

Ultrasound evaluation of techniques for internal jugular vein puncture in children¹

Avaliação ultra-sonográfica das técnicas de punção da veia jugular interna em crianças

Sérgio Tomaz Schettini¹, Luiz Fernando Ybarra Martins de Oliveira^{II}, Harold Ruiz Henao^{III}, Henrique Manoel Lederman^{IV}

¹ Associate Professor, Division of Pediatric Surgery, Department of Surgery, UNIFESP, Brazil.

^{II} Medical student, Scientific Initiation Program, Division of Pediatric Surgery, Department of Surgery, UNIFESP, Brazil.

^{III} Radiologist Member of the Division of Diagnostic Imaging in Pediatrics, Pediatric Institute of Oncology, UNIFESP, Brazil.

^{IV} Full Professor of Radiology, Department of Diagnostic Imaging, UNIFESP, Brazil.

ABSTRACT

Purpose: To determine by ultrasound which access and position the child must stay to obtain the best transversal section of the right Internal Jugular Vein (RIJV) allowing a safer puncture. **Methods:** Three possible accesses to the RIJV, anterior, lateral and posterior, from 57 healthy children, were analyzed through ultrasound images in a sequence of positions of the head, in supine position, with or without a roll under the scapula: head centered in neutral position with and without a roll (NPP and NP); contra lateral rotation with and without a roll (CLRP and CLR), neutral position and the patient raised in 30° in Trendelenburg position (TDG). To analyze the results it was applied one statistic method, with variation analysis to the same individuals. Basic Procedures: Ultrasound evaluation in each one of the proposed positions. **Results:** The statistical analysis of the results observed that the lateral puncture with the patient in the neutral position, in Trendelenburg without a roll, offers a bigger area in comparison to all the other options of puncture and positioning of the patient ($p < 0,0001$). **Conclusion:** The safer way for the puncture of RIJV in children is obtained in neutral position in Trendelenburg by lateral puncture, without a shoulder roll.

Key words: Jugular Veins. Ultrasonics. Child.

RESUMO

Objetivo: Determinar pelo ultra-som qual o melhor acesso e posicionamento da criança com o intuito de se obter a melhor secção transversal da veia jugular interna direita (VJID), permitindo uma punção com maior segurança. **Métodos:** Três possíveis acessos a VJID, anterior, lateral e posterior foram analisados pela ultrassonografia em uma sequência de diferentes posições da cabeça, estando o paciente em posição supina com ou sem um coxim sob a escápula; cabeça na posição neutra; (NPP E NP); rotação lateral da cabeça (CLRP e CLR), posição neutra com o paciente em posição de Trendlemburg a 30° (TDG). Para analisar os resultados foi aplicado um método estatístico com análise variada sobre os mesmos indivíduos. Procedimentos básicos: Avaliação ultrassonográfica em cada uma das posições propostas. **Resultados:** Pela análise estatística dos resultados observou-se que a punção lateral estando o paciente em posição neutra, em Trendlemburg sem a colocação de coxim sob a escápula oferece uma área maior em comparação a todas as outras opções de punção e posicionamento do paciente ($p < 0,0001$). **Conclusão:** A melhor técnica para a punção da VJID em crianças foi a posição neutra em Trendlemburg, por punção lateral, sem a colocação de um coxim sob a escápula.

Descritores: Veias Jugulares. Ultra-som, Criança.

¹Research performed at the Department of Diagnostic Imaging, Federal University of São Paulo (UNIFESP), Brazil.

Introduction

The catheterization of the internal jugular vein (IJV) is a procedure usually done in children and easily applied at the most clinical conditions with the usage of a simple technique. The main indications are:

At the emergency room, in the situations of hemodynamic instability or when the occurrence is foreseen mainly in those children whose disease presents a progressive worsening of vital functions. For instance we can mention the following situations: respiratory and cardiac arrest, sepsis, hemorrhagic and cardiogenic

shock, severe dehydration, respiratory failure, intoxications, great burn wounds, convulsive illness and brain trauma.

* At non-emergency situations the main indications are: monitorization of the central venous pressure, long term infusion of irritative medication, uniform drugs infusion, extended parenteral nutrition, venous access for transfusions, impossibility to obtain a peripheral vein access and chemotherapy administration via "port-a-cath" in oncology patients.

The possible complications of the IJV puncture are: accidental puncture of the common carotid artery (4-10%)¹ puncture of the nerves, of the main lymphatic duct in the left hemithorax,

malposition of the catheter with hydrothorax, hemothorax, venous thrombosis, pseudo aneurysm, arteriovenous fistula. The incidence of these complications are directly related to the skill and the physician's experience whereas the incapacity of obtaining the catheterization of IJV through puncture is referred in 19, 4%².

