

Treatment of Delayed Unions and Nonunions of the Proximal Fifth Metatarsal with Pulsed Electromagnetic Fields

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ABSTRACT

Nine delayed unions and nonunion of the proximal fifth metatarsal were treated with pulsed electromagnetic fields (PEMF). All fractures healed in a mean time of 4 months (range 2–8 months). Those fractures treated with both pulsed electromagnetic fields and a nonweightbearing cast healed in a mean time of 3 months (range 2–4 months). The average duration of follow-up was 39 months (range 24–60 months). There were no refractures.

When compared with reported healing times and morbidity for conventional casting, medullary curettage with inlay bone, and closed axial intramedullary screw fixation, pulsed electromagnetic fields provided an effective alternative for the treatment of delayed unions and nonunion of the proximal fifth metatarsal.

INTRODUCTION

The Jones fracture is defined by its occurrence at the base of the fifth metatarsal, distal to and within 1.5 cm of the tuberosity. It is distinguished from fractures through the tuberosity by its propensity for recurrence, delayed union, and nonunion. A third fracture of the proximal portion of the fifth metatarsal has been described as diaphyseal stress fracture.^{7,11,13,16}

Torg has established the following roentgenographic classification of Jones fractures: type I, acute; type II, delayed union; and type III, nonunion.¹⁸ Based in part upon this classification, there are three modalities of treatment available for Jones fractures and the diaphyseal stress fracture. Type I fractures are initially treated with immobilization in a nonweightbearing cast.¹⁹ In the presence of an established delayed union or nonunion, treatment options include medullary curettage with inlay bone grafting or closed axial intramedullary screw fixation.^{6,7,19} The drawbacks of surgical intervention include increased cost, the necessity of hospitalization,

the risk of anesthesia, and the potential complications of wound infection and neuroma formation. Additionally, intramedullary screw fixation has the added considerations of fracture propagation at the time of screw insertion, screw breakage, reoperation for screw removal, postoperative screw head prominence, and metatarsalgia.^{7,10}

It has been my observation that the length of time necessary to heal Jones fractures and diaphyseal stress fractures of the proximal fifth metatarsal is unsatisfactory. Invasive measures that may reduce the length of time also carry with them a measure of increased cost and morbidity. Low frequency pulsing electromagnetic fields (PEMF) have been advocated for the treatment of various delayed unions and nonunions.^{4,12,14,15,17} Because of the unsatisfactory length of time for healing and the inherent drawbacks to surgical intervention, this preliminary study was undertaken to evaluate PEMF as a possible alternative to surgery or prolonged immobilization for the treatment of delayed union or nonunion of the proximal fifth metatarsal.

MATERIALS AND METHODS

From 1987 to 1990, nine Jones fractures with clinical and radiographic signs of delayed union and nonunion were selected from a multicenter pool of patients with foot fractures treated with PEMF (Table 1). There were five men and four women in the group. The mean age of the patients was 36 years (range 21–59 years). The mean height was 68 inches (range 60–82 inches) and the mean weight was 190 pounds (range 125–250 pounds). Seven of the nine fractures involved the left foot.

The mean duration of treatment prior to the use of PEMF was 2.8 months (range 1–5 months). The mean duration of follow-up was 39 months (range 24–60 months). Follow-up information was obtained by direct interview with the patient or questionnaire to the treating physician or podiatrist. Pre- and posttreatment ra-

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of recurrent symptoms or refracture (Fig. 3, A and B). All but one patient had a fracture pattern involving both cortices and had early or complete sclerosis of the fracture site. Six patients had widening of the fracture site and one had extensive periosteal reaction.

Patients were treated with an external coil device which provided PEMF. The daily coil usage goals were 8 to 10 hr a day. The devices used consisted of looped copper wire coils in formed plastic. These were positioned over the lateral border of the foot centered over the base of the fifth metatarsal in the Helmholtz configuration. The pulse form is demonstrated as the time dependence of rate of change of magnetic flux. The magnitude of the induced electric field was proportional to the rate of change. The magnetic field consisted of a pulse burst of 4.5 msec duration repeated at 15 Hz. Each burst consisted of 20 magnetic field pulses with an increasing phase (0–20 gauss) of 200 μ sec duration and a decreasing phase of 20 μ sec followed by a 5- μ sec pause.

Treatment with PEMF was augmented by either a short leg nonweightbearing cast, short leg weightbearing cast, or weightbearing postoperative shoe. One

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patient had failed an attempt at bone grafting prior to use of PEMF.

RESULTS

All fractures healed with a mean time to healing of 4 months (range 2–8 months). In each case, after complete healing had been obtained, there were no further requirements of additional interventions. There were no recurrences of symptoms or refractures. All patients returned to their preinjury activities.

Three patients received PEMF fields in addition to being placed in a nonweightbearing cast. Healing was accomplished in these patients at 3 months (2, 3, and 4 months, respectively). The remaining six patients were treated in a short leg weightbearing cast or postoperative shoe. Healing was obtained in a mean time of 4½ months (range 2–8 months).

DISCUSSION

Treatment of Jones fractures and diaphyseal stress fractures has been marked by a relatively high incidence of delayed union or nonunion.^{5,6,10,20} A classification of these fractures as either acute, delayed union, or nonunion has been advocated by Torg¹⁸ for its usefulness in selection of the appropriate treatment intervention. It has been recommended that acute fractures be treated with a nonweightbearing plaster cast for a period of at least 6 to 7 weeks.¹⁹ Torg¹⁹ reported in 1984 that of 10 patients with delayed unions treated with a short leg weightbearing cast, seven went on to unite in a mean time of 14.8 months. The remaining three were initially treated surgically, with all healing in 12 weeks. In this same series, a total of 20 fractures were treated with bone grafting for symptomatic delayed union or nonunion. A 95% union rate was achieved between 12 and 16 weeks after surgery. The other option advocated for the treatment of delayed union or nonunion is the use of closed axial intramedullary screw fixation.¹⁰ However, with this technique, Kavanaugh et al.¹⁰ reported perioperative complications of screw fracture, prominence of the screw head, and failure to place the screw within the medullary canal. Using a similar technique, DeLee et al.⁷ reported no perioperative complications. However, in their series of 10 patients, 30% had persistent tenderness over the proximal head of the screw and 50% had pain under the head of the fifth metatarsal. Seven patients required shoe modifications or orthotic devices after surgery. Roentgenographic evidence of healing was achieved on average at 7.5 weeks (range 6–8 weeks).

All fractures selected for this study fulfilled the Torg criteria for delayed union or nonunion. The overall time to healing with PEMF was 4 months. This time was



Fig. 3. A. Anteroposterior radiograph of a Jones fracture with a nonunion. B. Oblique radiograph of a Jones fracture with a nonunion.

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