The Treatment of a Phalangeal Delayed Union Using Electrical Stimulation

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ABSTRACT: The use of electrical stimulation to heal ununited fractures or nonunions of phalanges has not been previously reported. A case is reported using pulsed electromagnetic fields (PEMF) in the treatment of a phalangeal delayed union.

Introduction

The use of electricity to heal ununited fractures or nonunions of long bones has been well documented in the orthopedic literature. However, no report has been written in which electrical stimulation was used to treat a nonunion of a finger phalanx. The following report describes this new clinical application for electrical stimulation.

Case Report

A 46-year-old male was injured at work when a bar of copper struck his nondominant left hand resulting in a fracture of the middle phalanx of his left long finger. He was referred to an orthopedist for evaluation, 2 months after the initial injury, when a malunion was apparent. Aggressive hand physical therapy was attempted but the finger’s loss of motion and deformity interfered with the patient’s job requirements. He was then referred to a hand surgeon where the initial examination found the long finger range of motion to be 0°/60° at the metacarpophalangeal joint, 0°/45° at the proximal interphalangeal joint, and only a few degrees at the flexed distal interphalangeal joint which was held in a 35° flexed position. This resulted in an overall 5 cm loss of full flexion from the mid-palmar crease. In addition, there was a moderate amount of tenderness over the prominent apex of the malunion in the palmar portion of the long finger. Radiographs confirmed the malunion (Fig. 1).

A corrective osteotomy was then performed using a smooth, obliquely positioned Kirschner wire and a circumferential wire loop to maintain the reduction (Lister’s technique). Intra-operative radiographs revealed satisfactory alignment of the fragments (Fig. 2A, B). A bulky hand dressing was applied incorporating the fingers and the wrist.

Postoperatively, the incision healed and the radiographic position remained unchanged. The patient remained asymptomatic as the splinting continued and the Kirschner wire was removed at 4 weeks postoperatively. Two weeks later, the osteotomy appeared to be developing a nonunion (Fig. 3A, B). Ten weeks after surgery, radiographs revealed progressive distraction at the osteotomy site with tenderness still present. It was then decided to change the
treatment and use an electrical stimulator (EBI Medical Systems) (Fig. 4). The stimulator was used at least 10 hours per day with no immobilization during the remainder of the day. After using the stimulator for one month, radiographic and clinical signs of healing were apparent. The treatment was continued for another 2 months until clinical and radiographic union were assured (Fig. 5A, B).

**Discussion**

Bony union usually occurs in fractures of the metacarpals and phalanges with nonunion being an uncommon occurrence. Most fractures show clinical signs of union in 3 to 6 weeks with open fractures
requiring a longer period of time. Radiographic union proceeds at a much slower rate, often requiring 4 to 5 months.

It may be argued that this case was a delayed union rather than a nonunion since at least 6 months had not passed since the inciting trauma. However, with the clinical evidence of persistent tenderness and radiographic distraction at the osteotomy site, it was decided to change the course of treatment. Various causes of nonunion have been identified. It may be due to sepsis, inadequate immobilization, loss of bone substance, or loss of soft tissue coverage. Jupiter et al reported that inadequate or improper primary Kirschner wire fixation was another common reason for nonunion.

The treatment of a nonunion may include external fixation, bone grafting, internal fixation, or a combination. In long bone nonunions, many studies have demonstrated that electrical stimulation is an effective alternative with the reported success rates being comparable to bone graft surgery. Similar success also has been demonstrated in scaphoid nonunions. Three major electrical stimulation systems are currently available. These systems may be totally implantable (invasive), semi-invasive, or noninvasive. Since electricity is not a substitute for poor fracture management, each system requires an adequate reduction and proper immobilization.

In this patient, the cause of nonunion following an osteotomy could not be determined. The treatment chosen for the nonunion was a noninvasive system using pulsed electromagnetic fields. The incidence of union using PEMF has been well documented. With this noninvasive system, patient compliance was important since an external power source was required during the use of the device.
Nevertheless, it was the opinion of these authors that such treatment was preferable to an attempted repeat surgical procedure to correct the nonunion.

Summary

This case describes the use of a portable electrical stimulator in order to obtain clinical and radiographic union of a phalangeal nonunion. The nonunion united in 3 months and did not require additional surgery. Range of motion of the finger could be maintained during the periods in which the device was not in use. As this case demonstrates, electrical stimulation is a welcomed addition to the orthopedists' armamentarium in the clinical treatment of phalangeal nonunions.

References