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Influence of protective measures after epidural catheter disconnection on catheter lumen colonization: an *in vitro* study

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SUMMARY

Background: Epidural anaesthesia provides excellent pain therapy and reduces postoperative morbidity and mortality. Epidural haematoma and infection are catastrophic complications of this therapy. Following accidental catheter disconnection the choice is between reconnection and premature treatment termination. There is little experimental or clinical data guiding clinical decision-making after epidural catheter disconnection.
Aim: Investigation of the *in vitro* effects of clinically applied safety measures after epidural catheter disconnection.
Methods: The proximal 20 mm of epidural catheters were submerged into a suspension of 1×10^8 cfu *Staphylococcus epidermidis*. Catheters were treated by the following potentially preventive measures: (i) cutting 2 cm distal to the level of contamination, (ii) disinfection by spray–wipe, or (iii) employing ropivacaine 0.75% as flushing solution instead of normal saline. All measures were used alone, in a dual combination or all together as a triple intervention ($N = 10$ catheters in each group). Control catheters were not treated. After 24 h of culturing, bacterial growth of the eluates was recorded.
Findings: All control catheters showed positive cultures. All 49 eluates of catheters that were cut as a single, dual or triple intervention remained sterile. Disinfection prevented bacterial growth in eluate of only six catheters in single or dual interventions. Ropivacaine did not prevent any bacterial growth.
Conclusion: Only cutting of epidural catheters 20 mm distal to the level of contamination completely prevented bacterial growth. Disinfection might further reduce risk as an additive measure. This supports the clinical practice of catheter shortening and reconnection. The safe window of time and length of shortening needs to be further investigated.
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Introduction

The worldwide need for surgical treatment increases continuously.[1] Epidural anaesthesia and analgesia are frequently used as cornerstones in the perioperative management of major thoracic, abdominal and orthopaedic surgery.[2] Thoracic epidural anaesthesia has been shown to reduce

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perioperative morbidity and mortality.[3,4] Epidural analgesia requires transcutaneous puncture of the epidural space and placement of an epidural catheter, which is continuously perfused with local anaesthetics and/or opioids for up to several days. Complications of epidural anaesthesia are rare but potentially devastating for patients left with persistent neurological deficits.[2,5] Consequently, it is crucial to prevent neuraxial bleeding and infectious complications.

Infectious complications of epidural anaesthesia include spinal and epidural abscess formation and meningitis. Haematogenous spread and intrusion of pathogens at the site of insertion are considered to be the major sources of infection in epidural anaesthesia.

Epidural catheters are introduced under sterile conditions.[6] Epidural drug infusion systems are usually prepared in the hospital pharmacy and delivered in sterile packages.[7] Once connected the system is safe against bacterial contamination of the catheter lumen and the infusion. Disconnection of the epidural catheter and the epidural infusion system expose the interior catheter lumen to the environment and may trigger subsequent epidural infection by contaminated epidural infusion. Clinical decision-making in this situation is usually based on institutional guidelines and is mainly influenced by the duration of the disconnection.[8,9] Premature discontinuation of epidural analgesia, however, exposes the patients to all the risks of the technique without achieving the intended perioperative protection.

We conducted this *in vitro* investigation of epidural infusion contamination to evaluate the efficacy of frequently used preventive clinical measures after disconnection of epidural catheters.

Methods

Bacteria and culture

Staphylococcus epidermidis (ATCC 14990/DSM20044) were cultured in trypticase soy yeast extract medium at 37 °C. A bacterial suspension with 1×10^8 colony forming units (cfu) in 5% brain–heart infusion was created by turbidimetric measurement in a dilution series.

Epidural catheters and contamination model

All experiments were performed at a room temperature of 24 °C and 45% humidity. 18-gauge closed-end multiport epidural catheters (Portex® Epidural Minipac CN004/052/515, Smith Medical Germany, Grasbrunn, Germany) were used. The proximal tip – connected to the luer connector and the bacterial filter in clinical use – was vertically submerged to a depth of 2 cm into the bacterial suspension. The contamination of the inner catheter was strictly passive by capillary motion. After the bacterial suspension had stopped rising in the catheter this position was kept for 1 min. Then the catheter was removed and fluid was allowed to drip back into the suspension and the catheter was placed on a sterile surface. After 5 min the contaminated parts of the catheters were treated with the preventive interventions described below and connected to an epidural catheter connector (Perifix catheter connector, Braun, Melsungen, Germany). The distal end – the epidural end in clinical use – remained untouched in the sterile package until that time. Then it was placed over a sterile container prefilled with 5 mL dextrose broth. The catheters were flushed with either 3 mL 0.9% saline solution or ropivacaine 0.75%. The eluate was collected from the distal end in the dextrose broth. One millilitre of the broth/eluate mix was incubated on Columbia blood agar at 37 °C. After 24 h the incubated agar plates were non-quantitatively assessed for presence or absence of bacterial growth (Figure 1).

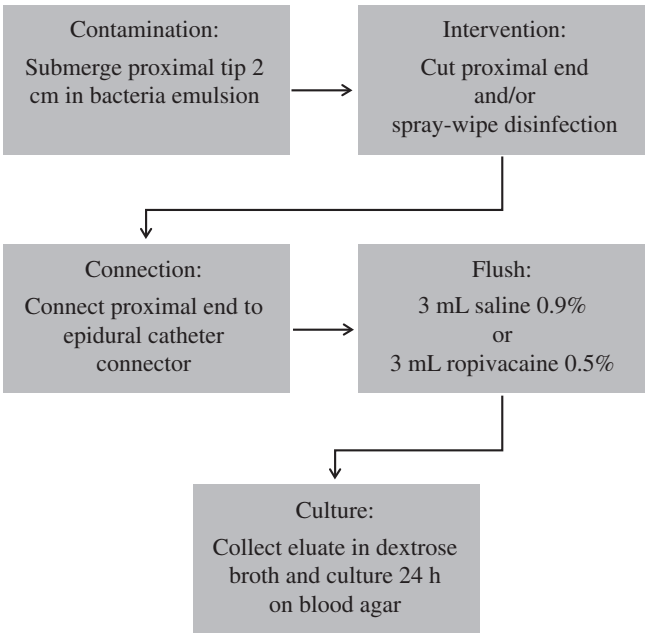

Figure 1. Flow chart of the model of epidural catheter contamination.

Interventions and study design

In this study, three interventions intended to prevent infectious complications after epidural catheter disconnection were tested:

(i) Cutting off the exposed proximal end of the epidural catheter with sterile scissors 20 mm distal to the level of the bacteria suspension.
(ii) Spray–wipe disinfection with disinfectant (Octenisept®, Schülke, Hamburg, Germany) with three cycles of spray, 30 s incubation and wiping with sterile gauze.
(iii) Continuing epidural infusion with local anaesthetics (ropivacaine 0.75%, Naropin, AstraZeneca, Wedel, Germany).

All these interventions were used alone or in combination, resulting in eight different groups investigating ten contaminated catheters each (Table I).

Statistics

The effect of each intervention on bacterial contamination rate was evaluated by Fisher's exact test by Sigmaplot 11.0 (Systat, Erkrath, Germany). Untreated control was used as the control group for the single intervention groups I, II and III, whereas the dual interventions were compared to the

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