The success rate in the catheterization of IJV is lower and the number of complications is higher in children than among adults due to the smaller size of the vein, the close proximity of the common carotid artery and the variation of the vein position related to the artery and to the cervical muscles not fully developed, which makes difficult the characterization of anatomical landmarks in order to due a precise puncture. We must also consider the lack of cooperation from the small patients, and the risks related to their sedation.

Therefore the larger the diameter of the IJV the easier will be to obtain catheterization, because there is a significant relation between the increase diameter of the IJV and the success rate at the first attempt to catheterization³.

There are three sites or ways to access the IJV for puncture. The landmarks are the margins of the sternocleidomastoid muscle: (A) anterior, (B) lateral and (C) posterior (Figure 1).

A) The puncture is done in the anterior margin of sternocleidomastoid muscle (ECM), at the middle from the mastoid process and the clavicle.

B) The puncture is done in the apex of the triangle formed between the clavicle and the ECM margins.

C) The puncture is done in the posterior margin of ECM towards the jugular sternal incisure.

These options are illustrated bellow:

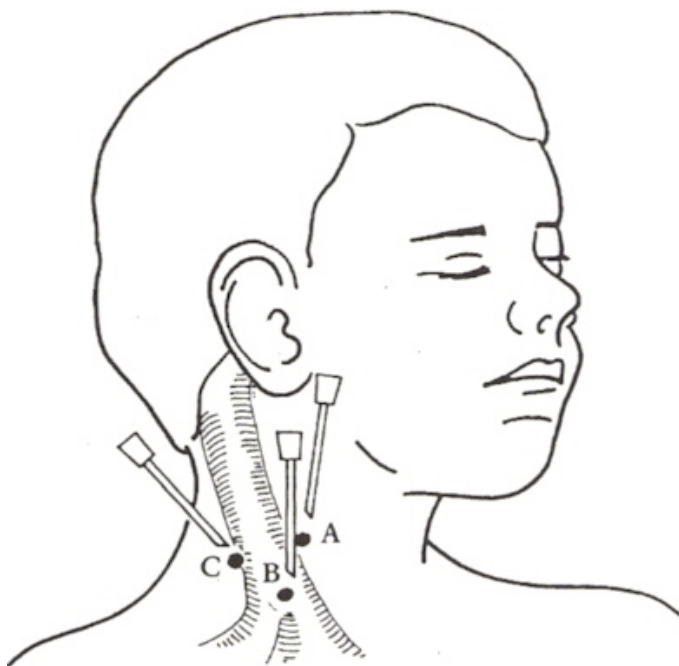


FIGURE 1

Concerning the puncture of the internal jugular vein is preferable the right side because we have a straight way from the vein, the brachiocephalic trunchus and the superior vena cava, lowering the risks and improving the chance to reach the right atrium, whereas on the left IJV, there is an acute angle between the vein and the brachiocephalic trunchus.

The purpose of this study, using the ultrasound, is to determine which would be the best way and patient position in order to obtain the larger transversal section of the right IJV (RIJV) for catheterization, allowing a safer and precise access.

Methods

The study was held at the Department of Diagnostic Imaging, UNIFESP, from January of 2004 to June of 2006, with volunteer patients from the outpatient clinic of the Division of Pediatric Surgery, in healthy condition, almost all of them bearers of phimosis, inguinal or umbilical hernia or cryptorchidic testes. Informed consent was provided by the parents or responsible tutor.

All procedures were done without sedation.

57 healthy children were selected, 21 girls and 36 boys with ages between 8 months and 16 years-old (average age of 5,9 years-old). The criteria of exclusion were the existence of previous access of IJV or primary or secondary affections in the cervical region which could change the anatomy of the IJV.

The three possible ways to access the RIJV, anterior, lateral and posterior, were analyzed through ultrasound images obtained with a linear transducer (10MHz) in a perpendicular section to the vessel, applied with the minimum pressure in order to obtain a good image⁴.

The ultrasound equipment that was used in all patients was a Siemens^R Sonoline Antares, Sie Scape, 3 Scape.

The sequence of examination was:

- 1) Supine position with the head in neutral position without the use of a roll under the scapula (NP);
- 2) Supine position with contra lateral rotation of the head without the use of a roll under the scapula (CLR);
- 3) Supine position with the head in neutral position with the use of a roll under the scapula (NPP);
- 4) Supine position with contra lateral rotation of the head with the use of a roll under the scapula (CLRP);
- 5) Supine position with the head in the neutral position with the patient in Trendelenburg (patient raised 30° related to the floor) without the use of a roll under the scapula (TDG).

The study was limited to the right internal jugular vein due to aforementioned reasons.

