

# MULTIDISCIPLINARY MANAGEMENT OF JONES FRACTURE FIBROUS NONUNION IN A POSTMENOPAUSAL RECREATIONAL RUNNER

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**BACKGROUND:** Jones fractures at the metaphyseal–diaphyseal junction of the fifth metatarsal are prone to delayed union and nonunion due to limited vascularity and repetitive mechanical load. Postmenopausal female athletes represent a particularly high-risk group because hormonal changes, metabolic alterations, and repetitive stress can further impair bone healing. This report presents an integrated approach combining serial ultrasound monitoring and metabolic optimization to guide early intervention in a recreational runner with a fibrous nonunion Jones fracture.

**METHODS:** A 49-year-old female recreational runner sustained a non-displaced Jones fracture following an inversion injury while running. She was postmenopausal (menopause at age 45) and otherwise healthy, with no history of fragility fractures or metabolic bone disease. Initial management included protected weight-bearing in a controlled ankle motion (CAM) boot, low-intensity pulsed ultrasound (LIPUS), and comprehensive metabolic evaluation with dual-energy X-ray absorptiometry (DXA). DXA scan showed normal bone density with T-scores of +2.5 (spine) and +1.9 (hip). Laboratory testing revealed mild vitamin D insufficiency (33 ng/mL) and elevated thyroid-stimulating hormone consistent with mild hypothyroidism (TSH, 8.3 mIU/L), prompting initiation of vitamin D supplementation and levothyroxine therapy.

**RESULTS:** Serial imaging with radiographs and musculoskeletal (MSK) ultrasound demonstrated a persistent hypoechoic fracture gap with cortical sclerosis suggestive of impaired healing. At 14 weeks post-injury, computed tomography (CT) confirmed fibrous nonunion (4.5 mm fracture gap, cortical sclerosis). The patient underwent open reduction and internal fixation (ORIF) with ipsilateral autologous proximal tibial cancellous bone grafting. Radiographic union was achieved by 10 weeks post-operatively, and the patient returned to running at 16 weeks post-op without pain or functional limitation.

**CONCLUSION:** Musculoskeletal ultrasound is a valuable, dynamic modality for assessing fracture healing, often identifying early signs of nonunion before they appear on radiographs. Early recognition allows for timely intervention addressing both mechanical and biological barriers to recovery. In postmenopausal athletes, optimizing metabolic factors—such as correcting vitamin D insufficiency and treating thyroid dysfunction—supports the systemic environment for bone repair. When nonunion persists despite these measures, surgical fixation with autologous bone grafting remains an effective option for achieving union and enabling safe return to sport (RTS). Emerging biologic therapies may further enhance healing and serve as adjuncts to surgical and metabolic optimization in complex cases of nonunion.

## BACKGROUND

Jones fractures—transverse fractures occurring at the metaphyseal–diaphyseal junction (Zone 2) of the fifth metatarsal—represent a distinct and challenging injury, particularly common in athletes and runners.<sup>1</sup> Although they constitute roughly 15–20% of fifth metatarsal fractures, Jones

fractures carry a significantly higher risk of delayed union and nonunion compared to fractures at other foot locations.<sup>2</sup> This increased risk stems from a combination of limited blood supply and unique biomechanical stresses at the fracture site.

Anatomically, the metaphyseal-diaphyseal junction corresponds to a vascular watershed area where the nutrient artery and metaphyseal perforating vessels provide a relatively tenuous blood supply that is vulnerable to injury.<sup>3</sup> This relatively tenuous blood supply impairs osteogenic potential and frequently delays healing. Biomechanically, the fracture site endures repetitive tensile and torsional forces during weight-bearing and activity. The peroneus brevis tendon inserts onto the dorsal aspect of the proximal fifth metatarsal base, contributing to lateral distraction at the fracture site—particularly during eversion and plantarflexion. Simultaneously, the lateral band of the plantar fascia exerts plantar tensile forces during gait, further amplifying mechanical stress across the injury zone.<sup>4</sup> Together, these forces challenge fracture stability and elevate the risk of nonunion.

