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# Focused Shock Waves in Delayed Union and No-union after Intramedullary Nailing in Lower Limbs

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## Abstract

Shock waves have changed medical therapy substantially. Accounting for the epidemiology of the treated diseases, this therapeutic tool may equal or even surpass the impact of extracorporeal shock wave lithotripsy. Lower limb fractures after intramedullary nailing generally heal without problems when there are good local conditions and no associated pathologies, but sometimes if the biomechanical or biological variables are not ideal, they can lead to a delay in healing or develop a non-union. Extracorporeal shock waves therapy is a treatment option in delayed union and no-union after intramedullary nailing in lower limbs cases in which there is mechanical stability or the possibility of giving stability to the fracture focus through immobilization, as they can allow healing without the need for new surgeries.

**Keywords:** Extracorporeal shockwave therapy, Shock waves, Non-union, Delayed union

## Introduction

Risk factors for delayed healing and non-union include patient dependent factors such as advanced age, medical comorbidities, smoking, use of non-steroidal anti-inflammatory drugs, various genetic disorders, metabolic diseases, and nutritional deficiencies [1-3].

Patient-independent factors include the pattern, location, and displacement of the fracture, the severity of the soft tissue injury, the degree of bone loss, the quality of surgical treatment, and the presence of infection [1-3].

Clinical evaluation of fracture healing is based on both radiological and clinical findings. Hypertrophic, oligotrophic, and atrophic radiological appearances allow the physician to make inferences about the degree of fracture stability and the biological viability of the fracture fragments while developing a treatment plan.

The surgical treatment of these conditions is complex, expensive and does not necessarily guarantee a good result.

A high degree of recommendation has been demonstrated for the use of shock waves in situations in which the fracture focus is mechanically stable [4]. The objective of this report is to describe the results of the use of focused waves in three cases of lower limb fractures that did not heal within the expected time.

## Case Report

### Case 1

A 45-year-old man, construction worker, had a 4-m fall. He suffered a fracture of the proximal right tibia that was treated with intramedullary nailing and subsequent distal dynamization.

At 13 months, the fracture did not show clear signs of healing (Fig. 1a).

He was treated with two sessions of focused shock waves (Dornier Epos Ultra) with an energy density of 0.40 mJ/mm$^2$, 3000 pulses per session (Fig. 1b).

Complete healing and excellent remodeling were achieved after 4 months without intramedullary nail extraction (Fig. 1c).

### Case 2

A 35-year-old man was involved in a traffic accident suffering a fracture of the right femur. Ten months after surgery, no signs of healing were evident on imaging studies (Fig. 2a).

One session of focused shockwaves was performed (Dornier epos ultra) with an energy density of 0.40 mJ/mm$^2$ applying 4000 pulses to the anterior and lateral diaphysis.

Complete healing and excellent remodeling were achieved after 4 months (Fig. 2b).

### Case 3

A 35-year-old female was involved in a motorcycle accident suffering a segmental fracture of the middle third of the left femoral shaft. She was treated with endomedullary nailing. At 4.5 months after surgery, she was diagnosed with delayed healing of the proximal fracture focus (Fig. 3a).

She was treated with three sessions of focused shock waves therapy with an energy density of 0.40 mJ/mm$^2$, 3500 pulses per session (Fig. 3b).

Healing was finally achieved (Fig. 3c).

## Discussion

Bone non-union remains one of the major

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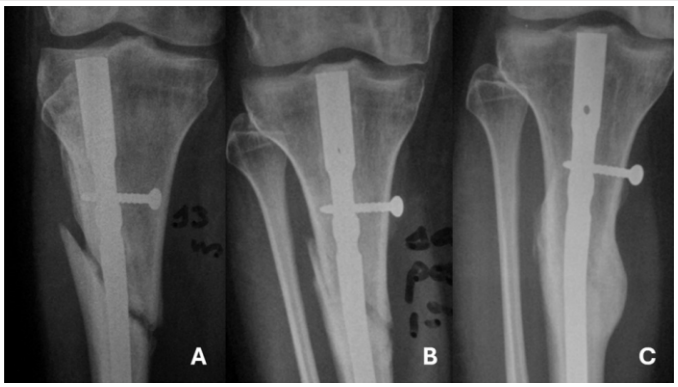


**Figure 1:** (A) Proximal tibia fracture 13 months after surgery, (B) after one session of focused shock waves, and (C) final healing and remodeling at 4 months.

