The Clavicular Notch as an Alternate Anatomical Landmark for Internal Jugular Vein Cannulation in Infants and Children: A Descriptive Study

Vijay Mohan Hanjoora, Agnes Suah Bwee NG, Josephine Swee Kim TAN, Nambiath Sujata

ABSTRACT

Objective: To evaluate an alternate anatomical landmark technique for internal jugular vein cannulation in infants and children.

Aim: To evaluate the success and safety of the clavicular notch as a bony landmark for central venous cannulation in infants and children.

Background: Central venous cannulation can be particularly difficult in infants and children. While ultrasound-guided techniques are well established, the majority of central venous catheters are placed using landmark guidance with variable success rate. This prospective study documents the success and safety of a modified landmark technique using the clavicular notch as a bony landmark for central venous cannulation in this group of patients.

Materials and methods: One hundred and fifty children under 12 years of age belonging to ASA grade I to III were included in the study. All children were placed in 15° trendelenburg position with head rotated 40° to the opposite side. The relationship of the IJV to the carotid artery was noted by audio Doppler. The notch technique was used only if the IJV was detected by Doppler at the notch. Using the standard seldinger technique the IJV was cannulated and the complications were noted. The traditional approach was our rescue method.

Results: The IJV was localized at the clavicular notch in 95.33% (143/150) cases by audio Doppler and the overall successful cannulation rate was 98.6% (141/143). We encountered complications in 13 (8.6%) cases, none of which had any adverse outcome.

Conclusion: This study confirms the consistent location of IJV at the clavicular notch. Therefore, the ‘notch technique’ can be used successfully for IJV cannulation in infants and children.

Keywords: Internal jugular vein, Infants and children, Cannulation.


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Conflict of interest: None declared

INTRODUCTION

Central venous cannulation (CVC) of the internal jugular vein (IJV) in neonates and infants is technically more challenging with an increased risk of complications as compared to older children and adults.1,2 While ultrasound-guided techniques are well-established,3 the majority of central venous catheters are placed using landmark guidance, as such devices are not available at all centers. Despite the multiplicity of the landmark based techniques for central venous cannulation, none are ideal.4,5 The purpose of this descriptive clinical study was to examine the success and safety of a modified landmark-guided technique using the clavicular notch as a bony landmark for IJV cannulation in paediatric patients. The ‘notch technique’ for IJV cannulation was first reported by Rao et al6 based on the consistent finding in children and adults of an easily identifiable notch located just above the medial end of clavicle. Bony landmarks of clavicular notch.6

Medial: Bounded by the upward curving projection of the sternal end of the clavicle.

Inferiorly: Superior surface of clavicle.

MATERIALS AND METHODS

After obtaining approval from the hospital ethics committee and written parental consent, one hundred and fifty children under 12 years of age belonging to ASA grade I to III were included in the study. Central venous cannulation was performed following monitor placement, induction of general anaesthesia and insertion of peripheral intravenous line. All IJV cannulations were attempted by paediatric anaesthesia registrars and consultants.

Position: All children were placed in 15° trendelenberg position, pillows removed and head rotated 40° to the opposite side of cannulation. The neck was extended with rolls under the shoulder. Audio Doppler (AD) guidance was provided by a 10 MHz Doppler. (Model MD 2/SD 2, Huntleigh Diagnostics). The relationship of the IJV to the carotid artery at notch was noted.

Technique: The notch was identified by palpation on the medial end of the clavicle. The AD probe was placed on the neck near the thyroid cartilage and moved laterally until the crisp pulsatile sound of carotid artery was identified. With further lateral advancement, the more continuous, low pitched venous hum of the IJV was heard. The course of the vein was then mapped until the clavicular notch
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and the consistency of the IJV entry at the notch into the thoracic inlet was documented. The notch technique was used only if the IJV was detected by Doppler at the notch. Under sterile conditions a 22G cannula was used to access the IJV below the apex of the sternocleidomastoid muscle triangle. The cannula was directed caudally, parallel to the sagittal plane, at 30° angle to the coronal plane toward the notch. IJV cannulation was identified by the easy aspiration of dark coloured blood from the vein. Using the standard seldinger technique, a guide wire was passed through the cannula, followed by tissue dilatation and advancement of an appropriate sized central venous catheter. Complications related to CVC were documented intraoperatively and post-operatively. The traditional landmark technique was used if the notch technique failed to successfully cannulate the IJV after a maximum of three attempts or the IJV was not localized at the notch by the AD.

RESULTS

One hundred and fifty children (83 males, 67 females) with a median weight of 9.2 kg (1.6-58 kg) were included in the study. In 38 subjects weighing <5 kg, 46 subjects weighing 5 to 10 kg and 59 subjects weighing >10 kg, the first attempt successful cannulation rate was 52.63, 82.60 and 81.36% respectively. The ultimate success rate (within three punctures) was 94.74% (36/38), 100% (46/46) and 100% (59/59) respectively (Table 1). The IJV was localized at the clavicular notch by AD in 95.33% (143/150) cases and the overall successful cannulation rate was 98.6% (141/143) (see Table 1). We encountered complications in 13 patients (8.6%) which included three cases of pneumothorax, nine cases carotid artery puncture and one incidence of false tract after dilatation (see Table 1). None of the complications had any adverse outcome.

