Case Report

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Stimulating Perineural Catheter Entrapment

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ABSTRACT

Today, outpatient surgery rates are increasing due to high hospital costs, and home going catheters provide excellent pain control for orthopedic and traumatology patients. Peripheral nerve catheters are usually removed 2-5 days postoperatively and are assumed to be easy and painless with a short training for ambulatory patients. It is a great comfort for the patients to be sent home with a catheter to provide good pain control, but they have to remove the catheter themselves or a relative at home. A possible problem is the removal of the catheter can cause serious anxiety to patients and their relatives, hence it is a very frustrating situation for patients especially who come from hundreds of miles away. In this report, we review the stimulating perineural catheter entrapment cases in the literature after describing our similar case and predict possible entrapment causes and propose management strategies for the safe removal of these peripheral nerve block catheters.

Case

A 72 you female with PMH of two right shoulder surgery, Obstructive Sleep Apnea, Hypertension, Rheumatoid Arthritis, Depression, Hypothyroidism, Bipolar Disorder, and Fibromyalgia was Scheduled for right Reverse Total Shoulder Arthroplasty. On the day of surgery, the stimulated interscalene catheter (Arrow, StimuCath® Peripheral Nerve Catheter, PA, USA) was placed under Ultrasound guidance preoperatively without bolus local anesthetic. The surgery was under general anesthesia, and once the patient reached the PACU after a neuro-exam performed by the surgeon, local anesthetic infusion (Ropivacaine 0.2% at 6ml/hr, 6ml PCA bolus, and lockout time 1 hour) started through the interscalene catheter with a home-going catheter pump (ambIT® Ambulatory Infusion Therapy Pump (Sorenson Medical Products, Utah, USA). During the connection of the pump, the patient and her husband were educated about using the pump and removing the catheter. POD 1 the patient was discharged without any complication and planned daily phone communication with the patient and the removal of the catheter at POD 3 at home by the patient's husband. At POD 3, during the phone interview, the patient refused the remove the catheter since she had still pain and wanted to keep more a few days. At POD 5, the patient's husband connected with Acute Pain Team because he could not remove the catheter. The patient was invited to the hospital for next day. The acute pain team examine the patient and the catheter was visualized with ultrasound. The patient describes paresthesia on the first three fingers. The catheter's coiled tip was entrapped inside the brachial plexus nerve bundles (Image 1). The team tried to remove the catheter with different techniques such as saline injection through the catheter, and move the catheter back and forth, turn itself around clockwise/counterclockwise. During the pulling back of the catheter, the patient felt pain in her neck. Finally, we decided to remove it under general anesthesia and/or with surgical dissection. The patient was scheduled for surgical catheter removal at POD 7. After general anesthesia with muscle relaxant the team tried again with the previous techniques, eventually, we insert a new sterile guidewire through the catheter, and spin it. We were able to remove the catheter with that technique without surgical dissection. After removal, the neck pain disappeared but the numbness in my fingers

was still keeping. The patient was referred to physical therapy. Five weeks later, the patient was still describing slight numbness in first three fingers at the radial nerve distribution area, although it diminished in time.

