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Original Article / Özgün Araştırma

Ultrasound-Guided Cannulation of the Brachiocephalic Vein in Infants and Children is Useful and Stable

Bebeklerde ve Çocuklarda Ultrason Kılavuzluğunda Brakiyosefalik Ven Kanülasyonu

Mark E. Thompson[1,2,3]

[1]*Department of Anesthesiology State University of New York at Buffalo, Buffalo NY, USA*

[2]*Department of Anesthesiology Texas Tech University of Health Sciences, Lubbock TX, USA*

[3]*Department of Anesthesiology Covenant Children's Hospital, Lubbock TX, USA*

Abstract / Öz

Objective: Ultrasound-guided (USG) cannulation of the brachiocephalic vein (BCV) has been shown to be technically easy. We hypothesised that adoption of USG in-plane cannulation of the BCV as the primary approach to central venous cannulation at our institution would lead to central venous cannulation for a greater variety of indications.

Methods: We performed retrospective, descriptive comparison of all central lines placed in patients aged <16 years who underwent any surgical operation during calendar years 2012–2014 at a small, free-standing children's hospital. The use and management of a central line was reviewed until the patient was discharged from the hospital. Analysis of the data was performed using simple comparative statistical methods.

Results: Forty-nine patients were identified, 20 who weighed <10 kg and 29 who weighed >10 kg. Cannulation was successful in all patients. No significant late complications occurred. Catheters were well tolerated post-operatively, with no accidental dislodgement and no removal because of discomfort. The average duration of insertion was 6.3 (3–20±3.77) days. Nine catheters were placed for access during emergency surgery. 15 were placed in patients with difficult peripheral intravenous (PIV) access. The central lines remained in place until discharge in 79.6% of patients. In 40% of patients, the PIV catheter was removed, and the central line was retained because of preference. Total parenteral nutrition (TPN) was administered in 11 (22.4%) patients.

Conclusion: Cannulation of BCV was well tolerated by children, with an average insertion duration of 6.3 days, which often lasted beyond the removal/failure of the PIV cannula. Catheters were useful for primary venous access during hospitalisation and for short TPN courses.

Keywords: Brachiocephalic vein, central venous cannulation, paediatric, ultrasonography

Amaç: Ultrason rehberliğinde (USG) brakiyosefalik ven (BCV) kanülasyonunun teknik olarak zor olmadığı gösterilmiştir. Uygulama kolaylığı ve hasta rahatından dolayı, bizim kurumumuzda santral ven kanülasyonu için ilk yaklaşım olarak kabul edilmesinin, santral ven kanülasyonu endikasyonlarını genişletebileceğini varsaymaktayız.

Yöntemler: 2012-2014 yılları arasında bağımsız bir çocuk hastanesinde herhangi bir cerrahi operasyon geçiren 16 yaş altındaki hastaların santral yolları retrospektif olarak incelendi. Hastaneden taburcu olana kadar yolların kullanımı ve yönetimi incelendi. Verilerin analizi karşılaştırmalı istatistik yöntemleri ile yapıldı.

Bulgular: Kırk dokuz olgu belirlendi. Bunların 20'sinin ağırlığı 10 kg'ın altında iken, 29'unun ağırlığı 10 kg'ın üzerindeydi. Tüm vakalarda kanülasyon başarılıydı. Önemli geç komplikasyonlar görülmedi. Kateterler kazayla yerlerinden çıkmadan ve rahatsızlık nedeniyle çıkarılmadan ameliyat sonrasında iyi tolere edildiler. Kateterlerin ortalama kalış süresi 6,3 gün (3-20±3,77) olarak bulundu. Dokuzunda acil cerrahide girişi sağlamak için yerleştirildi. On beş olguda bilinen veya karşılaşılan zor periferik intravenöz (PIV) giriş için yerleştirildi. Olguların %79,6'sında kateterler, hasta eve taburcu olana kadar yerinde kaldı. Vakaların %40'ında PIV kateteri çıkarıldı ve santral tüp tercihe bağlı olarak bırakıldı. On bir hastada (%22,4) total parenteral nutrisyon (TPN) uygulandı.

Sonuç: BCV kanülasyon, genelde PIV kanülün çıkarılması/başarısızlığının ötesinde, ortalama 6,3 günlük kalış süresiyle çocuklar tarafından iyi tolere edildi. Kateterler hastane yatışı sırasında primer venöz girişi olarak ve kısa süreli TPN yöntemi açısından faydalı bulundu.

