# Bacterial Colonization After Tunneling in 402 Perineural Catheters: A Prospective Study

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**BACKGROUND:** Bacterial colonization of peripheral nerve catheters is frequent, although infection is relatively rare. With central venous catheters, the tunneling of the catheter into the subcutaneous tissue significantly decreases catheter colonization and catheter-related sepsis. We evaluated the incidence of bacterial colonization in adult patients with tunnelized perineural nerve catheters.

**METHODS:** Peripheral nerve catheters placed under sterile conditions for postoperative analgesia were evaluated prospectively. After removal, they were analyzed for colonization. Quantitative culture was used as described by Brun-Buisson for intravascular catheters. The site of insertion was monitored daily for any signs of infection.

**RESULTS:** Four-hundred-two patients were included in the study during a 2-yr period. The mean duration of peripheral nerve catheters was 48 h (47–50.4). Positive culture occurred in 25 catheters, indicating that the incidence of colonization was 6.22% (3.8–8.5). The microbiological analysis of the catheter tip cultures revealed coagulase-negative staphylococci in 72%. Twenty-two catheters of 25 catheters each had one microorganism, and for three catheters, two microorganisms were identified. No infection was found in any patient.

**CONCLUSION:** The incidence of perineural catheter colonization is low with subcutaneous tunneling. Controlled randomized studies are warranted to determine whether this procedure decreases the risk for infection.

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Continuous peripheral nerve block is an effective and established technique for pain relief and rehabilitation after major orthopedic surgery.[1,2] However, several studies in which perineural catheter tips were cultured on removal report a high incidence of catheter tip colonization.[3,4] Cuvillon et al.[4] reported bacterial colonization in 57% of 208 femoral catheters with duration of 48 h after catheter placement, occurring mainly in asymptomatic patients. In a multicenter study, with approximately the same duration of catheter placement (56 h), Capdevila et al.[3] observed a positive culture in 28.7% of 969 catheters and a 0.07% incidence of infection. Even through the correlation between catheter colonization and infection has not been determined, the high incidence of colonization reported by these studies could indicate a risk factor for development of infection and adverse events.[3,4] Recently, in 2285 catheters, Neuburger et al.[5] found 3.2% of infection in a prospective study of continuous block for postoperative analgesia. Infection primarily originates from the skin-catheter junction and is presumably due to a similar mechanism as central venous catheter-related infection.[6] Since the use of tunnelized central venous catheters is also associated with a threefold decrease in catheter-related sepsis,[7] burying the perineural catheter in a subcutaneous tunnel may be effective in reducing the transfer of pathogens by increasing the distance between the skin-catheter junction and the nerve.[6] Several authors have described a safe and effective technique to fix the perineural catheter by making a subcutaneous tunnel using an IV catheter but did not specifically assess the incidence of catheter colonization.[8–11] The aim of this study was to determine the incidence of bacterial colonization and tunnelized peripheral nerve catheter-related infection.

## METHODS

After obtaining departmental review board approval and informed patient consent to perform this study, consecutive patients selected to undergo scheduled orthopedic surgery or emergency posttrauma surgery performed with a peripheral nerve catheter were prospectively included for 2 yr (from January 1, 2005 to December 31, 2006) in a single-center study. The exclusion criteria were as follows: age under 18 yr, previous damage to the nerve or plexus, preexisting peripheral neuropathy, refusal of regional anesthesia, major psychological disorder (psychotic disorders or

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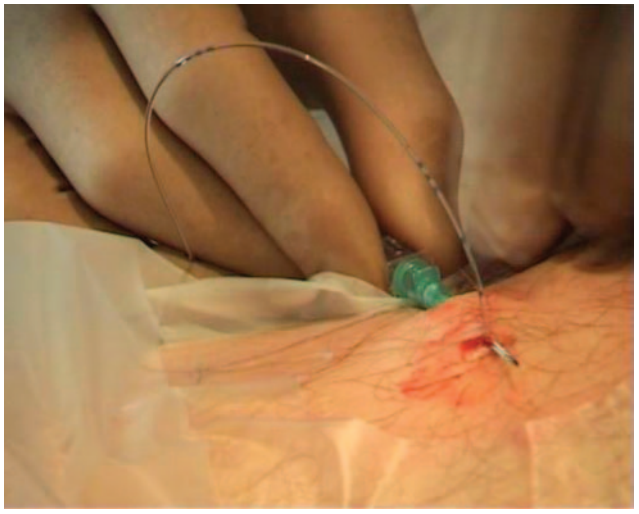

**Figure 1.** After skin infiltration with 3–4 mL lidocaine 1%, an 18-gauge IV cannula is inserted subcutaneously 3 cm laterally and advanced to exit 3–4 mm above the primary perineural catheter insertion point.

dementia pathology), major cardiac conduction disease (second- and third degree atrioventricular block) and history of recent (during the previous month) local or systemic infection. The data included patient demographics, surgery and the area of peripheral nerve catheters. The duration of catheter use and site localization were recorded.

