


enovis™

# KEY PUBLISHED CLINICAL RESEARCH

Noninvasive Ultrasound Therapy for  
treatment of Indicated Fresh Fractures  
and Fracture Nonunion

 Low Intensity Pulsed Ultrasound



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Brief prescribing  
information and  
indications





For many decades, noninvasive bone growth stimulation has been utilized to assist in achieving successful healing of musculoskeletal bone fractures. Clinical studies have shown that low-intensity pulsed ultrasound (LIPUS) technology can accelerate bone healing in indicated nonunion fractures and select fresh fracture cases.

The following summarized references provide only a sampling of the full body of literature compiled in support of the Manafuse Bone Growth Stimulator. A full summary and list of all references submitted in support of Manafuse may be found in the Clinical Section of the User Manual.



## LOW-INTENSITY PULSED ULTRASOUND IN THE TREATMENT OF NONUNIONS

Nolte PA, van der Krans A, Patka P, Janssen IM, Ryaby JP, Albers GH. Low-intensity pulsed ultrasound in the treatment of nonunions. J Trauma. 2001;51(4):693-703. <https://pubmed.ncbi.nlm.nih.gov/11586161/>

- 29 cases, located in the tibia, femur, radius/ulna, scaphoid, humerus, metatarsal, and clavicle, met the criteria for established nonunions.
- On average, the postfracture period before the start of ultrasound treatment was 61 weeks. Initial fracture treatment was conservative in 8 cases and operative in 21 cases.
- Additional treatments including bone grafting, reosteosynthesis, and other surgical procedures were performed an average of 52 weeks before the start of ultrasound treatment.
- Daily, 20-minute applications of low-intensity ultrasound at the site of the nonunion were performed by the patients at home.
- 25 of the 29 nonunion cases (86%) healed in an average treatment time of 22 weeks (median, 17 weeks).

Conclusion: Noninvasive ultrasound therapy can be useful in the treatment of challenging, established nonunions.

## ACCELERATION OF TIBIAL FRACTURE-HEALING BY NON-INVASIVE, LOW-INTENSITY PULSED ULTRASOUND

Heckman JD, Ryaby JP, McCabe J, Frey JJ, Kilcoyne RF. Acceleration of tibial fracture-healing by non-invasive, low-intensity pulsed ultrasound. J Bone Joint Surg Am. 1994;76(1):26-34. <https://pubmed.ncbi.nlm.nih.gov/8288661/>

- 67 closed or grade-I open fractures of the tibial shaft were examined in a prospective, randomized, double-blind evaluation of use of a new ultrasound stimulating device as an adjunct to conventional treatment with a cast. 33 fractures were treated with the active device and 34 with a placebo control device.
- At the end of the treatment, there was a statistically significant decrease in the time to clinical healing (86 +/- 5.8 days in the active-treatment group compared with 114 +/- 10.4 days in the control group) (p = 0.01)
- There was also a significant decrease in the time to overall (clinical and radiographic) healing (96 +/- 4.9 days in the active-treatment group compared with 154 +/- 13.7 days in the control group) (p = 0.0001).
- The patients' compliance with the use of the device was excellent and there were no serious complications related to its use.

This study confirms earlier animal and clinical studies that demonstrated the efficacy of low-intensity ultrasound stimulation in the acceleration of the normal fracture-repair process.

## LOW-INTENSITY PULSED ULTRASOUND: EFFECTS ON NONUNIONS

Dieter Gebauer, Edgar Mayr, Ernst Orthner, John P. Ryaby, Low-intensity pulsed ultrasound: Effects on nonunions, Ultrasound in Medicine & Biology, Volume 31, Issue 10, 2005; 1391-1402, <https://doi.org/10.1016/j.ultrasmedbio.2005.06.002> <https://www.sciencedirect.com/science/article/abs/pii/S0301562905002498>

- 67 cases met the study criteria of treated nonunion cases with a minimum fracture age of 8 months, no surgical intervention during 4 months before US treatment and radiographically ceased healing for 3 months before US. The study did not include any cases that were malaligned, grossly instable, actively infected or that had extensive bone loss.
- In a self-paired control study, the mean fracture age of the 67 patients was 39 ± 6.2 months.
- Patients underwent daily 20-minute LIPUS sessions at home for an average of 168 days
- 85% (57 of 67) of the nonunion cases were clinically and radiographically healed. Higher success was observed in subcutaneous bones like the tibia and radius compared to deeper bones such as the femur and humerus.

Conclusions:

- In this case series, investigators concluded that specific US can effect heal rates similar to those achieved by surgical means, without the associated risks and complications, and to those achieved by electrical bone growth stimulation or by extracorporeal shock-wave therapy.
- LIPUS was effective even in long-standing nonunions.

## ACCELERATED HEALING OF DISTAL RADIAL FRACTURES WITH THE USE OF SPECIFIC, LOW-INTENSITY ULTRASOUND

Kristiansen TK, Ryaby JP, McCabe J, Frey JJ, Roe LR. Accelerated healing of distal radial fractures with the use of specific, low-intensity ultrasound. A multicenter, prospective, randomized, double-blind, placebo-controlled study. J Bone Joint Surg Am. 1997;79(7):961-73. <https://pubmed.ncbi.nlm.nih.gov/9234872/>

- A multicenter, prospective, randomized, double-blind, placebo-controlled clinical trial was conducted to test the efficacy of a specifically programmed, low-intensity, non-thermal, pulsed ultrasound medical device for shortening the time to radiographic healing of dorsally angulated fractures (negative volar angulation) of the distal aspect of the radius that had been treated with manipulation and a cast.
- 60 patients (61 fractures) were enrolled in the study within seven days after the fracture. The patients used either an active ultrasound device (30 fractures) or a placebo device (31 fractures) daily for 20 minutes at home for 10 weeks. The 2 types of devices were identical except that the placebo devices emitted no ultrasound energy. Clinical examination was performed and radiographs were made at one, two, three, four, five, six, eight, ten, twelve, and sixteen weeks after the fracture by each site investigator.
- The time to union was significantly shorter for the fractures that were treated with ultrasound than it was for those that were treated with the placebo (mean [and standard error], 61 +/- 3 days compared with 98 +/- 5 days; p < 0.0001). Each radiographic stage of healing also was significantly accelerated in the group that was treated with ultrasound as compared with that treated with the placebo.
- Compared with treatment with the placebo, treatment with ultrasound was associated with a significantly smaller loss of reduction (20 +/- 6 per cent compared with 43 +/- 8 per cent; p < 0.01), as determined by the degree of volar angulation, as well as with a significant decrease in the mean time until the loss of reduction ceased (12 +/- 4 days compared with 25 +/- 4 days; p < 0.04).

Conclusion:

This specific ultrasound signal accelerates the healing of fractures of the distal radial metaphysis and decreases the loss of reduction during fracture-healing.

