Effect of Lymphedema Treatment for Management of Acute Pilon Fractures

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abstract

Pilon fractures are high-energy injuries that often result in considerable edema and compromise of the soft tissue envelope of the ankle. These injuries are typically staged with an external fixator until the soft tissue is amenable for definitive fixation. This study was conducted to determine the effects of lymphedema treatment for the management of pilon fractures. Patients who underwent open reduction and internal fixation of pilon fractures between 2007 and 2014 at the authors’ level II trauma center were identified by Current Procedural Terminology codes indicative of placement of an external fixator (20690) and open reduction and internal fixation of a pilon fracture (27826, 27827, or 27828). The primary efficacy endpoint to determine negative outcomes was 90 days after definitive fixation. Eighty-two patients with 84 pilon fractures met inclusion criteria. Forty-eight ankles (57%) received lymphedema treatment. There were no significant differences in population demographics between the control and treatment groups. Median times to internal fixation in the control and treatment groups were 20 days (interquartile range, 15.5-30 days) and 11 days (interquartile range, 6-18 days), respectively. This difference was statistically significant (P=.001). Additionally, there was no significant difference in the overall incidence of wound complications between the control and treatment groups (P=.246). Compression wrapping for posttraumatic edema was effective in reducing the time needed for soft tissues to be appropriate for definitive surgical fixation of pilon fractures without increasing the risk of wound complications. These promising results warrant future study. [Orthopedics. 2017; 40(4):e668-e674.]

Pilon fractures are high-energy injuries, typically occurring from falls from height or motor vehicle collisions and commonly resulting in highly comminuted and complex fractures. As such, there is often substantial edema and compromise of the soft tissue envelope of the ankle. Patients who have suffered a length-unstable pilon fracture are routinely staged with an external fixator to stabilize the ankle until the surrounding soft tissue is amenable for surgery, generally between 10 days and 3 weeks. Coupled with delaying surgical intervention, posttraumatic edema also increases the risk of wound complications and postoperative infections. Because pilon fractures have alarmingly high complication rates, it has been suggested that soft tissue management is as important as the bony reconstruction, further highlighting the need to control and reduce swelling in the affected limbs. Patients with breast cancer are most commonly afflicted with extremity edema, often due to lymph node removal during treatment. As such, standards of care for management of lymphedema are primarily derived from the cancer research literature. The current gold standard treatment for extremity lymph-
edema is complete decongestive therapy. Complete decongestive therapy is multimodal and consists of manual lymph drainage, compression wrapping, exercise, and skin care.

Currently, there is little evidence regarding the utility of these treatments in acute care settings for posttraumatic edema. These therapeutic techniques, specifically compression wrapping for edema management in lower extremity fractures, have been employed at the authors’ facility, a level II trauma center, in an effort to expedite the soft tissue condition for definitive surgery. This study aimed to determine the effects of this adjuvant therapy on time to definitive fixation and the incidence of wound complications. The authors hypothesized that the treatment group would exhibit shorter times to definitive fixation without an increase in complication rates.

**Materials and Methods**

Approval from the Louisiana State University Health Sciences Center—New Orleans Institutional Review Board was obtained prior to beginning this study. Patients 18 years or older who underwent open reduction and internal fixation of pilon fractures between 2007 and 2014 were identified in the financial operations database of the authors’ institution using the Current Procedural Terminology codes indicative of placement of an external fixator (20690) and open reduction and internal fixation of a pilon fracture (27826, 27827, or 27828). Demographic and clinical elements were collected from the electronic medical record. Patients were excluded if they were younger than 18 years, underwent primary tibiotaraf fusion, had an open fracture that required primary plastic surgery coverage at the time of presentation, or had incomplete follow-up records, defined as being lost to follow-up prior to the end of a 90-day global period. The authors determined that the 90-day follow-up period was a sufficient period for soft tissue or wound complications to manifest. Additionally, staying within the global postoperative period theoretically prevents losing patients to follow-up because of financial constraints.

With the exception of a few patients who underwent external fixation at other facilities, most external fixation and all internal fixation surgeries were performed at the authors’ institution by the same 3 board-certified orthopedic surgeons (J.A.L., C.C.G., K.B.R.)—2 being orthopedic traumatologists and 1 being a foot and ankle specialist. Certified physical therapists administered lymphedema treatment if ordered by one of these physicians while patients were in the hospital. There were no set criteria that determined which patients received treatment. The patients were ordered to receive lymphedema treatment at the discretion of each of the treating surgeons. All physical therapists at the authors’ institution who administered this therapy received certification in lymphedema management by completing a 4- or 9-day course through the Academy of Lymphatic Studies.

