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Safety and efficacy of central line removal by guidewire extraction technique in children

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Abstract

Background This study reviews a university pediatric surgery practice for the incidence of stuck subcutaneous port catheter (SSPC) removal and the efficacy of a guidewire extraction technique.

Methods We reviewed all central catheter removals between 2018 and 2020. A SSPC was defined as resistance to removal after dissection of the subcutaneous tissue with signs of impending device fracture. Details of the catheter duration, initial diagnosis, and medications administered through the device were all recorded.

Results One hundred eight patients underwent catheter removal and six were defined as SSPCs. Catheter in situ time ranged from 35 to 96 months. All six patients underwent the guidewire extraction technique and were removed in their entirety without the need for endovascular intervention or venotomy.

Conclusions Pediatric patients who have a SSPC should undergo the guidewire extraction technique.

Keywords Subcutaneous port, Difficult catheter removal, Surgery, Pediatric, Techniques and procedures

Background

Tunneled subcutaneous ports are commonly used in pediatrics for the treatment of various conditions that require long-term vascular access. Complications associated with port placement may occur at the time of insertion, including pneumothorax, hematoma, and line malposition, or during treatment, such as line thrombosis and infection. A serious complication can arise during port removal when the catheter is firmly embedded onto the vessel wall or subcutaneous tissue and is difficult to remove without fracturing the catheter. The incidence of these "stuck" subcutaneous port catheters (SSPCs) has been cited as 17% in a single institution study [1].

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It has been reported that the catheter of the port can become fixated in the vessel lumen or along the subcutaneous tract. Idowu et al. demonstrated the physics related to a SSPC [2]. During removal, force along the axis of the catheter causes a narrowing of the material with the greatest effect adjacent to the area of fixation. When excessive force is applied, the catheter will fracture at the site of fixation and leave intraluminal fragments. Suggested techniques to remove SSPC include performing a counter incision, vascular cut down, or endovascular removal. Subcutaneous catheters that are unable to be retrieved are sutured to muscle or other tissue and left in situ. The reported incidence of a retained catheter in situ ranges from 0.3 to 5.3% [3–6].

At our academic institution, if the catheter cannot be removed with moderate steady traction, then a counter incision is made to gain access to additional sections of the catheter. Dissection of the catheter from the subcutaneous tissue and muscle extends proximally towards the vein to alleviate any tethering. If the catheter still exhibits resistance to removal and there are visual signs of impending fracture, it is then defined as a SSPC. In these cases, the catheter is cut and a guidewire inserted

under fluoroscopy. A clamp is placed over both the wire and catheter then traction is applied (guidewire extraction technique). The purpose of this study is to review the incidence of stuck subcutaneous ports and determine the efficacy of the guidewire extraction technique in children.

Methods

Following institutional review board approval, a retrospective cohort of children who underwent port removal between January 2018 and December 2020 was identified. Patients were identified from a university database of all cases performed by the Division of Pediatric Surgery. Exclusion criteria were patients older than 18 years old. The operative notes from all patients were reviewed. Stuck catheters were defined as previously described: in brief, resistance to removal after dissection of the surrounding subcutaneous tissue and signs of impending fracture. The details from these patients were further analyzed including patient demographics, diagnosis, treatment course, complications, and all radiologic studies performed. Characteristics of the port were investigated including duration, catheter material (polyurethane versus silicone), size, medications administered through the device, and clinical notes about its function.

Results

Over 3 years, 108 children underwent port removal. Six (5.6%) children had a SSPC removal and all six patients required utilization of the guidewire extraction technique (Table 1). Age ranged from 5 to 16 years (mean = 10.3 years). There were more males than females (male = 4/female = 2). All catheters were 6 Fr polyurethane placed in the subclavian vein. The catheter in situ time was 35 to 96 months (mean = 57.1 months) and the most frequent diagnosis was acute lymphoblastic leukemia. None of the children received radiation to the area. The child with infantile myofibromatosis (IMF) had active disease surrounding the port and catheter. All catheters were removed in their entirety using a guidewire extraction technique without the need for endovascular intervention or venotomy. No complications of port removal were documented.

