Variables Prognostic for Delayed Union and Nonunion Following Ulnar Shortening Fixed With a Dedicated Osteotomy Plate

Michael P. Gaspar, MD,*† Patrick M. Kane, MD,*† Ralph C. Zohn, BS,* Taylor Buckley, MD,* Sidney M. Jacoby, MD,*† Eon K. Shin, MD*†

Purpose To examine potential risk factors for the development of delayed or nonunion following elective ulnar shortening osteotomy using a dedicated osteotomy plating system.

Methods We performed a retrospective review of all patients who underwent elective ulnar shortening using the TriMed single osteotomy dynamic compression plating system by 1 of 2 fellowship-trained hand surgeons over a 5-year period. Demographic data and medical, surgical, and social histories were reviewed. Time to bony union was determined radiographically by a blinded reviewer. Bivariate statistical analysis was performed to examine the effect of explanatory variables on the time to union and the incidence of delayed or nonunion. Those variables associated with the development of delayed or nonunion were used in a multivariate logistic regression model. Complications, including the need for additional surgery, were also recorded.

Results Seventy-two ulnar shortening osteotomy procedures were performed in 69 patients. Delayed union, defined as $\geq$ 6 months to union, occurred in 8 of 72 cases (11%). Of 72 surgeries, 4 (6%) resulted in nonunions, all of which required additional surgery. Hardware removal was performed in 13 of 72 (18%) of the cases. Time to union was significantly increased in smokers (6 $\pm$ 3 months) versus nonsmokers (3 $\pm$ 1 months). On multivariable analysis, diabetics and active smokers demonstrated a significantly higher risk of developing delayed union or nonunion. Patient age, sex, body mass index, thyroid disease, worker's compensation status, alcohol use, and amount smoked daily did not have an effect on the time to union or the incidence of delayed or nonunion.

Conclusions Despite the use of an osteotomy-specific plating system, smokers and diabetics were at significantly higher risk for both delayed union and nonunion following elective ulnar shortening osteotomy. Other known risk factors for suboptimal bony healing were not found to have a deleterious effect. *(J Hand Surg Am. 2016;41(2):237–243. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Prognostic III.

Key words Delayed union, diabetes, nonunion, prognostic variables, risk factors, smoking, ulnar shortening osteotomy.

Additional material is available online.

*From *The Philadelphia Hand Center, P.C.; and the †Department of Orthopedic Surgery, Thomas Jefferson University Hospital, Philadelphia, PA.*

Received for publication August 6, 2015; accepted in revised form October 9, 2015.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Michael P. Gaspar, MD, The Franklin Suite G114, 834 Chestnut Street, Philadelphia, PA 19107; e-mail: michaelpgaspar@gmail.com.

0363-5023/16/4102-0012$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2015.10.017

ULNAR SHORTENING OSTEOTOMY (USO) is a widely accepted surgical treatment option for ulnar-sided wrist pain associated with multiple conditions, including triangular fibrocartilage complex (TFCC) injuries, lunotriquetral ligament tears, and ulnar impaction syndrome.[1–4] USO can effectively treat pain associated with TFCC injury, even in the absence of ulnar positive variance, and particularly

when prior TFCC debridement or repair has failed.[2] Ulnar impaction syndrome is the direct result of positive static or dynamic ulnar variance, which causes the distal ulna to abut against the ulnar carpus. This is manifested clinically by pain with activities involving ulnar deviation and forearm rotation.[2,4] By shortening and leveling the ulna, USO offloads the ulnar carpus from the distal ulna, thereby relieving pain.[1]

Reported outcomes following USO are generally favorable, although complications including delayed or nonunion at the osteotomy site occur with variable incidence.[5–9] As with any bone requiring fixation, the incidence of bony union after USO is multifactorial, relying on a multitude of patient demographic, medical, and social factors. Among the risk factors for the development of nonunion or delayed union following bony fixation, the most commonly studied are advancing age,[10–13] malnutrition (including both a deficiency of nutrients or an excess, as in obesity),[13–17] diabetes,[18–23] thyroid disease,[17,24] smoking,[25–35] and alcohol use.[36–38]

The detrimental effects of smoking on bony union in particular are well documented. However, most of the clinical reports are focused on spinal or ankle arthrodesis or on long-bone fractures treated with or without fixation.[25–35] Similarly, although diabetes has also been shown to adversely affect bony healing, most clinical reports pertain to fracture fixation or arthrodesis of the foot and ankle.[21–23] Furthermore, it is unclear to what degree this effect is directly related to diabetes versus being related to an associated neuropathy.[39]

In a study investigating the effect of smoking on bony union following USO, Chen et al[40] reported that smokers took significantly longer to achieve bony union in comparison to nonsmokers while also demonstrating a significantly higher risk of developing nonunion. However, it is unclear if any other risk factors for adverse bony healing were studied, or if underlying comorbidities played any role in the authors' findings. In addition, this study was performed nearly 20 years ago, using the standard 3.5-mm dynamic compression plate with freehand osteotomy cuts.

As freehand osteotomy has been shown to be associated with a higher incidence of nonunion,[9] it is unclear if smoking would have the same magnitude of effect on bony union following USO when using newer techniques and procedure-specific devices. The role that thyroid disease, alcohol use, obesity, and other variables may play in the development of delayed union or nonunion remains unclear.

The purpose of this study was to examine the association of variables known to adversely affect bone healing with time to bony union and the rate of nonunion or delayed union following elective USO using a dedicated osteotomy plating system. Second, we investigated whether any of these predictor variables increase the likelihood of other complications or the need for additional surgery following USO. Thus, our null hypothesis was that there would be no difference in the time to bony union and incidence of nonunion or complications based on the studied variables following USO with a dedicated osteotomy plating system.

METHODS

Surgical technique and baseline data collection

We retrospectively reviewed the charts of all patients who underwent USO from January 2010 through December 2014 at our institution by 1 of 2 fellowship-trained hand surgeons. All surgeries were performed with a single osteotomy dynamic compression plating system (TriMed Ulnar Osteotomy Compression Plate; TriMed, Santa Clarita, CA) using a similar technique to that previously described, with the plate placed in the most anatomically accommodating position (volar vs dorsal) as determined by the treating surgeon.[41] All patients were treated identically with regard to postoperative splinting and immobilization for 1 month, followed by mobilization exercises and formal supervised therapy. As per our institution's standard, all patients were given a standardized questionnaire preoperatively, which included questions regarding smoking and tobacco history. Patients who had not disclosed their smoking history, whether positive or negative, were excluded from the study.

Demographic data, body mass index, workers' compensation status, and medical comorbidities, including cardiovascular disease, diabetes mellitus, and thyroid disease, were recorded for each patient. Social factors such as smoking and alcohol use were also examined. Finally, the plate position at the time of surgery and the degree to which the ulna was shortened, in millimeters, were also recorded. The body mass index, which was calculated using the height and weight values obtained preoperatively, was unavailable for 4 patients. Those 4 patients were excluded from that particular analysis. All other continuous variables and all categorical predictor variables were obtained for every patient included in this study.

The primary outcome measured was time to bony union as measured radiographically and confirmed by clinical examination. A fellowship-trained, attending hand surgeon served as a blinded reviewer, assessing orthogonal radiographs for cortical bridging across the osteotomy site beginning at 2 months postoperatively