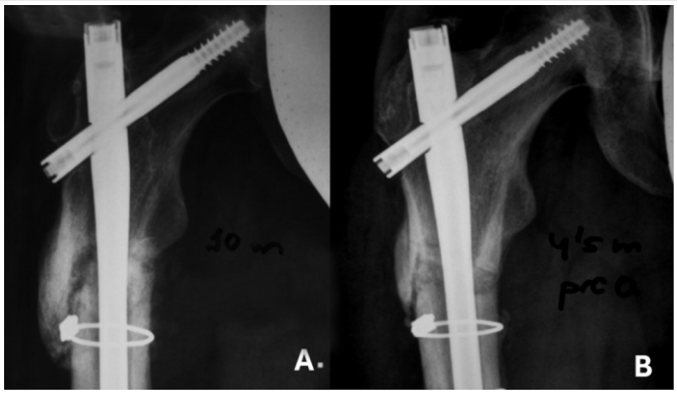


**Figure 2:** (A) Proximal femoral fracture at 10-month post-operative and (B) healing at 4, 5 months.

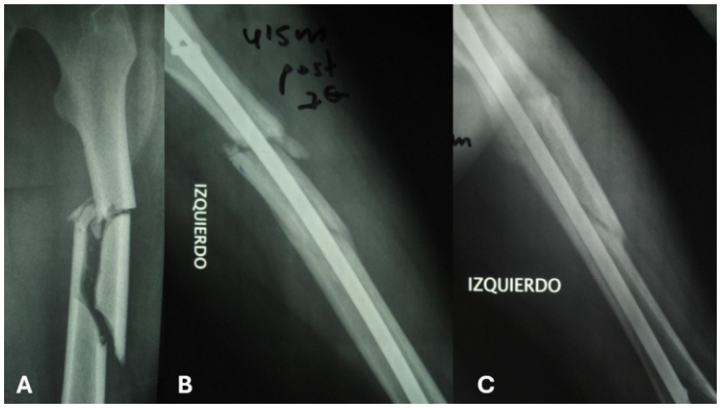


**Figure 3:** (A) Proximal femoral fracture, (B) non-union after 4, 5 months, and (C) healing after three sessions of focused shockwaves.

complications of fracture treatment despite the development of advanced operative techniques and osteosynthesis material [5,6]. Very often, revision surgery is needed, sometimes even requiring autogenous bone grafts [7].

Extracorporeal shock waves induced osteoneogenesis in vitro [8-10] and in animal models [11,12]. A significant number of clinical studies support the use of shock waves in cases of delayed union and non-union [7,13-17].

Comparable results with surgery have also been reported with less and less complex complications [18-20]. For all of the above, we agree that if the mechanical conditions of the fracture focus and the patient are given, shock waves are the first choice in cases of nonunions and delayed healing [21].

No complications were observed in our cases. High-energy shock wave therapy seemed to be an effective non-invasive tool for stimulation of bone healing in properly selected patients with a diaphyseal or metaphyseal non-union of the femur or tibia [22,23].

## Conclusion

Shock waves are a good indication for the treatment of nonunion of lower limbs previously treated with intramedullary nailing. Despite the time elapsed since the fracture, stable healing can be achieved without the need for any additional surgery. No complications were observed after treatment.

**Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

**Conflicts of Interest:** Nil. **Source of Support:** None.

## References

1. Jensen SS, Jensen NM, Gundtoft PH, Kold S, Zura R, Viberg B. Risk factors for nonunion following surgically managed, traumatic, diaphyseal fractures: A systematic review and meta-analysis. EFORT Open Rev 2022;7:516-25.

2. Zura R, Mehta S, Della Rocca GJ, Steen RG. Biological risk factors for nonunion of bone fracture. JBJS Rev 2016;4:e5.

3. Sadat-Ali M, Al-Omar HK, AlTabash KW, AlOmran AK, AlDakheel DA, AlSayed HN. Genetic influence of fracture nonunion (FNU): A systematic review. Pharmgenomics Pers Med 2023;16:569-75.

4. Moya D, Ramón S, Schaden W, Wang CJ, Guiloff L, Cheng JH. The role of extracorporeal shockwave treatment in musculoskeletal disorders. J Bone Joint Surg Am 2018;100:251-63.

5. Zura R, Xiong Z, Einhorn T, Watson JT, Ostrum RF, Prayson MJ, et al. Epidemiology of fracture nonunion in 18 human bones. JAMA Surg 2016;151:e162775.