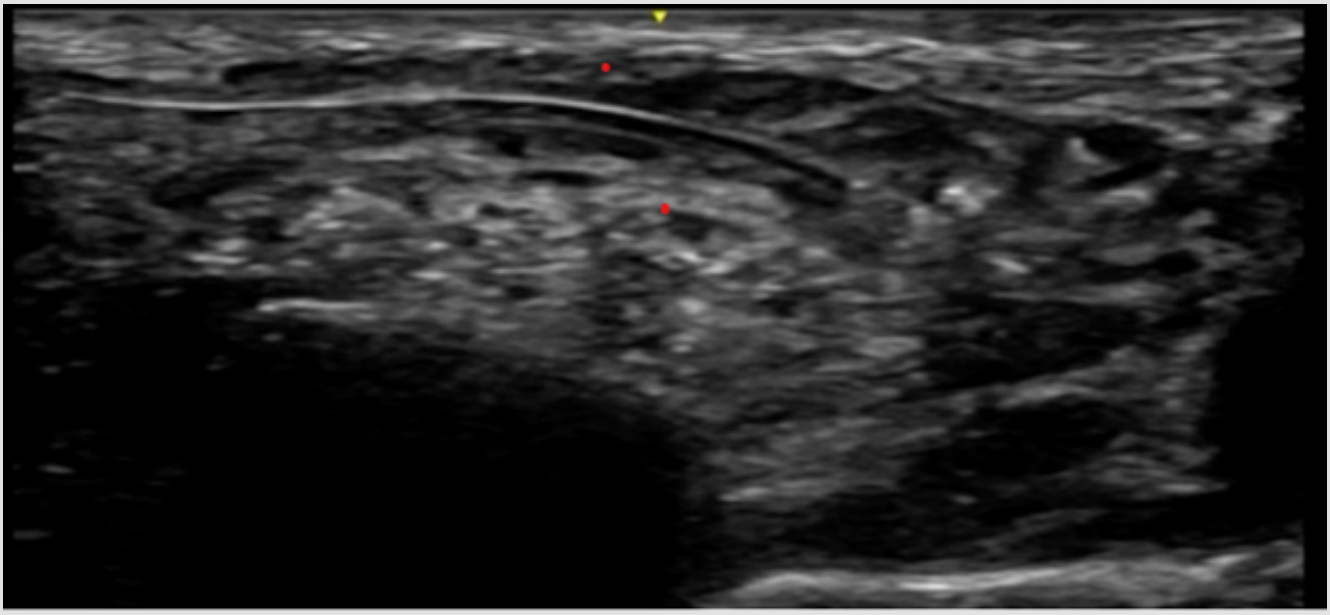

Image 1: The stimulating catheter indwelling to brachial plexus.

Review

Today, outpatient surgery rates are increasing due to high hospital costs and home going catheters provide excellent pain control for orthopedic and traumatology patients. A good pain control for ambulatory surgery facilitates postoperative mobilization, reduces opioid uptake and its side effects, making rare complications such as infection or nerve injury negligible [1,2]. Especially in the last two decades, the rapid spread of ultrasound uses and the emergence of new catheter designs such as stimulating catheters have made ambulatory peripheral nerve catheter applications safer and more successful [3-6]. Peripheral nerve catheters are usually removed 2-5. days postoperatively and are assumed to be easy and painless with a short training for ambulatory patients. It is a great comfort for the patients to be sent home with a catheter to provide good pain control, but they have to remove the catheter themselves or a relative at home. A possible problem the removal of the catheter can cause serious anxiety to patients and their relatives, hence it is a very frustrating situation for patients especially who come from hundreds of miles away.

Initial reports of entrapment of peripheral nerve catheters included knot formation, usually due to over advancement of polyamide non-stimulating catheters. Some recommendations made afterwards, such as not advancing more than 5 cm, reduced those complications. [7-9]. Some clinics use stimulating catheters that have a stainless-steel-containing wire within a polyurethane sheath ending in a tip of coiled steel wire for optimal stimulation quality. Although this type of catheter minimizes the chance of knotting or breaking, it has encountered different complications such as separation of the polyurethane outer part, uncoiling of the tip, and entrapment in nearby structures. When we look at the literature, we can see 9 different reports including a total of 18 cases between 2005-2016 regarding stimulated peripheral nerve catheter entrapment and serious removing difficulties [10-18] (Table 1). In almost all of these cases, removal attempts caused painful paresthesia. All these reports are related to Arrow StimuCath®, and even if the company updated this catheter in time, similar problems have been reported up to now. We believe that this problem happens much more than reported in different severity. At least we exposed difficulty removing two times in the last year in our clinic, we removed them after a couple of tries without complication. But in our last case, we had to undergo general anesthesia to be able to remove it.