Anahtar Kelimeler: Brakiyosefalik ven, santral venöz kanülasyon, pediatrik, ultrasonografi

Introduction

The brachiocephalic vein (BCV) occurs at the confluence of the internal jugular (IJ) and subclavian veins. The paired BCVs merge into the superior vena cava. The left BCV may rarely continue as a persistent left superior vena cava. BCV was previously known as the innominate vein or the 'vein without a name'. On the right side, BCV t is sometimes referred to as the superior portion of the superior vena cava, whereas on the left side, it is sometimes referred to as the continuation of the subclavian vein.

Poster abstract presentation at Post-Graduate Assembly of the New York State Society of Anesthesiology, New York City, New York USA, December 2015.

Bu araştırma, Aralık 2015 tarihinde New York Anesteziyoloji Derneği Lisansüstü Eğitim Kurulu, ABD'de poster özeti olarak sunulmuştur.

Address for Correspondence/Yazışma Adresi: Mark E. Thompson E-mail: methompsonmd@gmail.com

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Cannulation of BCV was initially described in 1965 by Yoffa (1) as a landmark-based approach in the supraclavicular fossa. Illustrations in that study clearly indicated that the needle was intended to enter what we now call BCV, although Yoffa used the older nomenclature of 'subclavian' and 'Pirogoff's confluence'. This approach may not have gained popularity because of early reports of pneumothorax in 1969 (2). Whether owing to concerns of causing pneumothorax, or confusion in the nomenclature, widespread adoption did not occur, leading to some authors to call the BCV approach 'the forgotten central line' (3, 4).

With the introduction of ultrasound into routine clinical practice, the brachiocephalic approach has regained interest because of the superficial location of BCV, and lack of bone overlying the vein, makes it possible to visualise the entire path of the needle during cannulation. In 2011, Breschan et al. (5) first described USG cannulation of BCV in children. They studied placement in children aged 26 months to 8 years. In the same year, Rhondali et al. (6) described placement in patients weighing <10 kg. Other studies have assessed placement in patients weighting <5 kg (7, 8). Three studies noted that USG BCV cannulation is technically easy in children in the paediatric intensive care unit and neonatal intensive care unit (8-10).

Methods

The internal review boards of Covenant Children's Hospital and Texas Tech University Health Sciences Center waived the requirement for informed consent for this retrospective, observational study. The study was conducted as per the protocol approved by both internal review boards.

A single anaesthesiologist began performing USG cannulation of BCV in January 2012 at our institution shortly after its initial description in the literature. Before that, central lines were infrequently placed; therefore, a case–control study was not possible given the lack of a historical control group. Patients in this study were consecutive cases of central venous cannulation by the author during calendar years 2012-2014. This study analyses the duration of insertion and characterisation of venous access at removal as primary outcome measures. Patients with central line placement were identified by billing records and case logs. Charts were reviewed via the electronic medical record for measurements of interest. Fifty-seven patients were identified. Six adults were excluded from this review, leaving 49 paediatric patients for review. Statistical analysis was performed with basic spreadsheet functions such as average, mean and standard deviation.

The SonoSite S-Series machine (Bothell, WA, USA) was used with a sterile sheath probe cover. For children weighing <10 kg, a narrow linear 13-6 MHz probe (LX25x, SonoSite) was used, and a 5-Fr 8-cm double-lumen catheter was chosen. For very small infants, a 5-cm double-lumen catheter was chosen, especially if cannulation of the right side was anticipated. For children weighing >10 kg, a linear 15-5 MHz probe (HFL50x, SonoSite) was used along with a 5-Fr 8- or 12-cm catheter. Portable radiograph confirmed placement before the child left the operating room.

The entry site of the catheter was covered with a chlorhexidine gluconate impregnated patch (BIOPATCH® Ethicon, Somerville, NJ, USA) and secured with Mastisol® (Ferndale IP Inc., Ferndale, MI, USA) and Tega-derm™ (3M, St. Paul, MN, USA).

Coincident with our adoption of the USG BCV cannulation technique, our institution also implemented an algorithm intended to limit the number of attempts made to place a PIV cannula in children to prevent trauma and loss of useful veins. The "Difficult IntraVenous Algorithm" advised that after 5 attempts, or twenty minutes of attempts at placing a PIV, the involved team caring for the child was to pause and reflect on the value of continuing to search for a PIV, or consider another method of establishing venous access. In the operating room, the most common method chosen in this situation was USG BCV cannulation by anaesthesiology.

