Single-stage autogenous bone grafting and internal fixation in the surgical management of pyogenic discitis and vertebral osteomyelitis

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Object. Patients with deep wound infections complicating previously placed internal instrumentation have been successfully treated by debridement and prolonged postoperative antibiotic therapy, which avoided removal of the hardware. Comparatively fewer patients with pyogenic discitis and vertebral osteomyelitis (PDVO) have undergone single-stage debridement, arthrodesis, and internal fixation. The purpose of this study was to determine the efficacy of combining debridement, arthrodesis in which iliac autograft is used, and segmental internal fixation in a single-stage procedure for patients in whom nonoperative management of PDVO has failed.

Methods. A retrospective analysis of 17 consecutive patients with PDVO treated between July 1996 and September 1999 was performed. Follow-up data (mean 30 months) included office examinations and telephone interviews, and patients were grouped according to the duration of preoperative antibiotic therapy. All patients experienced significant postoperative reduction in pain, and those with neurological deficits improved. Eleven patients were independently ambulatory, and three required a walker; only five had been ambulating independently preoperatively. Two patients died during the 1st postoperative week of medical complications; another developed a wound dehiscence that was managed with debridement, prolonged antibiotic administration, and removal of the hardware 1 year later. In no case was pseudarthrosis demonstrated on dynamic radiography. Most patients received only a 6-week course of intravenous antibiotics postoperatively.

Conclusions. The authors conclude that single-stage debridement, arthrodesis, and internal fixation can be effective in the treatment of PDVO. A 6-week course of postoperative intravenous antibiotics may be sufficient in patients with few risk factors. The harvesting of iliac autograft through the same operative exposure may not increase the risk of secondary infection.

KEY WORDS • discitis • pyogenic vertebral osteomyelitis • arthrodesis • instrumentation

The incidence of PDVO represents only 2 to 4% of all cases of bone infection and 8 to 16% of cases of hematogenously spread osteomyelitis. Whereas an epidural abscess is found in 5 to 18% of patients with PDVO, more than one third of PDVO cases are associated with epidural abscesses. Most patients with PDVO, even those with associated epidural abscesses, can be successfully treated with intravenous antibiotic medication, bedrest, and external immobilization; however, a small subset of patients will develop progressive biomechanical instability-related pain despite provision of nonoperative management. Complications of nonoperative management include spinal instability, progressive kyphotic deformity, chronic pain, neurological compromise, abscess formation, and death.

Surgical debridement has been recommended for patients who develop nonoperative-related complications. Because the infection involves the disc space and subjacent VBs, anterior debridement has been recommended. Not only are the posterior bone and ligamentous structures usually unaffected, but they are essential in maintaining biomechanical stability. Although laminectomy may not always result in neurological dysfunction, several surgeons have described neurological deterioration after decompressive laminectomy in patients with PDVO. Because anterior debridement may further alter spinal stability, anterior grafting combined with posterior stabilization has been recommended.

Significant concerns have been raised regarding the placement of instrumentation when an infection is present. Because wound healing and tissue adherence may be impaired in the presence of internal hardware in an infected space, postfixation management of infections has often included debridement and removal of the hardware. Early implant removal, however, may increase the risk of pseudarthrosis, thereby contributing to the perpetuation
of infection. Some surgeons have recommended that anterolateral debridement be performed and that the patient then undergo postoperative external immobilization. Others have suggested that internal hardware can be left in place if debridement is performed and prolonged intravenous antibiotics are given. Moreover, methods that may offer additional benefit include antibiotic-impregnated methylmethacrylate and continuous suction–irrigation systems. However, the efficacy of combined single-stage debridement, arthrodesis, and placement of internal hardware in the setting of PDVO is uncertain. In fact, many surgeons have treated patients in whom medical management failed by performing debridement that is followed several weeks later by internal fixation.

The purpose of this study was to determine the efficacy of combining single-stage VB and intervertebral disc debridement, arthrodesis in which autologous iliac autograft is used, and segmental internal fixation in patients in whom nonoperative management of PDVO failed. Other hypotheses investigated included the efficacy of a 6-week postoperative course of intravenous antibiotics alone in patients with few risk factors, the safety of obtaining graft material via the same operative exposure, and the effect of discontinuing postoperative intravenous antibiotics in patients treated with bacteria-specific antibiotics for 6 weeks.

Clinical Material and Methods

Patient Population

Between July 1996 and September 1999, 17 consecutive patients in whom the disease had either progressed to cause instability before the initiation of other treatment or in whom medical management had failed were treated for PDVO. The office and hospital medical records as well as the radiographs were reviewed, and demographic data were recorded. In all patients preoperative plain radiography, computerized tomography, and MR imaging studies had been obtained.

