Successful Bone Healing of Nonunion After Ulnar Shortening Osteotomy for Smokers Treated With Teriparatide

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Abstract

Ulnar shortening osteotomy is widely performed as the standard surgical treatment for ulnar impaction syndrome and has a high percentage of success for pain relief. However, delayed union and nonunion of the osteotomy site remain the most concerning complications. In particular, smokers have a higher incidence of nonunion, which amounts to 30% of cases. For the treatment of nonunion, secondary surgical interventions such as bone grafting will be necessary but are extremely challenging. Recently, teriparatide (recombinant human parathyroid hormone [PTH 1-34]) administration has been reported in several clinical studies as a noninvasive pharmacological systemic treatment for fracture healing or nonunion. The authors present 2 cases of smokers, a 62-year-old man and a 42-year-old woman, with nonunion after ulnar shortening osteotomy and fixation with 6-hole non-locking plate for ulnar impaction syndrome. For treatment of nonunion, noninvasive therapy with teriparatide (20-µg, subcutaneous injection) in addition to low-intensity pulsed ultrasound was undergone. In both cases, partial bone union began to be observed on radiographs after the first 4 weeks of teriparatide administration and successful bone healing without additional surgical interventions was achieved after 10 and 6 months of treatment with teriparatide, respectively. The current case reports showed that noninvasive combination therapy of teriparatide and low-intensity pulsed ultrasound were a possible alternative to surgical intervention. In the future, teriparatide therapy might be applied actively to patients who have risk factors for delayed union, such as a heavy smoking habit, and are expected to experience nonunion after ulnar shortening osteotomy. [Orthopedics. 2015; 38(8):e733-e737.]
Ulnar shortening osteotomy is widely performed as the standard surgical treatment for ulnar impaction syndrome and has a high percentage of success for pain relief and recovery of function.\(^1,2\) However, delayed union and nonunion of the osteotomy site remain the most concerning complications. In particular, smokers have a higher incidence of nonunion, which amounts to 30% of cases.\(^3\) Once nonunion has been established, additional surgical treatments such as bone grafting will be required but are extremely challenging.

To decrease the risk of nonunion and avoid secondary surgery for nonunion, various surgical procedures using an oblique or step-cut osteotomy and compression plating system with special compression devices have been introduced.\(^1,2\) As a noninvasive locally effective procedure, the use of low-intensity pulsed ultrasound (LIPUS) has been indicated in various other cases of nonunion and in accelerated bone healing after ulnar shortening osteotomy.\(^4\) Recently, as a noninvasive pharmacological systemic treatment for fracture healing or nonunion, teriparatide administration has been reported in several clinical studies.\(^5-8\) However, there have been no reports about teriparatide therapy for nonunion after ulnar shortening osteotomy.

The current study reports 2 cases of smokers with nonunion after ulnar shortening osteotomy who underwent noninvasive combination therapy with teriparatide and LIPUS and were able to achieve bone healing without additional surgical interventions.

**Case Reports**

**Patient 1**

A 62-year-old man, who had been affected by right ulnar wrist pain caused by ulnar impaction syndrome, underwent ulnar shortening osteotomy (Figure 1). He had smoked 15 cigarettes per day for more than 40 years and had no past medical history. An ulnar shortening transverse osteo-

![Figure 1: Patient 1. Preoperative anteroposterior (AP) radiograph showing neutral ulnar variance and cyst formation in the lunate (A). Preoperative AP magnetic resonance image showing high-intensity areas in the lunate and central part of the triangular fibrocartilage (B). Anteroposterior radiographs showing the site immediately after ulnar shortening osteotomy (C), nonunion at 10 months postoperatively and the start of daily teriparatide administration (D), progress in bone healing at the osteotomy site in the first 4 weeks after teriparatide administration (E), bone union at 10 months after teriparatide administration and then stopping of daily teriparatide administration (F), complete bone union at 36 months postoperatively (G), and successful bone healing after removal of the plate (H). Gross lateral appearance of complete ulnar bone union in the osteotomy site (I).
Case Report

A 67-year-old man, who had left ulnar wrist pain caused by ulnar impaction syndrome, underwent ulnar shortening osteotomy and a 6-hole non-locking plate with compression devices (Mizuho Co Ltd, Tokyo, Japan) was used for fixation. Postoperatively, he was immobilized in a long-arm cast for 3 weeks and then a wrist brace was applied for an additional 9 weeks, except during exercises involving wrist and forearm motion.

The 12-week postoperative radiograph showed radiolucency at the osteotomy site; therefore, LIPUS was initiated. However, nonunion of the osteotomy site was established at 10 months postoperatively, and daily teriparatide (20-µg, subcutaneous injection) was started with the objective of promoting bone healing. Partial bone union began to be observed on radiographs after the first 4 weeks of teriparatide administration. Bone union was achieved after 10 months of treatment with teriparatide, and teriparatide administration was terminated.

No side effects attributable to the drug were observed during treatment. Blood examination data remained normal, except for the serum phosphorus level, which showed a temporary low value of 2.1 mg/dL during treatment with teriparatide but returned to a normal value of 3.0 mg/dL after stopping teriparatide administration. Because complete endosteal union was successfully achieved at 36 months postoperatively, the plate was removed. The patient was satisfied and had no ulnar wrist pain at 40 months postoperatively.

Patient 2

A 42-year-old woman, who had right ulnar wrist pain caused by ulnar impaction syndrome, underwent ulnar shortening osteotomy (Figure 2). Although she had experienced adolescent anorexia nervosa, her weight was 45 kg and her body mass index was 17 kg/m² at surgery. She had smoked one pack of cigarettes per day for more than 20 years.

