

Fluorescence-Guided Surgical Debridement of Chronic Osteomyelitis Utilizing Doxycycline Bone Labeling: A Technical Trick Revived

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Introduction:

- Recalcitrant infections of bone and soft tissue are commonly encountered by orthopaedic surgeons.
- Treatment strategies include long-term antibiotic administration for suppression and/or surgical debridement to obtain source control.¹
- Intraoperatively identifying living, viable bone can be challenging.
- Debridement to bleeding bone may not correlate with a bone's metabolic state.⁸⁻¹⁰
- Living bone is known to contain fluorophores (Tryptophan, Tyrosine, Phenylalanine), which enable it to naturally fluoresce.^{5,6}
- Bone Fluorescence is also achieved via the chelation of tetracycline molecules within the inorganic mineral matrix of bone.^{3,4}
- The quantity of healthy osteocytes correlates with visible fluorescence. Thus, fluorescence can be used to demarcate viable bone.¹¹⁻¹³
- A form of this technique was originally described in 2002 and has not been presented since that time.²

Surgical Technique:

- Pre-op use of tetracycline allowing enough time for the metabolite to be incorporated into live bone.
- Doxycycline dosing can range from an IV formulation of 100 mg delivered in pre-op holding to a multi-week regimen in an oral formulation of 100 mg BID.
- OR lights turned off and a non-sterile team member uses a blacklight to illuminate the surgical field.
- The intensity of fluorescence will be in stark contrast to any non-viable areas of bone.
- Operations including ORIF, IM nailing, placement of antibiotic-laden cement/beads into a bone defect to stage for an additional procedure (i.e. Masquelet), can be done per clinical scenario.

Case Series:

- Intraoperative sample photos are included depicting bone fluorescence.
- **Figure 1:**



A) Intraoperative fluorescence of tibia noted pre-debridement.



B) More complete fluorescence of the same tibia noted following completion of debridement.