Table 1.

Author & Year	Patient	Location of Catheter	Clinic Awareness	Removal Technique	Residual Effect
De Tran, et al. [3]	52y, F	Infraclavicular	POD 1 PU part separated from the wire, cut the catheter	Surgical removal at POD1	No residual effect
Brenier, et all. 2009	31y, M	Interscalene	POD 3 Painful paresthesia on 1st and 5th fingers during traction	Surgical removal at POD4	No residual effect
Duclas Jr, et all. 2010	46y, M	Infraclavicular	POD 4 Resistant during traction	Reverse Seldinger technique, the tip enveloped with fibrous tissue, at POD6	No residual effect
Celendenen, et al. [13]	71y, F	Interscalene	POD 3 Resistant during traction	PU part separated from the wire, removed with a hemostat clamp	No residual effect
	69y, F	Interscalene	POD 3 Resistant during traction	PU part separated from the wire, removed with forced traction	No residual effect
	83y, F	Interscalene	POD 3 Painful paresthesia, electrical shock during traction	PU part separated from the wire, forced removed with a forceps	No residual effect
	73y, F	Interscalene	POD 3 Severe pain radiating arm,	PU part separated from the wire, catheter cutting, reverse Seldinger and removed with a hemostat	No residual effect
	54y, F	Interscalene	POD 3 Shooting pain radiating down during traction	PU part separated from the wire, removed by hemostat	No residual effect
Presta, et all. 2011	32y, F	Supraclavicular	POD 2 Painful paresthesia in the ulnar distribution during traction	Removed with forceful traction under fluoroscopy	No residual effect
Abrahams, et al. [15]	23y, F	Interscalene	POD 3 Pain on thumb and index finger during traction	Removed with traction under Propofol sedation	No residual effect
	17y, F	Supraclavicular	POD 3 Resistant during traction	Removed with traction under Propofol sedation	No residual effect
	50y, F	Interscalene	DOS at 6th hour Pain on thumb and index finger during manipulation	Removed with saline injection through catheter	Complaints numbness and pain after removal for weeks
	45y, F	Interscalene	POD 3 Painful paresthesia during traction	Removed by Surgery on POD 4	No residual effect

Adhikary, et al. [16]	48y, M	Interscalene	POD 3 Painful paresthesia during traction on thumb	Removed under GA by surgery	Mild paresthesia in palm for 4 weeks
Wiesmann, et al. [17]	71y, F	Supraclavicular	POD 2 Pain during traction	Separated PU part, cut the wire, attempted reverse Seldinger, removed forced traction under GA w/o incision	No residual effect
	32y, M	Interscalene	POD 3 Resistant during traction	Removed by skin massage	No residual effect
Mc Allister, et al. [18]	24y, F	Popliteal sciatic	POD 3 Resistant to traction	Removed by Saline injection	No residual effect
	28y, M	Popliteal sciatic	POD 5 Resistant and tenderness during traction	Uncoiled wire, cut the catheter, removed by traction	No residual effect
Sahin, et all. 2022	71y, F	Interscalene	POD 5 Painful paresthesia first three fingers, neck pain during traction	Removed under GA w/o incision on POD 7	Paresthesia on first three fingers for weeks

Note: PU: Polyurethan, POD: Post-operative Day, GA: General Anesthesia

In the previous reports, the authors assumed different factors as reasons for the difficulty of removing the catheter. Some mistakes during catheter placement, tissue inflammatory reaction, the catheter's coiling structure, wrong removing technique, or combine effects are some of those reasons. From all of the previous reports we can come to conclusion that the main reason for the entrapment is actually the overall design of the catheter. Although the coiled metal tip of the catheter gives is more flexibility, it is highly prone to entanglement with the surrounding tissues. It might be possible that due to the body heat the coils of the catheter expand. Interestingly, most of these case report related to interscalene (63%) and brachial plexus (89%). According to Wiesmann et all [17]. This could be due to interscalene block being more common than other blocks. However, the brachial plexus's complex anatomical structures including thin nerve fibers could be a reason for them getting stuck between the coils. In most cases, including ours, the patients feeling pain during traction could be a sign of the nerve fibers getting caught between the coils Unfortunately, some patients including ours had paresthesia for a while after the catheter removal. It shows us some nerve fibers or related tissue stuck between coils, then caused damage to these tissues during removing it.

