

Medical Policy



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Title: Electrical Bone Growth Stimulation of the Appendicular Skeleton

Professional

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Populations	Interventions	Comparators	Outcomes
Individuals: • With fracture nonunion	Interventions of interest are: • Noninvasive electrical bone growth stimulation	Comparators of interest are: • Conservative therapy • Surgery	Relevant outcomes include: • Symptoms • Change in disease status • Functional outcomes
Individuals: • With delayed fracture union	Interventions of interest are: • Noninvasive electrical bone growth stimulation	Comparators of interest are: • Conservative therapy • Surgery	Relevant outcomes include: • Symptoms • Change in disease status • Functional outcomes
Individuals: • With fresh fracture(s)	Interventions of interest are: • Noninvasive electrical bone growth stimulation	Comparators of interest are: • Conservative therapy • Surgery	Relevant outcomes include: • Symptoms • Change in disease status • Functional outcomes

Populations	Interventions	Comparators	Outcomes
Individuals: • With stress fracture(s)	Interventions of interest are: • Noninvasive electrical bone growth stimulation	Comparators of interest are: • Conservative therapy • Surgery	Relevant outcomes include: • Symptoms • Change in disease status • Functional outcomes
Individuals: • Who have had surgery of the appendicular skeleton	Interventions of interest are: • Noninvasive electrical bone growth stimulation	Comparators of interest are: • Standard postsurgical management	Relevant outcomes include: • Symptoms • Change in disease status • Functional outcomes
Individuals: • With fracture	Interventions of interest are: • Implantable and semi-invasive electrical bone growth stimulation	Comparators of interest are: • Conservative therapy • Surgery	Relevant outcomes include: • Symptoms • Change in disease status • Functional outcomes
Individuals: • With pseudoarthroses	Interventions of interest are: • Implantable and semi-invasive electrical bone growth stimulation	Comparators of interest are: • Conservative therapy • Surgery	Relevant outcomes include: • Symptoms • Change in disease status • Functional outcomes
Individuals: • Who have had surgery of the appendicular skeleton	Interventions of interest are: • Implantable and semi-invasive electrical bone growth stimulation	Comparators of interest are: • Standard postsurgical therapy	Relevant outcomes include: • Symptoms • Change in disease status • Functional outcomes

DESCRIPTION

In the appendicular skeleton, electrical stimulation with either implantable electrodes or noninvasive surface stimulators has been investigated to facilitate the healing of fresh fractures, stress fractures, delayed union, nonunion, congenital pseudoarthroses, and arthrodesis.

OBJECTIVE

The objective of this policy is to determine whether electrical bone growth stimulation of the appendicular skeleton improves the net health outcome in individuals with fractures or who have had bone surgery.

BACKGROUND

Delayed Fracture Healing

Most bone fractures heal spontaneously over a few months postinjury. Approximately 5% to 10% of all fractures have delayed healing, resulting in continued morbidity and increased utilization of health care services.¹

There is no standard definition of a fracture nonunion.² The Food and Drug Administration (FDA) labeling for one of the electrical stimulators included in this review defined nonunion as follows: "A nonunion is considered to be established when a minimum of 9 months has elapsed since injury and the fracture site shows no visibly progressive signs of healing for a minimum of 3 months." Others have contended that 9 months represents an arbitrary cutoff point that does not reflect the complicated variables present in fractures (ie, degree of soft tissue damage, alignment of the bone

fragments, vascularity, quality of the underlying bone stock). Other proposed definitions of nonunion involve 3 to 6 months from the original injury, or simply when serial radiographs fail to show any further healing. According to FDA labeling for a low-intensity pulsed ultrasound device, "a nonunion is considered to be established when the fracture site shows no visibly progressive signs of healing." Factors contributing to a nonunion include: which bone is fractured, fracture site, degree of bone loss, time since injury, extent of soft tissue injury, and patient factors (eg, smoking, diabetes, systemic disease).¹

Delayed union is generally considered a failure to heal between 3 and 9 months postfracture, after which the fracture site would be considered a nonunion. Delayed union may also be defined as a decelerating bone healing process, as identified in serial radiographs. (In contrast, nonunion serial radiographs show no evidence of healing.) Together, delayed union and nonunion are sometimes referred to as "united fractures." To determine fracture healing status, it is important to include both radiographic and clinical criteria. Clinical criteria include the lack of ability to bear weight, fracture pain, and tenderness on palpation.

