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ARAŞTIRMA YAZISI / ORIGINAL ARTICLE

Ultrasonography and Fluoroscopy-Guided Percutaneous Placement of Hickman Catheters in Children

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ABSTRACT

Purpose: Hickman catheters (HCs) are commonly used in children who need bone marrow transplantation. Although several methods of implantation have been described, the aim of the present study was to evaluate the results of ultrasonography-and fluoroscopy-guided percutaneous insertion of HCs into a central vein in children.

Materials and Methods: Data from patients who were hospitalized for ultrasonography-and fluoroscopy-guided percutaneous placement of HCs from August 2014 to January 2017 were retrospectively evaluated. The data were evaluated with respect to patient characteristics, complications, HC features, and outcomes.

Results: Three hundred and six times HC positioned in 206 patients were evaluated. One hundred and twenty-six patients were male, and the remaining 80 were female. The age of the patients ranged from 2 months to 19 (range, 7.31±4.85) years. HC implantation was technically successful in all patients. The right jugular vein was the preferred access vein in 87.4% of HCs. The length of time between HC

placement and removal was 147±108.9 days (range, 7–795 days). Three (0.01%) of the recorded complications were classified as early postoperative. Two of those three patients developed bleeding, and one had cardiac tamponade. No mortality was related to HC insertion during the perioperative or postoperative period.

Conclusion: Ultrasonography-and fluoroscopy-guided percutaneous HC insertion in a central vein is safe and applicable to all children regardless of size, age, or diagnosis.

Keywords: Hickman catheter, ultrasonography-guided, fluoroscopy-guided, vena jugularis interna, children

ÇOCUKLARDA HİCKMAN KATETERLERİNİN ULTRASONOGRAFİ VE FLOROSKOPİ KILAVUZLUĞUNDA PERKÜTAN YERLEŞTİRİLMESİ

ÖZET

Amaç: Hickman kateterleri (HC), kemik iliği transplantasyonuna ihtiyaç duyan çocuklarda yaygın olarak kullanılmaktadır. Her ne kadar çeşitli implantasyon yöntemleri tanımlanmış olsa da, bu çalışmanın amacı, HC'lerin ultrasonografi ve floroskopi kılavuzluğunda perkütan insersiyonunun sonuçlarını değerlendirmekti.

Gereç ve Yöntemler: Ağustos 2014-Ocak 2017 tarihleri arasında ultrasonografi ve floroskopi eşliğinde perkütan yerleştirme nedeniyle hastaneye yatırılan hastaların verileri retrospektif olarak değerlendirildi. Veriler hasta özellikleri, komplikasyonlar, HC özellikleri ve sonuçları açısından değerlendirildi.

Bulgular: İkiyüz alt hastada yer alan 360 kez HC yerleştirilen hastaların sonuçları değerlendirildi. Yüz yirmi altı hasta erkekti ve kalan 80 kadındı. Hastaların yaşı 2 aydan 19 yaş (aralık, 7,31±4,85 yıl) arasında değişmektedir. HC implantasyonu tüm hastalarda teknik olarak başarılıydı. Sağ juguler ven, HC'lerin %87,4'ünde tercih edilen giriş damarıydı. HC yerleştirme ve çıkarma arasında geçen süre 147±108,9 gün (aralık, 7–795 gün) idi. Kaydedilen komplikasyonların 3'ünde (%0,01) komplikasyonlar erken postoperatif olarak sınıflandırıldı. Bu üç hastadan ikisi kanama gelişti ve birinde kardiyak tamponat vardı. Hiçbir hastada perioperatif ve postoperatif mortalite görülmedi

Sonuç: HC yerleştirme, ultrasonografi ve floroskopi eşliğinde yapılan perkütanöz olarak; büyüklük, yaş veya tanıdan bağımsız olarak tüm çocuklarda güvenli ve uygulanabilir.

Anahtar sözcükler: Hickman kateter, ultrasonografi, floroskopi, vena jugularis interna, çocuk

The first vascular access may have been performed by William Harvey in 1628 (1). The clinical use of a central venous catheter was first published in 1952 (2). The combination of a silastic "cuffed" and tunneled central venous catheter was first described by Biovac in 1973, and it was improved by Hickman in 1979 (1,3,4). The use of ultrasonography (USG) for percutaneous cannulation was first described in 1990 (5). USG-guided catheter insertion has been used extensively; however, fluoroscopy was added in a few studies.