If a patient receiving or referred for lymphedema treatment was discharged home in the interim between external and internal fixation, treatment was given in one of two ways. Some patients received compression wrapping by home health therapists who were certified in lymphedema management in the same manner as the in-hospital therapists. In the instances where home health was unavailable, treatment was to be administered by a family member or other caregiver trained by hospital physical therapists and given instructions. Compression was achieved by using nonelastic, short-stretch bandages, which were applied per a previously described procedure. An example of an affected lower limb in compression wrapping is shown in Figure 1. In the acute care setting, compression bandages are changed daily or every other day, depending on whether the patient has wounds or a pin site and the rate of edema reduction.

Receipt of lymphedema treatment was determined by physical therapist or physician notes in the electronic medical record. Patients who did not receive the intervention served as the control group for the purposes of this study.

Medical records from clinic notes were used to collect information on 90-day postoperative follow-up measures regarding wound complications. As complications most often appear within 3 to 4 weeks after open reduction and internal fixation, the current authors determined that this time frame allowed the incidence of complications to be sufficiently captured. Complications were defined as either minor—requiring only oral antibiotics or local wound care—or major—deep infection, the need for an unplanned surgic-
cal procedure (late debridement), administration of intravenous antibiotics, or soft tissue coverage by plastic surgery that was deemed directly attributable to morbidity from the pilon fracture.

Statistical Analysis

Descriptive statistics were used to describe the cohort. Body mass index was grouped into 3 categories: 18.5 to 29.9 kg/m² (normal weight to overweight), 30 to 39.9 kg/m² (obese), and 40 kg/m² or greater (morbidly obese). Receipt of lymphedema treatment, history of smoking, history of specified comorbidities, and incidence of wound complications were each dichotomized and dummy coded. Chi-square analysis was used to examine differences among categorical patient characteristics between the control and treatment groups. Differences in the continuous variables of time to definitive fixation between the control and treatment groups were analyzed using the nonparametric Mann–Whitney U test. Chi-square analysis or Fisher’s exact test was used to analyze the relationship between categorized known risk factors for complications (ie, obesity, smoking, diabetes, and fracture type) and lymphedema treatment with the development of wound complications. Regardless of the outcome of this bivariate analysis, each risk factor was included in a multiple logistic regression model along with receipt of lymphedema treatment to determine which factors affected the incidence of wound complications. Odds ratio and 95% confidence interval were reported for each factor. If the confidence interval crossed 1, the risk factor was not significant. P<.05 was considered significant for all other analyses. All analyses were performed using SPSS version 22 software (IBM, Armonk, New York).

RESULTS

Of the 91 patients eligible for this study, 9 were excluded due to incomplete records or a follow-up period of less than 90 days. This left a total of 82 patients with 84 pilon fractures who were included in this analysis. Each fracture was considered a unique incident for lymphedema treatment, fracture classification, time to internal fixation, and wound complications. The total population was primarily male (59%) with a median age of 44 years. Table 1 describes the cohort as a whole as well as by control and treatment subgroups. Of the total cohort, 57% received compression wrapping for management of their lower extremity lymphedema. There were no statistically significant differences between the groups regarding basic demographic descriptors, history of comorbidities, or fracture type.

Most patients (85%) underwent external fixation of their pilon fractures on the
day of presentation to the hospital. All remaining patients were placed with external fixators 1 to 3 days after admission. Median time to internal fixation was 20 days (interquartile range, 15.5-30 days) for the control group compared with 11 days (interquartile range, 6-18 days) for the compression group (Figure 2). This difference was statistically significant at $P=.001$.

Follow-up records revealed a total of 35 patients (43%) who developed complications. Of these, 23 received lymphedema treatment. No significant difference in incidence of wound complications was found between the treatment and control groups ($P=.246$). A demographic comparison of those who developed wound complications with those who did not revealed no significant differences in age, body mass index, smoking history, or comorbidities (Table 2). However, women were significantly more likely to develop wound complications ($P=.042$), as were patients with open pilon fractures ($P<.001$).

The results of the logistic regression analysis are detailed in Table 3. Consistent with the bivariate analysis, only female sex and open fracture were significantly associated with an increased risk for wound complications. Neither receipt of lymphedema treatment nor presence of known risk factors were found to be predictive of wound complications.

Complications were further examined to delineate the incidence of minor and major complications (Table 4). Of the 35 total complications, 23 met criteria to be classified as major. The incidence of major complications was similar between treatment and control groups (n=13 vs n=10, respectively). Of these, 16 (70%) occurred in patients with open fractures. The remaining 12 complications were minor and resolved with the administration of oral antibiotics and/or local wound care. No significant relationship was found for the occurrence of major or minor complications with lymphedema treatment.

