Surgical insertion of central venous catheters in low-birth-weight neonates

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Aim: **Neonatal central vascular access (CVA) represents a daily practice in neonatal intensive care unit. Low birth weight (LBW) neonates pose a challenge to anesthetists who try the landmark technique to cannulate central veins. We reported our experience of open surgical cutdown (OSC) to insert catheters through right internal jugular vein (IJV) and assessed feasibility, operative time, durability of line, and postoperative complications of this technique.**

Methods: **A total of 660 LBW neonates needed CVA and underwent OSC of right IJV because of medical and surgical indications. We reported operative time, whether anesthesia or sedation, whether in the theater or at the bedside, difficulties, complications and duration of line, and causes of failure. Transverse neck incision was made 1 cm above the medial third of the clavicle, right IJV was identified, venotomy was performed, and catheter was inserted.**

Results: **A total of 660 LBW neonates had CVA in right IJV, ligation of vein occurred in the first 30 cases but later venotomy was repaired. Mean operative time was 11.3 min. No injury of the right carotid artery or vagus was reported. None had postoperative pneumothorax. Overall, 542 cases had lines until they were discharged. A total of 43 cases needed redo. Thirty-five cases had line-associated infection and 40 lines were thrombosed.**

Conclusion: **OSC of right IJV was feasible and had lower complication rates.** ***Ann Pediatr Surg*** **11:218–221 © 2015 Annals of Pediatric Surgery.**

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Introduction

Vascular access has become a very important aspect of care for neonates. Central venous access (CVA) has enabled the administration of medication and nutrition to neonates who often require long-term parenteral medications or nutrition that would be difficult or impossible to administer. Approximately 8.3–33% of neonates who are admitted into the NICU require CVA [1–4].

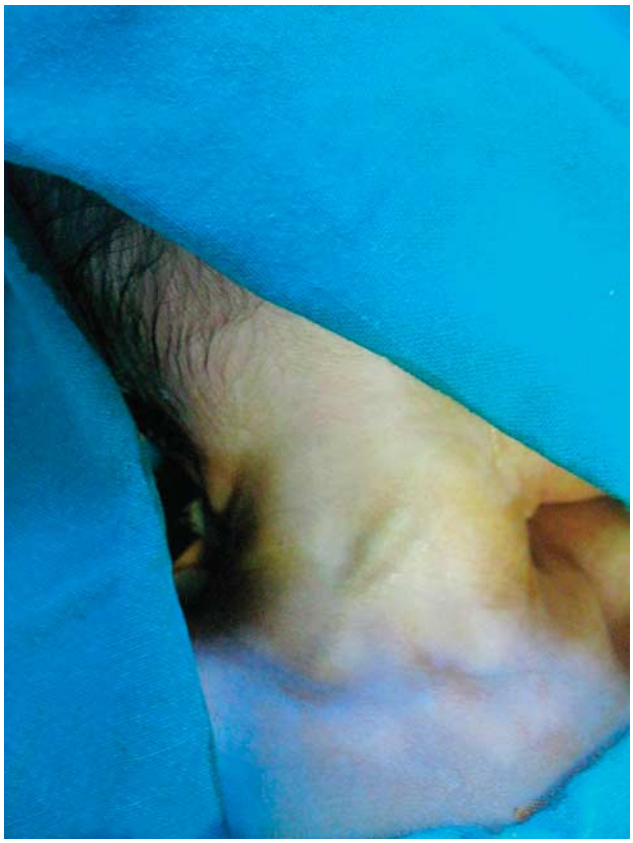
As advancements in both medical and surgical care have improved the survival of neonates significantly, the need for long-term CVA has also increased [5].

We assessed insertion of these CVA catheters through a small incision for venous cut down of the Rt. internal jugular vein (IJV) in low-birth-weight neonates.

Patients and methods

During the period from September 2008 to September 2014, we started to insert the CVA through venous cut down on the Rt. IJV. A total of 660 neonates were in need of CVA for different indications, either surgical or medical. There were no exclusion criteria for insertion. We inserted these lines either bedside in the NICU or in the operating room. Neonates who underwent the procedure in the operating room received general anesthesia and those in the NICU received local anesthetic infiltration if they were awake; we fixed the neonates using adhesive steps or sedated neonates on a ventilator. We started the procedure with the neonate in the supine position with a small bellow under the shoulder blades and securing the cervical spine (Fig. 1). A small transverse incision 1 cm in length was performed

Fig. 1



Positioning of the patient.