Fractures at certain locations (eg, scaphoid, proximal fifth metatarsal) are at greater risk of delayed union due to a tenuous blood supply. Systemic factors, including immunosuppression, cancer, and tobacco use, may also predispose patients to fracture nonunion, along with certain medications (eg, nonsteroidal anti-inflammatory drugs, fluoroquinolones).

Treatment

Individuals with recognized delayed fracture unions might begin by reducing the risk factors for delayed unions or nonunions, but may progress to surgical repair if it persists.

Electrical and Electromagnetic Bone Growth Stimulators

Different applications of electrical and electromagnetic fields have been used to promote healing of delayed and nonunion fractures: invasive, noninvasive, and semi-invasive.

Invasive stimulation involves the surgical implantation of a cathode at the fracture site to produce direct current electrical stimulation. Invasive devices require surgical implantation of a current generator in an intramuscular or subcutaneous space, while an electrode is implanted within the fragments of bone graft at the fusion site. The implantable device typically remains functional for 6 to 9 months after implantation, and, although the current generator is removed in a second surgical procedure when stimulation is completed, the electrode may or may not be removed. Implantable electrodes provide constant stimulation at the nonunion or fracture site but carry increased risks associated with implantable leads.

Noninvasive electrical bone growth stimulators generate a weak electrical current within the target site using pulsed electromagnetic fields, capacitive coupling, or combined

magnetic fields. In capacitive coupling, small skin pads/electrodes are placed on either side of the fusion site and worn for 24 hours a day until healing occurs or up to 9 months. In contrast, pulsed electromagnetic fields are delivered via treatment coils placed over the skin and worn for 6 to 8 hours a day for 3 to 6 months. Combined magnetic fields deliver a time-varying magnetic field by superimposing the time-varying magnetic field onto an additional static magnetic field. This device involves a 30-minute treatment per day for 9 months. Patient compliance may be an issue with externally worn devices.

Semi-invasive (semi-implantable) stimulators use percutaneous electrodes and an external power supply, obviating the need for a surgical procedure to remove the generator when treatment is finished.

REGULATORY STATUS

In 1984, the noninvasive OrthoPak® Bone Growth Stimulator (BioElectron, now Zimmer Biomet) was approved by the U.S. Food and Drug Administration (FDA) through the premarket approval process for treatment of fracture nonunion. Pulsed electromagnetic field systems with FDA premarket approval (all noninvasive devices) include Physio-Stim® (Orthofix), first approved in 1986, and OrthoLogic® 1000, approved in 1997, both indicated for treatment of established nonunion secondary to trauma, excluding vertebrae and all flat bones, in which the width of the nonunion defect is less than one-half the width of the bone to be treated; and the EBI Bone Healing System® (Electrobiology, now Zimmer Biomet), which was first approved in 1979 and indicated for nonunions, failed fusions, and congenital pseudoarthroses. No distinction was made between long and short bones. FDA has approved labeling changes for electrical bone growth stimulators that remove any timeframe for the diagnosis.

No semi-invasive electrical bone growth stimulator devices with FDA approval or clearance were identified.

FDA product code LOF.

POLICY

- A. Noninvasive electrical bone growth stimulation may be considered **medically necessary** as treatment of fracture nonunions or congenital pseudoarthroses in the appendicular skeleton (the appendicular skeleton includes the bones of the shoulder girdle, upper extremities, pelvis, and lower extremities). The diagnosis of fracture nonunion must meet ALL of the following criteria:
1. at least 3 months have passed since the date of fracture, **AND**
 2. serial radiographs have confirmed that no progressive signs of healing have occurred, **AND**

3. the patient can be adequately immobilized, **AND**
 4. the patient is of an age likely to comply with non-weight bearing for fractures of the pelvis and lower extremities.
- B. **Experimental / investigational** applications of electrical bone growth stimulation include, but are not limited to, delayed union, fresh fracture, immediate post-surgical treatment after appendicular skeletal surgery, stress fractures, or for the treatment of arthrodesis or failed arthrodesis.
- C. Implantable and semi-invasive electrical bone growth stimulators are considered **experimental / investigational**.