Postmenopausal women represent a high-risk group for delayed fracture healing due to the combined effects of hormonal decline, metabolic imbalance, and repetitive mechanical loading. Estrogen deficiency accelerates bone resorption, reduces osteoblastic activity, and impairs microvascular perfusion, creating an unfavorable biological environment for callus formation and cortical bridging.<sup>5,6</sup> These systemic changes are often compounded by modifiable factors such as vitamin D insufficiency and subclinical thyroid dysfunction, both of which can hinder bone regeneration and prolong recovery. Vitamin D insufficiency is highly prevalent in postmenopausal women—affecting an estimated 60–70% in the United States—while subclinical hypothyroidism is reported in approximately 10–15% of women over age 50; both represent important, modifiable contributors to impaired bone metabolism and delayed healing.<sup>7,8</sup>

Emerging evidence underscores sex-specific differences in bone healing, with postmenopausal women demonstrating higher rates of delayed union and nonunion than men. Park et al. (2021) reported significantly slower fracture consolidation in women—a disparity attributed to hormonal and metabolic influences on bone turnover.<sup>9</sup> Vitamin D insufficiency, common in athletic and midlife women, further disrupts calcium metabolism and skeletal remodeling, emphasizing the need for comprehensive endocrine and metabolic evaluation in female patients with fractures at high-risk anatomic sites such as the fifth metatarsal.<sup>10</sup>

An additional, often underrecognized factor is Relative Energy Deficiency in Sport (RED-S), a

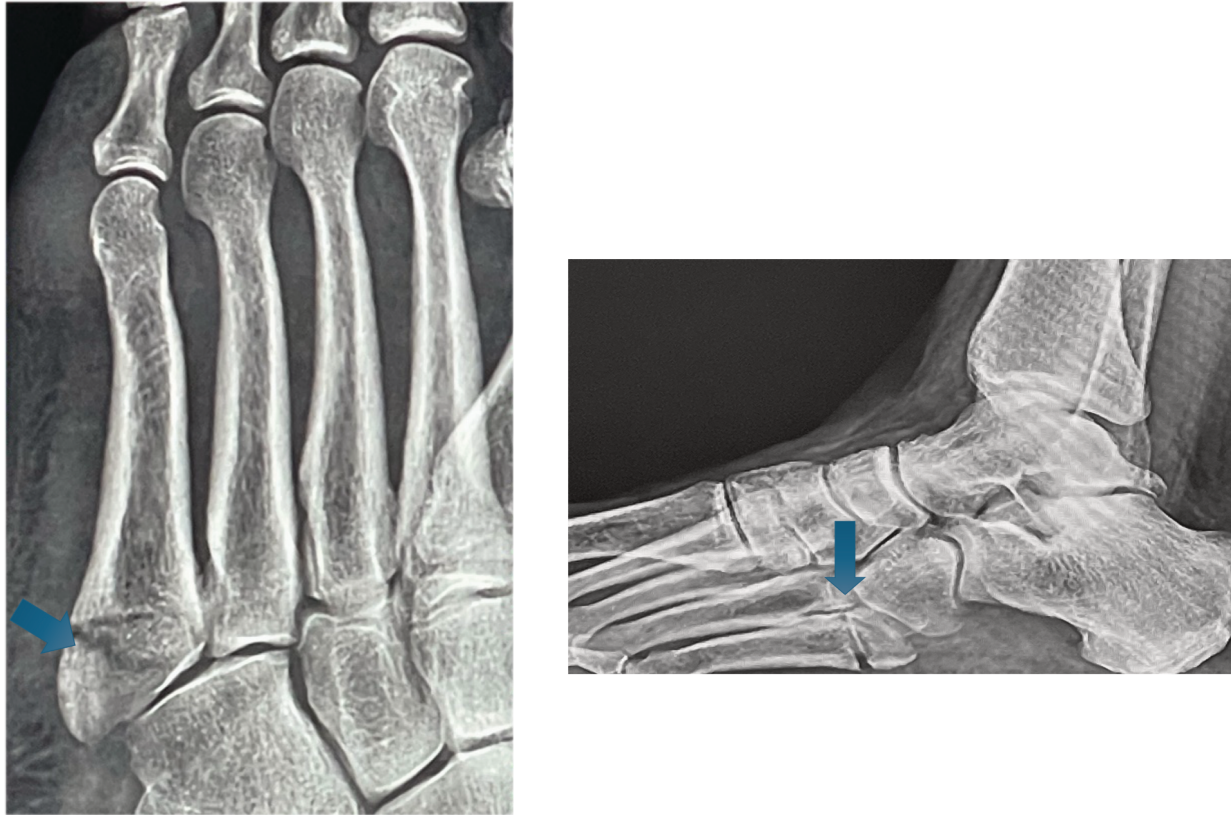
state of low energy availability in which nutritional intake fails to meet the combined demands of exercise and physiological function. Although classically associated with younger female athletes, RED-S is increasingly recognized in active postmenopausal women who sustain high training volumes without adequate caloric or protein intake.<sup>11,12</sup> During the peri- and early postmenopausal years, unfavorable shifts in body composition—including loss of lean mass, increased fat mass, and reduced basal metabolic rate—can obscure under-fueling despite stable body weight. Chronic low energy availability suppresses anabolic hormones, reduces collagen cross-linking, and impairs bone turnover, contributing to stress injuries and delayed fracture healing. While direct studies linking RED-S to Jones fractures are limited, these metabolic and hormonal mechanisms plausibly explain the higher prevalence of delayed union and nonunion in this demographic.