Risk Factors

The demographic data are summarized in Table 1. Diabetes mellitus, intravenous drug abuse, steroid agent use, and/or immunosuppression were risk factors identified in all but four patients. In four patients more than one risk factor was present. Four had previously undergone laminectomy and/or discectomy, and one patient received intradiscal injections of steroids. In two patients in whom no risk factors were demonstrated, other initial sites of infection were identified: one had pharyngitis complicated by endocarditis and the other had a cutaneous cellulitis. Six others had undergone laminectomy for debridement of PDVO performed by other surgeons.

Signs and Symptoms

All patients suffered pain and 13 had weakness attributable to the location of their infection. In one patient PDVO and epidural abscess caused acute thoracic-related paraplegia, whereas another developed severe lumbosacral nerve root dysfunction secondary to high-grade lumbosacral spondylolisthesis. One patient suffered paraplegia caused by a traumatic thoracic injury 28 years earlier. Two patients could not ambulate because of weakness and pain. Mean preoperative laboratory parameters for all patients are summarized in Table 2.

Antibiotic Therapies

Staphylococcal infections were found in 14 patients, and in one patient with a renal transplant a Klebsiella infection was present (Fig. 1). In two patients who had already undergone a 6-week course of intravenous antibiotic therapy, a diagnosis of PDVO was made by histopathological analysis. Patients were classified according to the duration of antibiotic therapy as follows:

<table>
<thead>
<tr>
<th>Antibiotic Therapy Duration</th>
<th>Preoperative Management</th>
<th>Postoperative Management</th>
<th>Surgery</th>
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<tr>
<td>Subacute</td>
<td>IV</td>
<td>IV/PO</td>
<td>TP</td>
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<tr>
<td>Acute</td>
<td>IV</td>
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</table>

*Risk factors were: intravenous drug abuse, DM, steroid use, and immunocompromise. Abbreviations: AC = anterior cervical; assist = assisted ambulation; bed = bedridden; indep = independent ambulation; LEC = lateral extracavitary approach; plegia = paraplegia; PLIF = posterior lumbar interbody fusion; post = midline posterior; TP = transpedicular.

**TABLE 1**

Summary of clinical data obtained in patients with PVDO*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs)</th>
<th>Sex</th>
<th>No. of Risk Factors</th>
<th>Preop Antibiotic Duration</th>
<th>Stage of PVDO</th>
<th>Symptom Duration (mos)</th>
<th>Gait</th>
<th>Postop</th>
<th>Surgery</th>
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<tr>
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<td>51, M</td>
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<td>none</td>
<td>acute</td>
<td>L1–2</td>
<td>3</td>
<td>assist</td>
<td>indep</td>
<td>LEC</td>
</tr>
<tr>
<td>2</td>
<td>49, F</td>
<td>none</td>
<td>none</td>
<td>acute</td>
<td>L3–4</td>
<td>6</td>
<td>bed</td>
<td>assist</td>
<td>LEC</td>
</tr>
<tr>
<td>3</td>
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<td>acute</td>
<td>C6–7</td>
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<td>indep</td>
<td>indep</td>
<td>AC</td>
</tr>
<tr>
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<td>L2–3</td>
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<td>indep</td>
<td>LEC</td>
</tr>
<tr>
<td>5</td>
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<td>6</td>
<td>plegia</td>
<td>plegia</td>
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<tr>
<td>6</td>
<td>49, M</td>
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<td>acute</td>
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<td>bed</td>
<td>indep</td>
<td>TP</td>
</tr>
<tr>
<td>7</td>
<td>78, F</td>
<td>7</td>
<td>wks IV over 4 mos</td>
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<td>L2–3</td>
<td>3</td>
<td>bed</td>
<td>indep</td>
<td>LEC</td>
</tr>
<tr>
<td>8</td>
<td>54, F</td>
<td>3</td>
<td>days IV/2 mos PO</td>
<td>subacute</td>
<td>L3–4</td>
<td>2</td>
<td>bed</td>
<td>indep</td>
<td>LEC</td>
</tr>
<tr>
<td>9</td>
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<td>subacute</td>
<td>L2–3</td>
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<td>bed</td>
<td>LEC</td>
<td>death</td>
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<td>subacute</td>
<td>T5–6</td>
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<td>indep</td>
<td>TP</td>
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<tr>
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<td>77, M</td>
<td>6</td>
<td>wks IV over 3 mos</td>
<td>subacute</td>
<td>C6–7</td>
<td>3</td>
<td>assist</td>
<td>indep</td>
<td>AC</td>
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<tr>
<td>12</td>
<td>80, F</td>
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<td>wks IV</td>
<td>subacute</td>
<td>T2–L1</td>
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<td>indep</td>
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<td>TP</td>
</tr>
<tr>
<td>13</td>
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<td>chronic</td>
<td>L2–3</td>
<td>9</td>
<td>indep</td>
<td>indep</td>
<td>LEC</td>
</tr>
<tr>
<td>14</td>
<td>44, F</td>
<td>2</td>
<td>3 mos IV</td>
<td>chronic</td>
<td>L3–4</td>
<td>7</td>
<td>bed</td>
<td>indep</td>
<td>TP</td>
</tr>
<tr>
<td>15</td>
<td>65, M</td>
<td>1</td>
<td>6 wks IV</td>
<td>chronic</td>
<td>L3–4</td>
<td>11</td>
<td>indep</td>
<td>Post</td>
<td>none</td>
</tr>
<tr>
<td>16</td>
<td>55, F</td>
<td>1</td>
<td>8 wks IV</td>
<td>chronic</td>
<td>T9–10</td>
<td>12</td>
<td>assist</td>
<td>TP</td>
<td>death</td>
</tr>
<tr>
<td>17</td>
<td>76, M</td>
<td>6</td>
<td>wks IV/2 mos PO</td>
<td>chronic</td>
<td>T9–10</td>
<td>12</td>
<td>assist</td>
<td>TP</td>
<td>death</td>
</tr>
</tbody>
</table>

