Metabolic Changes in Bone After Burn Injuries- Is There an Increased Fracture Risk?

A case study and literature review

Jason R. Miller, DPM, FACFAS[α], Lindsy Kragt, DPM[β], Katlin O'Hara, DPM[µ], Kayla Baloga[¥], DPM, Yashraj Chauhan, DPM, AACFAS[±]

[α]Fellowship Director, Premier Orthopaedics and Sports Medicine, Malvern, PA & Residency Director, Phoenixville Hospital PMSR/RRA, Phoenixville, PA

[β] Resident, PGY-3, Phoenixville Hospital PMSR/RRA at Tower Health, Phoenixville, PA

[µ]Resident, PGY-2, Phoenixville Hospital PMSR/RRA at Tower Health, Phoenixville, PA

Resident, PGY-1, Phoenixville Hospital PMSR/RRA at Tower Health, Phoenixville, PA

±Fellow, Pennsylvania Intensive Lower Extremity Fellowship, Malvern, PA

Introduction

Cutaneous burns can have both short and long term effects on the body system as a whole. Burns trigger an acute inflammatory and hypermetabolic response throughout the body.[1] The stress response created can increase serum levels of acute phase proteins, cortisol levels, catecholamines, and insulin resistance. The increase in cytokines can also up regulate the parathyroid gland, causing a disruption in calcium metabolism and bone matrix quality.[2] Additionally, vitamin D deficiency is often noted with burn patients.[2] All these metabolic disruptions have adverse effects on the skeletal system. Loss and remodeling to the bone can increase the incidence of fractures and osteopenia.[3] In the case study presented, we report a patient with a high total body surface area (TBSA) of burns, thus causing him to have decreased bone mineralization quality. With resultant bone loss, this patient was more susceptible to fractures, complications in bone healing, and even subsequent chronic nerve pain (CRPS).

Methods/Results

This case examines a 62-year- old male patient that suffered burns at the age of 37 caused by a gasoline fire – approximately 60% total body surface area (TBSA). The patient was bed-bound for greater than 1 year post-injury. Approximately 19 years after the initial burns, the patient sustained a right pilon fracture after a minor fall from a 2-step ladder. The senior author addressed the fracture with open reduction and internal fixation (Figure 1). Subsequently, the fracture went on to a non-union despite adequate reduction and fixation principles.

Twenty weeks after the patient's initial right ankle surgery, he underwent ankle and subtalar joint fusions with intramedullary nail fixation with bone graft and platelet rich plasma supplementation (Figure 2). At the patient's two week follow-up appointment, bone stimulation therapy was attempted but was discontinued due to skin irritation and rash. At four months post-operatively, radiographs demonstrated adequate osseous consolidation across the ankle and subtalar joints. The patient was transitioned into an AFO brace but still continued to report aching pain to his right leg.

Over the next two years, the patient sustained multiple lower extremity stress fractures from minor trauma. Initially, he had a right first metatarsal stress fracture after putting his shoe on

Methods/Results

(Figure 3). An MRI report noted that the fracture did not correlate with the mechanism of injury, and was instead attributed to patient's poor bone stock. The fracture occurred despite having a custom foot orthosis on at the time of the injury.

Later, the patient also sustained right second and third metatarsal base stress fractures after stepping on a stone while hanging his Christmas lights. Subsequently, a DEXA scan was ordered, revealing T scores between -1.9 and -2.5 which correlated with low bone mass and osteoporosis. These results were noted despite treatment with vitamin D, Forteo, and Prolia. The patient was referred to a rheumatologist who noted that he had low testosterone, for which the patient was started on Androgel. Surprisingly, his vitamin D levels were within normal limits.

Fig 1. AP and lateral radiographs of immediate postop ORIF RLE pilon fracture.

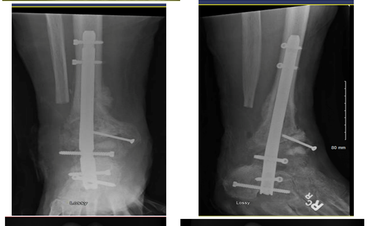

Fig 2. AP and lateral radiographs of immediate postop RLE ankle and subtalar arthrodesis with TTC nail, grafting, and PRP.

Fig 3. AP and oblique radiographs demonstrating 1st metatarsal fracture, which had began as a stress fracture 3 months prior

Discussion

Now 25 years out from his original burn injury with 60% TBSA, the patient presented in this case study still continues to struggle with poor bone health, non-healing fractures, and chronic pain due to the long term metabolic changes noted in burn victims. Decreased bone quality due to burns can be very difficult to treat, as our patient had been on multiple treatments for osteoporosis and vitamin D supplements with little improvement in his symptoms.

In reviewing the literature regarding the effect of burns on bone health, both the acute and chronic changes of the bone have been described. One study very closely matched the demographic of the patient we present in this case, investigating 32 males with a median age of 40.5 and a TBSA median of 40%. 1 They evaluated the early and prolonged phases of bone turnover markers (BTMs) after burn injury and found that ongoing changes of BTM suggest alterations in bone metabolism with an adverse influence on bone quality and structure. In the acute phase after a thermal injury, bone loss occurs quickly and is sustained, increasing the risk of post-burn fracture.[2] Klein describes the initial mechanism as an increase in glucocorticoid production, which results from the stress response, and an increase in resorptive cytokines resulting from the systemic inflammatory response.

References

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Discussion

Within 24 hours, the rise of proinflammatory cytokines (IL-1β and IL-6) stimulate osteoblasts to increase production of RANK-L which stimulates marrow stromal cells to differentiate into osteoclasts, resulting in bone resorption. Just days after burn injury, an up regulation of parathyroid calcium-sensing receptor from the inflammatory cytokine stimulation also disrupts the calcium metabolism.

In addition to the metabolic changes of the bone from the burn injury, disuse can further exacerbate the problem. Decreased bone mineral content (BMC) as a result of bed rest typically occurs within 8 weeks of injury and may last up to 5 years due to reduction in bone formation and is associated with higher incidence of subsequent fractures and osteoporosis.[3] Roshanzamir et al evaluated 34 burn victims 6-12 months post injury by means of DEXA scans. They found that thermal burn victims had a significantly lower bone density and higher prevalence of osteoporosis when compared to their healthy counterparts.[4]

In this case study, the patient sustained a major fracture 19 years after his burn injury. The effect of burn injury on bone health has been shown to be long lasting. A large scale study from Australia found that the burn cohort (17,753) had almost twice the hospitalization rate for musculoskeletal conditions and spent over 3.7 times as long in the hospital over a 33 year period when compared to the uninjured cohort (70,758), with significant increases at 15 and 20 years post burn discharge.[5] Specifically, Randall et al showed a large and significant increase in the rate of admissions due to disorders directly related to bone density. Another large study examining fracture admissions after both minor and serious burns in a 16 year follow up found that the burn patients had a significantly higher rates of admission for fractures than expected.[6]

This study and the concurrent review of the literature suggest that patients with a history of burn injury should be screened for bone health including lab work and DEXA scans. This may aide in planning for any surgical procedures or fracture treatment, as we may be facing an uphill battle with these patients.