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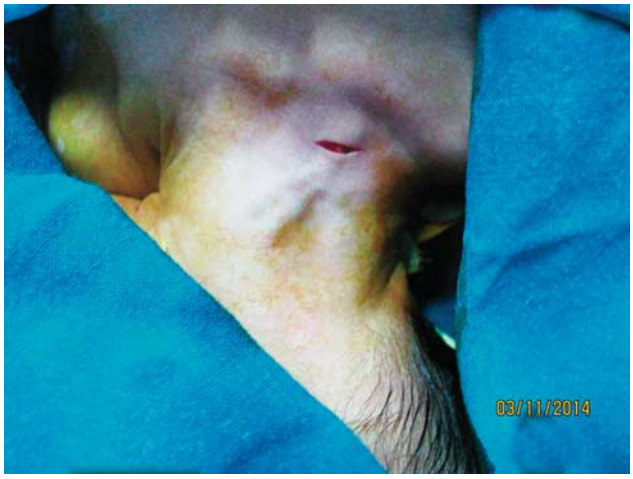
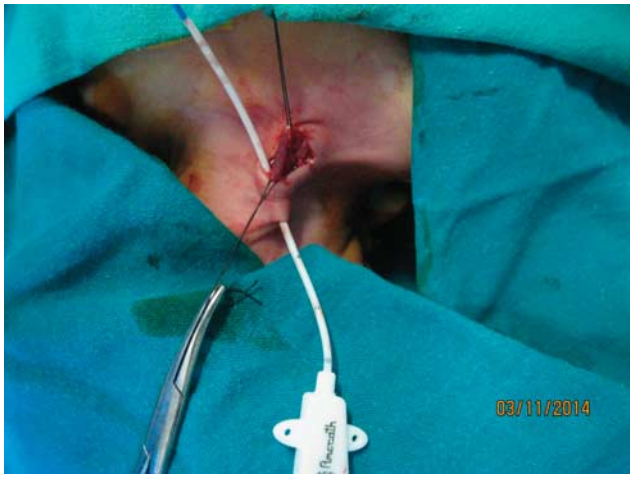
Fig. 2



Incision 2 cm above the medial 1/3 of the clavicle.

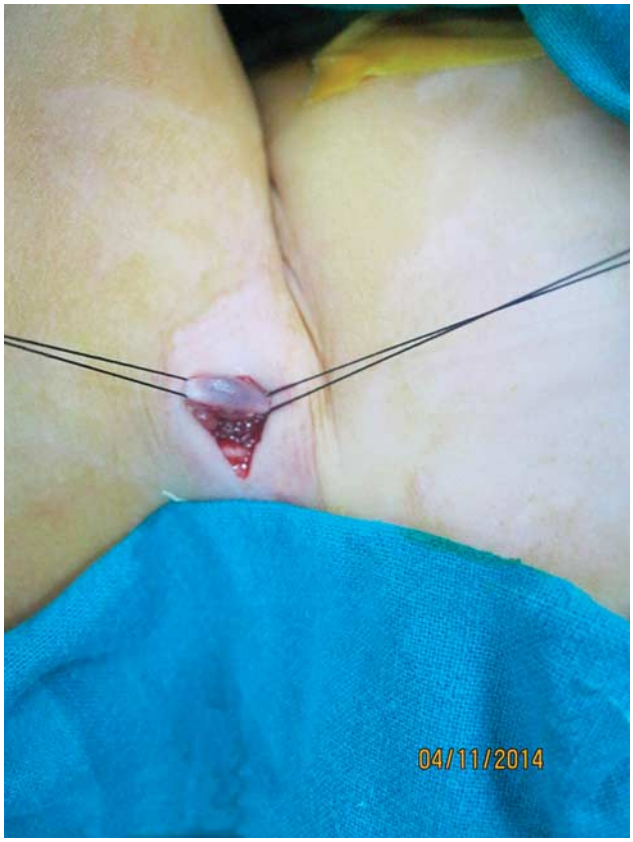
Fig. 3



Proximal and distal control of internal jugular vein.

