



Case Report

The use of abaloparatide to treat nonunion following dorsal closing wedge osteotomy for Freiberg's disease: A case report[☆]

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ABSTRACT

A middle-aged woman who was previously a long-distance trail runner presented with chronic right forefoot pain and was diagnosed with Freiberg's disease. She suffered from nonunion after undergoing a dorsal closing wedge osteotomy. The nonunion achieved full osseous union after treatment with abaloparatide. Patient reported outcome measures taken at 19 months postoperatively indicated good to excellent clinical outcomes and satisfaction. The aim of this case is to report on the effectiveness of abaloparatide to treat nonunion and support fracture healing.

1. Introduction

Freiberg's disease, also known as Freiberg's infraction, is defined as osteonecrosis of most commonly the second metatarsal head and typically affects female adolescents, but can occur in adults of all ages (D P, n.d.). Freiberg's disease was first described by Dr. Alfred Freiberg in 1914, when he proposed the etiology to microtraumas of the second metatarsal head (Talusán et al., 2014). However, the exact pathophysiology is unknown and various underlying causes have been postulated since then, including having arthritis, a long second metatarsal, a short first metatarsal, varied vascular genetics, or altered biomechanics (D P, n.d.; Talusán et al., 2014).

Conservative management for Freiberg's disease is exhausted before surgery is considered. There is a lack of consensus on the most effective operative methodology. Some options, beginning with most frequent, include dorsal closing wedge osteotomy, metatarsophalangeal joint debridement, metatarsal head resection, and arthroplasty (D P, n.d.). The body of literature on Freiberg's disease is limited to a small number of case reports and series. Few complications are noted, and if any are mentioned, it is generally lingering soreness. Nonunion is a rare complication that is ill-defined in the literature, yet when it does happen, poses an immense challenge for the surgeon and patient. Promising solutions to nonunion include osteoanabolic medications.

Abaloparatide and teriparatide, also known as Forteo and Tymlos, are two osteoanabolic medications traditionally used in the management of osteoporosis in postmenopausal women (Haas and LeBoff,

2018). They work by promoting bone formation through a mechanism similar to parathyroid hormone (Haas and LeBoff, 2018). The use of these medications in the field of fracture healing is emerging. Teriparatide has shown success in reducing fracture healing time in human subjects (Yamashita and McCauley, 2019; Xiaofeng et al., 2017). Abaloparatide, however, has not been published in human studies but has resulted in greater bone volume and bone mineral density when used in fracture healing studies in rats (Yamashita and McCauley, 2019; Lanske et al., 2019).

2. Case report

A 52-year-old female who was an avid long-distance trail runner and marathoner presented with an insidious onset of six months of right forefoot pain. Her pain worsened a few weeks prior to presenting to clinic after an episode of pushing a weighted sled. She was previously seen by different providers for conservative treatments, including limiting exercise, repeat steroid injections to the second metatarsophalangeal (MTP) joint, and custom orthotics. She has no history of diabetes, gout, kidney disease, smoking, or regular use of NSAIDs or corticosteroids. She does have mild right hallux valgus alignment and Morton's foot position.

After one month of repeat conservative therapy, which included wearing rigid-soled shoes, continuing to use custom orthotics, using a metatarsal pad and topical over-the-counter anti-inflammatories, and reducing activity, the patient's pain became unbearable, and she stopped

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Fig. 1. Axial MRI image of right foot illustrating osteonecrosis of the second metatarsal head (starred area).

exercising entirely. She had swelling and tenderness at the second MTP joint. Magnetic resonance imaging (MRI) revealed osteonecrosis of the second metatarsal head with the dorsal head most affected, consistent with a diagnosis of Freiberg's disease with subchondral collapse and synovitis (Fig. 1).

The patient underwent a dorsal closing wedge osteotomy, which was adapted from a previous technique by Gauthier and Elbaz in 1979 (Gauthier and Elbaz, 1979). Imaging intraoperatively (Fig. 2) showed good positioning and an acceptable amount of shortening of the second metatarsal with no significant angulation. Fixation of the osteotomy was achieved with an Arthrex QuickFix 2.0 × 12 mm screw. This technique was chosen over others proposed in the literature for multiple reasons. The DuVries method is traditionally considered a salvage procedure and results in excision and reshaping of the metatarsal head, which can lead to arthrofibrosis and significant loss of joint space. This was not ideal for our young, healthy, and active patient. The Weil osteotomy does not include a closing wedge component, which is required to bring the plantar osteochondral surface dorsal into the articular range. The patient has a screw in her fifth metatarsal from a traumatic inversion injury ten years prior.

Postoperative protocol for the first two weeks included using a non-weight bearing boot and crutches. The patient transitioned to minimal weightbearing with the boot and used a hard-soled sandal when driving. Between three and four months postoperatively, she tried weaning back into trail running, but experienced persistent pain and swelling around the second MTP joint. A computerized tomography (CT) scan and radiographs (Fig. 3) of her right foot at five months following surgery were concerning for delayed union at the osteotomy site. She was advised to minimize exercise and wear supportive shoes.

The patient did well for a few months and was running two to three miles multiple times a week with minimal pain. Unfortunately after a few months of doing well, she experienced worsening pain in her midfoot. Due to persistent pain and osteotomy nonunion, the Fracture Liason Service initiated abaloparatide at ten months postoperatively to support callus and bone formation. It is important to mention the patient had a



Fig. 2. Intraoperative image showing fixation of dorsal closing wedge osteotomy to second metatarsal with screw placement. Fifth metatarsal screw is from prior injury 10 years ago.



