

Black Bone Disease: An Incidental Finding During Routine Foot Surgery



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Purpose

Black bone disease is hyperpigmentation of bone seen as a rare side effect of long term tetracycline use. It is often seen in individuals treated for chronic issues such as acne and rheumatoid arthritis due to anti-inflammatory and immunosuppressive properties of this drug class. This is not to be confused with alkaptonuria, which is a genetic inability to process certain amino acids. There is much debate as to whether the pigmentation is from metabolized minocycline remnants depositing into the tissues or whether it is tetracycline chelating iron or calcium phosphates. While the soft tissues can also be affected and often improve with cessation of use, the staining of the bones and teeth is permanent. This can be difficult to detect and predict pre-operatively and is similar in appearance to other, more disconcerting disorders, such as infarct, necrosis, malignancy and metallosis. Due to the serious nature of these other conditions, black bone disease can be a startling finding when encountered during an otherwise routine surgical procedure. It can also call into question the strength and healing potential of the bone. The purpose of this case is to increase physician familiarity with this condition to more thoroughly prepare a surgeon to reliably diagnosis and plan intraoperatively with little notice. This knowledge combined with an extensive medical history will allow the surgeon to proceed or postpone the procedure as necessary. It will also allow the physician to properly collect and fixate bone samples when appropriate for reliable and accurate diagnosis confirmation.

Literature Review

Few cases of black bone disease of the foot have been documented in the literature. At the time of this encounter there were none. Since that time three cases of black bone disease of the foot have been published (1-3), both with hyperpigmentation of the first metatarsal for bunion procedures, one of which was noted bilaterally (1). In each case the proposed procedure was completed and there were no delays in wound or bone healing. While many often cited resources and texts endorse hyperpigmentation of the teeth and bones as a problem only encountered in children using tetracyclines (4), there are enough adult cases in the literature to warrant caution in its long term use. While most commonly reported in the oral cavity and jaw, there are now published cases of pigmented bone throughout the body including parietal bones, costal cartilage, the clavicle, thoracic vertebrae, the acromion, the femur and the tibia (5). Many feel that bones or joints experiencing trauma or inflammation more easily become pigmented (5-6). This is supported in the case of a femoral shaft fracture that became infected 10 months postoperatively. The patient had been on minocycline in that period of time. During the femoral debridement the bone callus was noted to be dark brown with normal appearing bone distal and proximal to the fracture site (7). At this time there is little evidence to suggest that black bone disease decreases the quality, strength or healing potential of bone. In all of the cases examined in the literature, there were no reports of delayed osseous or soft tissue healing. They all concluded that if pigmentation was suspected to be secondary to tetracycline use, it would be appropriate to continue surgery, rather than cancel or postpone. Cases typically reported normal appearing trabecular bone on microscopic evaluation. Often the only difference in the bone on microscopic examination is visible iron deposition or the ability of the bone to fluoresce. Soft tissue discoloration may act as an indicator of osseous discoloration. One group of doctors advocated that anyone receiving tetracycline therapy, especially minocycline, should undergo biannual examinations of the eyes, skin, nails and oral cavity for discoloration. They also recommended yearly thyroid function tests (8).

Case Study

A 46 year old female presented with a painful left second hammertoe of several years duration. Under the direction of multiple other physicians the patient had undergone years of conservative treatment including injections, orthotics and physical therapy, all of which did not resolve her pain. Her medical history consisted of hypertension, depression, hypothyroid and acne, for which she was taking verapamil, Amitriptyline, levothyroxine and amoxicillin respectively. She did not disclose any long term acne treatment. She also did not list any past complications or side effects of medications. Her surgical history consisted of two c-sections, a tonsillectomy and hysterectomy. She had undergone a left bunion correction 10 years prior with no complications or abnormal findings. The patient quit smoking cigarettes 23 years prior after only 4 years of smoking. Allergies included sulfa medications and pollen.

Clinical exam revealed a left second toe subluxed over the second metatarsal head and plantarflexed at the PIPJ. Dermatological and neurovascular examinations were normal except for a tyloma under the left second mtpj and a soft callus over the 2nd pipj. Radiographic evaluation (fig. 1) confirmed subluxation of the second toe and a long second metatarsal, possibly increased by the previous bunion correction. A third metatarsal shaft callus from a healed fracture and a first met-cuneiform joint dorsal spur was also noted.