The rolls were standardized for all patients according to their weight and height. The head was positioned with the auricular pavilion below the shoulder level and the chin at 90 degrees in relationship to the floor.

Images were performed in each position, in three different locations, in relation to the ECM muscle, anterior, lateral and posterior (Figure 1).

During the examination the carotid artery and jugular vein were identified by their anatomical locations, ultrasound characteristics and patterns of pulsation. Measurements of the transverse section of RIJV were obtained during the examination, from a frozen image on the monitor screen, using calipers. Also, measurements of the average distance from the skin to the center of the RIJV were obtained in each different acquisition.

All exams were performed by a single radiologist and data were registered in a pre designed table.

To analyze the results it was applied a statistic method of analysis with variation to the same individuals. It was established in 0,05 or 5% the rejection level of annulment hypothesis, with trust periods of 95%.

Results

Measurements of 855 images were obtained.

It was not found in this study any patient with anatomical alteration or congenital abnormalities.

The average measurement of each way of access of the RIJV in each position is demonstrated in the Table 1.

From the statistical analysis of the results it was observed that the lateral puncture with the patient in the Trendelenburg position without a roll under the scapula is the one that offers largest transversal section area (diameter in centimeters, cm) of the right internal jugular vein in comparison to all the other options of puncture and positioning of the patients ($p < 0,0001$).

Concerning the distance from the skin to the center of the vein, the average in the each position was from 1,0 to 1,3 cm or 3,0 mm. (Figure 2). This difference was considered without significance.

Discussion

The easy access, the superficial localization related to the skin (1,0 to 1,3 cm in this study) and the low incidence of pneumothorax in comparison to the puncture of the subclavia vein, make the IJV one excellent option to obtain a central venous access¹. It is well established the puncture on the right side it is easier to reach the vena cava due to better anatomical conditions, practically a straight way. That was the reason we have limited this study on the right internal jugular vein.

There is a straight correlation between the diameters of IJV with the success in the first attempt of catheterization by puncture³.

The position of the TDG increases the venous return and consequently the transversal section of IJV, increasing the success of the puncture. Also minimize the chance of gas embolism^{1,5,6}. Nevertheless, is not recommended in the cardiac pulmonary edema and in situation of reduced brain perfusion⁷.

In these conditions we can try CLR, which give the second largest diameter. On the other hand it may superimpose the RIJV to the common carotid artery, which increases the chance of

TABLE 1 - Average of the transversal section (diameter in cm) of the RIJV obtained at the ultrasound in 57 children

Position / Approach	Average Diameter (cm)		
	Lateral	Posterior	Anterior
NP	0,68	0,49	0,52
CLR	0,71	0,64	0,62
NPP	0,56	0,44	0,46
CLRP	0,65	0,5	0,47
TDG	0,9	0,85	0,8

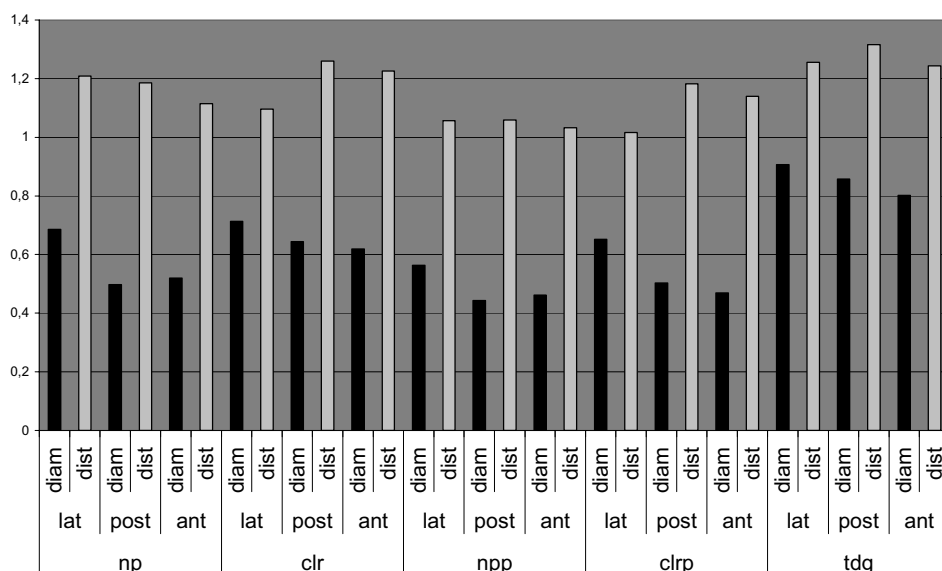


FIGURE 2 - Average of the transversal section (diameter in cm) of the RIJV and the distance of the center of the vein to the skin (in cm) obtained at the ultrasound in 57 children

accidental puncture of the artery⁸. The extreme rotation has the inconvenience of making difficult the IJV puncture⁹ and also interfere in the ventilation, increasing the risk in critical patients.