The catheter is placed into a large vein such as the internal jugular vein (IJV) or subclavian vein (6). The tip of the catheter is placed between the superior vena cava and the right atrium. There are two different methods of implantation for HC insertion in pediatric patients. In the past, HCs have been inserted using surgical techniques (cut-down or blind puncture). Recently, HC implantation has been guided by USG and/or fluoroscopy (7,8).

The present retrospective study evaluated the outcome of HC insertion with USG and fluoroscopy. Our study aimed to answer three specific questions: 1) Can HC be inserted percutaneously by USG and fluoroscopy in children at any age? 2) Is this approach safe in children? 3) Are there any complications of this approach in children?

Materials and methods

The medical data were retrospectively collected from the files of patients who were admitted for bone marrow transplantation and HC inserted by percutaneous USG and fluoroscopy guidance from August 2014 to January 2017. The collected data included the characteristics of the enrolled children, type of disease, site/size of insertion of the HC, and outcomes.

All HC insertions were performed using a standardized implantation technique. The size of HC was chosen according to the patient's age and weight. The lines inserted were all tunneled silicone Hickman lines with a Dacron cuff (size 7F-9F-12F, with two lumens) and the procedures were all performed under general anesthesia in the operating room. The USG probe was covered with a sterile cover. The patient was placed in the supine position, and a roll was placed under the shoulders, extending the neck with the head turned to the opposite side. The chosen vein was punctured under USG guidance. Once the needle entered the venous lumen, a guide wire was introduced and advanced into the superior vena cava via fluoroscopy. The introducer sheath was passed over the wire, an exit site was chosen, and the line was tunneled from the anterior chest wall up to the neck incision. The correct length of the line was assessed by holding the line over the anterior chest wall just above the nipple and taking a fluoroscopic image to check the position of the line tip at the level of the upper right atrium (Figure 1).

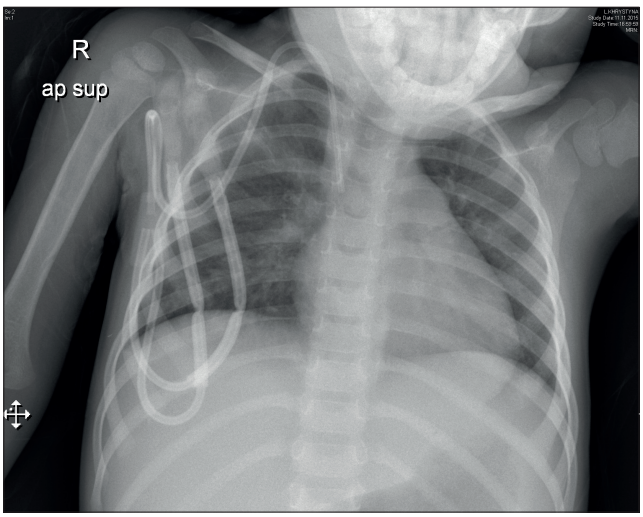

Figure 1. Catheter position at the end of the procedure.

The wire and dilatator were inserted, and then the catheter was inserted via a peel-apart sheath and checked by fluoroscopy. The neck incision was closed with an absorbable suture, and the exit line was stitched with silk. We didn't perform a postoperative chest x-ray in routine. However, if it was suspected for pneumothorax, we performed a postoperative chest x-ray.

The preferred implantation site is the right IJV (R-IJV). In case of a small R-IJV, a port or a thrombosed internal implantation site and a left-IJV (L-IJV) then the subclavian veins or femoral veins are chosen.

Contraindications for central venous catheter implantation were severe, non-correctable, hemorrhagic diathesis; systemic infections or infections at the planed (infections overlying the insertion site) implantation site; or a known allergy to parts of the catheter materials.

Statistical analyses

Data analysis was performed using SPSS version 14.0 statistical software. Preliminary analyses involved sample frequency tables. Data on the inserted HC were collected, and a descriptive statistical analysis of the demographic characteristics (age and sex), HC features, and outcomes was performed. The data were expressed as the mean (standard deviation) with a 95% confidence interval.