Before surgery, the patient was orally premedicated with hydroxyzine 1.5 mg/kg and was monitored using a pulse oxymeter, electrocardiogram and non-invasive arterial blood pressure. Peripheral nerve catheters were placed by experienced anesthesiologists (5 catheters per week). The insertion site was prepared with alcohol-chlorhexidine (0.5% and 20%, respectively) and sterile drapes. After local skin anesthesia with 1% lidocaine, the catheter (Contiplex®D) was inserted under aseptic conditions (the anesthesiologist wore a cap, gown, facemask, and sterile gloves), using electrical stimulation (Stimultex® HNS 11). The placement of the needle was considered successful when stimulation of the nerve was obtained with a current output of $<0.5$ mA (frequency 1 Hz and impulse duration 100 $\mu$s). The cannula (an 18G insulating IV-style catheter) was 33, 55 or 110 mm in length. The catheter (standard 20-gauge catheter) was advanced 3 cm past the needletip and was tunneled subcutaneously and secured to the skin with a clear self-adhesive dressing without disinfectant. After skin infiltration with 3–4 mL lidocaine 1%, an 18-gauge IV cannula was inserted subcutaneously 3 cm laterally and advanced to exit 3–4 mm above the primary perineural catheter insertion point (Fig. 1). The proximal end of the catheter was threaded retrogradely through the IV catheter, before the latter was removed, so that the catheter was finally tunneled 2–3 cm subcutaneously. After a negative aspiration blood test, 20 mL of 0.475% (10 mL of 0.750% and 10 mL of 0.02%) ropivacaine was injected. Postoperative analgesia was administered using a catheter connected to an automated infusion pump (infusor Baxter®) administering 0.2% ropivacaine at a perfusion rate of 5, 7 or 10 mL/h. Single-injection perioperative antibiotic prophylaxis was administered after peripheral nerve catheter placement and before surgery (cefazoline, cefuroxime or vancomycine), except for total hip or total knee arthroplasty with a postoperative duration of routine antibiotic use of 48 h. A single dose was deemed adequate for prophylaxis against perioperative infection for the other orthopedic surgery.

Nurses assessed all peripheral nerve catheters three times daily and the site of catheter insertion was evaluated for signs of infection, defined as the presence of purulence and a temperature of more than 38.5 degrees. The timing of temperature measurements was standardized (every 8 h). In cases of signs of severe infection, ultrasonography or computed tomography were performed to search for any abscess depending on the extent of infection. Moreover, blood cultures were obtained for those patients with evidence of infection. In the other cases (presence of redness, swelling or pain on pressure at the peripheral nerve catheter insertion site), strict monitoring was performed (every 8 h).

The catheters were removed under aseptic conditions (the anesthesiologist wore a facemask and sterile gloves). To prevent bacterial contamination of catheter tips, the skin was disinfected with alcohol (0.5%)-chlorhexidine (20%) for 1 min. Only when the skin had dried completely was the catheter removed to avoid direct contact of the catheter tip with the antiseptic agent. The distal catheter tip was cut with sterile scissors, placed in a sterile transport medium and transferred immediately to the microbiology laboratory. Quantitative culture was used as described by Brun-Buisson et al.[12] for intravascular catheters. The catheter tip was placed in 1 mL saline 0.9%, the suspension was vortexed for 1 min, and 0.1 mL was put onto blood agar-coated Petri plates. Plates were incubated at 37°C under aerobic condition. All colony types were counted at 24, 48, and 72 h and identified by standard methods and criteria. Bacteria were identified by colony morphology, Gram stain characteristics, and one of the following techniques: the BD Phoenix Automated Microbiology System (Becton Dickinson Diagnostic Systems, Pont de Claix, France) or the manual API system (API-20E for enterobacteria, API-20NE for nonfermenting Gram-negative bacilli, API-32 Staph for *Staphylococcus spp*, and API-32 Strept for *Streptococcus* and *Enterococcus spp*) (BioMérieux, LA Balme les Grottes, France). The systems were inoculated as recommended by the manufacturers from an agar pure culture.

