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Review

Perineural catheter infection: a systematic review of the literature☆

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Abstract Perineural catheter infection is a rare but potentially dramatic complication of continuous peripheral nerve block. Different risk factors have been identified and the incidence of infection is increased in trauma victims, intensive care unit patients, immunodeficient individuals, and diabetic patients. Also, postoperative hyperglycemia, the absence of antibiotic prophylaxis, and catheter lasting more than 48 hours seem to be associated with a greater risk of infection. Skin disinfection and a strict aseptic technique during catheter placement are fundamental. The use of micropore filters, antiseptic dressings, catheter tunneling, and aseptic preparation of the infused drug has all been hypothesized to reduce infection rate, but the existing evidence is conflicting.

Infection is a rare complication of continuous peripheral nerve blocks. Severe and even fatal cases have been reported, even if morbidity is generally very low. The identification of high risk patients and adoption of preventive measures might reduce the incidence of this complication.

1. Introduction

Perineural catheter (PNC) infection is a rare (0%-3%) but potentially dramatic complication of continuous peripheral nerve block (CPNB). In fact, patients in whom a CPNB is performed are often trauma victims undergoing orthopedic surgery with positioning of prosthetic material, which is prone to infection and colonization [1].

Despite the fact that more attention has been dedicated to PNC infection in the last years, only a few publications report on peripheral catheters, whereas most literature focuses on epidural PNC infection [2]. Finally, there are great differences between studies in terms of the definition of PNC infection, catheter position, aseptic technique for catheter placement and removal, indwelling time of catheters, and the use of medical dressings and antibiotics. All of these variabilities make comparison difficult [1].

2. Methods

We searched Medline, Institute for Scientific Information Web of Knowledge and scopus on May 3, 2016, using variable combinations of the following keywords: perineural catheter, continuous peripheral nerve block, continuous nerve

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block, peripheral nerve block, nerve block, regional anesthesia, brachial plexus block, sciatic block, femoral block, infection, colonization, inflammation, and abscess. In addition, we screened articles in the "Related citations in PubMed" section and conducted a snowballing procedure to examine the references cited in the papers retrieved through the systematic search. A time restriction focusing on the last 10 years was applied to the systematic search but not to the snowballing process. No language restriction was applied to the searches. Research was restricted to adult population. Papers 3 for Macintosh (Labtiva, Inc, Cambridge, MA) was used to compile the bibliography.

3. Results

Initial search results were analyzed by reading the title and abstract; manuscripts unrelated to the research topic were identified and excluded. After this process, 37 papers were included in the review including 22 trials, 6 case reports, and 9 reviews. Snowballing led to other 9 articles that were included in the review.

3.1. Incidence

The existing literature makes a distinction between catheter colonization, inflammation of the catheter insertion site, and actual infection [2,3]. Catheter colonization (ie, microbial growth on catheter tip culture) is quite common, with an overall incidence between 6% and 57% [4,5]. The highest incidence of colonization was described in a series of femoral catheters, where no skin preparation was performed before PNC removal [5]. When a catheter removal protocol with skin preparation was applied and attention was paid to sterile precautions, the incidence of colonization was found to be as low as 6%, suggesting that many positive cultures reflect catheter contamination during removal rather than actual colonization [4]. In fact, only a small part (0%-3.2%) of positive catheter cultures turned out to be real infections [3-5]. Moreover, the clinical diagnosis of PNC infection with a negative catheter culture has also been described [6]. Inflammation at the catheter entry site is seen as erythema, itchiness, or warmness and seems to be less common (3%-9%) compared with catheter tip colonization [3,7-10]. Two studies found a correlation between inflammation and catheter tip colonization [3,10]. However, Neuburger et al [3] proposed that inflammation could be related to tissue trauma caused by catheter movements, as shown by a significantly higher incidence of inflammation among interscalene PNCs when compared with catheters with lower mobility, such as lateral sciatic ones. Finally, *catheter infection* is defined as signs of systemic infection (fever, leucocytosis, elevated infection/inflammation markers, positive blood cultures) in a patient with signs of catheter entry site inflammation or evidence of abscess, pyomiositis, or cellulites [11]. The incidence of local or systemic infection can range between 0% and 3% [2,3], but the majority of studies report an incidence below 1% [4,9,12-15]. Life threatening infections are extremely rare [16,17], and there has only been 1 case report about a lethal infection after a one-shot axillary block [18].

3.2. Pathogenesis

Three possible mechanisms have been proposed for PNC-related infection: bloodstream diffusion, contamination of infused drugs, and pathogen penetration through catheter entry [2,4]. In bloodstream diffusion, a pathogen entering the bloodstream from another site of infection spreads through circulation and migrates to the catheter site, colonizing the foreign body. This mechanism was proposed in 1975 by Baker et al [19] to explain some of the reported epidural catheter infections. However, more recent work suggests that remote infection foci play little if any role in epidural catheter infection, meaning that infection in a distant location is no longer considered a contraindication to spinal/epidural anesthesia [20]. Catheter infection after drug contamination was recently proposed by Capdevilla et al [2] after previously published reports of joint and epidural infections due to the contamination of drugs from multidose vials [21]. Despite old-generation local anesthetics, such as bupivacaine, being known to have an intrinsic antibacterial activity [22], this seems to be minimal for new-generation molecules, which are more often used for perioperative analgesia, such as ropivacaine and levobupivacaine [23,24]. A recent review by Head and Enneking [25] draw attention to standards for drug preparation techniques and precautions, and every practitioner should be aware of national recommendations for drug preparation and storage. Notably, contamination of infusion lines (hubs, filters, and taps) seems to play a major role, even if the drug is correctly prepared and was found in 40%-54% of patients developing epidural catheter infection [26]. Pathogen penetration is thought to be responsible for the majority of PNC infections [2]. The mechanism is similar to that involved in central venous catheter infection. In this case, a pathogen finds its way through the skin at the PNC entry site and moves on following the path of the catheter toward deeper tissues [4]. Another possibility is a breach in aseptic technique during positioning, so that the pathogen is directly injected through the skin by the operator [26].

3.3. Risk factors

Intrinsic risk factors include trauma, drug abuse, coexisting malignancies, diabetes, and other conditions of mild to overt immunosuppression, such as chemotherapy and immunosuppressant therapy [17,26]. Notably, not only diabetes mellitus but also postoperative hyperglycemia seems to play an important role. Recently, a study by Richards and colleagues [27] found postoperative hyperglycemia in nondiabetic patients to be an independent risk factor for surgical site infection after