Original Research

POSTTRAUMATIC TIBIAL OSTEOMYELITIS: A COMPARISON OF THREE TREATMENT APPROACHES

Kenneth J. Koval, MD
Steve E. Meadows, MD
Howard Rosen, MD

Lester Silver, MD
Joseph D. Zuckerman, MD

ABSTRACT

The treatment of 25 tibias in 25 patients with posttraumatic chronic osteomyelitis was reviewed. The approaches to soft tissue management fell into three groups: 1) muscle flap coverage; 2) primary closure with suction irrigation; and 3) open cancellous bone grafting. Treatment success was judged by the presence or absence of drainage and the local signs or symptoms of infection, and by the status of the tibial nonunion. Overall, 19 of 25 tibias (76%) had successful treatment. We found flap coverage to have a higher success rate (80%) than either primary closure with suction irrigation (45.5%) or open cancellous bone grafting (40%). These results further attest to the refractory nature of chronic osteomyelitis.

Chronic tibial osteomyelitis remains one of the most challenging problems in orthopedic surgery.1-4 The subcutaneous location of the tibia makes it vulnerable to direct injury, which often results in open fractures and extensive soft tissue injury. The combination of these factors makes it a common site of posttraumatic osteomyelitis.

Many protocols have been proposed for the treatment of chronic tibial osteomyelitis, including antibiotic therapy,5-7 debridement,8 closed irrigation and suction drainage,9-14 open cancellous bone grafting,1,15-20 and muscle transposition.21-23 Despite many reports of treatment techniques and their efficacy, there is a dearth of studies comparing treatment protocols. We undertook this retrospective study to evaluate the efficacy of three different approaches for the treatment of chronic tibial osteomyelitis.

MATERIALS AND METHODS

Twenty-five tibias in 25 patients with chronic osteomyelitis were treated at the Hospital for Joint Diseases, Orthopedic Institute between June 1980 and December 1987. All cases met the following criteria: 1) the infection occurred following trauma; 2) there were positive bacterial cultures; 3) bone histology was consistent with chronic osteomyelitis; and 4) treatment included either flap coverage, primary closure over suction irrigation, or open cancellous bone grafting.

There were 19 male and six female patients. There were 14 left and 11 right tibias. The average age at presentation was 32.2 years (range: 20 to 61). Follow up averaged 53.5 months (range: 20 to 95).

Nineteen tibias (76%) had previous open fractures, while six (24%) developed chronic osteomyelitis following open treatment of closed fractures. The mechanism of injury included motor vehicle accident (7 patients), motorcycle accident (6 patients), pedestrian accident (8 patients), fall from height (3 patients), and gunshot wound (1 patient). Twenty-four tibias (96%) presented with draining sinuses; 14 (56%) had an infected nonunion. The time from injury to presentation averaged 32.8 months (range: 2 months to 27 years). Twenty-one tibias (84%) had previous attempts at eradication of infection, with an average of 3.4 attempts (range: 1 to 10).

Thirteen tibias (52%) were infected with a single organism: Staphylococcus aureus in 8, Pseudomonas aeruginosa in 3, Staphylococcus epidermidis in 1, and beta-hemolytic Strepto-
coccius in 1 tibia. Twelve tibias (48%) had mixed infections.

Treatment consisted of meticulous debride-
ment(s), osseous stabilization (if necessary), intravenous antibiotics, and bone grafting if a nonunion was present or if debridement resulted in a significant bony defect. However, the different approaches to soft tissue management could be divided into three treatment groups:

Group 1—free or rotational muscle flap coverage; Group 2—primary closure with suction irrigation; and Group 3—open cancellous bone grafting (Papineau technique).

The choice of soft tissue management was at the discretion of the primary surgeon. There were 15 tibias in Group 1, 11 in Group 2, and 5 in Group 3. Six tibias were included in more than one group because failure to eradicate the infection using the initial protocol necessitated a second treatment approach.

Group 1 consisted of 11 males and four females with an average age of 30.9 years (range: 20 to 50). Five fractures resulted from pedestrian accidents, 4 from motor vehicle accidents, 3 from motorcycle accidents, and 3 from falls. Ten of 15 tibias (67%) had previous open fractures. Eight (53.3%) initially presented with an infected nonunion. The time from injury to presentation averaged 20.1 months (range: 4 to 46). Thirteen tibias (86.7%) had previous attempts at eradication of infection, with an average of 31.1 attempts (range: 1 to 10).

