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The anatomic relationship between the internal jugular vein and the carotid artery in children after laryngeal mask insertion. An ultrasonographic study.

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Abstract:

Background: Central venous cannulation although challenging in children and prone to complications is frequently required for total parenteral nutrition and infusion of drugs.

Aim: The aim of this study was to determine the anatomic relationship between the internal jugular vein (IJV) and carotid artery (CA) before, and after, insertion of laryngeal mask airway (LMA) in children using ultrasound.

Methods: Patients aged 2-16 yrs were recruited into this prospective study and divided into 3 groups of 20 patients each: group 1: LMA size 2, group 2: LMA size 2½ and group 3: LMA size 3. Prior to, and following, LMA insertion, the position, depth and time to location of the vessels was recorded. All measurements were made at the level of the cricoid cartilage in a neutral head position in the spontaneously breathing patient during expiration. The IJV position in relation to the CA was noticed as anterior (A), anterolateral (AL), lateral (L) or medial (M).

Results: The position of the IJV was found to be in the anterolateral (AL) or anterior (A) position to the CA in the majority of cases. The anatomic relationship changed in 10/120 (8.3%) following insertion of the LMA. The mean depth was 0.80 (± 0.15) cm for the right IJV before LMA insertion and 0.84 (± 0.17) cm after insertion. Similar measurements were made on the left side (0.81 (± 0.14) cm and 0.83 (± 0.18) cm). The diameter as well as the depth of the IJV increased with the age and weight of the patient.

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Conclusions: This study demonstrates that the IJV is anterior or anterolateral to the artery in the majority of cases and the anatomic relationship may change following the insertion of the LMA. It supports the need of using ultrasound-guided techniques for IJV cannulation following LMA insertion in spontaneously breathing children.

Keywords: Laryngeal mask airway, Internal jugular vein, ultrasound.

For Peer Review

Introduction

Central venous cannulation although challenging in children and prone to complications (1,2) is often required for total parenteral nutrition and infusion of drugs. Ultrasound guided central venous cannulation results in higher success rate and lower complications compared to landmark technique (3-6). The position of the internal jugular vein (IJV) in relation to the carotid artery (CA) has been studied in adults (7-9). Few studies have been reported in children, with one study demonstrating a variable position of the IJV in relation to the CA following tracheal intubation (10). This study describes the anatomic relationship between the IJV and CA before and after laryngeal mask (LMA) insertion.

Methods

Following local ethics committee approval and parental consent, a total of 60 healthy patients aged 2-16 years were recruited into this prospective study. The children were divided into different groups depending on their weight, Group1 (LMA size 2), Group 2 (LMA size 2½) and Group 3 (LMA size 3). Exclusion criteria included emergency surgery, patients requiring rapid sequence induction, parental refusal, patients with previous IJV cannulation and patients with known or suspected anatomical abnormality.

Following inhalational or intravenous induction of anaesthesia, the child was placed supine with the head in a neutral position. Ultrasound measurements of the neck were performed by a single investigator using a Sonosite (Micromaxx^R ultrasound system, Transducer SLA 13-6 MHz, 25 mm broadband linear array). The ultrasound probe was placed perpendicular to the skin and the images were obtained from the right and left side of the neck at the level of the cricoid cartilage in the spontaneously breathing patient during expiration. The positions

of the right and left IJV in relation to the CA, the depth and diameter of the vein, as well as the time taken to locate the vessel were determined. Any distortion of the vein in relation to the CA, depth and diameter were noted.

The IJV position in relation to the CA was noted as anterior (A), anterolateral (AL), lateral (L) or medial (M). All measurements were repeated following insertion of the LMA. Data are expressed as mean $\pm$ SD.

Results

Sixty patients were recruited into this study. Mean ($\pm$ 1 SD) age and weight were 3.45 ($\pm$ 6) years, 8 ($\pm$ 2) years, 12.3 ($\pm$ 1.4) years and 16.32 ($\pm$ 3.8) kg, 26.6 ($\pm$ 2.9) kg, 50.5 ($\pm$ 7.9) kg for groups 1, 2 and 3 respectively.