Policy Guidelines

1. Fresh Fracture
A fracture is most commonly defined as “fresh” for 7 days after the fracture occurs. Most fresh closed fractures heal without complications with the use of standard fracture care, ie, closed reduction and cast immobilization.
2. Delayed Union
Delayed union is defined as a decelerating healing process as determined by serial x-rays, together with a lack of clinical and radiologic evidence of union, bony continuity, or bone reaction at the fracture site for no less than 3 months from the index injury or the most recent intervention. In contrast, nonunion serial x-rays (described next) show no evidence of healing. When lumped together, delayed union and nonunion are sometimes referred to as “united fractures.”
3. Nonunion
There is not a consensus for the definition of nonunions. One proposed definition is failure of progression of fracture-healing for at least 3 consecutive months (and at least 6 months following the fracture) accompanied by clinical symptoms of delayed/nonunion (pain, difficulty weight bearing) (Bhandari, 2012). Patients with the following comorbidities may be at higher risk for nonunion fracture:
 - a) Diabetes
 - b) Steroid therapy
 - c) Osteoporosis
 - d) History of alcoholism
 - e) History of smoking

The original FDA labeling of fracture nonunions defined nonunions as fractures that had not shown progressive healing after at least 9 months from the original injury. The original FDA labeling defined nonunion as follows: “A nonunion is considered to be established when a minimum of 9 months has elapsed since injury and the fracture site shows no visibly progressive signs of healing for minimum of 3 months.” This timeframe is not based on physiologic principles but was included as part of the research design for FDA approval as a means of ensuring homogeneous

populations of patients, many of whom were serving as their own controls. Others have contended that 9 months represents an arbitrary cutoff point that does not reflect the complicated variables that are present in fractures, ie, degree of soft tissue damage, alignment of the bone fragments, vascularity, and quality of the underlying bone stock. Some fractures may show no signs of healing, based on serial radiographs as early as 3 months, while a fracture nonunion may not be diagnosed in others until well after 9 months. The current policy of requiring a 3-month timeframe for lack of progression of healing is consistent with the definition of nonunion as described in the clinical literature.

RATIONALE

The most recent literature review was conducted through February 5, 2018.

Evidence reviews assess the clinical evidence to determine whether the use of a technology improves the net health outcome. Broadly defined, health outcomes are length of life, quality of life, and ability to function—including benefits and harms. Every clinical condition has specific outcomes that are important to patients and to managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms.

To assess whether the evidence is sufficient to draw conclusions about the net health outcome of a technology, 2 domains are examined: the relevance and the quality and credibility. To be relevant, studies must represent one or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. RCTs are rarely large enough or long enough to capture less common adverse events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice.

Noninvasive Electrical Bone Growth Stimulation

Fracture Nonunion

As noted, there is no consensus on the definition of nonunion. One proposed definition is the failure of progression of fracture healing for at least 3 consecutive months (and for at least 6 months following the fracture) accompanied by clinical symptoms of delayed union or nonunion (pain, difficulty bearing weight).²

U.S. Food and Drug Administration approval of electrical bone growth stimulation as a treatment of fracture nonunion involving the appendicular skeleton was based on a number of case series in which patients with nonunions, primarily of the tibia, served as their controls. These studies from the 1980s have suggested that electrical stimulation results in subsequent unions in a significant percentage of patients.³⁻⁷