The use of ultrasound for puncture the RIJV is an easy procedure^{10,11}. Adequate transverse diameter is necessary for small children.

In patients suspected to have injury in the cervical column or in the initial treatment of the infantile trauma that needs the central venous access we can use the NP position, which becomes very important despite reducing the vision field and presenting smaller average diameter in comparison to the TDG position.

On the contrary, as the referred by Parry¹⁰, the use of a roll under the scapula which is a very common practice among several professionals, did not determined any benefit, in any of the positions studied.

Lukish *et al.*¹² have the same conclusion in regard to the subclavian vein in children. Their conclusion are against the

recommended maneuvers of turning the head or turning the head and placing a posterior shoulder roll. According to the authors these procedures significantly reduce the cross-sectional area of the subclavian vein and maintaining the head in a normal position with the chin midline without a shoulder roll optimizes subclavian vein size. These recommendations may serve to reduce the morbidity associated with percutaneous subclavian vein cannulation.

In a similar study performed in adults, concerning the puncture of the IJV, Suarez *et al.*¹³ went to the same conclusion, like the present study in children.

Conclusion

The best and precise way for the catheterization of RIJV in pediatric patients is obtained in Trendelenburg, with lateral access without the use of a roll under the scapula.

References

1. Lobato EB, Sulek CA, Moody RL. Cross sectional area of the right and left internal jugular veins. *J Cardiothorac Vasc Anesth.* 1999;13:136-8.
2. Denys BG, Uretsky BF, Reddy PS. Ultrasound-assisted cannulation of the internal jugular vein: a prospective comparison to the external landmark guided technique. *Circulation.* 1993;87:1557-62.
3. Gordon AC, Saliken JC, Johns D, Owen R, Gray RR. US-guided puncture of the internal jugular vein: complications and anatomic considerations. *J Vasc Interv Radiol.* 1998; 9:33-8.
4. Defalque RJ. Percutaneous catheterization of the internal jugular vein. *Anesth Analg.* 1974;53:116-21.
5. Lobato EB, Florete OG, Paige GB, Morey TE. Cross-sectional area and intravascular pressure of the right internal jugular vein during anesthesia: effects of Trendelenburg position, positive intrathoracic pressure and hepatic compression. *J Clin Anesth.* 1998;10:1-5.
6. Botero M, White SN, Younginer JG. Effects of Trendelenburg position and positive intrathoracic pressure on internal jugular vein cross-sectional area in anesthetized children. *J Clin Anesth.* 2001;13:90-3.
7. Mallory DL, Shawker T, Evans RG, McGee WT, Brenner M, Parker M, Morrison G, Veremakis L, Parillo JE. Effects of clinical maneuvers on sonographically determined internal jugular vein size during venous cannulation. *Crit Care Med.* 1990;11:1269-73.
8. Sulek CA, Gravenstein N, Blackshear RH, Weiis L. Head rotation during internal jugular vein cannulation and the risk of carotid artery puncture. *Anesth Analg.* 1996;82:125-8.
9. Bazaral M, Harlan S. Ultrasonographic anatomy of the internal jugular vein relevant to percutaneous cannulation. *Crit Care Med.* 1981; 9:307-10.
10. Parry, G. Trendelenburg position, head elevation and a midline position optimize right internal jugular vein diameter. *Can J Anesth.* 2004;51:379-81.
11. Verghese ST, McGill WA, Patel RI, Sell JE, Midgley FM. Ultrasound-guided internal jugular venous cannulation in infants. *Anesthesiology.* 1999;91:71-7.
12. Lukish J, Valladares E, Rodrigues C, Patel K, Bulas D, Newman KD, Eichelberger MR. Classical positioning decreases subclavian vein cross-sectional area in children. *J Trauma.* 2002;53:272-5.
13. Suarez T, Baerwald JP, Kraus C. Central venous access: the effects of approach, position and head rotation on internal jugular vein cross-sectional area. *Anesth Analg.* 2002;95:1519-24.

Conflict of interest: none
Financial source: none

Correspondence:

Rua Butirapoã, 111
05050-030 Sao Paulo – SP Brazil
Phone/Fax: (55 11)5539-4621
stschettini@uol.com.br

Received: March 28, 2008
Review: May 29, 2008
Accepted: June 30, 2008

How to cite this article

Schettini ST, Oliveira LFYM, Henao HR, Lederman HM. Ultrasound evaluation of techniques for internal jugular vein puncture in children. *Acta Cir Bras.* [serial on the Internet] 2008 Sept-Oct;23(5). Available from URL: <http://www.scielo.br/acb>