**DISCUSSION**

Significant edema is frequently observed following orthopedic trauma, which negatively affects wound healing and can delay definitive surgical intervention. Although there are multiple methods to manage lymphedema, complete decongestive therapy is considered the treatment of choice due to its being effective, conservative, and noninvasive without known side effects. It boasts the additional advantage of being transferable, in that it can be taught to the patient or to caregivers for ongoing management when the patient is not in a health care setting. Although there are several published case reports describing patient outcomes after complete decongestive therapy for lower extremity lymphedema, scant data are available on the clinical benefits of this intervention in the management of posttraumatic edema in the acute care setting.

Rohner-Spengler et al found that multiple compression therapy resulted in faster reduction of posttraumatic edema compared with ice and elevation for patients with ankle and hindfoot fractures and suggested that compression therapy might reduce hospital length of stay. However, they did not investigate the effect these therapies had on time to definitive fixation of the injury. In the current study, the authors showed marked reduction in median time to surgery of 9 days for those who received compression wrapping. No other differences between the 2 groups were found that would account for this, indicating that the decreased time to open reduction and internal fixation in the treatment group is attributable to the therapy. In agreement with Rohner-Spengler et al, the current authors believe this intervention has the potential to reduce length of stay.

Historically, pilon fractures have had high complication rates, often attributable to the soft tissue damage of the injured area. Therefore, the current authors examined wound complications to determine if the lymphedema treatment...
resulted in an increase in adverse events. Because of the complexity and high degree of variability in fracture patterns and patient factors, previously reported wound complication rates for pilon fractures have ranged from 0% to 40%.\textsuperscript{5,16-21} The overall incidence of complications in the current study was 39%. Although this rate is at the higher end of previously reported rates, it is likely inflated due to the current authors’ stringent and widely inclusive definition of complications. If only major complications are considered, the rate decreases to 27%. Most importantly, the incidence of wound complications was not statistically different between the therapy and control groups, indicating that compression wrapping of the injured extremity does not result in increased adverse events compared with traditional management. Interestingly, women were significantly more likely to develop complications than were men; however, the authors currently offer no explanation for this finding.

Open fractures inherently exhibit higher levels of soft tissue injury and thus are often accompanied by increased risk and incidence of wound complications and infections.\textsuperscript{2,5,7,13,16} The current findings were in agreement with this, as the presence of an open fracture was strongly associated with the development of wound complications and most often resulted in the development of major complications. The proportions of patients with open or closed fractures in the intervention and control groups were nearly identical, indicating that fracture type was the primary impetus for the development of wound complications. Importantly, lymphedema treatment in the presence of open pilon fractures did not result in an increase in major complications.

Although not examined in the current study, benefits of this adjuvant therapy to the management of pilon fractures likely extend beyond time considerations. It is conceivable that its use also results in financial benefits in the form of reduced health care costs. As previously suggested, patients may have shorter hospital stays and may use less narcotic pain medicine. The benefits may even extend to noticeable increases in quality of life measures, which the authors suspect based on anecdotal reports from practitioners and patients. Future studies may provide further insight.

This study had several limitations due to its retrospective nature. First, the authors were limited to deriving information solely from electronic medical records and thus lacked specific information regarding edema treatment administered in outpatient settings. For example, for patients treated at home by home health therapists or a family caregiver, the authors did not know how many treatments patients received, the rate of edema reduction, or patient fidelity and adherence to the intervention. Therefore, the authors could not determine an optimal number

<table>
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<th>Characteristic(^a)</th>
<th>No Complications(^b)</th>
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<td>19 (54)</td>
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Abbreviation: IQR, interquartile range.
\(^a\)N=82 except for fracture type (N=84) and lymphedema treatment (N=84) because 2 patients had bilateral pilon fractures.
\(^b\)N=47 except for fracture type (N=49) and lymphedema treatment (N=49) because 2 patients had bilateral pilon fractures.
of treatments or formulate specific guidelines. Second, there may be error due to confounding variables and bias for patient and treatment selections. Third, time to definitive surgical fixation can be dependent on more factors than the suitability of soft tissue, such as operating room availability or the schedules of the surgeons or patients. However, the considerable difference in median time to open reduction and internal fixation can be dependent on more factors than the suitability of soft tissue, such as operating room availability or the schedules of the surgeons or patients. However, the considerable difference in median time to open reduction and internal fixation between the control and treatment groups indicates that this finding is likely not attributable to scheduling conflicts. Additionally, there were no set criteria for which patients received a course of oral antibiotics or were referred for formal wound care. There was also no differentiation for various surgical approaches. Finally, this was a single institution study, so the results may not be generalizable to other facilities. However, there are no confounding aspects of this patient population to suggest that these treatments would not be as efficacious at other institutions.

**Conclusion**

This study showed the utility of lymphedema treatment in the acute care setting for the management of pilon fractures. Compression wrapping for posttraumatic edema was effective in reducing the time needed for soft tissues to be appropriate for definitive surgical fixation of the fracture without increasing the risk of wound complications.

**References**