Eight tibias (53.3%) were infected with a single organism: S. aureus in 5, S. epidermidis in 1, P. aeruginosa in 1, and beta-hemolytic Streptococcus in 1 tibia. Seven tibias (46.7%) were infected with multiple organisms. The duration of parenteral antibiotic therapy averaged 39.2 days (range: 5 to 84). Six patients were placed on oral antibiotics following parenteral therapy.

The number of debridements per tibia prior to flap coverage averaged 2.3 (range: 1 to 4). Two tibias had flap coverage at the initial debride-
ment. Nine tibias (60%) required stabilization; all were treated with external fixation. Eleven tibias (73.3%) needed autologous iliac bone grafts. Coverage consisted of nine free muscle flaps and six rotational muscle flaps. The latissimus dorsi was harvested as a free flap in six cases and the rectus abdominis in three cases. Local flaps were always rotated from the gastro-
soleus complex.

Group 2 consisted of eight males and three females with an average age of 31.5 years (range: 20 to 54). Five fractures resulted from motor vehicle accidents, 2 from motorcycle accidents, 2 from pedestrian accidents, 1 from a fall, and 1 from a gunshot wound. Ten of 11 tibias (91%) had previous open fractures. Eight (72.7%) presented with an infected nonunion. The time from injury to presentation for 10 of the 11 tibias averaged 20.7 months (range: 5 to 36). The 11th tibia presented 27 years after a gunshot wound. Nine tibias (81.8%) had prior attempts at eradication of infection, with an average of 3.4 attempts (range: 1 to 10).

Five tibias (45.5%) were infected with a single organism; 4 with S. aureus, and 1 with P. aeruginosa. Six tibias (54.5%) had a mixed infection. The duration of parenteral antibiotic therapy averaged 28.5 days (range: 10 to 91). Eight patients were placed on oral antibiotics following parenteral therapy.

Treatment consisted of a one-stage debride-
ment and closure over suction irrigation. At the discretion of the surgeon, 10 of 11 cases (90.9%) had antibiotic irrigation: cephalothin in 7, gentamycin in 1, oxacillin in 1, and a triple antibiotic mixture—bacitracin/polymyxin/neosporin—in 1 case. Irrigation was instilled at a rate of 1 L every 12 hours for an average of 7.8 days (range: 4 to 15). Seven tibias required stabilization; all presented as infected nonunions. Six were treated with external fixation and one was stabilized with flexible intramedullary nails. Eight tibias received autologous cancellous iliac bone grafts.

Group 3 consisted of four males and one female with an average age of 37.0 years (range: 24 to 61). Two fractures resulted from motor-
cycle accidents, 2 from pedestrian accidents, and 1 from a fall. Two of five tibias (40%) had previous open fractures. Two (40%) presented with an infected nonunion. The time from injury to presentation averaged 11 months (range: 2 to 24). All five tibias had previous attempts at eradication of infection, with an average of 4.4 attempts (range: 1 to 7). Three tibias (60%) were infected with a single organism; two tibias with S. aureus and one tibia with P. aeruginosa. Two tibias (40%) had mixed infections. The duration of parenteral antibiotic therapy averaged 30 days (range: 5 to 74). Two patients were placed on oral antibiotics following parenteral therapy.

Treatment consisted of debridement(s) and local wound care until the wound was covered with granulation tissue. This required a single debridement in three cases and three debridements in two cases. Three tibias (60%) required stabilization; all three were treated with external fixation. When the wound was covered with granulation tissue, an autologous cancellous iliac bone graft was applied. Skin grafting was performed if necessary.

The results were evaluated by patient exami-
nation as well as chart and roentgenographic review. Treatment success was judged by the presence or absence of drainage and the local signs or symptoms of infection, and by the status of the tibial nonunion.
### SUMMARY DATA OF THE 25 PATIENTS WITH CHRONIC TIBIAL OSTEOMYELITIS