Fig. 3. Reverse oblique XR concerning for delayed union at the osteotomy site of second metatarsal.

normal DEXA scan, in addition to normal levels of vitamin D, parathyroid hormone, and calcium.

The osteotomy observed full osseous union at 15 months postoperatively in the setting of being on abaloparatide for five months.



Fig 4. (Left): 18-month postoperative image showing full union. The patient at this point had been on abaloparatide for five months.

(Figs. 4 & 5) The patient gradually returned to all of her activities without significant pain or limitation and reports no issues with activities of daily living.

Patient reported outcome measures 19 months after surgery revealed good to excellent clinical outcomes. On the American Orthopedic Foot & Ankle Society Lesser Metatarsophalangeal Interphalangeal Scale (AOFAS-LMIS), the patient scored 90 out of 100 points, indicating an excellent outcome. On the Foot and Ankle Outcomes Score (FAOS), where 100% correlates with the best outcome, she scored 100% for symptoms, 91.6% for pain, 100% for activities of daily living, 85% for sports and recreation, and 75% for quality of life. There was a reduced score in the last two categories due to the patient experiencing a mild lack of confidence in performing more rigorous activities like running, jumping, and pivoting, in addition to experiencing mild pain on a monthly basis. The Foot and Ankle Ability Measure (FAAM) Activities of Daily Living Score was 92.9%, and the FAAM Sports Score was 78.6%. A higher score represents a higher level of physical function. The Sports Scale was lower due to the patient reporting some difficulty running, jumping, landing, and performing cutting movements.

It is noteworthy to mention that this patient was not a candidate for Distal Metatarsal Metaphyseal Osteotomy (DMMO) because this is described as a percutaneous osteotomy and is not designed for angular correction (Biz et al., 2018). This patient required opening of the joint for debridement, and a joint sparing procedure was most beneficial since she was Smillie Stage 2–3. There is not a predictive value of the Maestro Criteria on the outcome of DMMO (Biz et al., 2018), nor is it published relating to a closing wedge type shortening osteotomy.

The patient was informed that data concerning the case would be submitted for publication, and she provided written consent.

3. Discussion

We report on the first known case of nonunion in the setting of Freiberg's disease treated successfully with abaloparatide. The current literature is limited to describing case reports and series of Freiberg's disease in teens and young adults (Palamarchuk and Oehrlein, 2000; Lin and Liu, 2013; Biz et al., 2017; Al-Ashhab et al., 2013; Kim et al., 2012; Chao et al., 1999; Lee et al., 2016; Kinnard and Lirette, 1991; Pereira et al., 2016; Hayashi et al., 2002; Kline, 2008). Rarely are complications described, like nonunion. This demonstrates two significant gaps, with the first being a lack of literature on Freiberg's disease in middle-aged and elderly patients, where this disease is not infrequently seen. The second gap is an overall lack of evidence describing the treatment of nonunion after dorsal closing wedge osteotomy.

Gauthier and Elbaz in 1979 reported on outcomes of a large case series of 53 patients with avascular necrosis of the second and third



Fig 5. (Right): 18-month postoperative image showing full union. The patient at this point had been on abaloparatide for five months

metatarsal head (Gauthier and Elbaz, 1979). At 22 months post-operatively, only one patient had pain and there were no other complications (Gauthier and Elbaz, 1979). There is one case report of Freiberg's disease in a geriatric patient (D P, n.d.). This case described a 78-year-old woman with a history of osteopenia who presented with chronic forefoot pain and had a dorsal closing wedge osteotomy without complications (D P, n.d.).

Although the exact cause of nonunion is difficult to pinpoint, the primary intention of this case is to discuss the effectiveness of abaloparatide in treating nonunion. Abaloparatide was the optimal treatment course that helped our patient achieve full osseous union. Her dose of abaloparatide was 80 micrograms via subcutaneous administration daily. During only the first month of being on abaloparatide, she had occasional headaches, which is a known side effect.

It is important to end by briefly discussing differences between abaloparatide and other osteoanabolic drugs like teriparatide. Abaloparatide is an amino acid synthetic analog of parathyroid hormone-related peptide (PTHrP), while teriparatide is a recombinant human PTH (Haas & LeBoff, 2018). They both stimulate bone formation by activating and stimulating osteoblasts (Haas & LeBoff, 2018). Abaloparatide is a newer drug that has been shown in mouse models to increase the bone density and reduce fracture risk significantly more than teriparatide (Bernhardsson & Aspenberg, 2018). In a clinical trial studying differences in bone mineral density of postmenopausal women with osteoporosis after treatment with abaloparatide or teriparatide, the results showed abaloparatide increased the bone density in the lumbar spine, femoral neck, and hip significantly more than teriparatide (Leder et al., 2015). The authors do believe abaloparatide can be used as a promising alternative in patients who have difficulty with fracture healing.

4. Conclusion

To our knowledge, this is the first case report identifying a patient with nonunion following dorsal closing wedge osteotomy for Freiberg's disease treated with abaloparatide. When nonunion occurs, it poses a significant challenge in orthopedic surgery, and osteoanabolic drugs may be a good option to consider for patients. It is important to report on cases where successful nonunion was treated so orthopedic surgeons can learn various solutions and improve patient care and clinical outcomes.

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