Systematic Reviews

Alem et al (2016) reported on a meta-analysis of the efficacy of electrical stimulators for bone healing.⁸ The review was reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Reviewers searched MEDLINE, EMBASE, CINAHL, and the Cochrane Library up to March 6, 2016, supplemented with hand searches of major orthopedic conference proceedings from March 2013 to March 2016, for RCTs comparing direct current, capacitive coupling, or pulsed electromagnetic field (PEMF) therapy with sham control for nonunion, delayed union, fresh fracture, osteotomy, or symptomatic spinal instability requiring fusion. Analyses were performed with the intention-to-treat principle using random-effects models. Fifteen trials were identified, of which five included treatment of nonunion⁹⁻¹¹ or delayed union^{12,13} fractures. Nonunion or delayed-union fractures were combined in subgroup analyses including 174 participants. The estimated relative risk for electrical stimulators vs sham for the outcome of radiographic nonunion at the last follow-up or 12 months was 0.57 (95% confidence interval [CI], 0.29 to 1.12; $I^2=76\%$; $p=0.002$). Overall, reviewers found no evidence to support a difference in treatment effect due to treatment indication (interaction $p=0.75$) and moderate quality evidence supporting electrical stimulation in reducing patient-reported pain and radiographic nonunion across indications.

Griffin et al (2008) reported on a systematic review of electromagnetic bone growth stimulation that included 49 studies, three of which were RCTs.¹⁴

The 2 largest and most recent trials of nonunion fractures are described in the following section.

Randomized Controlled Trials

An RCT by Scott and King (1994) compared capacitive coupled electric fields with sham treatment (dummy unit) in 23 patients who had a nonunion fracture (at least 9 months old and without clinical or radiographic signs of progression to union within the last 3 months) of a long bone.¹¹ In this trial, electrodes were passed onto the skin surface through holes in the plaster cast. Twenty-one patients completed the protocol (10 treatment, 11 control). Six months after patients began treatment, an orthopedic surgeon and a radiologist, neither of whom were involved in patient management, examined radiographs and determined that 6 of 10 in the treatment group healed, while none of those in the control group healed ($p=0.004$).

Simonis et al (2003) compared PEMF stimulation with placebo treatment for tibial shaft fractures ununited at least 1 year after fracture, with no metal implant bridging the fracture gap, and no radiographic progression of healing in the 3 months before treatment.⁹ All 34 patients received surgical treatment with osteotomy and unilateral external fixator before randomization. Treatment was delivered by external coils; control subjects received sham treatment using identical machines not passing current through the coils. Patients were assessed monthly for 6 months, and clinical and radiographic assessments were conducted at 6 months. Treatment was considered a failure if union was not achieved at 6 months. In the treatment group, 89% (16/18) of fractures healed compared with 50% (8/16) in the control group ($p=0.02$). While a larger percentage of smokers in the treatment group healed compared with those in the control group, there was an imbalance in the number of smokers in each group, and the difference in healing rates between groups was not statistically significant. The authors concluded that the available evidence supported the use of PEMF therapy in the treatment of nonunion of the tibia and suggested that future trials consider which electromagnetic stimulation modality and for which anatomic sites the treatment is most effective.

Section Summary: Fracture Nonunion

Sham-controlled randomized trials with fewer than 60 patients in total have concluded that noninvasive electrical stimulators improve fracture healing for patients with fracture nonunion. Pre-post studies of patients with nonhealing fractures have also suggested the efficacy of this treatment. There are few nonsurgical options in this population.

Delayed Fracture Union

Systematic Reviews

The Aleem et al (2016) review (discussed previously) reported on a combined meta-analysis of delayed and nonunion fractures.⁸ Similarly, the Griffin et al (2008) review also combined delayed and nonunion fractures.¹⁴ Both included RCTs (n=92 patients) of delayed fractures, which are described in the following section.

Also, the portion of the evidence review on electrical stimulation for delayed unions was informed by a TEC Assessment (1992) of the RCT by Sharrard (described below), which offered the following conclusion: "...Sharrard's health outcome data do not show that noninvasive electrical bone growth stimulation delivers an advantage over placebo."¹⁵