Finally, a normal bone mineral density (BMD) result—such as in the present case—does not exclude systemic contributors to impaired bone quality or healing potential. Although useful for estimating fracture risk, BMD measures static mineral content rather than the dynamic properties of bone remodeling and microarchitecture that determine repair capacity—factors often altered in postmenopausal athletes despite normal DXA values. Therefore, a comprehensive bone health evaluation—including DXA, serum vitamin D, calcium, thyroid function, and relevant hormonal markers—should be considered standard in midlife women with fractures at high-risk sites.<sup>4,12,13</sup> Early identification and correction of these modifiable factors foster an optimal metabolic environment for bone repair, reduce the likelihood of nonunion, and support sustained athletic performance and skeletal health.

## CASE REPORT

A 49-year-old recreational female distance runner presented with acute lateral foot pain and swelling following an inversion injury sustained during a run earlier that day. Radiographs revealed a non-displaced transverse fracture at the metaphyseal-diaphyseal junction of the fifth metatarsal (Zone 2), consistent with a Jones fracture (Figure 1A/B). Her medical history was notable for bilateral severe hallux valgus, with no prior fractures or known systemic comorbidities.

Given her postmenopausal status (menopause at age 45), a targeted bone health evaluation was undertaken. Dual-energy X-ray absorptiometry



**Figure 1.** (A) Initial weight-bearing anteroposterior x-ray showing transverse fracture at the metaphyseal-diaphyseal junction of the fifth metatarsal (arrow). (B) Initial lateral x-ray

(DXA) confirmed normal bone mineral density (T score hip+1.9, T score spine +2.5), while serum testing revealed borderline vitamin D insufficiency (33 ng/mL), prompting immediate supplementation with oral vitamin D3 (5000 IU daily) and vitamin K2 (90 mcg daily). Thyroid function testing showed a mildly elevated thyroid-stimulating hormone (TSH) level of 8.3  $\mu$ U/mL with low-normal free T4 consistent with subclinical hypothyroidism. An endocrinology referral was initiated, and the patient was started on low-dose levothyroxine (50mcg/day) to support metabolic optimization and promote fracture healing. Follow-up laboratory evaluation at ten weeks post injury demonstrated normalization of thyroid function (TSH 2.1 mIU/L) and significant improvement in vitamin D status (57 ng/mL), confirming adequate systemic response to the interventions (Table 1).

Initial conservative management consisted of protected weight-bearing in a controlled ankle motion (CAM) boot, low-intensity pulsed ultrasound therapy (Exogen), and structured activity modification. Serial radiographs were obtained at 2 days, 2 weeks, 4 weeks, and 8 weeks post-injury,

complemented by musculoskeletal ultrasound (MSK US) assessments at weeks 2, 8, and 12, which provided dynamic visualization of the cortical break and vascularity at the fracture site. Low-intensity pulsed ultrasound (LIPUS) was initiated early to enhance biological stimulation at the fracture site, consistent with evidence supporting its role in promoting microvascular perfusion and callus maturation during the early stages of bone repair.<sup>14</sup>

Serial musculoskeletal ultrasound (MSK US) assessments were performed in real time to evaluate cortical continuity, fracture gap morphology, and local vascular response. Color Doppler imaging was utilized to assess perfusion at the fracture site, complementing grayscale evaluation of callus formation and cortical remodeling. At twelve weeks, ultrasound demonstrated a persistent hypoechoic fracture gap with cortical thickening/ sclerosis and reduced vascular signal, consistent with delayed biological healing. (Figure 2A/B). Concurrent radiographs showed only mild interval changes with indistinct early callus formation, remaining inconclusive for union. These find-