*Risk factors were: intravenous drug abuse, DM, steroid use, and immunocompromise. Abbreviations: AC = anterior cervical; assist = assisted ambulation; bed = bedridden; indep = independent ambulation; LEC = lateral extracavitary approach; plegia = paraplegia; PLIF = posterior lumbar interbody fusion; post = midline posterior; TP = transpedicular.
Preoperative antibiotic therapy: six patients receiving antibiotics at the time of debridement suffered from acute PVDO (Fig. 2); six patients who received no more than 4 weeks of continuous preoperative intravenous antibiotics suffered subacute PVDO; and five patients suffered chronic PVDO after undergoing at least a 6-week course of continuous intravenous antibiotic therapy before debridement. Surgical treatment was performed for spinal deformity (Fig. 3) and instability in 15 patients and for epidural abscess formation–related neurological deterioration in two.

Results

All patients underwent single-stage and -approach debridement with arthrodesis, in which autologous iliac crest graft placement and segmental internal fixation were performed (Table 1). In all but one patient (Case 16) a structural interbody iliac autograft was placed. Graft material was harvested through the same single exposure site in seven of 12 patients with lumbar PVDO. The extent of segmental fixation ranged from four to nine vertebral levels (median five levels). Patients in whom thoracolumbar surgery was performed were immobilized for 2 months in a rigid external orthosis, whereas those in whom cervical surgery was conducted were immobilized for 3 months in a halo vest, including one in whom rigid cervical collar therapy failed due to noncompliance.

Postoperative Antibiotic Therapy

All but two patients with acute PVDO received only a 6-week course of intravenous antibiotics: one received an additional 6 weeks of oral antibiotics on the advice of his internist, and the other underwent only 4 weeks of therapy because pancytopenia developed. Five of the six patients (one died) with subacute PVDO received a 6-week course of intravenous antibiotics. Two patients additionally underwent between 3 and 6 months of oral antibiotic therapy; in both significant risk factors for persistent infection were present. Levels of CRP in patients with acute or subacute PVDO normalized within 3 months of surgery. Finally, two of the four patients (one died) with chronic PDVO received no postoperative antibiotics, and one patient with a postoperative superficial cellulitis received only 2 weeks of intravenous antibiotics. In the fourth patient (Case 14) with chronic PDVO there were two risk factors for infection; she developed the only wound dehiscence in the series 3 months postoperatively and received intermittent intravenous and oral antibiotics for 1 year beyond the initial 6-week postoperative course.

Incidence of Mortality

An 85-year-old man (Case 9) with a history of DM, hypertension, and prior myocardial infarction died 1 week postoperatively of multisystem organ failure that including deep venous thrombosis and aspiration pneumonia. A 76-year-old man (Case 17) with DM and hypertension and in whom previous coronary artery bypass surgery had been performed died 1 day postfixation of dysrhythmia and myocardial infarction.