Randomized Controlled Trials

Shi et al (2013) reported on a randomized sham-controlled trial that included 58 patients with delayed union of surgically reduced long bone fractures (femur, tibia, humerus, radius ulna).¹² Delayed union was defined as a failure to heal after at least 16 weeks and not more than 9 months following surgical reduction and fixation of the fracture. Patients with fracture nonunion, defined as failure to heal after more than 9 months, were excluded from the trial. Treatment with 8 hours of PEMF per day was stopped when no radiographic progression was observed over 3 months or when union was achieved, with union defined as no pain during joint stressing or during motion at the fracture site and callus bridging for 3 of 4 cortices on blinded assessment. Three months of treatment resulted in a slight, but not statistically significant, improvement in the rate of union between PEMF-treated patients (38.7%) and controls (22.2%). The success rate was significantly greater with PEMF (77.4% vs 48.1%) after an average of 4.8 months of treatment. The time to union did not differ significantly between PEMF therapy patients (4.8 months; range, 2-12 months) and sham controls (4.4 months; range, 2-7 months).

In the double-blind RCT by Sharrard (1990), PEMF stimulation was compared with a sham procedure using a dummy device in 45 patients with delayed union of the tibia.¹³ Stimulators were positioned on the surface of the plaster cast. Treatment began 16 to 32 weeks after injury. Patients with fracture gaps greater than 0.5 cm after reduction, systemic disease, or who were taking steroids were excluded, as were patients with marked bony atrophy or hypertrophy. Fifty-one patients were recruited; 45 completed the protocol (20 treatment, 25 control). In the treatment group, 3 patients achieved union, 2 achieved probable union, 5 showed progression to union, and 10 showed no progress after 12 weeks. In the control group, none had united, 1 had probably united, 3 progressed toward union, and 17 showed no progress.

Griffin et al (2011) published a Cochrane review of electromagnetic field stimulation (including 3 specifically on PEMF) for treating delayed union or nonunion of long bone fractures in adults.¹⁶ In addition to the RCTs previously reviewed, the systematic review included a study by Barker et al (1984) that randomized 17 participants with tibial nonunion to electromagnetic field stimulation or sham treatment.¹⁰ Thus, 4 studies (total N=125 participants) were analyzed. The primary

outcome measure was the proportion of participants whose fractures had united at a fixed time point. For this outcome, the overall pooled effect size was small and not statistically significant (relative risk, 1.96; 95% CI, 0.86 to 4.48). Interpretation is limited due to the substantial clinical and statistical heterogeneity in the pooled analysis. Also, there was no reduction in pain found in 2 trials, and none of the studies reported functional outcomes. Reviewers concluded that electromagnetic stimulation might offer some benefit in the treatment of delayed union and nonunion, but the evidence was inconclusive to inform current practice.

Section Summary: Delayed Fracture Union

Two randomized sham-controlled trials have been identified in the treatment of delayed union with PEMF. In the Sharrard trial, radiographic healing was improved at 12 weeks, but there were no statistically significant differences between groups for clinical outcomes. In the Shi trial, only the rate of healing at an average of 4.8 months was statistically significant, and it is not clear if this was a prespecified end point. The time to healing was not reduced by PEMF. Additional study is needed to permit greater certainty on the effect of this technology on delayed unions.

Fresh Fracture(s)

Systematic Reviews

The Aleem (2016) systematic review (described previously) also included subgroup analyses for fresh fractures with the outcome of radiographic nonunion at last reported follow-up (to 12 months) for electrical stimulators vs sham.⁸ Five trials (total N=366 patients) were included.¹⁷⁻²¹ The combined relative risk of radiographic nonunion was 0.83 (95% CI, 0.51 to 1.35; $I^2=11%$; $p=0.35$). The selected trials were of moderate-to-high quality. The 2 largest are summarized below.

Randomized Controlled Trials

Adie et al (2011) reported on results of a multicenter, double-blind, sham-controlled, randomized trial, which evaluated 12 weeks of PEMF stimulation for acute tibial shaft fractures.¹⁷ The end points examined were secondary surgical interventions, radiographic union, and patient-reported functional outcomes. Approximately 45% of patients were compliant with treatment (>6 hours daily use), and 218 (84%) of 259 patients completed the 12-month follow-up. The primary outcome (the proportion of participants requiring a secondary surgical intervention because of delayed union or nonunion within 12 months postinjury) was similar for the 2 groups (15% active vs 13% sham). A per-protocol analysis comparing patients who received the prescribed dose of PEMF stimulation with sham treatment also showed no significant differences between groups. Secondary outcomes, which included surgical intervention for any reason (29% active vs 27% sham), radiographic union at 6 months (66% active vs 71% sham), 36-Item Short-Form Health Survey Physical Component Summary scores at 12 months (44.9 active vs 48.0 sham), and the Lower Extremity Functional Scale scores at 12 months (48.9 active vs 54.3 sham), also did not differ significantly between the groups.