**Table 1.** Vitamin D/TSH levels pre/post supplementation

| Factor      | Levels Pre/Post     | Intervention                             | Rationale for Bone Healing                        |
|-------------|---------------------|--|---|
| Vitamin D   | 33 ng/mL → 57ng/mL  | 5,000 IU D <sub>3</sub> + K <sub>2</sub> | Supports calcium metabolism & osteoblast function |
| Thyroid/TSH | TSH 8.3 → 2.1 mIU/L | Levothyroxine 50 mcg/day                 | Restores bone turnover rate and callus remodeling |

ings underscored the greater sensitivity of MSK ultrasound in detecting impaired healing during early follow-up. A computed tomography (CT) scan performed at 14 weeks confirmed fibrous nonunion, revealing a 4.5 mm fracture gap with cortical sclerosis. Given the persistence of functional impairment and imaging evidence of nonunion, surgical intervention was pursued. The patient underwent open reduction and internal fixation (ORIF) using two 3.0 mm headless cannulated screws combined with autologous tibial cancellous bone graft to achieve mechanical stabilization and biological augmentation. Headless cannulated screws were selected to provide rigid interfragmentary compression with minimal soft tissue irritation, thereby reducing the likelihood of symptomatic hardware and the need for subsequent removal.<sup>15</sup>

## DISCUSSION

### *Imaging and Diagnostic Integration*

Radiography remains the primary imaging modality for diagnosing Jones fractures; however, it lacks sensitivity for assessing early healing and local vascularity.<sup>16</sup> Musculoskeletal ultrasound, though operator-dependent, has emerged as a valuable adjunct by enabling serial evaluation of fracture gaps, cortical bridging, and blood flow with Doppler imaging.<sup>12</sup> A recent prospective study demonstrated that serial MSK US predicted fracture union with 92% accuracy by week six, outperforming radiographs.<sup>17</sup> MSK US provides high spatial resolution and real-time correlation with palpation, but wider adoption is limited by practical factors, including operator dependence, variability in training, and the absence of standardized protocols. As a result, despite its diagnostic potential, musculoskeletal ultrasound has yet to achieve consistent, standardized use across clinical settings.<sup>15</sup> In this case, ultrasound findings of diminished vascularity and a persistent fracture gap were crucial in prompting advanced imaging and surgical referral.

When healing is equivocal or symptoms per-

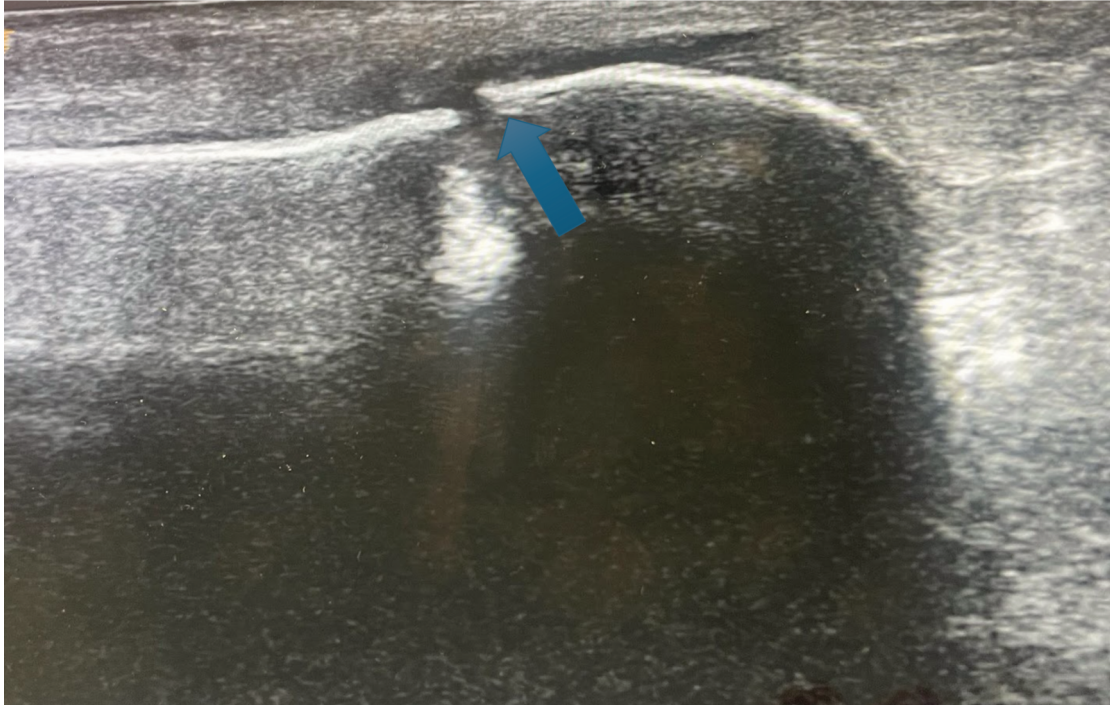
sist beyond 12 weeks, advanced cross-sectional imaging is warranted. Computed tomography (CT) provides high-resolution evaluation of cortical bone, fracture gaps, and sclerosis, reliably confirming nonunion status.<sup>15</sup> In this patient, CT imaging at 14 weeks corroborated MSK US findings (Figure 3), confirming fibrous nonunion with a 4.5 mm fracture gap and cortical sclerosis, thus guiding surgical planning. Magnetic resonance imaging (MRI), while effective for detecting marrow edema and soft tissue pathology, is less commonly utilized in the workup of Jones fracture nonunion but may offer adjunctive information in chronic or ambiguous cases.<sup>18</sup> The combined use of serial radiographs, MSK US, and CT provides a comprehensive imaging strategy that facilitates early detection of nonunion and timely surgical intervention, optimizing patient outcomes.