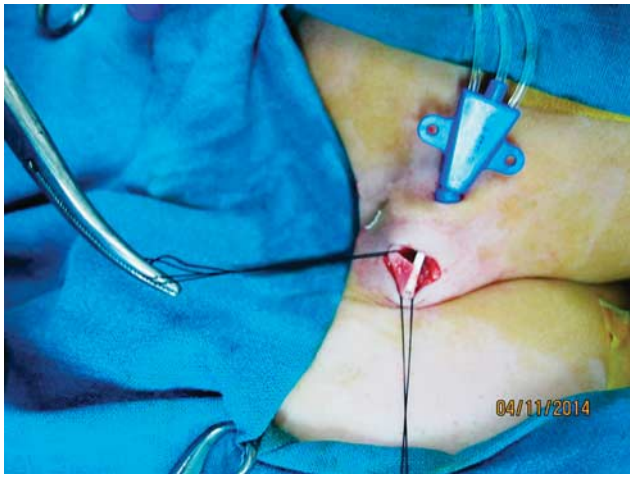
2 cm above the medial third of the right clavicle (Fig. 2); dissection was started between the two heads of the right sternomastoid muscle toward the Rt. IJV. We identified it with the Rt. carotid artery and the Rt. vagus nerve. Distal and proximal venous control was performed using two fine rubber threads (Fig. 3). Tunneling was performed in the cephalic direction and the venous catheter was passed through this tunnel (Fig. 4). The size of the catheters were either 4-Fr 6 cm or 5-Fr 6 cm. We performed venotomy along the long axis of the anterior wall of the vein (Fig. 5). The catheter was introduced into the vein and then repaired by venotomy using 6/0 monofilament sutures. We insured free flow of blood through all the lines of the catheter is either double or triple channels. Then, the line was fixed into the neck skin using monofilament suture material 3/0 and the wound was closed in layers. The line was routinely flushed using heparinized saline, either infusion or every

Fig. 4



Tunneling for the line.

Fig. 5



Venotomy and line insertion.

2 h, to prevent thrombosis of the line and its subsequent occlusion.

Results

During the period between December 2008 and November 2014, we operated on 660 low-birth-weight neonates with venous cut down on the Rt. IJV to insert the CVA.

Table 1 Demographic data and indications

Demographic data and indications for CVA	
Total number of cases	660
Males	370
Females	290
Mean age (days)	3.3
Mean weight (g)	1050
Indications	
Surgical	550
Duodenal atresia	120
Other causes of IO	140
CDH	60
NEC	180
TEF	50
Medical	110
RDS	70
Severe prematurity	40

CDH, congenital diaphragmatic hernia; CVA, central venous access; IO, intestinal obstruction; NEC, necrotizing entercolitis; RDS, respiratory distress syndrome; TEF, tracheoesophageal fistula.

Table 2 Operative and postoperative data

Type of anesthesia and place of procedure	
General anesthesia in the theater	550 neonates
Local analgesia bedside	110 neonates
Mean operative time (min)	11.3
Operative complications	
Injury of Rt. IJV and complete ligation	30
Repair of venotomy	630
Injury of the Rt. carotid artery	None
Injury of the Rt. vagus	None
Postoperative complications	
Pericardiac effusion	None
Pneumothorax	None
Wound infection	19 cases
Hematoma	None
Leak of infused fluids	27 cases
Thrombosis of line	40 cases
Accidental dislodgement	16 cases
Associated sepsis and removal	35 cases
Mean duration of the line (days)	22.5
Need for redo on the same site	43 cases

IJV, internal jugular vein.

The mean weight of our patients was 1050 g and the mean age was 3.3 days. In terms of sex, there were 370 males and 290 females. There were 550 neonates with surgical neonatal diseases (neonatal intestinal obstruction, tracheoesophageal fistula, congenital diaphragmatic hernia, necrotizing entercolitis) and 110 neonates with medical diseases (respiratory distress, severe prematurity) (Table 1).

A total of 550 neonates underwent the CVA under general anesthesia in the theater and 110 neonates underwent bedside procedures (patients received local analgesics by a subcutaneous injection and sedation). The mean time needed to insert CVA was 11.3 min. The mean duration of CVA was 22.5 days. Accidental dislodgement occurred in 27 cases. Thrombosis of the line occurred in 22 cases. No cases developed pneumothorax. No injury of the Rt. carotid artery or the Rt. vagus occurred. No accidental bleeding or tear of the Rt. IJV occurred. No cases developed hematoma. No pleural or pericardiac complications occurred. Leak from the wound occurred in 27 cases of accidental dislodgement, which was incomplete. Wound infection occurred in 19 cases. In 20 cases, we had to completely ligate the Rt. IJV because of venotomy that extended to more than two-third of the circumference and this occurred during our early experience. Infection of the line occurred in 35 cases and this necessitated extraction of CVA and their tips were sent for culture and sensitivity. We encountered no associated mortality because of the procedure. Except for complicated cases, catheters were removed on elective bases. In cases with accidental dislodgement or thrombosed lines still in need of CVA, this approach enabled us to reinsert on the same side with high success rates in 49 cases (Table 2).