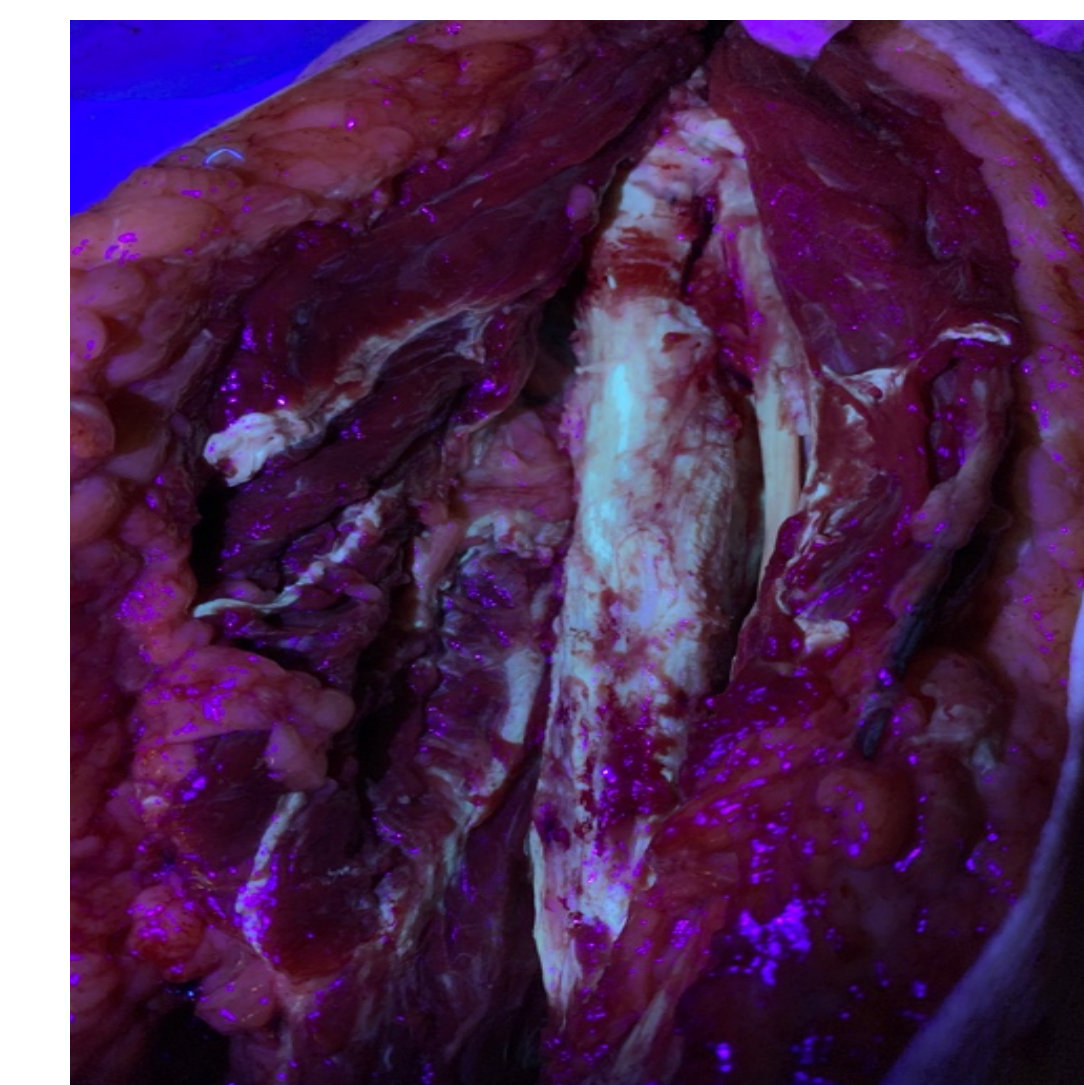
- **Figure 2:**



Demonstrated is a live, viable tibia with bone fluorescence noted intraoperatively. This patient had not received any preoperative doxycycline.

Case Series Continued:

- **Figure 3:**



Specimen of fresh-frozen cadaveric humerus with blacklight exposure. Notice that minimal to no fluorescence is exhibited by non-viable, dead bone.

Case Example: 30 YO F

- PMH: Recurrent skin abscesses.
- Presented in 2018 with vague leg pain.
- CT and MRI findings consistent with chronic osteomyelitis and intramedullary abscess of the tibia.
- Taken to the OR for I&D and cultures, which grew MRSA.
- 5 days later, taken back to the OR for gentamicin/vancomycin-coated intramedullary nail and gentamicin/vancomycin-impregnated cement placement.
- She was discharged on IV daptomycin and PO doxycycline 100mg BID.
- 7 weeks later returned for repeat I&D with bone grafting of her tibia.
- Intraoperatively, OR lights were shut off and a black light was used to illuminate the wound.
- All exposed bone fluoresced, indicating live bone with no need for further debridement or resection.
- At 1 year follow up, there was no tenderness over the tibia with full ROM and no complaints.

Discussion:

- The senior author of this manuscript prefers preoperative administration of 100 mg BID doxycycline for at least 1 month combined with the usage of an ordinary blacklight as the intraoperative excitation source.
- The use of an ordinary blacklight is cost-effective, readily attainable, and proven to be efficacious.⁷
- A limitation of the work is that lack of quantitative fluorescence measurements. It is hoped that any curious surgeon merely gives this technical trick an opportunity to demonstrate its worth.
- More formal trials to objectively quantify fluorescence intensity should follow.

Conclusion:

- The present manuscript has revived the concept of fluorescence-guided bone debridement based upon the biochemistry of bone labelling by tetracyclines.
- Preoperative administration of doxycycline in a patient with osteomyelitis may allow for increased efficacy in guiding the surgical debridement procedures.
- Variations in the technique do exist and can function quite well, however the concept of bone labelling for fluorescent-guided resection of chronic osteomyelitis can be a useful tool in these challenging cases.

Citations

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