Effectiveness of closed suction drainage tip culture in hip arthroplasty

Jai Hyung PARK1, Hyun-Chul SHON2, Ji Wan KIM3, Se-Jin PARK1, Taeg Su KO1, Jong-Hyon PARK1

1Sungkyunkwan University School of Medicine, Kangbuk Samsung Hospital, Department of Orthopedic Surgery, South Korea
2Chungbuk National University Hospital, Department of Orthopedic Surgery, South Korea
3Inje University Haeundae Paik Hospital, Department of Orthopedic Surgery, South Korea

Objective: The aim of the present study was to investigate the correlation between bacterial growth in closed suction drainage tip culture and periprosthetic joint infection (PJI).

Methods: Retrospective review included 256 patients who had undergone hip arthroplasty in which the closed suction drainage tip was cultured. Follow-up periods were longer than a year. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated in order to determine the significance of closed suction drainage tip culture in early diagnosis of infection. Patients with positive culture test were monitored to determine the effect of change in antibiotics on treatment of early infection.

Results: Eight of the 13 infections showed positive results from closed suction drainage tip culture. Eleven of the 243 non-infectious cases showed positive results after closed suction drainage tip culture (p<0.001). Sensitivity of closed suction drainage tip culture was 61.5%, with a specificity of 95.5%. Positive and negative predictive values were 42.1% and 97.9%, respectively. Systemic antibiotics were administered according to in vitro sensitivity of bacteria cultured from closed suction drainage tip in 13 of 19 positive culture cases. No statistically significant difference in infection risk was observed between the antibiotics group and the group to which antibiotics were not administered (p=0.51).

Conclusion: Closed suction drainage tip culture can aid in the early detection of infection.

Keywords: Closed suction drainage tip culture; hip arthroplasty; hip joint; periprosthetic joint infection.

Level of Evidence: Level III, Diagnostic study.

The number of cases of hip arthroplasty has increased among the aging population. Periprosthetic joint infection (PJI) can cause chronic pain, limitation of motion, bacteremia, and social burden. Postoperative infection rates after hip arthroplasty approached 1% in previous reports, and only 22% of infected prosthetic joints recovered function when treated. Treatment result is highly improved if irrigation and debridement is administered at an early stage. PJI is generally diagnosed by recognition of physical symptoms such as heat sensation and redness of wound site, or through laboratory findings including white blood cell count, erythrocyte sedimentation rate, and C-reactive protein. Culturing the closed suction drainage tip can provide additional
Most surgeons are advised by American Academy of Orthopaedic Surgeons guidelines, which strongly recommend use of intraoperative gram stain to rule out PJI. Culturing the closed suction drainage tip can similarly provide additional means of diagnosis. Controversy persists regarding correlation between wound infection and bacterial growth from closed suction drainage tip culture. In spite of this controversy, closed suction drainage is sometimes used in arthroplasty, and drainage tips are often cultured for early detection of infection. Correlation between PJI and closed suction drainage tip culture was investigated in the present study.

Patients and methods
A retrospective review was performed for all patients who had undergone hip arthroplasty between March 2004 and February 2012. The review identified 256 cases in which closed suction drainage tip was cultured and follow-up periods were longer than a year. Included were 87 male and 169 female patients with a mean age of 68.6 and 80.4, respectively. The most common indication for hip arthroplasty was femoral neck fracture. Types of arthroplasty performed included 183 bipolar hemiarthroplasties, 65 total hip arthroplasties (THAs), and 10 revisional THAs, all of which were performed by a single surgeon (Table 1). All surgeries were performed under the same aseptic conditions, and all hip arthroplasties were performed by posterior approach. Surgeries were performed under a laminar air flow system to as great an extent as possible in order to prevent infection. Antimicrobial film and double gloving were also used. Rivaroxaban (Xarelto; Bayer Healthcare AG, Leverkusen, Germany) was used for 4 weeks of postoperative period as an anticoagulant for deep vein thrombosis prophylaxis. Closed suction drainage was removed after clamping at 24 hours or when drainage was less than 100 ml. Before removal, surrounding skin was disinfected with 10% aqueous povidone-iodine ball. After removal, inner tip was held with aseptic forceps and aseptic scissors were used to cut inner part of tube more than 5 mm. Upon removal, drainage tips were sent for culture, where they were stored in screw-cap tubes under sterile conditions and cultured in blood agar, MacConkey agar, and thioglycollate medium for 48 hours. Second-generation cephalosporins were used as prophylactic antibiotics, administered an hour prior to surgery and continued for 3 days. Infections that occurred within 3 months of surgery were considered to be surgical infections, while infections occurring after this period were excluded, as they were most likely caused by external factors. Criteria for infection were purulent matter that exuded from the wound area spontaneously or by incision and serous discharge with growth of bacteria from the wound area during reoperation. Subcutaneous infections were classified as superficial, while infections occurring around the prosthesis were classified as deep. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated in order to determine significance of closed suction drainage tip culture in early diagnosis of infection. Sensitivity was calculated by the ratio of the number of cases with culture-positive results to the number of cases with early infection. Specificity was calculated by the ratio of the number of cases with culture-negative results to the number of cases without early infection. Positive predictive value was calculated by the ratio of the number of cases that showed positive results after culture test to the number of cases that showed early infection. Negative predictive value was calculated by the ratio of the number of cases without early infection to the number of cases without early infection. Statistical analyses were performed using Fisher’s exact test. P values less than 0.05 were considered significant, and SPSS version 18.0 (SPSS Inc., Chicago, IL, USA) was used for all statistics.