Discussion

Although CVA is an essential procedure for the functioning of any major tertiary-level pediatric hospitals, there are few studies comparing the various techniques of insertion. Fatalities and failure to cannulate the vein using the traditional landmark technique (LT) without ultrasound guidance are well reported. As a result and although there are no large studies of open surgical cutdown (OSC) for direct comparison, many pediatric surgeons use OSC as a technique of choice; even those interested in using LT often prefer OSC in smaller babies requiring CVA [6–10].

Also, in recent years, the development and increasing success of peripherally introduced central catheters have markedly reduced the need for invasive OSC. Also, neonatal care advances and much more smaller and premature babies survive and these babies are small enough to require OSC [11,12].

In our study, we used Rt. IJV as the first and only choice to perform the OSC in our neonatal patients as it is easier and associated with fewer complications compared with the femoral or subclavian veins.

Chait *et al*. [13] used Rt. IJV for the same reasons and they attempted to place CVA lines through this vein even it had stenosis or partial thrombosis.

During our procedure, we clearly identified the Rt. IJV and venotomy was performed carefully to avoid injury to any other structures.

Alderson and colleagues showed that about 18% of children younger than 6 years of age have anatomical factors that could complicate the classic LT to cannulate the Rt. IJV. They showed that IJV overlaid the common carotid artery in 10% of infants, was unusually small in 4%, ran widely lateral in 2%, and could not be identified in a further 2% [14].

Also, positioning maneuvers such as rotation of the head to the contralateral side can cause the IJV to overlap the common carotid artery, and flatten the IJV even more and decrease the distance between the IJV and the carotid artery [15].

LT for CVA is known to be more difficult in children than adults. The small diameter of IJV in low birth weight neonates to the age and the weight makes its success more difficult than in adults. The smaller dimensions of the IJV in infants increase the number of attempts, favor the changes in puncture points and the depth of needle

insertion, and finally increase the risks of complications including carotid artery injury or pneumothorax [16].

In our work, the overall success rate was 100% as there were no multiple trials to puncture the vein and no accidental puncture of adjacent structures.

Verghese *et al.* [17] reported that the overall success rate was 81% for landmark technique (LM) patients compared with 94% with ultra sound (US)-guided insertion, and fewer attempts to achieve successful cannulation and fewer inadvertent carotid punctures.

However, Grebenik *et al.* [18] reported that the overall success rate for LM increased to 89% and there was increased incidence of carotid puncture in the US group, but this was may have been because of limited experience with the US techniques.

The use of LM technique to insert CVA requires multiple trials maneuver can lead to hematoma formation that might induce changes in IJV or might even cause external compression, which makes its access more difficult even when US locations is used as rescue techniques [16].

The rate of venous line occlusion or thrombosis in our series was 3.33%. We adequately visualized the vein before and during venotomy; thus, there was no need for multiple punctures.

Koksoy *et al.* [19] reported 40% venous thrombosis after LT and found that this was significantly associated with the need for multiple needle punctures.

Barnacle and colleagues, showed that the rate of venous thrombosis after OSC may be as high as 33%. They attributed this to the need for multiple punctures and thus adequate visualization before and during cannulation of the vein by US reduced this rate to less than 3% [20].

In our series, we inserted CVA as a bedside technique in 110 neonates, either intubated or by sedation and local analgesia.

This was identical to Hong *et al.* [5], who reported their experience with central venous cut down in neonates as a bedside procedure without general anesthesia.

We encountered no complications such as hematoma, pneumothorax, or pleural effusion, and also avoids inadvertent punctures of the carotid artery or related nerves.

The overall complications rate after LT ranged from 10 to 20% in all cases, but this complication rate decreased to about 3% in neonates subjected to a US-guided approach [21].

Conclusion

We believe that OSC on the Rt. IJV is safe, quite easy, and can be performed either in the operating room or as a bedside procedure; it can also save time and resources in low-birth-weight neonates. In addition, it is associated with lower complication rates. This procedure represents a solution for low-birth-weight neonates subjected to multiple failed trials by LT to cannulate the IJV.

Acknowledgements

Ethical committee approval was obtained.

Conflicts of interest

There are no conflicts of interest.

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