Complications of peripheral nerve catheter removal at home: case series of five ambulatory interscalene blocks

Complications suite au retrait d'un cathéter nerveux périphérique à la maison: une série de cas de cinq blocs interscaléniques en ambulatoire

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Abstract

Purpose The placement of continuous peripheral nerve catheters on an ambulatory basis is increasing and is routine at our institution. There are few reports of complications associated with peripheral nerve catheter removal in the literature. Described herein is a case series of five patients where complications related to catheter withdrawal were observed.

Clinical features A stimulating catheter with a stainless steel coil surrounded by polyurethane (19-G, 60-cm) exhibited shearing when removal proved difficult in five patients. In four cases, catheter removal by the patients was not possible, requiring them to return to hospital for management. No long-term sequelae were observed in any patient.

Conclusions There can be various causes for difficulty with catheter removal, such as a technical aspect of catheter placement, catheter design, tissue reaction at the catheter site, or a combination thereof. The majority of complications related to outpatient perineural catheters can be handled over the telephone, but our case series may highlight a potential management dilemma in placing continuous stimulating perineural catheters on an ambulatory basis.

Résumé

Objectif Le positionnement des cathéters nerveux continus périphériques dans un contexte ambulatoire est de

plus en plus fréquent; il s'agit d'une procédure de routine dans notre institution. La littérature ne comporte que peu de comptes-rendus rapportant les complications associées au retrait des cathéters nerveux périphériques. Nous décrivons ici une série de cas de cinq patients chez lesquels nous avons observé des complications associées au retrait d'un tel cathéter.

Éléments cliniques Des cisaillements ont été observés sur un cathéter stimulant muni d'une spirale en acier inoxydable entourée de polyuréthane (19 G, 60 cm) lorsque son retrait s'est avéré difficile chez cinq patients. Dans quatre cas, les patients ne sont pas parvenus à retirer le cathéter, et ils ont dû retourner à l'hôpital pour être pris en charge. Aucune séquelle à long terme n'a été observée chez ces patients.

Conclusion Différentes causes peuvent être à l'origine du retrait difficile d'un cathéter: il peut s'agir d'un aspect technique de positionnement du cathéter, du modèle de cathéter, d'une réaction tissulaire à l'emplacement du cathéter ou encore d'une combinaison de ces différentes difficultés. La plupart des complications liées aux cathéters nerveux périphériques dans un contexte ambulatoire peuvent être réglées par téléphone, mais notre série de cas met en lumière un dilemme potentiel de prise en charge lors du positionnement ambulatoire de cathéters nerveux stimulants périphériques continus.

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There are several reports of successful use of peripheral nerve blockade in the outpatient setting.^{1–3} This practice requires the patients themselves to remove the indwelling catheter, usually within the first two to three postoperative days. Removal of the indwelling catheter is presumed to be easy and painless, and there are only a few reports of

complications associated with peripheral nerve catheter removal,⁴⁻⁸ making this technique an attractive alternative to prolonged inpatient stay. However, when outpatient catheter removal proves to be complicated necessitating a return visit to the hospital, much of the gained ambulatory benefit is lost. We describe five cases of difficult removal of a stimulating peripheral nerve catheter that demonstrate this experience. The five cases, four of whom required return to the hospital, were among the more than 2,500 outpatients with ambulatory stimulating catheters during a period of 60 months. All patients gave permission for publication of the report, and the manuscript received institutional review board approval.

Case 1

A 71-yr-old woman was scheduled for revision of a right shoulder subacromial decompression and capsular release. She had a history of difficulty with postoperative pain management with intolerance to opioids due to nausea and vomiting. An anesthesiologist (experienced in peripheral nerve catheters) placed a continuous interscalene nerve block using a stimulating catheter (19-G 60-cm Stimucath®; Arrow International, Reading, PA, USA) and ultrasound guidance (13-6 MHz 38-mm broadband linear array transducer; Sonosite MicroMaxx, Bothell, WA, USA) using an out-of-plane approach. An elicited motor response via the insulated needle was obtained distal to the deltoid muscle with a nerve stimulator set at a current of 0.5 mA. The catheter was introduced easily with continuous stimulation exhibiting motor response with advancement to a distance of 5 cm beyond the needle tip. The guidewire was removed, the connector was attached, and the catheter was secured with Steri-Strips® adhesive skin closures (3 M Company, St. Paul, MN, USA). The initial loading dose of local anesthetic consisted of 0.5% ropivacaine 20 mL administered in 3-mL increments every one to two minutes. Following an uneventful operation, the patient was discharged home with a portable infusion pump (Accufuser®; Curlin Medical Inc, Huntington Beach, CA, USA) that was filled with 0.2% ropivacaine and programmed to deliver 5 mL·hr⁻¹. The patient had excellent analgesia and required no oral opioids for the first two postoperative days. The patient's son, a physician, attempted to discontinue the catheter on postoperative day three, but he encountered significant resistance with catheter removal. That afternoon, the patient presented to the ambulatory surgical centre where she was evaluated. A radiograph of the operative shoulder failed to demonstrate any knotting or kinking of the catheter. Manual steady traction was applied to the catheter in an attempt to remove it, at which time the outer white polyurethane covering of the catheter

