



Diabetic Ulcer of the Lower Extremity

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Patient History

Patient is an 80 year old Native American male who developed an ulcer on the right 5th toe and web space in late 2011. He was seen by Podiatry during an initial hospitalization for ascending lymphangitis. His PMH was significant for IDDM, hypertension, MI, CAD s/p stenting and s/p CVA (no residual deficit). He was a former 3 pack a day smoker for about 50 years. He was referred to the Wound Center while hospitalized.

Initial Presentation



Physical Exam

Initial inpatient evaluation by Podiatry showed active lymphangitis, dry gangrene of the left 5th toe tip and web space. Pulses were palpable at the femoral and popliteal levels but by Doppler only at the ankle level. The right foot was cool with capillary refill of < 3.0 second. Monofilament testing showed decreased sensation bilaterally.

Diagnostic tests revealed the following: HgA1c: 6.2; PVR's show RLE ABI: 0.89 with normal triphasic wave forms in the thigh and calf. Waveforms were minimally decreased at the ankle. His TBI was markedly abnormal at 0.28; MRI was positive for osteomyelitis of the 5th toe without abscess; culture was (+) for *S. Aureus* (non-MRSA). An outpatient TCOM (transcutaneous oxygen measurement) was performed and was consistent with severe intra-pedal/distal tibial arterial disease (chest: 59, lateral calf: 49, dorsal foot: 9). Angiography showed a totally occluded anterior tibial artery, a diseased peroneal artery with a patent posterior tibial artery to the ankle. There was no direct arterial flow in to the foot arch vessels.

TCOM Testing



Impression

Wagner grade IV ulcer of the right 5th toe/web space with underlying osteomyelitis and PAD.

Therapeutic Options/ Clinical Course

The patient began on Vancomycin. His soft tissue infection at initial presentation rapidly responded to IV therapy. Surgical inter-

vention was not urgent as the gangrenous process was ischemic, remaining dry and localized. As the patient showed improvement on IV Vancomycin, initial therapy for his PAD was deemed priority prior to surgical amputation. He underwent endovascular repair with reopening of the occluded posterior tibial artery to reestablish direct flow into the pedal arch.

The patient began HBO therapy for the Wagner Grade IV ulceration and continued receiving IV Vancomycin. Offloading was achieved with an orthotic shoe.

After completing 26 HBO treatments along with 5 weeks of IV therapy, the patient underwent surgical amputation of the 5th toe with local flap rotation. Due to issues with flap edge viability, the patient received an additional 10 HBO treatments. Complete healing of the foot is evident at 3 months post initial presentation.

Immediate Post-Op



NOTE: Early Flap Edge

Diabetic Ulcer of the Lower Extremity

Separation and Slough



Staples Removed with Stabilization and Flap Edges



NOTE: Granulation Tissue Formation

Essentially Closed with Minor Suture Line Eschar



Overview of Hyperbaric Oxygen Therapy

Hyperbaric oxygen therapy (HBO) is a modality in which the entire patient is exposed to oxygen under increased atmospheric pressure. The patient's body is enclosed in a pressurized chamber while breathing 100% oxygen at greater than one atmosphere pressure.

Hyperbaric oxygen therapy serves four primary functions:

- 1) It increases the concentration of dissolved oxygen in the blood which enhances tissue perfusion
- 2) It stimulates the formation of collagen matrix so that new blood vessels may develop
- 3) It replaces inert gas in the bloodstream with oxygen, which is then metabolized by the body
- 4) It is bactericidal

Use of Hyperbaric Oxygen Therapy in the treatment of healing chronic diabetic ulcers of the lower extremities is well established and studied. The triad of neuropathy, pressure and vascular disease is crucial in understanding the etiology of diabetic foot ulcers. Neuropathy causes loss of protective sensation and autonomic skin changes leading to skin dryness, keratosis and cracking. Development of foot deformity with imbalance of the intrinsic foot muscle tone leads to abnormal pressure areas. Charcot foot is but one example. Peripheral artery disease (PAD) only further complicates the healing of already damaged tissues. Thus, neuropathy, when combined with PAD and mechanical abnormalities of the foot (triad), are the major contributing factors to diabetic foot ulcer formation.

The Wagner Grading System is very useful for the clinical staging of diabetic foot ulcers. Ulcers are classified as grade I to IV. Ulcers graded as I or II are superficial and do not involve the deeper tissues such as joint, bone and tendon. Grade III ulcers include those with bone involvement (osteomyelitis), plantar space abscess or tendonitis with extension of the infection along the mid-foot compartments and tendon sheaths. Operative drainage/debridement is usually mandatory. Grade IV ulcerations show evidence of gangrene of the toes or mid-foot and will require some form of surgical amputation. It is the Grade III/IV ulcers that can benefit from HBO therapy.

Wounds with surrounding skin transcutaneous oxymetry (TcPO₂) readings of less than 30 mmHg, while breathing room air, have a poor prognosis for healing. Hypoxia increases the morbidity of infection, resulting in sepsis, loss of limb, life or both. Hyperbaric oxygen can greatly increase tissue oxygen levels. Restoration of TcPO₂ to normal or slightly raised levels enhances wound healing including epithelialization, fibroplasia, collagen deposition, angiogenesis and bacterial killing. Angiogenesis may be the fundamental benefit of HBO and has been demonstrated by improved capillary density in healing tissues of the diabetic foot.

About the Authors



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