Treatment-Related Morbidity

Morbidity included one case of transient quadriceps weakness that gradually resolved. One patient devel-
oped asymptomatic pancytopenia during the 4th week of a course of intravenous vancomycin; after discontinuation of the antibiotic, his cell counts normalized. One patient with immunosuppression who had been an intravenous drug abuser developed a paraspinal abscess and new cervical region PDVO 17 and 28 months after thoracolumbar surgery, respectively. His thoracolumbar instrumentation (Fig. 4) was removed and a solid fusion was found, and no infection was demonstrated around the implants. In one elderly patient, who refused to wear a rigid cervical collar after undergoing anterior cervical fixation for a two-level corpectomy, a fracture of the caudally instrumented VB developed 6 weeks postoperatively. He underwent reexploration for plate removal. The graft was firmly in place, and examination of intraoperatively obtained cultures showed no growth. Successful fusion was achieved after he underwent additional posterior fixation and halo vest immobilization. One patient with hepatitis and a history of chronic alcohol abuse developed a late-onset superficial drain-site infection, which resolved with administration of intravenous antibiotics. His erythrocyte sedimentation rate and CRP level were not elevated, and dynamic radiography revealed a stable fusion mass. Finally, one patient with a history of DM and intravenous drug abuse developed wound drainage 3 months postoperatively. An incision was made, the wound was drained, and local wound care was applied; she underwent a prolonged course of intravenous and oral antibiotic therapy for a new vancomycin-resistant Enterococcus. Granulation tissue slowly covered the exposed hardware; she underwent removal of the hardware and subsequent wound closure nearly 1 year postoperatively.

Fourteen patients ambulated postoperatively; only three required an assistive device. One patient with acute thoracic spine–related paraplegia became ambulatory with an assistive device, and another with thoracic spine–related paraplegia secondary to a prior traumatic event remained paraplegic. All patients experienced substantial pain relief and no longer required medication for pain control. Dynamic radiographs were obtained in all patients 3 and 6 months postoperatively; none demonstrated movement and all shared that the anterior graft had fused with the adjacent VBs.

**Discussion**

The diagnosis of PVDO is often delayed because of the paucity of systemic signs of illness; most patients only describe severe axial skeletal pain. The duration of symptoms before diagnosis is greater than 3 months in
two thirds of patients. Most patients have predisposing risk factors including intravenous drug abuse, DM, rheumatoid arthritis, or immunosuppression due to steroid use, organ transplantation, or infection with human immunodeficiency virus. Although the overall incidence of PVDO has been declining, treatment delay may result in sufficient tissue destruction to cause spinal instability. Despite appropriate intravenous antibiotic medications and immobilization techniques, a small group of patients will continue to develop worsening pain and progressive spinal deformity.

Prior to the late 1950s the pathogenesis of PVDO was thought to be a retrograde dissemination of a pelvic infection by route of the abdominal–pelvic venous plexus. Increased abdominal pressure was believed to produce retrograde flow into the epidural venous plexus. However, Wiley and Truep demonstrated that the segmental arterial supply of the spine included the disc space and adjacent VB halves, which represents the observed anatomical involvement in PDVO. Two factors predisposing the intervertebral disc to indolent infection include its relative avascularity in adulthood and trapping of hematogenously spread bacterial emboli in arteries within the bone trabeculae that exit after a sharp 180° turn.

Because there has been an observed 2 to 9% increased risk of infection after placement of spinal instrumentation, many surgeons have treated patients with PDVO in two stages; internal fixation devices were placed several weeks after debridement and initiation of intravenous antibiotic medication. However, successful management of postoperative wound infections after debridement, spinal fixation, and primary closure suggests that a single-stage treatment may also succeed.

In 1979, Fountain described a single-stage debridement and fixation procedure for the treatment of L4–5 Staphylococcal PDVO. Although the sacral hooks dislodged 8 months after surgery, exploration during hardware removal at 12 months demonstrated that successful fusion had been attained. Since that publication, the authors of eight additional reports have described 89 patients (Table 3) treated with single-stage debridement and fixation for PDVO. A mortality rate of 7.5% was demonstrated in 106 cases (total number of patients including our 17). All deaths were unrelated to the infection but rather reflect the compromised nature of the patients being treated. Instrumentation displacements occurred in 6.6%, and superficial infections occurred in 2.8%. A similar incidence of postoperative infections has been described previously in patients undergoing placement of spinal instrumentation for reasons other than infection. Various grafting techniques were used including fibular autograft, fibular allograft, and antibiotic-impregnated methylmethacrylate, one of which was associated with a late infection recurrence. Despite inclusion of some patients with short follow up, it has been suggested that delayed-onset wound infections do not occur beyond 4 to 8 months after surgery.

