One-stage Total Joint Arthroplasty for Patients With Active Tuberculosis

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Total joint arthroplasty is the most effective surgical solution for the treatment of end-stage pathological joint conditions. One of the most devastating complications of total joint arthroplasty is periprosthetic infection. Therefore, an infected joint is the absolute contraindication for this surgery. Recently, several clinical reports have introduced 1-stage total joint arthroplasty for the treatment of active tuberculosis of the hip or knee joint. Tuberculosis is an infectious disease found in 2% to 5% of all tubercular lesions in the body. The spine is the most common site of bone involvement, followed by the hip and knee joints. With the use of total joint arthroplasty, joint tuberculosis in the quiescent stage has been successfully treated. Patients with quiescent-stage hip or knee tuberculosis who undergo total joint replacement could regain a pain-free, good range of motion and a stable artificial joint with little risk of reactivation of the tuberculosis.

However, the use of total joint arthroplasty to treat active joint tuberculosis remains controversial. Here, the definition of active joint tuberculosis means that the involved joint has typical clinical symptoms of persistent pain and loss of range of motion along with the involvement of other organs. Laboratory tests, including erythrocyte sedimentation rate and C-reactive protein, are abnormal. In addition, radiographs and magnetic resonance imaging show the typical destructive changes with abscess formation. Patients could receive a diagnosis of tuberculosis through a positive culture of Mycobacterium tuberculosis or the biopsy or pathological examination of typical tuberculosis nodularis.

Most issues for patients with active joint tuberculosis arise if they do not receive anti-tuberculosis therapy before arthroplastic surgery. Traditionally, the surgical treatment for active joint tuberculosis includes debridement, arthrodesis, and resection arthroplasty combined with a period of anti-tuberculosis therapy. However, joint function and resultant lifestyle will have dramatic effects on these patients. After debridement of hip joint, patient will experience the painful hip with decreased ROM because of the joint cartilage damage. Arthrodesis will give patient a pain-free hip joint, but ankylosed hip could cause inconvenience of daily life, especially for women patients. The clinical outcomes of 1-stage total joint arthroplasty for the treatment of active hip and knee joint tuberculosis infection have been explored. Current published studies for this clinical research analysis all had a minimum of 4 patients (Table).

Su et al reviewed 15 patients (16 knees) who underwent 1-stage joint arthroplasty to treat active and quiescent-stage knee joint tuberculosis. Patients were divided into 2 groups: those in group A (8 knees) were diagnosed with tuberculosis and preoperatively received 2 to 20 months of anti-tuberculosis therapy, and those in group B (8 knees) were not diagnosed with tuberculosis preoperatively so they did not receive preoperative anti-tuberculosis therapy. Patients in both groups received 12 months of anti-tuberculosis therapy postoperatively. In group A, only 1 knee had tuberculosis reactivation because of corticosteroid use for rheumatoid control. However, in group B, 4 of 8 knees showed reactivation: 3 were conservatively controlled by prolonged anti-tuberculosis therapy alone without prosthesis removal.

Yoon et al reported 7 patients who had active hip tuberculosis with hip abscess but without sinus drainage that were successfully treated by cementless total hip arthroplasty with thorough debridement and anti-tuberculosis therapy for 12 months postoperatively. At a mean follow-up of 4.8 years, patients showed excellent hip joint performance without any reactivation. However, the authors did not mention whether patients had received anti-tuberculosis therapy preoperatively.
Sidhu et al\textsuperscript{8} reported 23 patients, the majority of whom were diagnosed with active hip tuberculosis on a clinicoradiological basis, with confirmation obtained from histopathological examination and polymerase chain reaction with tissue samples taken intraoperatively. All patients received anti-tuberculosis therapy 3 months pre- and 18 months postoperatively. Cemented total hip arthroplasty was used for all patients. At an average follow-up of 4.7 years, clinical outcomes were satisfactory without any reactivation.\textsuperscript{8}

So, why is 1-stage total joint replacement able to treat patients with active joint tuberculosis? First, the distinctive biological characteristic of \textit{M tuberculosis} shows that this bacterium divides every 15 to 20 hours, which is extremely slow compared with other bacteria (such as \textit{Staphylococcus aureus}, which has a division time of approximately 20 minutes). Second, periprosthetic infections are mainly caused by common biofilm-forming bacterial pathogens. \textit{Mycobacterium tuberculosis} has biologically specific behavioral characteristics that differ from pyogenic bacteria.\textsuperscript{13} Comparing the adherence and biofilm properties of \textit{M tuberculosis} and \textit{S epidermidis}, Ha et al\textsuperscript{14} confirmed that \textit{M tuberculosis} rarely adheres to the metal surfaces and has little or no biofilm formation. In another study examining the adhesive ability of \textit{M tuberculosis} on the surface of different joint prostheses materials, Ma et al\textsuperscript{15} found no biofilm formation for \textit{M tuberculosis} on the surface of cobalt-chromium-molybdenum alloy or titanium alloy. Third, metal implants have been used for patients with spinal tuberculosis and have had good results with no reactivation.\textsuperscript{16,17} These 3 reasons could become the fundamental considerations to ensure the feasibility of 1-stage joint arthroplasty surgery for the treatment of active joint tuberculosis.