DISCUSSION

It is well accepted that accessing the vein with the aid of ultrasonography is superior to other techniques for CVC in paediatric patients.1-3 But, such devices are expensive and not available in all centers. Different approaches for IJV cannulation based on surface landmarks like the sternocleidomastoid muscle and carotid artery has been described in the paediatric population,4,5 but their success rates and complications vary from study to study, and is probably related to operator experience.

Traditional anatomical landmark technique can achieve more than 90% success rate in children and adults, but it drops to 77 to 81.3% in infants and younger children,7 with an incidence of arterial puncture ranging from 11.3 to 25%.3,7 In our study, the ultimate success rate was over 94% in children weighing <5 kg while the incidence of arterial punctures was 15.38%. The incidence of increased carotid artery punctures could be due to the small calibre of the vessels and proximity of carotid artery to the vein in the less than 5 kg group. Alderson et al8 reported anomalous venous anatomy in 18% of the children by ultrasonography, which may account for some of the difficulties reported for CVC cannulation by traditional landmark technique. They also opined that the diameter of IJV was predicted poorly by the patient’s age and weight.

Various studies in infants using AD probe to map the course of the artery and vein before needle insertion have not reported a better success rate. Kayashima and Fukutome9 reported an ultimate success rate of 61% while Arai and Yamashita10 obtained a success rate of 45.3% within 3 punctures and an ultimate success rate of 65.6%. In a subsequent study by the same investigators, the success rate improved to 69.2% though the 1st attempt success rate was only 26.9%.11 They opined that greater familiarity with the AD method might have led to the better results.

We used AD to confirm the consistency of the location of the IJV at the notch on the clavicle. The IJV was localized on the notch in 95.33% and cannulation was successful in 98.6% of cases. In 4 patients less than 10 kg, the notch on the clavicle was too wide to accurately confirm the position of the IJV. In 3 patients, belonging to more than 10 kg group, the notch was not very prominent. We used traditional landmark technique successfully in

<table>
<thead>
<tr>
<th>Weight</th>
<th>&lt;5 kg</th>
<th>5-10 kg</th>
<th>&gt;10 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>First attempt</td>
<td>52.63 (20/38)</td>
<td>82.60 (38/46)</td>
<td>81.36 (48/59)</td>
</tr>
<tr>
<td>Second attempt</td>
<td>26.32 (10/38)</td>
<td>8.70 (4/46)</td>
<td>16.95 (10/59)</td>
</tr>
<tr>
<td>Third attempt</td>
<td>15.79 (6/38)</td>
<td>8.70 (4/46)</td>
<td>1.69 (1/59)</td>
</tr>
<tr>
<td>Ultimate success (within three punctures)</td>
<td>94.74 (36/38)</td>
<td>100 (46/46)</td>
<td>100 (59/59)</td>
</tr>
<tr>
<td>Notch technique*</td>
<td>97.4 (38/39)</td>
<td>93.9 (46/49)</td>
<td>95.2 (59/62)</td>
</tr>
<tr>
<td>Complication</td>
<td>20.5 (8)</td>
<td>6.1 (3)</td>
<td>3.2 (2)</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>2.56 (1)</td>
<td>4.08 (2)</td>
<td>0</td>
</tr>
<tr>
<td>Art puncture</td>
<td>15.38 (6)</td>
<td>2.04 (1)</td>
<td>3.22 (2)</td>
</tr>
<tr>
<td>False tract</td>
<td>2.56 (1)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*% of patients whose IJV was confirmed at the clavicular notch by audio-Doppler. Values are in percentage (number)
9 patients. Since, the study was done in a teaching hospital, cannulation was done by consultants and trainees. Hence, we allowed up to three attempts. Bratton et al\textsuperscript{12} reported an increased rate of successful CVC by AD in paediatric patients when used by inexperienced operators. There were 3 children (less than 10 kg) who developed pneumothorax which could be due to the medial angulation of the needle and the less experienced trainees.

IJV cannulation using the ‘Notch technique’ is easy and can be quickly learned by the trainees with improved success rate. The notch can be palpated on the clavicle even in patients where the anatomy of sternocleidomastoid muscle is ill defined. Audio Doppler is cheap (860 USD vs 26,000 USD for ultrasound) and can be used for defining the course of the IJV and its consistent location at the clavicular notch.

Limitations of this study should be considered. There was no control group. Besides consultants, trainees were also allowed to cannulate the IJV, though under supervision. Three attempts were allowed. We did not note the cannulation time and the number of cannulations done by consultants and trainees separately.

**CONCLUSION**

This study confirms the consistent location of IJV at the clavicular notch. Therefore, the ‘notch technique’ can be used successfully for IJV cannulation in infants and children. While this technique can be used even in the absence of Doppler or ultrasound in older children, the authors suggest caution in its use in children weighing < 5 kg because of the higher rate of complications we encountered in this age group in our study. A randomized controlled study may unequivocally establish the routine use of ‘Notch technique’ for CVC placement in neonates and infants in the absence of ultrasonography.

**REFERENCES**


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