A review of reports in which different techniques and antibiotic therapy durations are used has significant limitations. We have suggested a classification scheme that may...

Fig. 4. Anteroposterior (left) and lateral (right) radiographs obtained 1 year after a single-incision lateral extracavitary approach for L1–2 debridement, interbody fusion with iliac autograft, and posterolateral T11–L4 arthrodesis for acute Staphylococcal PDVO; note that fusion has occurred across the interspace.
standardize the postoperative antibiotic management of patients undergoing single-stage debridement, arthrodesis, and internal fixation for PDVO. Although treatments varied because of differences in the primary care physician’s desired management, successful arthrodesis without wound-related complications was observed in most patients with acute PDVO; this was demonstrated after only 6 weeks of intravenous bacteriospecific antibiotics and without subsequent oral suppressive therapy. Moreover, no relapse occurred in the two patients receiving intravenous antibiotics for fewer than 4 weeks. Although patients with incompletely treated subacute PDVO may be managed similarly, other risk factors, including DM and immunosuppression in a renal transplant patient and DM in another patient, prompted the provision of additional oral antibiotics for 3 to 6 months. However, in both patients CRP normalized within 3 months of surgical treatment. Finally, two patients with chronic PDVO received no postoperative antibiotics, whereas the third patient received only a 2-week course of antibiotics to treat cellulitis. All three received at least a 6-week course of preoperative antibiotics, and a normalized erythrocyte sedimentation rate was demonstrated before surgery. Only one patient developed a deep wound infection at 3 months postoperatively despite having undergone 3 months of preoperative antibiotic therapy; a new bacterium was identified on cultures. The risk factors present in this patient were intravenous drug abuse, DM, and the use of iliac bolts to treat severe lumbosacral spondylolisthesis, which may have contributed to wound breakdown.

This study shares the limitations of the retrospective nature and small patient population seen in comparable reports. However, the cumulative experience from 10 studies describing 106 patients supports the hypothesis that single-stage debridement, arthrodesis, and internal fixation can successfully treat PDVO and result in reasonable morbidity and mortality rates, considering the patients’ ages and comorbid medical conditions frequently observed. Our study additionally provides a framework for standardizing the postoperative duration of intravenous antibiotics, which depends on the preoperative duration already administered. Moreover, use of the lateral extracavitary approach and iliac graft harvesting through the same incision did not seem to predispose patients to secondary infection. Although a prospective study is important to test this management scheme, a multicenter cooperative effort would be necessary to accumulate a sufficient number of cases from which to draw meaningful conclusions.

Conclusions

Pyogenic discitis and vertebral osteomyelitis represent an infrequent infection that is often successfully treated with intravenous antibiotic medications and immobilization. Delays in diagnosis and certain risk factors may contribute to the failure of medical management in a small subgroup of patients who develop progressive pain and spinal instability. Single-stage debridement, arthrodesis, and internal fixation can be successfully used in the treatment of PDVO without excessive surgery-related complications. Six uninterrupted weeks of bacteria-specific intravenous antibiotics may be sufficient to eliminate the risk of postoperative infection recurrence in patients with few risk factors, even if already given preoperatively.

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References


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**Table 2**

Mean preoperative parameters obtained in 17 patients*

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<thead>
<tr>
<th>Laboratory Parameter</th>
<th>Stage of PDVO</th>
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<tr>
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<tr>
<td>WBC (10^3/ml)</td>
<td>8.2</td>
</tr>
<tr>
<td>ESR (mm/hr)</td>
<td>53</td>
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<tr>
<td>CRP (mg/dl)</td>
<td>3.4</td>
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</table>

* WBC = leukocyte count; ESR = erythrocyte sedimentation rate.

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**Table 3**

Summary of 10 clinical series of patients with PDVO who underwent single-stage procedures

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>No. of Patients</th>
<th>Average Age (yrs)</th>
<th>Antibiotic Duration (wks)</th>
<th>Follow Up (mos)</th>
<th>Deaths</th>
<th>Wound Infection</th>
<th>Acute</th>
<th>Subacute/Chronic</th>
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<td>Fountain, 1979</td>
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<td>10</td>
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<td>1</td>
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<td>Graziano &amp; Sidhu, 1993</td>
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<td>29</td>
<td>8</td>
<td>7</td>
<td>13</td>
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