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>L/R</th>
<th>Treatment Group</th>
<th>Open (O) vs Closed (C)</th>
<th>Drainage</th>
<th>Organisms</th>
<th>Previous Procedures</th>
<th>Bone Graft</th>
<th>Fixation</th>
<th>Follow up (months)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>F</td>
<td>L</td>
<td>I</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>1</td>
<td>Ext. Fix</td>
<td>28</td>
<td>Failure*</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>M</td>
<td>L</td>
<td>I</td>
<td>O</td>
<td>O</td>
<td>B hem. strep</td>
<td>0</td>
<td>None</td>
<td>36</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>M</td>
<td>R</td>
<td>I</td>
<td>O</td>
<td>O</td>
<td>S. aureus</td>
<td>1</td>
<td>Ext. Fix</td>
<td>42</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>31</td>
<td>F</td>
<td>L</td>
<td>I</td>
<td>O</td>
<td>O</td>
<td>S. aureus</td>
<td>7</td>
<td>None</td>
<td>20</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>31</td>
<td>F</td>
<td>L</td>
<td>I</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>4</td>
<td>None</td>
<td>30</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>24</td>
<td>M</td>
<td>L</td>
<td>I</td>
<td>C</td>
<td>O</td>
<td>Multiple</td>
<td>2</td>
<td>None</td>
<td>69</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>M</td>
<td>L</td>
<td>I</td>
<td>-</td>
<td>O</td>
<td>Pseudomonas</td>
<td>0</td>
<td>None</td>
<td>52</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>41</td>
<td>M</td>
<td>L</td>
<td>I[III]</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>10</td>
<td>Ext. Fix</td>
<td>67</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>M</td>
<td>L</td>
<td>I[III]</td>
<td>O</td>
<td>O</td>
<td>S. aureus</td>
<td>2</td>
<td>None</td>
<td>39</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>25</td>
<td>M</td>
<td>R</td>
<td>I</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>2</td>
<td>Ext. Fix</td>
<td>63</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>38</td>
<td>F</td>
<td>R</td>
<td>I[III]</td>
<td>O</td>
<td>C</td>
<td>Multiple</td>
<td>2</td>
<td>Ext. Fix</td>
<td>51</td>
<td>Failure**</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>31</td>
<td>M</td>
<td>L</td>
<td>I[III]</td>
<td>C</td>
<td>-</td>
<td>S. aureus</td>
<td>1</td>
<td>Ext. Fix</td>
<td>33</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>34</td>
<td>M</td>
<td>R</td>
<td>I[III]</td>
<td>C</td>
<td>C</td>
<td>S. aureus</td>
<td>1</td>
<td>Ext. Fix</td>
<td>60</td>
<td>Failure*</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>48</td>
<td>F</td>
<td>R</td>
<td>I[III]</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>6</td>
<td>Ext. Fix</td>
<td>85</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>34</td>
<td>M</td>
<td>L</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>S. aureus</td>
<td>6</td>
<td>Int. Fix</td>
<td>79</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>31</td>
<td>M</td>
<td>R</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>0</td>
<td>Ext. Fix</td>
<td>79</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>25</td>
<td>M</td>
<td>L</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>1</td>
<td>Ext. Fix</td>
<td>37</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>23</td>
<td>F</td>
<td>R</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>Pseudomonas</td>
<td>2</td>
<td>None</td>
<td>95</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>20</td>
<td>M</td>
<td>L</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>0</td>
<td>None</td>
<td>66</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>54</td>
<td>M</td>
<td>R</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>2</td>
<td>Ext. Fix</td>
<td>58</td>
<td>Failure**</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>45</td>
<td>M</td>
<td>L</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>S. aureus</td>
<td>1</td>
<td>None</td>
<td>50</td>
<td>Failure†</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>24</td>
<td>M</td>
<td>R</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>Pseudomonas</td>
<td>6</td>
<td>None</td>
<td>35</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>61</td>
<td>M</td>
<td>R</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>Multiple</td>
<td>6</td>
<td>None</td>
<td>66</td>
<td>Success</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>31</td>
<td>M</td>
<td>R</td>
<td>I[II]</td>
<td>O</td>
<td>O</td>
<td>S. aureus</td>
<td>7</td>
<td>Ext. Fix</td>
<td>55</td>
<td>Failure‡</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>28</td>
<td>M</td>
<td>L</td>
<td>I</td>
<td>O</td>
<td>C</td>
<td>S. epiderm.</td>
<td>3</td>
<td>Ext. Fix</td>
<td>38</td>
<td>Success</td>
<td></td>
</tr>
</tbody>
</table>

*Below knee amputation
**Fracture united, persistent drainage
†Persistent drainage
‡Persistent nonunion, persistent drainage

### RESULTS (TABLE)

Overall, 19 of 25 tibias (76%) had successful treatment. This includes four tibias which had treatment failure using the initial protocol but had eventual treatment success using a different approach. Ten of 11 tibias (90.9%) presenting with an infected union and nine of 14 tibias (64.2%) presenting with an infected nonunion had treatment success. These results are not statistically significant. Ten of 13 tibias (76.9%) infected with a single organism and nine of 12 (75%) with a mixed infection had treatment success. All treatment failures were evident within 2 years.