Figure 1: Pre-operative X-ray



The patient presented to the operating room for routine surgical correction of the left second hammertoe and long second metatarsal. A dorso-linear incision was made over the second mtpj. After releasing the dorsal capsule the cartilage of the proximal phalanx and metatarsal head were noted to have significant degeneration as well as an unusual green-black discoloration of the underlying bone, similar to necrosis. The soft tissues were dissected proximally and distally to better visualize the bone and the same discoloration was noted with increased intensity on the metatarsal compared to the proximal phalanx. Specimens were collected from the metatarsal, placed in formalin, and sent to the pathology lab for examination. Bone was also sent to the microbiology lab for aerobic, anaerobic, acid-fast and fungal cultures. Bone quality was normal and soft tissues were without discoloration. Due to the questionable etiology, viability and healing potential of the discolored bone the remainder of the procedure was postponed and tissues were reapproximated.

After the procedure the abnormal findings were discussed with the patient who reported previous staining of her teeth, unobservable

Case Study Continued

due to dental laminates, attributed to long term Minocin treatment for acne. A former physician of the patients was contacted who added that the patients acne had been treated with minocycline, doxycycline, amoxicillin and trimethoprim over the last 27 years. In the 10 years prior to surgery the patient had also sustained pseudoporphyria cutanea tarda, photosensitivity and blue discoloration of the ears and sclera, all of which improved after discontinuing tetracyclines. No pigmentation of bone was observed during the bunion procedure 10 years prior. No abnormalities in bone quality were observable on radiographic evaluation.

Pathology results showed unremarkable bone on microscopic evaluation with no pigment in the specimens. UV fluorescence and electron microscopy with x-ray diffraction analysis was performed to assess iron deposition in the bone. Both tests were negative and the lab could not confirm minocycline toxicity. The lab communicated that formalin has the ability to remove calcium, aluminum and tetracycline from samples and may have compromised the sample. They recommended sending future samples in 70-95% ethanol.

The diagnosis of black bone disease was made based on the patient history and a lack of evidence in support of other causes such as infarct, malignancy or necrosis. When the patient returned for her first post-operative exam, she expressed a desire to proceed with the previously planned procedure. She was informed that the cause of the discolored bone was likely long term tetracycline use but that there was no guarantee against complications associated with any other causes. The patient chose to proceed with surgery and underwent a chevron shortening osteotomy of the 2nd metatarsal and a PIPJ fusion with K-wire fixation. The middle and proximal phalanx and the metatarsal were all again observed to have green-black discoloration (fig. 2). Another bone specimen was collected and a local pathologist physically attending the case personally prepared the sample and sent it to the pathology lab fixed in saline. The surgery was completed uneventfully and closed primarily.

The pathology report returned stating that though there were no iron deposits visible under electron microscopy with x-ray diffraction, there was however many trabeculae within the bone sample displaying weak orange-yellow fluorescence consistent with minocycline toxicity. The surgical wound healed uneventfully and a successful and timely osseous union was achieved to the metatarsal head as well as the PIPJ fusion. The patient maintained correction and proper alignment observed six years postoperatively.

Figure 2: Intraoperative Visualization



Analysis and Discussion

Soft tissue and oral pigmentation as a result of long term minocycline use is far more common and better documented than discoloration of bone in other areas of the body. Minocycline is one of the more commonly utilized drugs in this class, likely due to its broad spectrum of activity and excellent absorption and tissue penetration. It can be used for a variety of illnesses and conditions. Depending on the dosage and length of use, soft tissue pigmentation from minocycline ranges anywhere from 0.4 to 5.6% of users (9). Though no adverse affects on the structure, stability and healing of the minocycline induced pigmented bones have been noted, the serious nature of other conditions similar in appearance that would greatly reduce the ability of a routine bone cut to heal is worthy of caution. When such a discovery is made incidentally in an otherwise routine surgery, this can be a very unsettling finding.

At the time of this case, a literature search revealed only two cases of black bone disease outside of the orofacial region and none in the foot. Though more cases are being reported in the literature, bone pigmentation secondary to tetracycline use is still relatively uncommon and was unknown to the physician at the time of presentation. This patients bones appeared to be necrotic and nonviable. Without the information later gained from the additional medical history and the pathology results, there was insufficient evidence that proceeding with surgery would lead to normal healing and function. Diligent subjective and objective investigation confidently informed the surgeon that the cause was previous minocycline therapy rather than necrosis, malignancy or metabolic disorders which would prevent bone healing. The patient proceeded with surgery, healing without complication.

Due to the rare nature of this condition it is difficult to produce quality research that could compare with statistical significance healing time or pain scales between patients with or without this condition. At present, there is no reason to believe black bone disease inhibits bone healing. Doctors who experience suboptimal results in the presence of black bone disease are encouraged to report these findings.

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