Results

Two hundred and six patients were included in this study. In total, 306 times of HC were positioned in 206 patients. One hundred and twenty-six patients were male, and the remaining 80 were female. The age range of the patients was 2 months to 19 (mean, 7.31±4.85) years. The patients weighed 4 to >50 kg. For almost all cases, a large-lumen central venous catheter was required for bone marrow transplantation (BMT).

Thirty-seven patients had more than one time HC inserted. For six of them, the HC was inserted four times. Successful cannulation occurred in 100% of the patients, for whom 45.4% of the HCs were 12F double-lumen lines, and 17.6% of the HCs were 7F lines.

The R-IJV was the preferred access vein, and 87.4% of the HCs were inserted in the R-IJV. The remaining patients had thrombosis, an already implanted (port) catheter was inserted through the right jugular vein, and therefore the L-IJV (11.1%) was used. The subclavian or femoral veins were used in 2.5% of the HCs inserted because of R-IJV and L-IJV had thrombosis. The mean length of time between catheter placement and removal was 147±108.9 (range, 7–795) days. In 64.1% of the patients, the catheters were removed because the therapy was successfully completed and the catheter was no longer needed. When catheter-related local or systemic infection was suspected, the catheter was removed also.

Of the 3 (1.4%) recorded as early postoperative complications: one patient had cardiac tamponade, and the other two had postoperative bleeding. It is illustrated in Table 1. The patient with cardiac tamponade underwent surgery to repair the puncture of the right atrium wall (Figure 2) (Figure 3). This patient was treated by sternotomy and primary suturing of the puncture area. The patients with bleeding were treated conservatively.

No intraoperative and postoperative mortalities were related to the inserted HCs.

Table 1. Catheter complications

Complications (Pre-interventional (within 24 h)	*Number*	*Therapy*
Bleeding	2	Manual compression
Cardiac tamponade	1	Primer suturation of puncture
Infection	Non	
Catheter migration	Non	
Extracorporeal catheter rupture	Non	

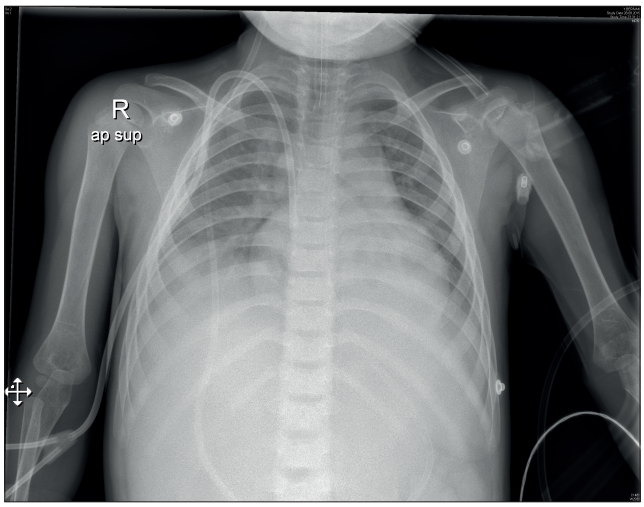

Figure 2. The view X-ray scan shows post procedure of HC insertion of cardiac tamponade.

Figure 3. The view computed tomography scan shows the patient with cardiac tamponade.

Discussion

Multi-lumen-tunneled central venous catheters are used often during BMT (7). These catheters are tunneled under the skin's protective barrier (2). There are many advantages of the multi-lumen central venous catheter, including the allowance of intensified therapy using different lumens for incompatible medication or the infusion of large volumes. The lumen of the catheter is large enough to allow stem cell acquisition, and the long subcutaneous catheter course reduces infectious complications during the period of leukopenia and can stay in place for weeks or months (7).

HC insertion through the jugular or subclavian veins is preferred (9, 10). However, the ideal vein is the R-IJV. The advantage of the R-IJV is the straight catheter course,

reducing the complication rate (7). In this study, we used the R-IJV for insertion in 87.4% of the patients. The remaining patients had a port or thrombosis; therefore, we used the L-IJV, subclavian or femoral veins.