### *Treatment Algorithm and Surgical Decision-Making*

Management of Jones fractures requires a tailored, patient-specific approach that considers fracture morphology, activity level, and systemic risk factors affecting healing.<sup>19</sup> Non-operative treatment remains the first-line option for nondisplaced fractures in low-demand patients, typically involving 6–8 weeks of immobilization with either non-weight-bearing or protected weight-bearing using a controlled ankle motion (CAM) boot. Adjunctive therapies such as low-intensity pulsed ultrasound (LIPUS), vitamin D supplementation, smoking cessation, and nutritional optimization are frequently employed to enhance biological healing capacity.<sup>20</sup>

However, in athletic populations, non-operative management is associated with union rates as low as 50%, and return-to-sport (RTS) timelines often exceed 16 weeks.<sup>11</sup> Clinical and radiographic signs including persistent pain, fracture lucency, cortical sclerosis, and failure of progressive callus formation signal a poor prognosis for spontaneous healing, prompting reconsideration of treatment strategy.

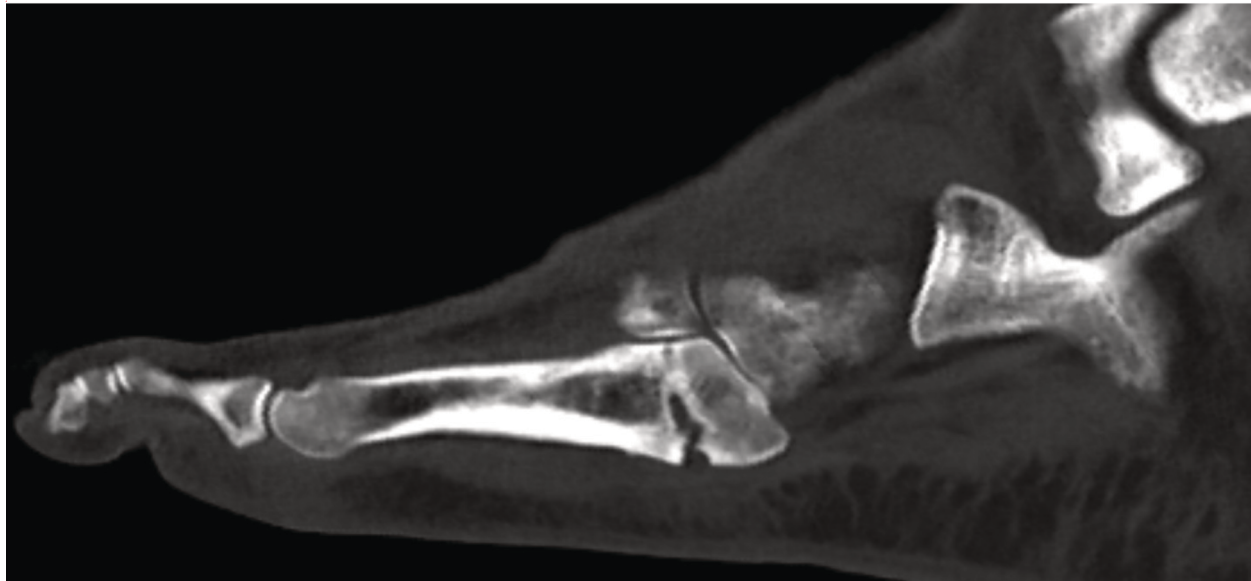
Recent technological advances in fixation materials, such as bioactive calcium phosphate-



**Figure 2A.** MSK Ultrasound of 5th MT fracture. Longitudinal plantar view of proximal 5th MT 2 weeks post injury demonstrates cortical break and hypoechoic fracture gap.



**Figure 2B.** MSK US of 5th MT fracture at 12 weeks. Persistence of cortical break and fracture gap with thickening of cortex and cortical sclerosis noted.