Perineural catheter colonization was defined as the growth of at least one microorganism on quantitative peripheral nerve catheters culture regardless of

the colony-forming unit count. Infection complications were subdivided into local inflammation and infection. Local inflammation was defined as the presence of redness, swelling or pain on pressure at the peripheral nerve catheters insertion site. Infection was defined as the presence of purulence and a temperature of higher than 38.5 degrees. All infection complications were documented in detail according to their severity, time course, and duration. Severe infection was defined by the presence of abscess. If any infection was found, the catheter was withdrawn immediately and sent to the laboratory for culture. An initial antibiotic therapy (vancomycin) was begun and was altered according to the culture results.

Descriptive analyses were performed using means for continuous variables and frequencies and percentages for categorical variables with calculation of 95% confidence intervals. The Kruskall and Wallis test was applied to determine statistical differences among values.

## RESULTS

Four-hundred-two patients were included in the study during a 2-yr period. Five anesthesiologists performed the six peripheral regional techniques. The patients were ASA physical status I-IV, aged 55 ± 17.5 yr and 34.6% were male. Twenty-nine of the 402 evaluated peripheral nerve catheters were placed in trauma patients (Table 1).

Positive culture occurred in 25 catheters, indicating an incidence of colonization of 6.22% (3.8–8.5). The microbiological analysis of the catheter tip cultures revealed coagulase-negative staphylococci in 72% (Table 2). Twenty-two of 25 catheters each had one microorganism and for three catheters, two microorganisms were found. The rate of colonization according to the localization of peripheral nerve catheter placement is summarized in Table 3. A subgroup analysis of the 29 trauma patients showed colonization rates higher for this group of patients (10% compared to 5.9% of elective surgery [$P$ value $<0.05$]). There was no difference in the incidence of colonization in the 82 patients who received prolonged antibiotic therapy compared to those who received a single dose of antibiotic (6.1% and 5.9%, respectively).

The mean duration of peripheral nerve catheter placement was 48 h (47–50.4). There was no correlation between the duration of catheter placement and colonization (Table 4). No infection was found in any patient.

**Table 1.** Type of Surgery

| | No. of peripheral nerve catheters |
|---|---|
| Foot arthrodesis | 53 (13.2%) |
| Shoulder rotator cuff repair | 17 (4.2%) |
| Knee ligament repair | 30 (7.5%) |
| Hallux valgus | 112 (27.8%) |
| Shoulder arthroplasty | 17 (4.2%) |
| Knee arthroplasty | 66 (16.4%) |
| Hip arthroplasty | 16 (4%) |
| Knee tumorectomy | 11 (2.7%) |
| Hip fracture | 8 (2%) |
| Others | 72 (18%) |

## DISCUSSION

In this prospective, noncontrolled study, subcutaneous perineural catheters were associated with a low incidence of colonization in 402 peripheral nerve catheters over a 2-yr period and no catheter-related infection was observed.

In comparison with other studies, a lower incidence of colonization was observed in the present study (6.22%). Cuvillon et al.[4] reported bacterial colonization in 57% of 208 femoral catheters with a duration of 48 h catheter placement, occurring mainly in asymptomatic patients. In a multicenter study, with approximately the same duration of catheter placement (56 h), Capdevila et al.[3] observed in 969 catheters a positive culture in 28.7% with 0.07% infection. These authors used a quantitative culture technique from previous reported series for central venous catheter[12] that had 97.5% sensitivity and 80% specificity. In contrast, Cuvillon et al. used a semi-quantitative technique as described by Maki et al.[13] This difference could explain the significant difference of incidence colonization observed between the two studies. In our study, subcutaneous tunneling of perineural catheters was associated with a low incidence of colonization, identified by the same technique as Capdevila et al. Moreover, no infection was observed. As described for central venous catheters, because infection and colonization mainly originates from the skin-catheter junction, particularly in catheters used for the short term, it has been suggested that burying the catheter in a

**Table 2.** Results of the Type of Microorganism Relative to the Type of Catheter

| | Interscalene | Infraclavicular | Fascia iliaca | Femoral | Popliteal |
|---|---|---|---|---|---|
| Coagulase-negative *Staphylococci* | 2 | 2 | 2 | 10 | 2 |
| *Acinetobacter* spp | 0 | 0 | 3 | 0 | 0 |
| *Pseudomonas* spp | 0 | 1 | 1 | 0 | 0 |
| *Enterococci* | 0 | 0 | 1 | 1 | 0 |
| *Escherichia coli* | 0 | 1 | 1 | 0 | 0 |
| *Corynebacterium* spp | 1 | 0 | 0 | 0 | 0 |
| *Proteus spp* | 0 | 0 | 0 | 1 | 0 |