Hannemann et al (2014) reported on a multicenter, double-blind, randomized, sham-controlled trial (N=102) conducted in the Netherlands; they found little advantage to 6 weeks of PEMF therapy for fresh scaphoid fractures (≤ 5 days from injury).²⁰ Outcomes included the time to clinical and radiologic union and functional outcome at 6, 9, 12, 24, and 52 weeks. Radiologic union measured by computed tomography did not differ significantly between groups. The median time to clinically defined union was 6 weeks in both groups. The return to normal range of motion at the wrist was 12 weeks in both groups. Grip strength of the dominant hand returned

to normal sooner with PEMF therapy, but there was no significant difference in return of grip strength of the nondominant hand. Functional outcomes were reported in 2015.²² There were no significant differences in either the pain or the function subscales of the Patient-Rated Hand/Wrist Evaluation between the PEMF group and the sham group at any of the 5 follow-up time points. Each of the 5 domains of the EuroQoL-5D as well as the EuroQoL visual analog scale was also compared at each time point. There was a single marginally significant difference in these domain scores (anxiety/depression domain at week 24), which would have been expected by chance given the number of statistical tests performed. The mean number of working days lost was similar in 2 group (10 days vs 13 days; $p=0.65$), and the total mean quality-adjusted life years was 0.84 for PEMF and 0.85 for sham (difference = 0.01; 95% CI, -0.01 to 0.04), respectively.

Section Summary: Fresh Fracture(s)

Five RCTs including 366 participants have compared electrical stimulators with sham in the treatment of fresh fractures. A systematic review and meta-analysis of these trials found moderate quality evidence that the risk of radiographic nonunion is about 17% lower in participants treated using electrical stimulators compared with sham, but this difference was not statistically significant. No differences in functional outcomes were reported between electrical stimulators and sham.

Stress Fracture(s)

Beck et al (2008) reported on a well-conducted RCT (N=44) of capacitively coupled electric fields (OrthoPak) for healing acute tibial stress fractures.²³ Patients were instructed to use the device for 15 hours each day, and usage was monitored electronically. Healing was confirmed when hopping 10 cm high for 30 seconds was accomplished without pain. Although an increase in the hours of use per day was associated with a reduction in the time to healing, there was no difference in the rate of healing between treatment and placebo. Power analysis indicated that this number of patients was sufficient to detect a difference in healing time of 3 weeks, which was considered to be a clinically significant effect. Other analyses, which suggested that electrical stimulation might be effective for the radiologic healing of more severe stress fractures, were preliminary and a beneficial effect was not observed for clinical healing.

Section Summary: Stress Fracture(s)

The evidence on the use of noninvasive electrical bone growth stimulation to treat stress fracture(s) consists of an RCT. In this well-conducted trial, there was no difference in the healing rates between the stimulation and placebo groups.

Appendicular Skeletal Surgery

A comprehensive search found 2 small RCTs on noninvasive electrical bone growth stimulation after orthopedic surgery. Borsalino et al (1988) reported on a randomized double-blind, sham-controlled trial of PEMF stimulation (8 h/d) in 32 patients who underwent femoral intertrochanteric osteotomy for osteoarthritis of the hip.²⁴ Radiographic measurements at 90 days revealed significant increases in the periosteal bone callus and trabecular bone bridging at the lateral, but not the medial, cortex. The trial lacked clinical outcomes and enrolled few patients.