**Figure 3.** CT scan at 14 weeks post injury demonstrates minimal cortical bridging and a 4.5mm fracture gap with cortical sclerosis consistent with fibrous nonunion

coated screws, have shown promise in reducing time to union and minimizing hardware-related complications. A multicenter randomized trial demonstrated that patients treated with calcium phosphate-coated screws experienced faster radiographic union and lower rates of symptomatic hardware irritation compared to those receiving standard titanium screws.<sup>21</sup> In this case, the patient underwent open reduction and internal fixation (ORIF) using two 3.0 mm headless cannulated screws combined with tibial cancellous autograft to achieve mechanical stabilization and enhance biological healing (Figure 4). Postoperative ultrasound at 14 weeks post-op demonstrated callus formation with cortical continuity and revascularization at the fracture site, confirming radiographic union (Figure 5).

Intramedullary screw fixation remains the standard surgical approach for Jones fractures, achieving union rates exceeding 95% in athletic and active populations.<sup>22</sup> In cases of fibrous nonunion or when sclerosis and biological quiescence are present, autologous cancellous bone grafting is frequently used to reestablish bone-healing potential and promote union. For this procedure, the proximal tibia was selected as the donor site because it provides high-quality cancellous bone with low harvest-site morbidity, allowing faster recovery and less postoperative pain than iliac-crest harvest.<sup>11,21</sup> This approach offers sufficient graft volume while minimizing donor-site symptoms, making it particularly suitable for

foot and ankle surgery.

#### *Rehabilitation and Return-to-Sport Protocol*

Postoperative protocols following primary surgical fixation of acute Jones fractures have evolved toward earlier mobilization in selected cases, with some authors reporting safe progression to partial or full weight-bearing within 2–4 weeks when stable fixation is achieved in healthy bone.<sup>23</sup> However, in revision surgeries for established nonunion – particularly when accompanied by autologous bone grafting – most experts advocate a more conservative rehabilitation timeline to protect the biologically compromised fracture environment.<sup>24</sup>

A history of nonunion implies impaired local biology, often characterized by sclerotic fracture ends, limited vascularity, and previous mechanical failure, necessitating enhanced protection during the early healing phase. Bone graft incorporation, whether autograft or allograft, requires a stable, low-micromotion environment to support revascularization and osteogenesis.<sup>25</sup> Accordingly, recommended protocols for revision fixation with grafting typically involve strict non-weight-bearing for 6–8 weeks, followed by a staged transition to partial weight-bearing in a controlled ankle motion (CAM) boot until early radiographic consolidation is confirmed.<sup>26</sup> This approach aims to optimize union rates and minimize the risk of recurrent nonunion or fixation failure.

Rehabilitation focuses on progressive strength



**Figure 4.** Postoperative anteroposterior (AP) radiograph of the left foot, 6 weeks post-surgery demonstrates early interval healing at the fifth metatarsal (Jones fracture) site. Two bicortical headless cannulated screws are visible, providing stable fixation across the fracture line.

training, proprioceptive exercises, and functional reconditioning, with gradual introduction of sport-specific drills beginning around week 8-10. Radiographic confirmation of trabecular bridging guides timing of weight-bearing advancement, while functional assessments – including single-leg hop tests and biomechanical gait analysis – are used to evaluate readiness for return to sport.<sup>27</sup>

In addition to physical rehabilitation, psychological readiness is increasingly recognized as a critical determinant of successful return to sport (RTS). Recent evidence suggests that incorporating validated psychological readiness tools into post-fracture rehabilitation reduces re-injury risk by up to 25% in athletes recovering from lower extremity fractures.<sup>28</sup> This holistic approach ensures both physical capacity and mental preparedness are addressed before resuming high-impact activities.

In this case, the patient remained non-weight-bearing in a controlled ankle motion (CAM) boot for six weeks postoperatively, followed by a gradual transition to partial and then full weight-bearing. A formal physical therapy program began at eight weeks, emphasizing ankle and foot range of motion, mobility, and progressive strengthening. During the initial four weeks of rehabilitation, isolated open kinetic chain (OKC) ankle strengthening was implemented to minimize disuse atrophy of the ankle-foot complex. Manually resisted dorsiflexion, inversion, eversion, and plantarflexion were introduced early to preserve muscle activation while protecting the surgical repair. Particular attention was given to restoring pure ankle dorsiflexion, which is commonly limited after foot or ankle surgery due to prolonged immobilization and periods of non-weight-bearing.