Discussion

Removal of a tunneled subcutaneous port can be challenging. The literature has evolved to better understand characteristics of catheters (silicone vs polyurethane) and patient characteristics that are associated with SSPC [6, 7]. The focus of the current study is to review the management of SSPC using the guidewire extraction technique practiced in a university pediatric surgical group. This cohort includes catheters placed for induction chemotherapy, maintained for an extended duration, and with external compression from neoplastic disease. In all cases of a SSPC, removal using the guidewire extraction technique was successful for complete removal of the device without the need for additional invasive maneuvers.

The characteristics of our pediatric cohort are diverse and reinforce the utilization of this technique in varying circumstances. Sixty percent of patients had acute lymphoblastic leukemia. Induction treatment for this disease has been hypothesized to increase the risk of a stuck catheter by creating an organized and calcified fibrin sheath around the device [8, 9]. The insulation of these solutions may also exacerbate the tenuous nature of certain catheters. In all six cases, a polyurethane catheter was used which has been considered a risk for difficult removal [7, 10, 11]. The use of this technique can overcome SSCP that develops from catheter properties and the purpose of its use.

Table 1 Patient and catheter characteristics

	Age (years) Gender	Diagnosis	Treatment*	Catheter duration (months)	Preoperative Notes
Case A	7M	Infantile Myofibromatosis (IMF)	VB,MT	84	Subcutaneous nodule around port; pain at port site; cannot draw from port
Case B	5M	B-cell ALL	VC,DO,MT	47	Pain at port
Case C	8M	Juvenile Pilocytic Astrocytoma	VC,CP	33	none
Case D	14M	T-cell ALL	VC,DA,DO,MT	48	cannot draw from port
Case E	16F	ALL	VC,DA,DP,MT	35	none
Case F	12F	Hypogammaglobulinemia	IVIG	96	cannot draw from port

* *VC* vincristine, *VB* vinblastine, *MT* methotrexate, *DA* daunorubicin, *DO* doxorubicin, *CP* carboplatin, *IVIG* immunoglobulin

Duration in situ has been shown as a predictor of difficult port removal with a mean duration of 2 to 3 years [6]. In this cohort, a duration of up to 7 years was noted yet still the guidewire extraction technique was successful. Idowu et al. examined the physics of catheter removal over a guidewire and their results showed that the insertion of a guidewire allowed for greater force to be applied to the catheter prior to fracture. By placing the guidewire through the catheter, the force applied is exerted through the length of the catheter with a uniform decrease in the diameter as opposed to disproportionate stretching of the catheter, leading to narrowing at the site adjacent to the adherence. In doing so, they were able to increase the amount of force applied by 160% prior to fracture. Utilizing this technique, the hypothesized bridging that develops over time between the catheter and the vein wall can be broken, making it the preferred method of removal [12].

All patients in this cohort had their subcutaneous port placed into the subclavian (SC) vein. This location has been associated with difficulty at removal due to a "pinch off" phenomenon between the first rib and the clavicle [13]. Given the subclavian's trajectory under the clavicle, a venotomy and extensive dissection of the vessel cannot be relied upon like in the case of an internal jugular (IJ) catheter. Although a similar technique has been described for the removal of catheters in the IJ location, this is the largest cohort undergoing SC catheter removal using the guidewire extraction technique. In the current study, this technique was successful in all cases and averted the need for endovascular instrumentation or leaving the catheter in situ permanently. The guidewire extraction technique has been a standard practice of the pediatric surgical group at our institution with optimal results.

Conclusion

This cohort shows that removal over a guidewire can be successfully employed in the rare instance of a SSCP. This is the largest group of its type with consistent use of one method and successful results of removal each time. Although other techniques have been described in similar instances, we consider this method first for SC-placed ports. Duration of time since placement or extensive chemotherapy regimen should not dissuade the surgeon. In the present study, all fractured catheters were removed in their entirety without any complications or retained fragments using a guidewire extraction technique. Therefore, we recommend the utilization of a guidewire as a first-line technique in removal to prevent fractured catheters in the pediatric population.

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MF—writing of the article and editing. MS—writing of the article, editing, and PI. SS—data analysis, statistics, and literature review. SC—editing and critical revisions. AI—editing and critical revisions.

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Availability of data and materials
Data sharing is not applicable to this article as no dataset was generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate
The study was approved by the Institutional Review Board at University Medical Center (UMC-2021–382) and the Kirk Kerkorian School of Medicine (UNLV-2021–50).

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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