**Table 3.** Incidence of Bacterial Colonization for the Different Peripheral Nerve Catheters

| | No. of peripheral nerve catheters N | Colonized peripheral nerve catheters *n* (%, [95% CI]) |
|---|---|---|
| Interscalene | 50 | 3 (6% [0–12]) |
| Infraclavicular | 12 | 3 (25% [0–50]) |
| Fascia iliaca | 33 | 3 (9.09% [0–19]) |
| Femoral | 120 | 14 (11.67% [5–17]) |
| Popliteal | 187 | 2 (1.07% [0–2]) |
| Total | 402 | 25 (6.22% [3.8–8.5]) |

No significant differences were noted between groups.

CI = confidence interval.

**Table 4.** Peripheral Nerve Catheters Duration Related to Colonization

| | No. of peripheral nerve catheters N | Colonized peripheral nerve catheters *n* (%, [95% CI]) |
|---|---|---|
| <24 h | 3 | 0 (0%) |
| 24–48 h | 70 | 2 (2.86% [0–6.8]) |
| 48–72 h | 260 | 14 (5.38% [2.6–8.1]) |
| >72 h | 69 | 9 (13% [4.8–21]) |

There were no significant differences between groups.

CI = confidence interval.

subcutaneous tunnel could reduce the transfer of pathogens by increasing the distance under the skin.

The catheter insertion site and duration of the catheter placement have been demonstrated to influence the bacterial colonization rate.[3] However, in our study, neither of these variables was significant, perhaps due to the smaller overall incidence of colonization and the number of overall patients included. Although *Staphylococcus aureus* is the most common causative organism cultured from epidural or central venous catheter-related sepsis, it was not the most common organism isolated from peripheral analgesic catheters and has been generally regarded as a pathogen of clinical significance. Similar to two studies focused on perineural catheter colonization,[5,14] we observed that the coagulase-negative *Staphylococci* were the most frequently isolated bacteria from catheters. Based on these studies, this organism was primarily found in femoral, interscalene and popliteal catheters. Moreover, Gram-negative bacilli were also found in femoral catheters. The predominance of coagulase-negative *Staphylococci* at the perineural catheter tip in the current study was not surprising. We speculate that this could represent colonization of the skin at the catheter insertion site and subsequent contamination of the catheter tip on removal of the catheter despite aseptic conditions. This hypothesis was supported by the study of Sato et al.[15] who showed that regardless of the antiseptic used, all protocols were insufficient against *Staphylococcus epidermidis* during the use of epidural catheters.

We used an antiseptic solution of alcoholic chlorhexidine, which has been consistently demonstrated as more effective against skin infection when compared with nonalcoholic solutions of povidone iodine that were used by Capdevila et al. or Cuvillon et al., or with alcoholic solutions used by Neuburger et al.[3–5] Chlorexidine acts to disrupt the cellular membranes of bacteria and is preferred for its long-lasting activity against Gram-positive and Gram-negative organisms found on human skin.[16] The reports in the current literature strongly suggest that chlorhexidine is more effective than other antiseptics for preoperative antisepsis for patients because this solution provides a prolonged reduction in skin contamination.[16,17] Moreover, compared with povidone iodine, in children, the use of chlorhexidine for cutaneous antisepsis before epidural catheter insertion reduces the risk of catheter colonization kept in place for a median duration of 50 h.[18] The difference between our results and other studies in the choice of antiseptic solution used before perineural catheter insertion may also have played a role in the low incidence of colonization observed in our catheters. In addition, the use of different solutions to disinfect the site of the puncture before removing the catheter could have, in part, reduced the rate of colonization of the catheter's tip passing through the skin during withdrawal. For example, chlorhexidine was more effective than povidone-iodine in reducing the incidence of blood culture contamination when this solution was used for skin preparation.[19]

Some results of our study deserve comment. The lack of blinding and the potential for bias must be considered. Moreover, the conclusions regarding the colonization and infection remain limited by the study design, which did not include comparison with an untunelled group. Therefore, we cannot determine if subcutaneous perineural catheter is involved in a lower frequency of colonization lower than that reported by Capdevila et al.[3]

In conclusion, the incidence of perineural catheter colonization with catheter tunneling is low and may be reduced by using this technique. Further controlled, randomized studies are warranted to determine whether this simple procedure, in fact, reduces the risk for colonization and infection.


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