Results

Forty-nine patients were identified, 20 weighing <10 kg and 29 weighing >10 kg. Cannulation was successful in all patients. Patient weights ranged from 1.4 to 88 kg. Descriptive and calculated variables are presented in Table 1. All central lines were placed in the operating room during the induction of anaesthesia. Nine catheters were placed for resuscitation during emergency surgery, three of which were in infants weighing <10 kg. Fifteen catheters were placed for known or encountered difficult intravenous access or no intravenous access status. The rest of the catheters were placed for craniotomy, thoracic, major abdominal or major orthopaedic surgeries.

Central line cannulation of the BCV was successful in all patients. Difficulty was noted in three patients, one with arterial puncture, and two with difficulty threading the wire. All three were managed successfully by changing the approach to the contralateral side. Placement was on the left side in 31 (63.2%) patients.

The average insertion duration was 6.3±3.77 (2–20) days. In patients weighing <10 kg, the average insertion duration was 7±4.10 (3–20) days, which remained in place slightly longer than that in patients weighing >10 kg. There were no cases of thrombosis, infection, accidental removal or pneumothorax. Three patients who experienced fever postoperatively with temperature >38.1°C had their central lines removed per sepsis workup protocol. All three had sources of infection (surgical) far removed from site of cannulation. Short courses of total parenteral nutrition (TPN) were administered in 11 (22.4%) patients. PIV cannula was removed within an average of 3 days post-operatively as per the hospital protocol or

Table 1. Description of patients (n=49)

	<10 kg (n=20)	>10 kg (n=29)	Combined (n=49)
Age (range)	10.6 (1–30) mo†	5.3 (1–16) yr‡	3.8 yr (1 mo to 16 yr)
Weight in kg⁰ (range)	7.46±2.04 (1.4–9.8)	22.44±17.54 (10.1–88)	16.33±15.38 (1.4–88)
Duration in days (range)	7±4.10 (3–20)	5.8±3.51 (2–16)	6.3±3.77 (2–20)
Removed at discharge	95% (19/20)	68.9% (20/29)	79.6% (39/49)
Used for TPN	5	6	11
Emergency surgery	3	6	9
Difficult venous access	10	5	15
Left/Right sided	12/8	19/10	32/19

TPN: total parenteral nutrition; †mo, months; ‡yr, years; ⁰kg, kilograms

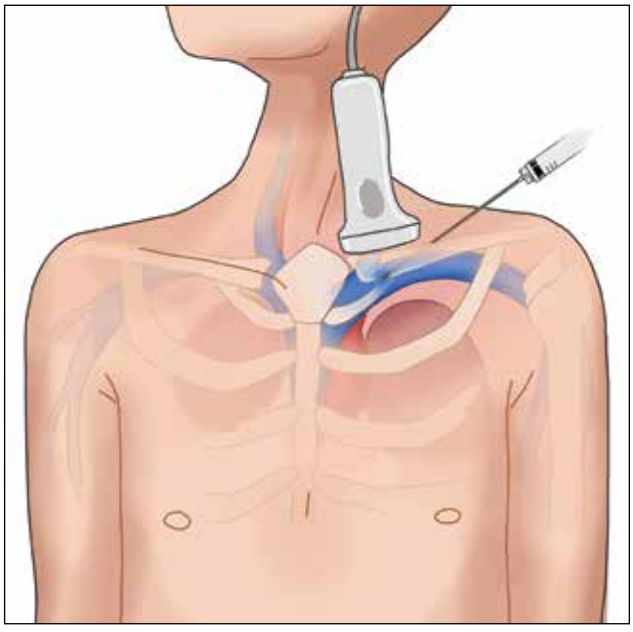

Figure 1. Supraclavicular position of ultrasound probe and needle

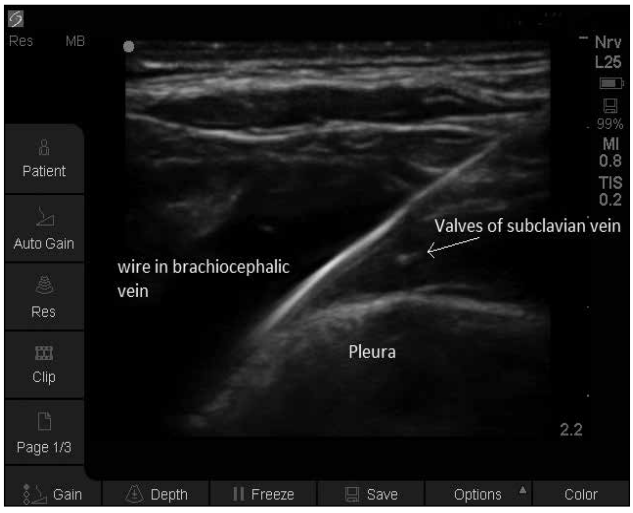

Figure 2. Ultrasound image of wire entry at the confluence and extending down into BCV

failure of PIV, and the central lines were kept in place as the primary venous access in 40% of patients. The central lines were removed within 2 hours of the patients being discharged from the hospital 79.6% of the time. In patients weighing <10 kg, the central lines were more likely to be retained until discharge with 95% (19/20) remaining until being discharged home.