The mean depth overall was 0.80 ($\pm$ 0.15) cm for the right IJV before and 0.84 ($\pm$ 0.17) cm after LMA insertion and 0.81 ($\pm$ 0.14) cm and 0.83 ($\pm$ 0.18) cm on the left side. (Table 1) The position of the IJV was found to be in the anterolateral (AL) or anterior (A) position in relation to the CA in the majority of cases and the anatomic relationship changed in 10/120 (8.3%) following insertion of the LMA. (Figure 1) The diameter as well as the depth of the IJV increased with the age and weight of the patient.

Mean duration for localization of the vessels was 4.3 ($\pm$ 0.9) s and 4.2 ($\pm$ 1.0) s for the right and left IJV, respectively. The LMA was easily identified using ultrasound.

Discussion

The use of ultrasound for central venous access is associated with a lower technical failure rate; reduction in complications and faster access. The success of IJV cannulation in infants and children has been reported in different studies to vary from 77% to 97.2% (1,11). The use of ultrasound results in an 86% relative risk reduction of failure and 57% reduction in complications compared to landmark techniques (4). Verghese et al have demonstrated a 100% success rate without arterial puncture versus 77% with 25% carotid puncture in children below 12 months using ultrasound (3). Internal jugular vein cannulation by landmark methods is often difficult and carries a high incidence of CA puncture due to the close proximity and the small calibre of the vessels (11). In addition, there are anatomic variations in the relative positions of IJV and CA (7,8,10).

The LMA is useful airway device in children for a variety of surgical procedures. It is easy and atraumatic to insert, eliciting minimal autonomic response. Mason et al have demonstrated LMA is a safe device in children and in only 2.5% of cases had to use an alternate airway (12). A survey by Lopez-Gil et al in the use of LMA in children concluded that LMA provides a safe and effective form of airway management in experienced trainees (13). In children with difficult airway and intubation, LMA obtained a good airway in 73% of patients and an adequate airway in 27% of patients (14). LMA is a vital component of the difficult intubation trolley (15).

This current study determined the relationship between IJV and CA before and after laryngeal mask airway insertion at the level of cricoid cartilage in spontaneously breathing patients. Ultrasound location of the neck vessels was easy and did not delay the procedure. The IJV was anterolateral or anterior to the CA in the majority of patients with the head

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placed in the neutral position and the diameter as well as the depth of the IJV increased with the age and weight of the patient and is consistent with previous reports (10).

LMA insertion did alter the anatomical relationship between the CA and IJV in approximately 8% of the spontaneously breathing patients. This may be of relevance when attempting IJV cannulation using a landmark technique following initial ultrasound location of the IJV. This study, therefore, provides further evidence for the use of ultrasound for IJV cannulation following LMA insertion in spontaneously breathing children.

For Peer Review

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Table 1

Depths and diameters of the internal jugular vein before and after LMA insertion in spontaneously breathing patients. Results are mean ($\pm$ SD) in mm.

SIZE 2 (n=20)	DEPTH		DIAMETER	
	RIGHT	LEFT	RIGHT	LEFT
BEFORE LMA	0.70 $\pm$ 0.19	0.71 $\pm$ 0.2	1.18 $\pm$ 0.26	1.11 $\pm$ 0.28
AFTER LMA	0.71 $\pm$ 0.19	0.71 $\pm$ 0.18	1.28 $\pm$ 0.3	1.15 $\pm$ 0.29

SIZE 2.5 (n=20)	DEPTH		DIAMETER	
	RIGHT	LEFT	RIGHT	LEFT
BEFORE LMA	0.73 $\pm$ 0.16	0.76 $\pm$ 0.14	1.21 $\pm$ 0.32	1.19 $\pm$ 0.32
AFTER LMA	0.78 $\pm$ 0.16	0.75 $\pm$ 0.13	1.26 $\pm$ 0.35	1.18 $\pm$ 0.32

SIZE 3 (n=20)	DEPTH		DIAMETER	
	RIGHT	LEFT	RIGHT	LEFT
BEFORE LMA	0.98 $\pm$ 0.28	0.97 $\pm$ 0.22	1.36 $\pm$ 0.31	1.01 $\pm$ 0.33
AFTER LMA	1.03 $\pm$ 0.29	1.04 $\pm$ 0.23	1.34 $\pm$ 0.33	1.06 $\pm$ 0.32

Figure 1

Relationship between internal jugular vein and carotid artery. The figures represent the total number of cases before/ after LMA insertion in each group.