6. Tian R, Zheng F, Zhao W, Zhang Y, Yuan J, Zhang B, et al. Prevalence and influencing factors of nonunion in patients with tibial fracture: Systematic review and meta-analysis. J Orthop Surg Res 2020;15:377.

7. Rompe JD, Rosendahl T, Schöllner C, Theis C. High-energy

*extracorporeal shock wave treatment of nonunions. Clin Orthop Relat Res 2001;387:102-11.*

*8. Tamma R, Dell'Endice S, Notarnicola A, Moretti L, Patella S, Patella V, et al. Extracorporeal shock waves stimulate osteoblast activities. Ultrasound Med Biol 2009;35:2093-100.*

*9. Hofmann A, Ritz U, Rompe JD, Tresch A, Rommens PM. The effect of shock wave therapy on gene expression in human osteoblasts isolated from hypertrophic fracture non-unions. Shock Waves 2015;25:1:91-102.*

*10. Suhr F, Delhasse Y, Bungartz G, Schmidt A, Pfannkuche K, Bloch W. Cell biological effects of mechanical stimulations generated by focused extracorporeal shock wave applications on cultured human bone marrow stromal cells. Stem Cell Res 2013;11:951-64.*

*11. Wang CJ, Huang KE, Sun YC, Yang YJ, Ko JY, Weng LH, et al. VEGF modulates angiogenesis and osteogenesis in shockwave-promoted fracture healing in rabbits. J Surg Res 2011;171:114-9.*

*12. Li B, Wang R, Huang X, Ou Y, Jia Z, Lin S, et al. Extracorporeal shock wave therapy promotes osteogenic differentiation in a rabbit osteoporosis model. Front Endocrinol (Lausanne) 2021;12:627718.*

*13. Haupt G. Use of extracorporeal shock waves in the treatment of pseudarthrosis, tendinopathy and other orthopedic diseases. J Urol 1997;158:4-11.*

*14. Alkhawashki HM. Shock wave therapy of fracture nonunion. Injury 2015;46:2248-52.*

*15. Willems A, Van der Jagt OP, Meuffels DE. Extracorporeal shock wave treatment for delayed union and nonunion fractures: A systematic review. J Orthop Trauma 2019;33:97-103.*

*16. Sansone V, Ravier D, Pascale V, Applefield R, Del Fabbro M, Martinelli N. Extracorporeal shockwave therapy in the treatment of nonunion in long bones: A systematic review and meta-analysis. J Clin Med 2022;11:1977.*

*17. Wang CJ, Chen HS, Chen CE, Yang KD. Treatment of nonunions of long bone fractures with shock waves. Clin Orthop Relat Res 2001;387:95-101.*

*18. Cacchio A, Giordano L, Colafarina O, Rompe JD, Tavernese E, Ioppolo F, et al. Extracorporeal shock-wave therapy compared with surgery for hypertrophic long-bone nonunions. J Bone Joint Surg Am 2009;91:2589-97. Erratum in: J Bone Joint Surg Am 2010;92:1241.*

*19. Furia JP, Juliano PJ, Wade AM, Schaden W, Mittermayr R. Shock wave therapy compared with intramedullary screw fixation for nonunion of proximal fifth metatarsal metaphyseal-diaphyseal fractures. J Bone Joint Surg Am 2010;92:846-54.*

*20. Notarnicola A, Moretti L, Tafuri S, Gigliotti S, Russo S, Musci L, et al. Extracorporeal shockwaves versus surgery in the treatment of pseudoarthrosis of the carpal scaphoid. Ultrasound Med Biol 2010;36:1306-13.*

*21. Schaden W, Mittermayr R, Haffner N, Smolen D, Gerdesmeyer L, Wang CJ. Extracorporeal shockwave therapy (ESWT)--first choice treatment of fracture non-unions? Int J Surg 2015;24:179-83.*

*22. Haffner N, Antonic V, Smolen D, Slezak P, Schaden W, Mittermayr R, et al. Extracorporeal shockwave therapy (ESWT) ameliorates healing of tibial fracture non-union unresponsive to conventional therapy. Injury 2016;47:1506-13.*

*23. Sandoval C, Valenzuela A, Rojas C, Brañes M, Guiloff L. Extracorporeal shockwave therapy for atrophic and oligotrophic nonunion of tibia and femur in high energy trauma patients. Case series. Int J Surg 2017;9:36-40.*

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