Ulnar shortening transverse osteotomy was performed and a 6-hole non-locking plate with compression devices was used for fixation. Postoperatively, she was immobilized in a long-arm cast for 3 weeks and then a wrist brace was applied for an additional 3 weeks. The 6-week postoperative radiograph showed radiolucency with slight callus formation at the osteotomy site; therefore, LIPUS was initiated. However, nonunion of the osteotomy site was established at 6 months postoperatively, and daily teriparatide (20-µg, subcutaneous injection) was started. Partial bone union was observed on radiographs after the first 4 weeks of teriparatide administration. Complete endosteal union was successfully achieved after 6 months of treatment with teriparatide, and teriparatide administration was stopped. No side effects attributable to the drug were observed.

Figure 2: Patient 2. Preoperative anteroposterior (AP) radiograph showing positive ulnar variance of 2 mm (A). Preoperative AP magnetic resonance image showing a low-intensity area in the lunate (B). Anteroposterior radiographs showing the site immediately after ulnar shortening osteotomy (C), nonunion at 6 months postoperatively and the start of daily teriparatide administration (D), progress in bone healing in the first 4 weeks after teriparatide administration (E), complete bone union at 14 months postoperatively (F), and successful bone healing after plate removal (G).
observed during treatment, and blood examination data remained normal. The plate was removed at 14 months postoperatively and the patient returned to work. She was satisfied, with no ulnar wrist pain and bone healing at 25 months postoperatively.

**Discussion**

The reported rates of nonunion after ulnar shortening osteotomy are 13% to 18% for traditional AO plating techniques and 4% to 7% for ulnar shortening osteotomy plating systems, including custom cutting jigs and reduction devices. In particular, Chen et al reported that the mean times to union after ulnar shortening osteotomy were 7.1 months in smokers and 4.1 months in nonsmokers, and that smokers had increased potential for nonunion, which amounted to 30% of cases.

For nonunion, secondary interventions will undoubtedly be necessary, carrying additional risks and more potential complications and preventing early return to work, sports, and activities of daily living. Therefore, any effective treatment that can accelerate bone healing and avoid further surgical interventions should be considered, especially for patients who have risk factors for delayed union or nonunion after ulnar shortening osteotomy.

Urita et al clarified the positive effects of LIPUS on healing of ulnar shortening osteotomy sites. LIPUS is a pain-free noninvasive modality and has positive biological effects on the fracture healing process by increasing the local blood flow; upregulating the expressions of master transcription factors for osteoblastic differentiation such as Runx2, Msx2, Dlx5, and osterix; and facilitating adhesion of osteoblasts at the fracture site by increasing the expressions of integrins. Currently, several clinical studies have demonstrated that LIPUS enhances the healing of fresh fractures, delayed unions, and nonunions.

Teriparatide is a recombinant human parathyroid hormone (PTH 1-34) preparation used in the treatment of osteoporosis and is expected to be a potent agent for fracture healing and nonunion. The anabolic effect of PTH on bone is attributable to the stimulation of osteoblastic activity, and intermittent administration of PTH systemically accelerates fracture healing by augmenting fracture site chondrogenesis and osteogenesis. In a more detailed prospective, randomized, double-blinded study of conservative fracture treatment for 102 postmenopausal women with distal radius fractures, Aspenberg et al showed that the time to healing was shorter in the 20-mg teriparatide group than in the placebo group. Recently, teriparatide has started to be used for successful bone healing in numerous cases of nonunion in the sternum, odontoid, radius, humerus, femur, and ankle. The current article contains the first report of application of teriparatide for nonunion in smokers after ulnar shortening osteotomy.

Combined effects of teriparatide and LIPUS on the stimulation of bone healing have been reported in both animal and clinical studies. Warden et al reported that teriparatide and LIPUS had contrasting additive, rather than synergistic, effects during fracture healing in rat studies; that is, teriparatide primarily increased the callus bone mineral content, whereas LIPUS increased the callus size. Nozaka et al described that successful bone healing for femoral shaft atrophic nonunion was achieved with LIPUS and teriparatide combination therapy. The current case reports show that noninvasive combination therapy of teriparatide and LIPUS is a possible alternative to surgical intervention in difficult cases of nonunion with risk factors such as heavy smoking after ulnar shortening osteotomy.

In Patient 1, twenty months was required to achieve complete bone union. This time period was too long, but the initiation of teriparatide might have been delayed because this was the first case involving teriparatide therapy for nonunion after ulnar shortening osteotomy. If teriparatide administration had been started earlier than 10 months, the bone union would have been achieved earlier than expected. Secondary bone grafting has been the only option for nonunion after ulnar shortening osteotomy to date. From now on, teriparatide administration can be tried for nonunion to avoid additional surgery. The authors do not intend to apply teriparatide therapy to all patients with ulnar shortening osteotomy.

As mentioned previously, the nonunion rate after ulnar shortening osteotomy is approximately 10%. The authors believe that the indication for teriparatide therapy is only those patients suspected of nonunion. The remaining 90% of patients could achieve bone union without LIPUS or teriparatide therapy in general. In the future, the authors would like to actively apply teriparatide therapy solely to patients who have risk factors for delayed union, such as a heavy smoking habit, and are expected to experience nonunion by about 3 months after ulnar shortening osteotomy. However, teriparatide therapy still has an associated problem of high cost. Further studies involving prospective randomized clinical trials with larger patient groups are needed to confirm the combined effectiveness of teriparatide and LIPUS on bone healing for nonunion after ulnar shortening osteotomy.

**References**