Some studies have compared various techniques of insertion, including USG-guided insertion, which is safe and useful. A venous puncture can be performed blindly or under USG guidance (1,10). The jugular veins vary greatly in size and location and may develop complete or partial thrombosis, the use of a guide for percutaneous cannulation of the vein has been shown to result in a lower complication rate and a higher rate of success (1,7). Thus, the procedure is safe and feasible in all age groups.

Therefore, we observed no perioperative arterial puncture; all bleeding occurred at the ward a few hours after surgery in two patients. Postoperative bleeding was successfully treated conservatively using a compressive dressing.

Potential disadvantages of USG and fluoroscopy guidance include the additional cost of the USG and fluoroscopy device, sterile transducer dressing (as well as the dressing time), and radiation-related fluoroscopy. However, all of these factors are negligible in relation to the overall procedural costs. Compared with the open technique, this technique does not require a post-intervention chest X-ray to exclude complications such as pneumothorax and confirm the catheter tip position. Intraoperative fluoroscopy is required to confirm the catheter tip's proper position without malposition or kinking; therefore, the use of intraoperative fluoroscopic imaging to guide the insertion of catheters proved to be very helpful in minimizing complications (9). A very low incidence of immediate complications was detected post procedurally. Therefore, the chest X-ray is not mandatory as a routine method after fluoroscopy-guided insertion of HC (11). An X-ray should be performed only in cases of clinical suspicion (12). Because there was a 2.2% incidence of immediate pneumothorax and a 0.5% incidence of delayed pneumothorax after CVC insertion in a previous study (11), we didn't have a postoperative pneumothorax.

HC insertion is associated with technical accidents, arterial puncture, cardiac tamponade, hemopneumothorax, thrombosis, and infections (4,5,13). However, the cut-down method can lead to difficult reoperation, venous occlusion, and thrombosis more than the percutaneous method. Venous occlusion following open cut-down insertion of a central venous catheter is a common complication (1). The use of intraoperative USG-fluoroscopic imaging to guide the insertion of lines has several advantages, including less frequent maintenance, a smaller risk of complication, lower cost, and improved self and social acceptance (11,14). In our study, 1.4% of patients had complications, of those patients who had early complications: two had bleeding that was recovered by compression, and one had a cardiac tamponade that was recovered by suture of the puncture. Perioperatively, we could not diagnose a related small puncture. The patient was diagnosed at the ward during the postoperative period.

The complication rate in USG-guided insertion at the pediatric age ranges from 2.4% to 4.6% according to previous studies (5). This rate is high when USG and fluoroscopy are not employed. The complication rate of our patients was 1.4% for placed catheter bleeding and cardiac tamponade, a rate concordant with that in the literature.

Previous studies involved catheter insertion via open procedure in small, young patients (5,15), however, we performed a percutaneous procedure by USG and fluoroscopy in patients of all ages and weights. Particularly, the use of USG guidance in children is safe (15). In a previous study, HC insertion was performed on females more than males (10). However, in this study, there were males more than females. However, age and sex did not change the results.

In a previous study, the puncture procedure showed more complications, such as pneumothorax, than the open approach (14). However, we did not observe pneumothorax in our patients because we used USG for puncture; blind puncture may have been performed in that study.

The percutaneous technique allows an easier one-time approach to the same vein. Venous occlusion due to thrombosis is rare; however, the incidence may be higher after the open procedure (1,5). The presumption is that the dissection and suture of the vein in the open procedure traumatized the surrounding tissue and the vein itself, thus increasing the difficulty in reoperation and the risk of thrombosis (5). USG- and fluoroscopy-guided HC insertion with a low complication rate did not seem to be correlated with the experience of the operator (16). However, the procedure was not associated with thrombosis.

There are some limitations in this study that should be considered. One potential limitation is that the HC is a large bore and silicon catheter, therefore, we preferred it more than the peripherally inserted central venous

catheter. Because our patients are small age and their vessels are so small related to their chronic diseases and longer dwell time. Therefore, PICC couldn't be used for axillary and basilic veins. Finally, echocardiography and electrocardiography were used to locate the tip of the catheter more than fluoroscopy.

In conclusion, HCs are important for BMT in patients. USG- and fluoroscopy-guided percutaneous HC insertion is safe and has a high success rate and a low complication rate. Additionally, the procedure enables the same vein to be used many times and can be applied in children of all ages.

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