Results
Out of 256 cases, 19 closed suction drainage tip cultures were positive. Methicillin-resistant coagulase-negative
staphylococci (MRCNS) was the most common bacteria (14 cases), followed by Enterococcus faecalis. No case of anaerobic bacteria was observed. Three positive tissue cultures were confirmed in 6 cases of MRCNS infection at postoperative debridement. All Enterococcus faecalis and methicillin-resistant Staphylococcus aureus infections were confirmed in postoperative debridement tissue culture (Table 2). Among the 256 cases included, there were 13 cases of infection, all of which were classified as early and deep within 3 months of surgery. Eight tested positive and 5 tested negative on closed suction drainage tip culture test. Correlation between infection and closed suction drainage tip culture-positive results was statistically significant \((p<0.001; \text{Table 3})\). Sensitivity, specificity, positive predictive value, and negative predictive value were 61.5\%, 95.5\%, 42.1\%, and 97.9\%, respectively (Table 4).

Among the 19 patients with positive closed suction drainage tip culture, 8 early infections were classified as deep. After irrigation and debridement, identical bacteria were found in tissue culture and closed suction drainage tip culture in 5 patients. MRCNS was cultured in 3 patients (Table 5). Sensitive antibiotics, which took an average of 5 days to become available, were administered to patients with positive culture results. Systemic antibiotics were changed according to in vitro sensitivity of bacteria cultured from closed suction drainage tip in 13 of 19 patients, after which 5 patients still had infection. Six of the 19 were administered with no antibiotics, 3 of whom had infection. The difference in infection rate between the group with changes of antibiotics and the group with no antibiotics was not statistically significant \((p=0.51; \text{Table 6})\).
Table 6. Infections with positive drain tip cultures with regard to change in antibiotics.

<table>
<thead>
<tr>
<th>Antibiotics changes</th>
<th>Operation</th>
<th>Infection</th>
<th>Operation</th>
<th>Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>13</td>
<td>5</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>-</td>
<td></td>
<td></td>
<td>MRCNS: 3 cases</td>
<td>MRCNS: 3 cases</td>
</tr>
<tr>
<td></td>
<td>MRSA: 1 case</td>
<td>Enteroceccoliiae: 1 case</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comparison of risk of infection: p=0.51. MRCNS: Methicillin-resistant coagulase-negative staphylococci; MRSA: Methicillin-resistant Staphylococcus aureus.

Discussion

PJI can be a postoperative complication that leads to failed surgery. PJI can be caused by infection near the surgical site, hematoma after surgery, bacteremia, or pneumonia. Infectious episodes were defined as early, delayed, or late, depending on period and etiology. According to Zimmerli et al., infections occurring within 3 months of surgery are considered early and are usually caused by infection during surgery or wound infection. Infections occurring within 2 years of surgery are classified as delayed, and the likely cause is low-virulence bacteria. Infections occurring more than 2 years after surgery are defined as late and appear with either a sudden systemic inflammatory response syndrome or without initial signs of sepsis, but with a delayed course after clinically unrecognized bacteremia. The focus of the present study was early infection. Controversy persists regarding the use of drains. Closed suction drainage can prevent hematoma, which can be an ideal medium for bacterial colonization and postoperative infection. As a result, closed suction drainage lowers risk of infection after surgery and shortens healing time of soft tissues, decreasing pain and swelling in the operative field. However, Parker et al. reported through meta-analysis that closed suction drainage for hip and knee arthroplasty has no major benefit. In addition, Willemen et al. reported that maintenance of suction drain for longer periods resulted in increased risk of infection, concluding that suction drain should be removed at the earliest recommended time.