separated from the inner stainless steel coil. Using continuous traction, the wire was grasped with a hemostat and removed intact. The patient had no adverse effects from catheter removal and was discharged without further complications.

Case 2

A 69-yr-old woman with a history of chronic opioid use for shoulder pain was scheduled for left total shoulder replacement. An anesthesia resident (supervised by a regional anesthesiologist), using ultrasound guidance and an out-of-plane approach, advanced a 17-G insulated needle with continuous nerve stimulation as described previously. A Stimucath catheter was advanced easily to a distance of 5 cm beyond the tip with catheter stimulation exhibiting shifting motor stimulation with advancement. The guidewire was removed and the catheter was secured with Steri-Strips skin closures. The initial local anesthetic loading dose consisted of 0.5% ropivacaine 30 mL. Following an uneventful operation, the patient was discharged home on postoperative day one with a portable infusion device (On-Q C-Block with ONDemand®; I-Flow Corporation, Lake Forest, CA, USA). On postoperative day three, the patient's husband attempted to remove the catheter as per routine instructions, but he was unable due to increased resistance. Since the patient lived over 400 km from our hospital, her husband was instructed over the telephone to apply gentle continuous traction to the catheter in an attempt to remove it. The outer white polyurethane portion of the catheter separated from the wire coil, but the catheter was ultimately removed successfully with the stainless steel electrode tip intact. The patient reported minor discomfort from skin traction during catheter removal, but she did not experience any paresthesia during removal and had no subsequent adverse effects.

Case 3

An 83-yr-old patient was scheduled for left total shoulder replacement. A continuous interscalene nerve block was performed by an experienced anesthesiologist using a stimulating catheter that was placed easily on the first attempt under ultrasound guidance using an out-of-plane approach with continuous nerve stimulation as described previously. The catheter was advanced 3 cm beyond the needle tip with continuous stimulation. The catheter was tunnelled (to prevent accidental removal) using a 16-G 1.77-inch intravenous catheter (BD Insyte™ Autoguard; Sandy, UT, USA) lying 9 cm deep at the skin in its final

position. Following an uneventful surgery, the patient was discharged home with a portable infusion device (On-Q C-Block with ONDemand). The patient's daughter attempted to remove the indwelling interscalene catheter on postoperative day three. Her attempts were met with resistance, and the patient experienced sharp pain in the arm and hand once traction was applied to the catheter; the pain subsided once traction on the catheter was released. The patient and family were instructed both verbally and in writing to call the regional catheter team in case of any pain or difficulty with the catheter removal. A second attempt to remove the catheter caused the white polyurethane outer catheter cover to separate from the inner stainless steel coil, and traction again caused some discomfort to the patient. The patient and daughter were instructed to return to the hospital so that the catheter could be inspected. The catheter was removed successfully with a set of 4-inch metal forceps while applying a moderate amount of continuous traction. During the catheter removal, the patient experienced an "electric shock" at the catheter insertion site that quickly resolved with no distal paresthesia. Upon removal, the inner stainless steel core was uncoiled, but the characteristic stainless steel electrode tip was intact. The patient reported no subsequent sequelae.