The trial by Dhawan et al (2004) randomized 64 patients (144 joints with triple arthrodesis or subtalar arthrodesis) to PEMF stimulation for 12 hours a day or an untreated control condition.²⁵ Patients at high-risk of nonfusion (rheumatoid arthritis, diabetes, or on oral corticosteroids) were

excluded from the trial. The blinded radiographic evaluation found a significant decrease in the time to union (12.2 weeks for talonavicular arthrodesis vs 17.6 weeks for controls; $p=0.003$; 13.1 weeks for calcaneocuboid fusion vs 17.7 weeks for controls; $p=0.01$). Clinical outcomes were not assessed.

Section Summary: Appendicular Skeletal Surgery

The evidence on the use of noninvasive electrical bone growth stimulation to treat those who have had surgery of the appendicular skeleton consists of several RCTs. The trials showed some benefit of stimulation treatment, but clinical outcomes of interest were not assessed, limiting conclusions that can be drawn about treatment efficacy.

Invasive Bone Growth Stimulation

A TEC Assessment (1992) indicated that semi-invasive bone growth stimulators are no longer in wide use.¹⁵

An updated comprehensive search for implantable bone stimulators identified a small number of case series, all of which focused on foot and ankle arthrodesis in patients at high-risk for nonunion (summarized in Petrisor and Lau [2005]²⁶). Risk factors for nonunion included smoking, diabetes, Charcot (diabetic) neuroarthropathy, steroid use, and previous nonunion. The largest case series is Lau et al (2007), who described outcomes of the foot or ankle arthrodesis in 38 high-risk patients.²⁷ Union was observed in 65% of cases by follow-up evaluation ($n=18$) or chart review ($n=20$). Complications were reported in 16 (40%) cases, including 6 cases of deep infection and 5 cases of painful or prominent bone stimulators necessitating stimulator removal. A multicenter retrospective review by Saxena et al (2005) described outcomes from 28 high-risk patients with arthrodesis of the foot and ankle.²⁸ Union was reported for 24 (86%) cases at an average of 10 weeks; complications included breakage of the stimulator cables in 2 patients and hardware failure in another. Five patients required additional surgery.

Section Summary: Invasive Bone Growth Stimulation

The evidence on the use of implantable and semi-invasive electrical bone growth stimulation to treat fractures, pseudoarthroses, or those who have had surgery of the appendicular skeleton consists of a small number of case series, reporting on small numbers of patients. Prospective controlled trials are needed to evaluate this procedure.

SUMMARY OF EVIDENCE

Noninvasive Electrical Bone Growth Stimulation

For individuals who have fracture nonunion who receive noninvasive electrical bone growth stimulation, the evidence includes randomized controlled trials (RCTs) and systematic reviews of RCTs. Relevant outcomes are symptoms, change in disease status, and functional outcomes. The U.S. Food and Drug Administration has approved noninvasive electrical bone growth stimulation for fracture nonunions and congenital pseudoarthroses in the appendicular skeleton, based largely on studies with patients serving as their own controls. There is also evidence from 2 small sham-controlled randomized trials that noninvasive electrical stimulators improve fracture healing for patients with fracture nonunion. However, there are few nonsurgical options in this population, and the pre-post studies of patients with nonhealing fractures support the efficacy of the treatment. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who have delayed fracture union, fresh or stress fracture(s), or who have had surgery of the appendicular skeleton who receive noninvasive electrical bone growth stimulation, the evidence includes RCTs and systematic reviews of RCTs. Relevant outcomes are symptoms, change in disease status, and functional outcomes. A meta-analysis of 5 RCTs found no statistically significant benefit of electrical bone growth stimulation for fresh fractures. RCTs on delayed union of the other types of fractures were limited by small sample sizes and did not show significant differences in outcomes between study groups. The evidence is insufficient to determine the effects of the technology on health outcomes.

Invasive Electrical Bone Growth Stimulation

For individuals who have fracture, pseudoarthroses, or who have had surgery of the appendicular skeleton who receive implantable and semi-invasive electrical bone growth stimulation, the evidence includes a small number of case series. Relevant outcomes are symptoms, change in disease status, and functional outcomes. The evidence is insufficient to determine the effects of the technology on health outcomes.