Whether closed suction drainage can be used as an early infection index has been debated. It has been unclear whether closed suction drainage tip culture is effective in hip arthroplasty. Some authors reported no correlation between results of positive drain tip culture and onset of PJI. Overgaard et al., Takada et al., Petsatodis et al., and Weinrauch reported that drain in THA was not prognostic of surgical site infection (SSI). 

Satodis et al. identified 8 positive cultures among 110 cases of THA, though no postoperative infection was recorded. Weinrauch identified 3 positive cultures among 145 cases of THA with no postoperative infection recorded. Overgaard et al., identified 5 positive cultures among 81 cases of THA with no postoperative infection recorded. Takada et al. identified 11 positive cultures among 1380 cases of THA. While cases of postoperative infection were not culture-positive, 4 cases of SSI occurred though drain tip cultures were negative. Due to the low likelihood of positive drain tip culture and SSI, some studies concluded that drain tip culture cannot be prognostic in determining SSI after THA.

However, Sankar et al. and Sørensen et al. reported significant correlations between positive drain tip culture and SSI in orthopedic surgeries. Sankar et al. identified 12 positive cultures among 214 cases of clean orthopedic surgeries, including 4 hip arthroplasties. Six of the 12 tip culture-positive wounds developed deep wound infection. In each of these infections, culture from the wound and suction tip yielded growth of the same bacterial species with similar antibiotic sensitivity. Suction tip cultures had sensitivity of 75%, specificity of 97%, positive predictive value of 50%, and negative predictive value of 99% in detecting wound infection. The association between incidence of suction tip culture positivity and incidence of wound infection was statistically significant. Sørensen et al. concluded that virulence of isolated bacteria influences the correlation between positive drain tip culture result and onset of SSI. Risk of infection was increased if Staphylococcus aureus, enterobacteriaceae, or Streptococcus faecalis were cultured from drain tips. A similar result was demonstrated in the present study, likely due to difficulties in distinguishing pathogenic from contaminant cultures. According to a previous report, the bacteria most frequently observed after arthroplasty were coagulase-negative staphylococci (CNS) and Staphylococcus aureus. CNS, commensal skin bacteria, are known as the most common cause of bacteremia related to indwelling devices. Bacterial species belonging to CNS are Staphylococcus epidermidis, Staphylococcus saprophyticus, Staphylococcus haemolyticus, Staphylococcus intermedius, Staphylococcus hyicus, etc. It has been reported that many deep infections are caused by Staphylococcus epidermidis after arthroplasty. According to James et al., 12 out of 18 epidermidis bacteria were MRCNS that had been collected from deep infection after hip arthroplasty. Skin swabs obtained from 100 consecutive patients at time of admission for THA revealed MRCNS in 25. Of the 19 positive closed suction drainage tip culture cases in the present study,
MRCNS was the most common in 14, 6 of which were deep. Sanderson et al. reported that in the context of increasing incidence of methicillin resistance in CNS, the use of antibiotic prophylaxis in total joint replacement surgery became more important. Therefore, positive drainage tip culture results must be taken seriously when considering the potential for early infection. Either close observation of the condition of the surgical site or other methods of early infection diagnosis are necessary.

There were limitations to the present study. First, there are significant differences among trauma patients undergoing hemiarthroplasty, primary THA, and revision THA, as a result of which there were significant differences among underlying risks of infection and chances of preexisting colonization. Second, routine culture of suction drain tip is expensive and may not be cost-effective. Third, patients with diabetes mellitus or rheumatoid arthritis were included in the present study, as were patients on steroids or other immunosuppressants, as well as those who had undergone revision operations. Infection risk among these patients varied. The focus of the present study was limited to the usefulness of closed suction tip culture rather than risk of infection.

Early diagnosis and prompt treatment of surgical site bacterial infection are important. Closed suction drainage is still widely used in orthopedic surgery despite the risk of infection, and closed suction drainage tip culture can aid in the early detection of infection.

Conflicts of Interest: No conflicts declared.

References
23. Willemen D, Paul J, White SH, Crook DW. Closed suc-