Another important factor is the inflammatory reaction of the surrounding tissue against the metal tip and increasing adhesion over time. Buckenmaier et all [19]. reported that the StimuCath needed almost 20 times the force to remove compared to the other Arrow models. This result suggests that the Arrow StimuCath catheter tip may contribute to the adhesion of the tip in an intense inflammatory environment. Also powdered gloves or contamination of the tip during catheter placement may cause adhesion to tissues. Some technique mistakes during catheter placement may contribute to catheter entrapment theoretically. Clendenen et all [13]. claimed that the catheter style must be removed before the Tuohy needle is removed. Otherwise, "creating an external artificial resistance to catheter stylet removal can result in the occurrence of a 'pigtail' at the distal end of the catheter due to tension on the stainless-steel coil". However, Wiesmann et all argue that there is no sufficient reason in his own practice. Also withdrawing the catheter through the needle may cause of damaging the catheter and removal complications. There is no definite information about if there are any other triggering reasons for possible inflammatory reaction and adhesion, such as comorbidities, use of drugs, age, patient stabilization, etc. Published reports include patients of different age groups, so it is difficult to say that only elderly patients are prone to this.

Finally, we think that this catheter is preferred by many centers, including our clinic because it is easy to apply, the catheter can be seen easily under ultrasound, and the risk of kinking or knots is minimal. However, the widespread use of ultrasound in regional anesthesia and the use of neurostimulators were generally abandoned, leading

to the rare need to use stimulating properties of the catheter now. The high cost due to a feature that is not generally used and the risk of complications that have been reported many times reveal that the benefit-harm perspective needs to be reconsidered.

Recommendations

- First of all, you should consider that stimulating catheter adhesion risk is high for interscalene and supraclavicular approaches.
- During the catheter placement do not touch the tip of the catheter, especially with powdered gloves. Far away from the nerve bundle, place the catheter underneath the fascia instead of between nerve bundles for interscalene and supraclavicular approach. Do not withdraw the catheter through the needle.
- If patients are at home and have a challenge removing it, do not insist them on removing it, invite them to the hospital immediately.
- Perform a detailed neurologic exam before trying to remove the catheter, then an ultrasound examination should be performed to understand the interrelation to plexus structures of the catheter. Also, the preservative-free normal saline injection can be used for both seeing the tip and helping to release it. If traction on the catheter produces pain, paresthesia, and strain of the neural bundle under ultrasound guidance, do not force traction. If you suspect with knot, take an X Ray.
- If the catheter is superficial and does not cause pain in traction, massage application can be tried [17].
- If the catheter is deep or integrated into the neural tissue, free saline may be injected to facilitate its release adhesion by ultrasound-guided hydro dissection. Also, traction can be attempted by spinning it clockwise and counterclockwise after a new guide is inserted through the catheter, as we did. Although it is known that the guidewire does not reach the coiled distal end of the catheter, it facilitates traction by improving catheter tension.
- We never recommend cutting the catheter or inserting another needle over the catheter, because these include the risk of extra different injuries. we think that the separation of the outer polyurethane part from the inner part reported before is a result of forced traction instead of a reason. We experienced this problem partially (Image 2), but we did not perform forced traction.

Image 2: Stacked (left) and normal (right) catheter.

- All these attempts should be done under sterile conditions and if the patient cannot tolerate it, they should be tried under sedation and then under general anesthesia. Surgical dissection should be kept in mind as the last option and traction should never be forced during trials.

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