CLINICAL INPUT FROM PHYSICIAN SPECIALTY SOCIETIES AND ACADEMIC MEDICAL CENTERS

While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.

In response to requests, input was received from 5 academic medical centers while this policy was under review in 2012. The input supported use of noninvasive electrical bone growth stimulation for the treatment of fracture nonunions or congenital pseudoarthroses of the appendicular skeleton. Input agreed that noninvasive electrical bone growth stimulation is investigational for immediate postsurgical treatment after appendicular skeletal surgery and treatment of fresh fractures. Most reviewers considered the use of noninvasive electrical bone growth stimulation to be investigational for the treatment of delayed union, for arthrodesis, or for the treatment of failed arthrodesis.

PRACTICE GUIDELINES AND POSITION STATEMENTS

No guidelines or statements were identified.

U.S. PREVENTIVE SERVICES TASK FORCE RECOMMENDATIONS

Not applicable.

ONGOING AND UNPUBLISHED CLINICAL TRIALS

A search of ClinicalTrials.gov in March 2017 did not identify any ongoing or unpublished trials that would likely influence this review.

CODING

The following codes for treatment and procedures applicable to this policy are included below for informational purposes. Inclusion or exclusion of a procedure, diagnosis or device code(s) does not constitute or imply member coverage or provider reimbursement. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

CPT/HCPCS

20974	Electrical stimulation to aid bone healing; noninvasive (nonoperative)
20975	Electrical stimulation to aid bone healing; invasive (operative)
E0747	Osteogenesis stimulator, electrical, noninvasive, other than spinal applications
E0749	Osteogenesis stimulator, electrical, surgically implanted

ICD-10 Diagnoses

The appropriate ICD-10 diagnoses consistent with the medical criteria and intent of the policy should be used.

REVISIONS

03-26-2013	Policy added to the bcbsks.com web site.
05-07-2013	Effective for Institutional providers 30 days after the Revision Date In Policy section: <ul style="list-style-type: none"> In Item A, bullet #2, added "and" to read "...healing have occurred; and" In Item A, removed bullet #3, "the fracture gap is 1 cm or less; and"
03-07-2014	In Policy section: <ul style="list-style-type: none"> In Item C, added "stress fractures," to read "Experimental / Investigational applications of electrical bone growth stimulation include, but are not limited to, immediate post-surgical treatment after appendicular skeletal surgery, stress fractures, or for the treatment of fresh fractures or delayed union." Updated Rationale section. In Coding section: <ul style="list-style-type: none"> Added ICD-10 Diagnosis (<i>Effective October 1, 2014</i>) Updated Reference section.
12-22-2015	Description section updated In Policy section: <ul style="list-style-type: none"> In Item A 4 add "for fractures of the pelvis and lower extremities" to read "is of an age likely to comply with non-weight bearing for fractures of the pelvis and lower extremities" Updated Policy Guidelines Rationale section updated In Coding section: <ul style="list-style-type: none"> Removed all ICD-9 and ICD-10 codes due to the volume of codes applicable to the policy topic. Added "The appropriate ICD-9 or ICD-10 diagnoses consistent with the medical criteria and intent of the policy should be used." References updated
10-17-2016	Updated Description section. In Policy section: <ul style="list-style-type: none"> Removed previous Item B, "Noninvasive electrical bone growth stimulation is considered medically necessary as a treatment of joint fusion." In new Item B, added "arthrodesis or failed arthrodesis" to read "Experimental / investigational applications of electrical bone growth stimulation include, but are not limited to, delayed union, fresh fracture, immediate post-surgical treatment after appendicular skeletal surgery, stress fractures, or for the treatment of arthrodesis or failed arthrodesis." In Policy Guidelines Item 3, added "Patients with the following comorbidities may be at higher risk for nonunion fracture: a) Diabetes b) Steroid therapy c) Osteoporosis d) History of alcoholism e) History of smoking" Updated Rationale section.

	Updated References section.
05-24-2017	Updated Description section.
	Updated Rationale section.
	Updated References section.
05-23-2018	Updated Description section.
	Updated Rationale section.
	In Coding section: ▪ Removed references to ICD-9 coding.
	Updated References section.

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