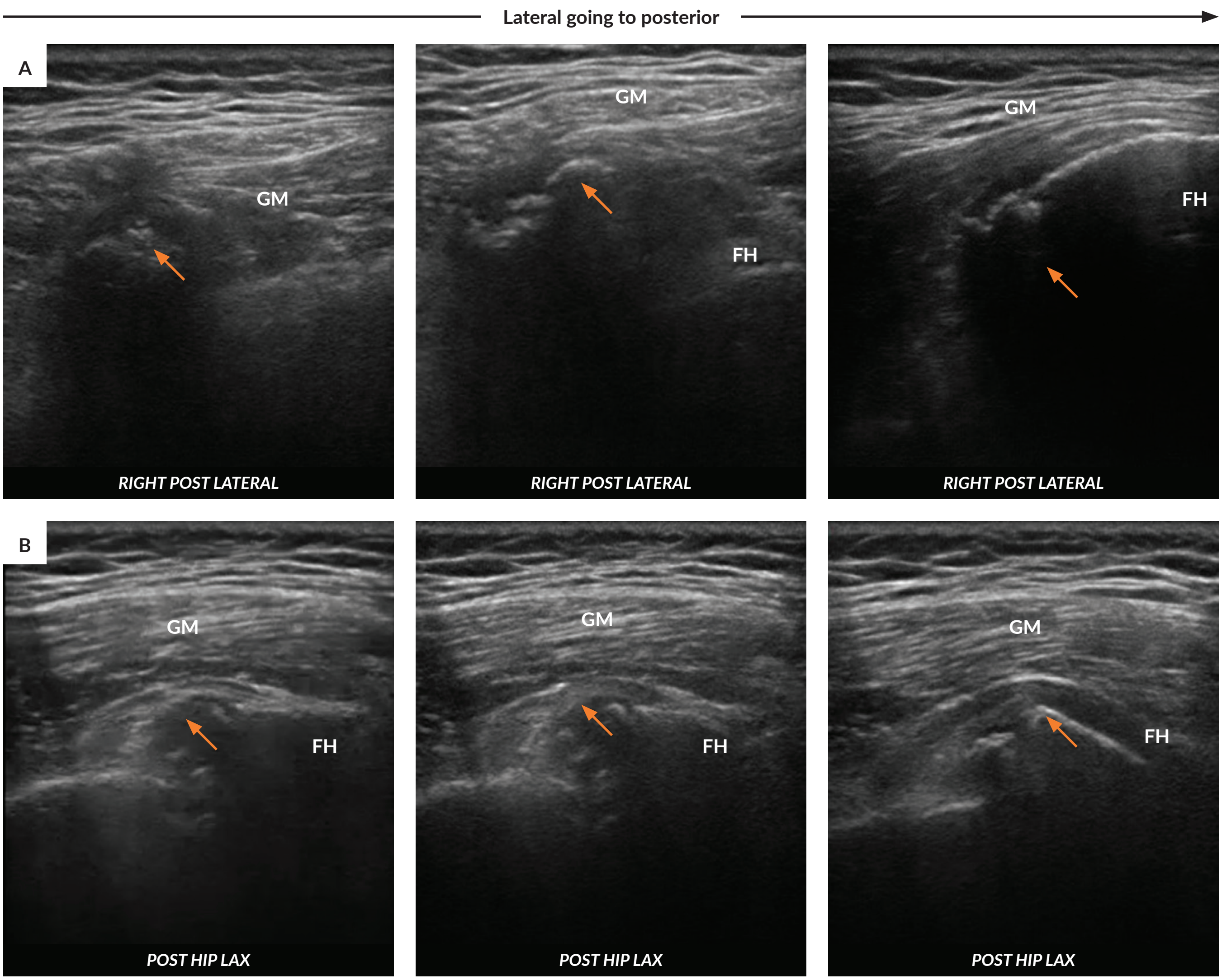

Figure 2. Long-axis sonologic images of right **(A)** and left **(B)** posterior hips from lateral to posterior aspects, showing calcific densities *(orange arrows)* along the femoral head (FH) underneath the gluteus maximus (GM).

Inflammation in the affected tissue attracts myeloid cells and lymphocytes that catalyze the release of cytokines.[3] This widespread inflammation, coupled with immobilization may further predispose a patient to HO.

The following are the three main risk factors in developing HO in burn injuries: (1) greater than 50% total body surface area, (2) joints with overlying burn, and (3) long-term immobilization.[4] Although our patient only had a burn covering 22% of the total body surface area and no burn wounds were in the area of the hip, there was no initiation of rehabilitation during the post-burn period, causing the patient to become immobilized and bedridden.

Radiographs are useful in detecting HO. However, plain radiography does not provide information on depth and is limited by the patient's ability to position properly for the required view. This limitation can lead to the overlapping of osseous shadows and difficulty in localizing the lesion. In contrast, musculoskeletal ultrasound can detect evidence of HO on up to 10–14 days before when radiographic evidence appeared. Serial ultrasonography provided an earlier and more specific diagnosis of a hip muscle HO lesion than did X-ray or MRI.[3] In comparison with plain radiographs, ultrasound images clearly showed the altered anatomy and morphology of the involved soft tissues with heterotopic ossification.[5]

Our patient presented with hip contractures where a proper view of the radiographs could not be obtained. With the reading of non-specific calcifications in hip radiographs, musculoskeletal ultrasound was used to localize the HO within the confines of the contractures. With the findings of HO in the posterolateral hips, the rehabilitation management was modified and progressed accordingly. The gluteus maximus muscle was strengthened within the available range of motion because it was the muscle directly overlying the HO focus. Precautions against aggressive stretching and forceful contractions were observed during rehabilitation sessions.

CONCLUSION

Musculoskeletal ultrasound is an important diagnostic tool for localized soft tissue lesions. Through the use of ultrasound, the exact area of HO in a pediatric patient with hip contractures resulting from burn injury was determined and affected the rehabilitation plan of care. Musculoskeletal ultrasound is an investigative modality that is readily available at the point of care and can impact management.

Patient Perspective

The patient and the family had a better understanding of the patient's condition after the musculoskeletal ultrasound of the hips was performed since they were able to visualize the structures and correlate the images with the physical findings. The family also had a positive experience with the diagnostic procedure because they were able to see the joints in question in real-time and they were able to appreciate the improvements of the patient. Although the patient and the family knew that the patient could not achieve a normal range of motion for the hip, they were satisfied with what the patient was able to accomplish.

Informed Consent

The patient's assent together with the parent's consent was obtained for the write-up and publication of this report.

Statement of Authorship

All authors contributed in the conceptualization of work, acquisition and analysis of data, drafting and revising and approved the final version submitted.

Author Disclosure

All authors declared no conflicts of interest.

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