The 15 tibias in Group 1 were followed for an average of 47.8 months (range: 20 to 85). At follow up, 12 of 15 tibias (80%) were judged to have had successful treatment. Nine of the 12 tibias required no further operative treatment after flap coverage. One of the remaining four tibias, covered with a rotational flap, had persistent drainage. This was successfully treated with a repeat debridement and free flap closure. One tibia required four additional procedures—two repeat debridements and two bone grafts—before successful treatment. One tibia required a subsequent posterolateral bone graft. Three tibias developed stress fractures; all three united with cast treatment.

The two tibias which had flap coverage at the initial debridement had successful treatment. Both presented with infected unions; neither required further operative treatment after closure.

The three treatment failures—all infected nonunions—included one patient with sickle cell trait who had two unsuccessful free flaps. These were followed by an unsuccessful open cancellous bone graft. Two patients had below-knee amputations at 6 and 16 months, respectively, following flap coverage. One of the two had prior failed primary closure over suction irrigation. The tibia developed a stress fracture following apparent treatment success, drainage recurred, and the patient opted for amputation. The other patient developed a septic knee related to external fixator pin placement and opted for amputation.

In Group 1, all seven tibias presenting with an infected union and five of eight tibias (62.5%) presenting with an infected nonunion had treatment success. Seven of eight tibias (87.5%) infected with a single organism and five of seven tibias (71.4%) with a mixed infection had treatment success.
The 11 tibias in Group 2 were followed for an average of 65 months (range: 37 to 95). At follow up, five of 11 tibias (45.5%) had successful treatment. Three of the five required no further operative treatment after primary closure. The remaining two tibias needed repeat debridement with placement of closed suction irrigation secondary to persistent drainage. One tibia developed a stress fracture 9 months after surgery, which united with cast treatment.

The six treatment failures included three infected nonunions that united but had persistent drainage and therefore were considered treatment failures. Two of the three had subsequent flap coverage; the third patient refused further surgery. A fourth infected nonunion did not unite, had persistent drainage, and subsequently needed flap coverage. The remaining two treatment failures presented with infected unions. Despite repeat debridements with closed suction irrigation, both tibias had persistent drainage. One of the two had subsequent flap coverage; the other refused further surgery.

In Group 2, one of three tibias (33.3%) presenting with an infected union and four of eight tibias (50%) presenting with an infected nonunion had treatment success. Two of five tibias (40%) infected with an isolated organism and three of six tibias (50%) with a mixed infection had treatment success.

The five tibias in Group 3 were followed an average of 52 months (range: 35 to 66). Two of the five (40%) had successful treatment. Both tibias presented as infected unions and had multiple debridements. One was infected with a single organism, *P. aeruginosa*, and the other had a mixed infection.

The three treatment failures included one infected union in a patient with sickle cell trait which had two failed free flaps. At last follow up, 51 months postsurgery, the tibia had persistent drainage. A second tibia required flap coverage after failure of the open bone graft to develop a healthy bed of granulation tissue. A third tibia had repeat debridement with application of a compression-distraction external fixator.

**CASE REPORT**

A 26-year-old male suffered a Grade IIIB open right tibia fracture 3 years prior to presenting with an infected nonunion and draining sinus (Figs 1 and 2). The patient required four debridements and external fixation (Figs 3 and 4) before iliac crest bone grafting (Fig 5) and coverage with a free latissimus dorsi flap (Fig 6). At 42 months follow up, he had united, had no evidence of infection, and ambulated without assistive devices (Figs 7 and 8).

**DISCUSSION**

It is generally accepted that successful treatment of osteomyelitis must fulfill the following criteria: 1) adequate debridement of necrotic, infected soft tissue and osseous structure; 2) preservation or creation of bony stability; 3) ablation of dead space by packing and dressing changes, methylmethacrylate, bone grafting, closed suction irrigation, or muscle insertion; 4) adequate antibiotic therapy—the duration of which is controversial; and 5) soft tissue coverage.

The technique of open cancellous bone grafting was first described by Rhinelander. In animal experiments, he showed that cancellous grafts are rapidly revascularized. This technique was later popularized by Papineau and coworkers, and has come to be known as the Papineau or Rhinelander-Papineau technique. It is useful when a bony defect is associated with soft tissue loss and one cannot or does not want to provide local or distant flap coverage.