If 1-stage joint arthroplasty is chosen to treat active joint tuberculosis infections, perioperative anti-tuberculosis therapy is crucial. The current recommendation for the treatment of osteotuberculosis includes the combination of isoniazid, rifampin, ethambutol, and pyrazinamide. This drug regimen should begin at least 2 weeks preoperatively to ensure that the inflammatory markers (eg, erythrocyte sedimentation rate and C-reactive protein) show a positive reaction. The anti-tuberculosis therapy should be continued for a minimum of 12 months and up to 15 months postoperatively for certain situations, such as reaction postoperatively\textsuperscript{10} or sinus drainage preoperatively.\textsuperscript{8} Consultation with an infectious disease specialist is also recommended due to the possibility of drug resistance and patient’s individualized conditions.

Thoroughly debriding and completely curetting inflamed soft tissues and the necrotic bone at the time of operation is another crucial step to guarantee the success of surgery. Local radiographs, magnetic resonance imaging, computed tomography scans, and ultrasound examinations will provide detailed informations of the involved area. Careful evaluation of obtained imaging information could help surgeons decide the debridement and excision area, to choose the proper prosthesis, and to pay attention to the existence of extended abscess or gravitation abscess.

Most authors suggest that patients with sinus drainage are not good candidates for 1-stage joint arthroplasty.\textsuperscript{2,18,20} The presence of sinus drainage usually indicates pyogenic superinfections.

### Table

**Data Summary**

<table>
<thead>
<tr>
<th>Study</th>
<th>Joint</th>
<th>No. of Patients</th>
<th>Abnormal ESR &amp; CRP</th>
<th>Histologic Confirmation</th>
<th>No. of Sinus Drainage</th>
<th>ATT Duration</th>
<th>Prosthesis</th>
<th>Postop ATT, mo</th>
<th>Mean FU Duration</th>
<th>Reactivation</th>
</tr>
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<tbody>
<tr>
<td>Su et al\textsuperscript{6}</td>
<td>Knee</td>
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<td>13</td>
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<tr>
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<td>0</td>
<td>N/A</td>
<td>CL</td>
<td>4.8 y</td>
<td>0</td>
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<tr>
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<td>23</td>
<td>Yes</td>
<td>0</td>
<td>3 m</td>
<td>C</td>
<td>4.7 y</td>
<td>0</td>
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<tr>
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<td>9</td>
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<td>7 p:0; 2 p:2 wk</td>
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<td>5.6 y</td>
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<td>Neogi et al\textsuperscript{10}</td>
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<td>12</td>
<td>N/A</td>
<td>Yes</td>
<td>1</td>
<td>10 p:0; 2 p:4-8 wk</td>
<td>CL:10; C:2</td>
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<td>2</td>
<td>&gt;2 wk</td>
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<td>CL</td>
<td>46 m</td>
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</table>

Abbreviations: ATT, anti-tuberculosis therapy; C, cemented prosthesis; CL, cementless prosthesis; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; FU, follow-up; N/A, not available; Postop, postoperative; p, patients.
from S aureus or other pathogens. Neogi et al\textsuperscript{10} reported 1 patient with preoperative sinus drainage who had tuberculosis reactivation 4 months postoperatively. This patient was noncompliant with anti-tuberculosis therapy and had a superinfection with S aureus.\textsuperscript{10} Wang et al\textsuperscript{11} reported 2 patients with preoperative sinus drainage; under careful surgical debridement and regular anti-tuberculosis therapy treatment, no tuberculosis reactivation occurred. Therefore, for patients with sinus drainage, total resection of the sinus with efficient anti-tuberculosis therapy is essential for obtaining a good outcome. If the drained sinus cannot be completely excised or if superinfections from pyogenic pathogens occurred preoperatively, 2-stage total joint arthroplasty is recommended to avoid a high risk of reactivation.

If the patient receives efficient perioperative anti-tuberculosis therapy treatment and thorough debridement, the choice of either a cemented or cementless prosthesis is not a critical factor for the clinical outcome. Both cemented and cementless total hip arthroplasty have excellent short- and mid-term follow-up results. However, long-term follow-up studies are still needed to prove this conclusion.

Various degrees of bone defect can be problematic after thorough debridement in the bone bed. Knowledge gained from spinal tuberculosis surgeries indicated that fresh frozen allograft with internal instrumentations is a safe and efficient procedure for curing and stabilizing the destroyed spinal column.\textsuperscript{17} Neogi et al\textsuperscript{10} also used morselized allograft to fill the acetabular bone defects. He also used iliac crest autograft to fill small cavities. Therefore, morselized autograft or iliac crest allograft will be the safe technique for bone defect intraoperatively.

The management of a reactivated infection or unsuspected active tuberculosis before joint arthroplasty is challenging. Efficient and prolonged anti-tuberculosis therapy alone\textsuperscript{6,21} or with thorough debridement\textsuperscript{22-24} has the ability to save the prosthesis. If these attempts fail, prosthesis removal with or without arthrodesis will be the only choice to control the infection. Surgeons must be aware of the possibility of tuberculosis infection if any periprosthetic infection with a negative culture appears.

With the addition of more successful clinical reports on 1-stage total joint arthroplasty for the treatment of active tuberculosis of the hip or knee joint, this treatment will be safe and efficient to cure active tuberculosis infections and save the joint function. The most important factors to achieve successful clinical outcomes include the accurate disease diagnosis, efficient pre- and postoperative anti-tuberculosis therapy, thorough debridement, and complete curetted inflamed soft tissues and the necrotic bone at the time of surgery.

**References**