Case 4

A 73-yr-old woman was scheduled for right arthroscopic rotator cuff repair and subacromial decompression. A continuous interscalene nerve block was performed by an anesthesia resident (supervised by a regional anesthesiologist) using a stimulating catheter that was advanced 4 cm beyond the needle tip under ultrasound guidance using an out-of-plane approach with continuous nerve stimulation as described previously. Following an uneventful surgery, the patient was discharged home with a portable infusion device (On-Q C-Block with ONDemand). On postoperative day three, the patient's husband attempted to remove the catheter and encountered resistance. Slight traction on the catheter resulted in separation of the outer plastic coating from the inner metal core, and the patient reported sharp pain radiating down her arm. The patient presented to the emergency department where the anesthesia resident on call attempted to remove the catheter by applying gentle traction; this resulted in severe arm pain radiating to the hand. The attending anesthesiologist subsequently evaluated the patient with ultrasound to assess catheter position. The catheter was cut 6 cm proximal to the skin entry site, and the area was prepared with betadine and draped in a sterile fashion. Lidocaine 1.5% was injected around the skin entry point. The extruding wire was threaded through a 16-G 1.77-inch intravenous catheter (BD Insyte™

Autoguard), and the catheter was advanced into the skin up to the hub. Both the catheter and the inner wire were then grasped with a hemostat 1 cm proximal to the skin entry point, and they were withdrawn through the 16-G intravenous cannula during application of gentle continuous traction. The catheter and the separated wire were removed *in toto* without producing paresthesia or pain.

Case 5

A 54-yr-old woman was scheduled for revision of a right shoulder subacromial decompression and capsular release. A continuous interscalene nerve block was performed by a supervised regional anesthesia Fellow using a stimulating catheter that was advanced 3 cm past the needle tip under ultrasound guidance using an out-of-plane approach with continuous nerve stimulation as described previously. The catheter was secured with Steri-Strips adhesive skin closures. The patient's husband attempted to remove the catheter 68 hr after catheter insertion once the local anesthetic reservoir was empty. The patient reported severe "shooting" pain radiating down her arm when gentle traction was applied. After a second attempted removal, the outer catheter separated from the inner wire. The patient insisted that her husband cut the catheter, and they later presented to the emergency department for catheter removal (Fig. 1). The catheter was prepared with betadine, and the area was draped in a sterile fashion. Lidocaine 1.5% was used for local anesthesia. A 16-G 1.77-inch catheter (BD Insyte™ Autoguard) (Fig. 2) was then guided over the extruding wire until the hub of the catheter contacted the skin (Fig. 3). During catheter insertion, slight tension was applied to the wire to prevent bending. The catheter and wire were then grasped with a hemostat 1 cm proximal to the skin entry point and withdrawn during application of gentle traction. Mild transient paresthesia and pain were reported by the patient, and the procedure was aborted. The intravenous catheter was then replaced with a longer (12 cm) dilator catheter obtained from a central venous catheterization kit (arrow). The dilator catheter was advanced over the wire, and the catheter and wire were removed as a single unit by applying traction with the hemostat. The patient reported no pain or paresthesia during catheter/wire removal (Fig. 4).

Discussion

Complications related to peripheral nerve catheter removal are reported rarely in the literature.⁴⁻⁸ Previously described cases involved shearing or knotting of catheters that did not contain stainless steel coils. If resistance or motor response

Fig. 1 Close-up view of a stimulating catheter (19-G 60-cm Stimucath; Arrow International, Reading, PA, USA) demonstrating stretching of the stainless steel coil

Fig. 2 The extruding wire is inserted through a 16-G 1.77-inch intravenous catheter (BD Insyte™ Autoguard; Sandy, UT, USA), and the catheter is advanced subcutaneously

Fig. 3 Extruding wire from a stimulating catheter (19-G 60-cm Stimucath; Arrow International, Reading, PA, USA)

is lost during catheter advancement, it is our practice to remove the entire needle catheter system as a single unit. There is one previous case involving a stimulating catheter

Fig. 4 Tissue dilator obtained from a central venous catheterization kit and intact wire from a stimulating catheter (19-G 60-cm Stimucath; Arrow International, Reading, PA, USA)