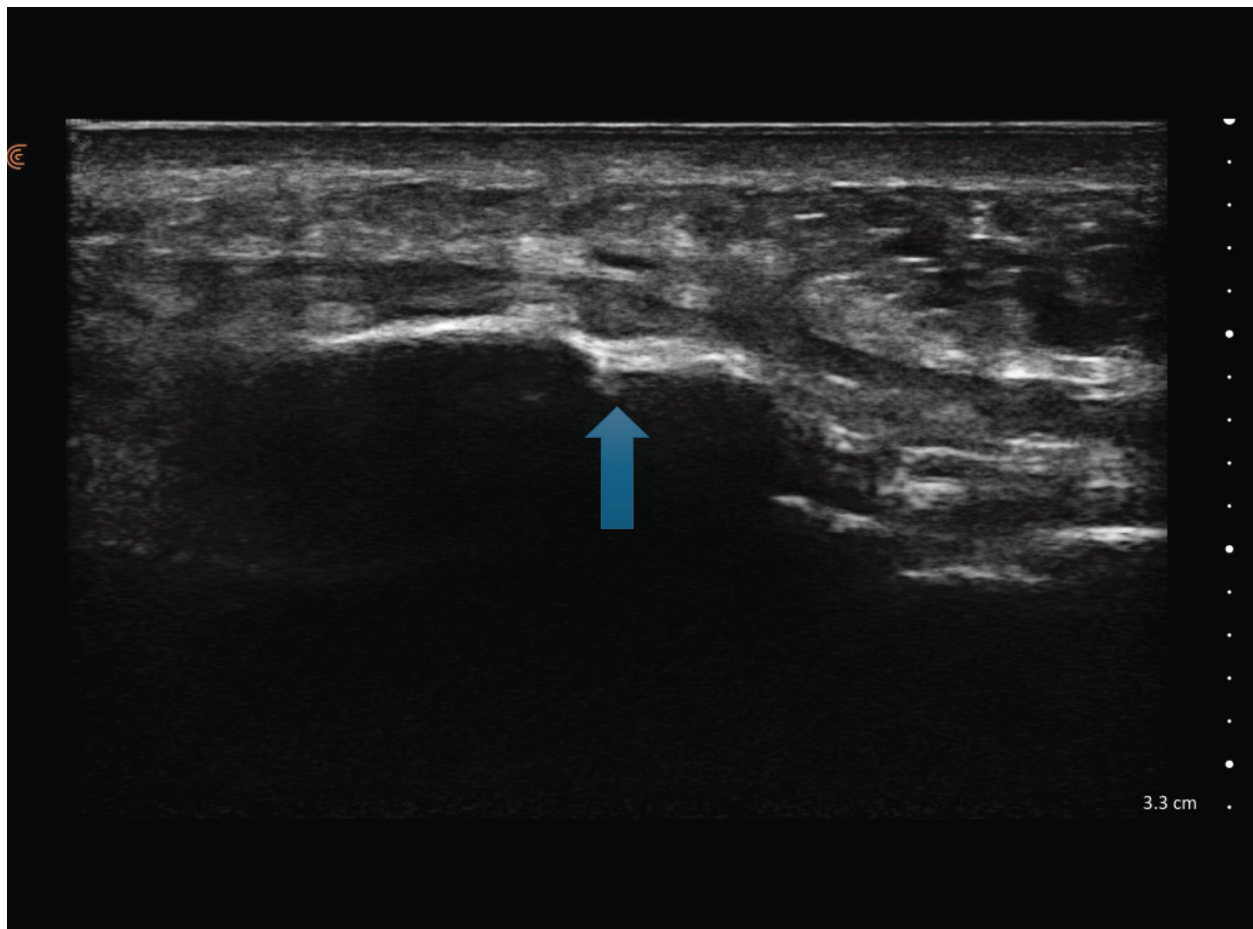
ing. Once radiographic union was confirmed, the program advanced to include strengthening, proprioceptive, and plyometric exercises.

Lower-body positive pressure treadmills, such as the Alter G, have been shown to reduce musculoskeletal loading and improve gait symmetry during post-surgical rehabilitation, allowing earlier reintroduction of running activities.<sup>29,30</sup> In this case, an anti-gravity treadmill was used to facilitate graded return to running, beginning at 30% body weight and increasing incrementally each week. A carbon-fiber shoe insert was also utilized to offload the lateral foot and reduce stress at the fifth metatarsal. The patient successfully returned to recreational running at 16 weeks postoperatively without pain or functional limitation, consistent with outcomes reported for surgically managed Jones fractures in recreational athletes.<sup>29</sup>

#### *Bone Health, Women's Health and Long-term Outcomes*

Midlife female athletes face unique challenges in bone health that can complicate fracture healing; alongside optimizing systemic factors, emerging biologic therapies offer promising avenues to enhance recovery in fractures prone to delayed union or nonunion.