Wound irrigation in the management of osteomyelitis dates back to at least 1917. Closure of wounds with irrigation and drainage using vitallium tubes was first reported in 1945. The objective of the suction tubes is not
wound irrigation, but wound drainage and elimination of dead space. The purpose of the irrigation fluid is to prevent clogging of the suction system.

Although both open cancellous bone grafting and closed suction irrigation decrease dead space, neither directly increases wound vascularity. Muscle transposition, however, besides obliterating dead space, may improve local vascularity through delivery of a new permanent blood supply. This increased vascularity may improve delivery of antibiotics and provide cellular, noncellular, and oxygen environment necessary to help control infection, promote wound healing, and provide a soft tissue envelope resistant to further breakdown.

Although not statistically significant, we found flap coverage to have a higher success rate (80%) than either primary closure over suction irrigation (45.5%) or open cancellous bone grafting (40%) in the treatment of chronic tibial osteomyelitis. This is probably related to several factors:

- Thirteen of 15 tibias (86.7%) treated with flap coverage had multiple debridements. The tibias treated with closed suction irrigation had primary closure after a single debridement.
- The tibias covered with a muscle flap may have had a more thorough debridement. One may be more likely to perform a needed radical debridement with the knowledge that a flap can cover a large defect.
- The presence of muscle prevents adherence of skin to bone. This adherence is seen with open cancellous bone grafting; the involved skin area is quite friable and prone to breakdown.
- The presence of a muscle flap improves wound vascularity.

Debridement of dead and infected tissue may be the most important factor in the treatment of chronic osteomyelitis. All dead tissue must be excised. Debridement of bone is particularly difficult, however, because it is often hard to distinguish between living and dead tissue.

To help assess bone viability, some authors advocate the use of vital or nonvital dyes, blood flow measurements, or the visualization of punctate bleeding. Actual bleeding of bone, however, has limitations because blood flow in cortical bone is only 1 mL to 2 mL/100 g of tissue per minute. This difficulty in determining bone viability suggests that multiple debridements may be necessary in order to excise all necrotic tissue.

Our success rates in all three groups do not approach some of those reported in the literature. Our success rates of 45.5% using primary closure over closed suction irrigation and 40% using open cancellous bone grafting are far below those reported by Kelly et al (80%) and Clawson et al (73.5%) using closed suction irrigation, and Papineau et al (93%) and Cabanela (89%) using open cancellous bone grafting.

Our success rate using flap coverage (80%) does not compare to the 100% success rates reported by May et al and Mathes et al. The maximum follow up for any of the previously mentioned studies was 2 years, compared with 65 months for our primary closure group, 52 months for our Papineau group, and 47.8 months for our flap group. However, our 20% failure rate in the flap group corresponds to the 21% recurrent sepsis rate reported by Weiland et al after 41.4 months. Although all our treatment failures were evident within 2 years, these higher failure rates may reflect the need for long term follow up. These results further attest to the refractory nature of chronic osteomyelitis.

Overall, 19 of 25 tibias (76%) had eventual treatment success. This includes those tibias which had treatment failure using the initial protocol but had subsequent treatment success using a different approach.
It is not surprising that our success rate was higher in infected unions (90.9%) than infected nonunions (64.3%). Infected nonunions are difficult to manage and amputation has often been the sequela of treatment when a functional limb was unobtainable. Preservation or creation of bony stability is prerequisite if one hopes to control osteomyelitis. However, infection leaves large areas of the fracture surfaces necrotic, making fracture healing difficult, if not impossible.

West et al. reported a higher success rate in treating cases of chronic osteomyelitis infected with penicillin G susceptible S. aureus than penicillin G resistant strains, gram-negative organisms, or mixed infections. In our series, all eight tibias infected with S. aureus as a single organism had a penicillin G sensitive strain. We found a slightly higher success rate in tibias infected with a single organism than in those with mixed infections. However, there was no relationship between success rate and the type of infecting organism.

This is a retrospective study lacking randomization, a control group, or specific indications for the different treatment protocols outlined. In addition, because of the small number of patients in each group, the results are not statistically significant. We are aware of the limitations inherent in any retrospective study; a similar prospective study is in progress.

Chronic osteomyelitis remains one of the most challenging problems in orthopedic surgery. The key to treatment is radical debridement of all necrotic tissue. Depending on local factors, one may elect to cover the wound with either the surrounding soft tissue, a local or distant flap, or an open cancellous bone graft. We found that flap coverage offers the best chance for success in eradicating chronic osteomyelitis. In addition, our experience further supports the need for long term follow up to assess the efficacy of any treatment protocol for chronic tibial osteomyelitis.

REFERENCES