in which the polyurethane covering and the inner stainless steel coil separated; however, this complication likely occurred because the catheter was cut intentionally during attempted removal.⁷ There are no other reports of a similar catheter separation during attempted catheter removal. There can be various causes for difficulty with catheter removal, such as a technical aspect of catheter placement, catheter design, tissue reaction at the catheter site, or a combination thereof. Should the cause of catheter separation be due to improper catheter tunnelling, one would expect the outermost portion of the catheter (white polyurethane portion) to be better anchored to tissues than to the inner stainless steel coil, allowing the inner coil to be pulled through the outer white cover upon removal. In fact, just the opposite occurred in all five of our cases. The white polyurethane outer catheter cover became dislodged, while the metal coil core remained anchored to the tissues. Furthermore, only one of the five catheters was tunneled subcutaneously. If the needle remained subcutaneous at the time of catheter stylet removal, it is possible that difficult removal of the stylet could disrupt the union between the white polyurethane and stainless steel coil portions of the catheter, similar to the way a previous report described complete catheter shearing.³ It is the authors' experience that creating an external artificial resistance to catheter stylet removal can result in the creation of a "pigtail" at the distal end of the catheter due to tension on the stainless steel coil. However, in three cases, the needle was removed from the tissues prior to stylet removal, and the catheter stylets were removed without encountering resistance, making this an unlikely cause.

Excessive catheter advancement can be a cause of difficult catheter removal due to knotting or kinking of the catheter.⁹ However, all five catheters were advanced easily past the needle tip, and only one catheter was advanced more than 5 cm, a distance accepted as standard for this

Fig. 5 Artist drawing demonstrating exposed catheter wire in close proximity to a nerve bundle

type of continuous nerve block;¹⁰ none of the catheters were knotted or kinked upon inspection. In two of our cases, the patients reported severe paresthesia during attempted catheter removal, which may have been caused by the exposed wire lying on a nerve bundle, thus producing pain during attempted removal and traction (Fig. 5). In cases four and five, the angiocatheter and central line dilator catheter used for extraction of the stimulating catheter may have acted to insulate the exposed wire lying on the nerves and, therefore, prevented paresthesias at the time of removal. If persistent paresthesia had continued, consultation with a neurosurgeon or interventional radiologist may have been necessary to facilitate removal. There are also instances where catheter separation during attempted unsuccessful removal resulted in the need for surgical exploration for femoral nerve catheter removal.¹¹ Finally, it is possible that a tissue reaction may have occurred with the catheter *in situ*, leading to the formation of adhesions. However, all five catheters remained subcutaneous for approximately 72 hr, a duration likely too brief to allow adhesions to develop. A recent study has shown that significant adhesions can develop on a stimulating catheter with a 0.5-cm coiled stainless steel electrode in a rat model after a period of seven days.¹² While the catheters in this animal study are identical to the catheters placed in all five of our patients, we found no evidence of adhesion formation on the catheter tips at the time of their removal.

The difficulty in managing our patients was the fact that they were all outpatients, and two of them lived far from our institution. There are several reports of successful use of ambulatory peripheral nerve blockade in the literature.¹⁻³ While the goals of shorter hospital stays and the resultant decreased medical costs are clear benefits of this practice, problems with patient management due to issues of proximity to the provider need to be considered. Unfortunately, since many of our patients live far from our

hospital, they do not have quick and easy access to qualified personnel when complications arise. Much of the concern in sending patients home with indwelling perineural catheters revolves around infection, local anesthetic toxicity, and injury due to an insensate extremity. However, our case series suggests that difficult catheter removal should be equally concerning. Too forceful an attempt at catheter removal could potentially result in nerve injury (avulsion from a knotted catheter), bleeding (postoperative low molecular weight heparin in the setting of an adhesion), or a retained foreign body (catheter fracture). While patients are given clear instructions on how to manage and remove the catheter at home, this does not obviate the need for medical attention if the catheter is not easily removed. Of note, in our database of over 2,500 patients, we have not experienced any of these complications in outpatients receiving non-stimulating catheters in the past three years. This experience may suggest it is logical to avoid the use of stimulating catheters in the ambulatory population. However, reports of difficulty removing non-stimulating catheters are present in the literature as well.⁴⁻⁷ One reason to consider continuing to place stimulating catheters is the fact that a recent prospective randomized double-blind trial demonstrated a significantly improved functional outcome six weeks post shoulder surgery in patients receiving stimulating vs non-stimulating interscalene catheters.¹³ However, the difficulties described here with stimulating catheter removal may prove to outweigh benefits gained in functional outcome. Finally, it should be noted that the authors reported these complications to the United States Food and Drug Administration's MedWatch system.

In conclusion, the majority of complications related to outpatient perineural catheters can be handled over the telephone, but our case series may highlight a potential management dilemma in placing continuous stimulating perineural catheters on an ambulatory basis. Further research is needed to explore the safety of indwelling stimulating catheter use in the ambulatory setting and to determine whether a different catheter design may reduce or avoid catheter disruption during removal.

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Competing interests None declared.

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