The intersection of bone health and women's health is critical in managing Jones fractures in midlife female athletes. Estrogen deficiency during menopause accelerates bone loss, increases fragility fracture risk, and can impair healing capacity.<sup>29</sup> Vitamin D insufficiency, prevalent in up to 40% of elite and recreational athletes, compromises calcium absorption and bone remodeling.<sup>31</sup> Clinical guidelines recommend assessing bone mineral density, serum vitamin D levels, and hormonal status in women with fragility fracture patterns to



**Figure 5.** Longitudinal plantar musculoskeletal ultrasound of the fifth metatarsal Jones fracture at 14 weeks post-operatively demonstrating cortical bridging with hyperechoic callus formation

## KEY CLINICAL TAKEAWAYS

- Serial musculoskeletal ultrasound enabled early identification of impaired fracture healing/fibrous nonunion of a fifth metatarsal Jones fracture.
- Comprehensive bone health optimization—including vitamin D repletion, thyroid normalization, and hormonal evaluation—are essential even when dxa scan/bone density is normal.
- Post-menopausal female athletes face an elevated risk of nonunion due to combined mechanical stress and hormonal changes.
- Open reduction/internal fixation with autologous tibial bone grafting remains a reliable option for achieving union and restoring full function in fibrous nonunion metatarsal fractures.

guide supplementation and treatment.<sup>32</sup> Addressing modifiable risk factors optimizes fracture healing and reduces the risk of recurrence.

Emerging biologic adjuvants are gaining attention for improving healing in fractures prone to delayed union or nonunion, including Jones fractures. Autologous options such as platelet-rich plasma (PRP) and mesenchymal stem cell (MSC) therapy aim to enhance the local healing environment by promoting vascular and cellular repair responses. Early studies suggest that PRP applied at the time of fixation may shorten time to union and improve function, while MSC-based augmentation from bone marrow or adipose sources may enhance bone regeneration, though large-scale trials are still limited.<sup>33</sup>

Synthetic biologics such as bone morphogenetic proteins (BMPs) and newer Osteoinductive compounds have also shown promise in high-risk nonunion, though their use in foot and ankle surgery remains constrained by high cost and regulatory factors.<sup>34</sup> As postmenopausal female athletes may experience lower baseline anabolic signaling and microvascular perfusion, biologic augmentation represents an appealing adjunct in this population. Future integration of these emerging biologic options—particularly in higher-risk patients such as postmenopausal female athletes—may offer additional support for bone healing when combined with targeted metabolic and mechanical optimization.

Long-term outcomes after surgical fixation of Jones fractures are generally excellent, with low refracture rates (<5%) when proper rehabilitation and return-to-sport criteria are followed.<sup>34</sup> Emphasis on individualized care, imaging surveillance, and holistic management of bone health remains essential to sustaining athletic participation.

A comprehensive approach that integrates multimodal imaging, potential targeted biologics, and proactive bone health optimization is vital to achieving successful healing and long-term functional recovery in midlife female athletes. Addressing both mechanical and metabolic factors—such as vitamin D status and thyroid function—can further enhance outcomes and support timely recovery.

## CONCLUSION

Jones fractures remain a clinical challenge, particularly in active midlife women, where vascular anatomy, repetitive mechanical stress, and hormonal factors increase the risk of delayed or fibrous nonunion. This case demonstrates the importance of integrating serial musculoskeletal ultrasound with conventional imaging to detect impaired healing early and guide timely intervention. In addition, systemic metabolic optimization, including correction of vitamin D insufficiency and thyroid dysfunction, was essential even in the presence of normal bone mineral density, underscoring the value of comprehensive bone health evaluation in female athletes during the menopause transition. Open reduction and internal fixation with autologous tibial bone grafting provided both mechanical stability and biological augmentation, enabling complete radiographic union and return to sport.

Effective management of Jones fracture nonunion requires a multidisciplinary strategy that addresses both mechanical and metabolic contributors to healing. Ongoing efforts to refine ultrasound-based monitoring and explore biologic or hormonal adjuncts tailored to the unique physiology of postmenopausal female

athletes may further enhance recovery and long-term outcomes.

### Conflict of Interest Statement

Thomas Best reported being a paid consultant for Vitruvia. Aimee Kamat reported receiving study materials from Vitruvia, holding a patent for RELIEF treatment held by Vitruvia and being a board member of the health advisory committee for the city of Miami Beach.

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