Discussion

The benefits of USG cannulation of BCV include visualisation of the needle along its entire path from the skin to the vein, patient comfort when the catheter is secured over the top of the shoulder and ease of maintaining dressings, which may reduce incidence of early removal for contamination concerns. Cannulation of IJ, which despite being a large vein that is easy to cannulate, is often very uncomfortable for patients. Neck movement often disrupts the integrity of the catheter dressing, rendering the insertion site vulnerable to contamination. Likewise, it is difficult to maintain barrier sterility with femoral central lines because of patient movement, and patients may remain immobile owing to discomfort with femoral lines. The supraclavicular approach to BCV is unique in that the catheter dressing usually tightly adheres and inconspicuously drapes over the shoulder in a manner that does not restrict arm or neck motion. It does not transverse the pectoralis muscle; therefore, it is less likely to limit upper extremity movement compared with the infraclavicular subclavian approach. Cannulation of the BCV has been promoted to have a lower potential for contamination compared to internal jugular, subclavian, or femoral central lines (11).

Despite variation in nomenclature, the important distinction from other central venous approaches is that the catheter lies predominately within BCV, even if it enters through the distal portion of the subclavian vein into Pirogoff's confluence. Figure 1 shows an artist's rendition of the arrangement of anatomy and the cannulation approach. Figures 2 and 3 demonstrate the USG approach with confirmation of cathe-

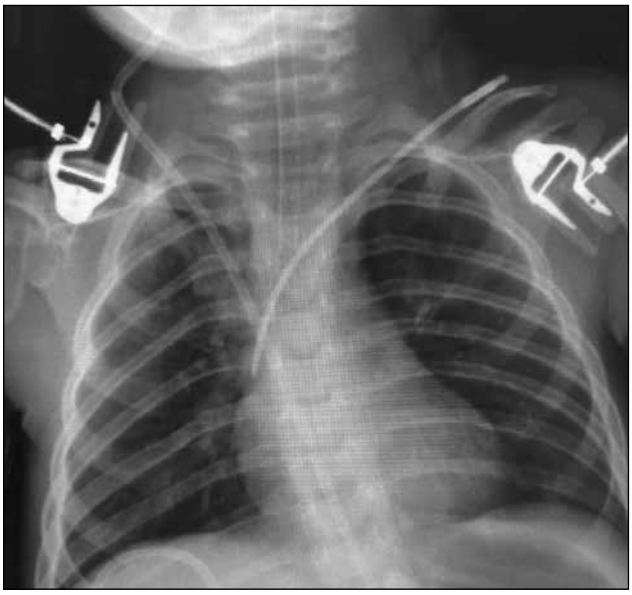

Figure 3. Plain film confirmation of central line placement

Figure 4. Catheter secured and draping over the left shoulder

ter placement obtained with plain film x-ray. The catheter can be secured across the top of the shoulder, and in this position it is not uncomfortable with movement of the head or arm (Figure 4).

Descriptions of USG cannulation of BCV may be confused with USG infraclavicular and supraclavicular cannulation techniques of the subclavian vein around the mid-portion of the clavicle (12-15). A recent meta-analysis of 10 studies in adult patients noted that employing ultrasound guidance for subclavian cannulation significantly reduced adverse events (16). There are insufficient studies of cannulation of BCV in children to complete a similar meta-analysis. , It is reasonable to assume that a reduction in complications would also be found.

In these patients, placement in the left BCV was more common but both sides are reported as being used successfully (17, 18). It may be helpful to scan both supraclavicular fossa pre-procedure to evaluate which side has the most complete visualisation of the arc of the subclavian/brachiocephalic confluence (7).

Although we did not experience any adverse outcomes, this study was not designed to examine safety compared to other methods.

Conclusion

This study presents descriptive evidence that central lines in BCV are well tolerated by children and are a useful option for intermediate-term venous access in patients undergoing complicated surgery or those with known or anticipated difficult PIV cannulation. This case series uniquely follows patients until discharge and assesses how the central lines were used and managed. These lines were retained post-operatively for an average of 7 days because they are well tolerated by children, easy to care for and useful for intravenous access. USG supraclavicular in-plane cannulation of BCV is both useful and durable.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Covenant Children's Hospital and Texas Tech University Health Sciences Center.

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