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SCIENTIFIC ARTICLE

The association between thenar eminence and I-gel™ dimensions in paediatric patients☆

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KEYWORDS
Thenar eminence;
I-gel™ airway device;
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Abstract
Objectives: A practical anatomic landmark may be helpful to perform the appropriate size of the airway devices easily in paediatric patients. The aim of this study was to investigate the association between thenar eminence and I-gel dimensions in children.
Methods: After Institutional Ethics Committee approval, two hundred and seventy ASA Class I–II patients between 0 and 12 years old, who were scheduled for elective procedures under general anaesthesia not requiring tracheal intubation, were recruited to the study. The size of the I-gel selected was based on the patient's body weight according to the manufacturer's recommendation. After successful insertion of the I-gel, thenar eminence dimensions were determined. Long-axis (Th-l) was measured from junction point of the thumb to wrist curl and short-axis (Th-w) constitutes the largest portion of the thenar eminence from lateral end of the thumb to the first hand line. The manufacturer's dimensions of the I-gel which was inserted into the patients were compared with the measurements obtained from thenar eminence.
Results: The mean (SD) values for (Ig-w) and (Ig-l) were 2.98 cm (0.53) and 4.54 cm (0.82), and the mean (SD) values for (Th-w) and (Th-l) were 2.99 cm (0.60) and 3.88 cm (0.93), respectively. There was a statistically significant correlation between Th-w and Ig-w ($r = 0.794$, $p < 0.001$), and between Th-l and Ig-l ($r = 0.820$, $p < 0.001$).
Conclusion: The dimensions of thenar eminence were fitted to that of the weight based size of I-gel and this anatomic landmark may be a practical tool to assess appropriate size for paediatric patients.

☆ The study was approved by the Ethics Committee of Kirikkale University, Kirikkale, Turkey and carried out at the Kirikkale and Giresun Universities.

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PALAVRAS-CHAVE
Eminência tênar;
Dispositivo de via aérea I-gel™;
Pediátrico

A associação entre as dimensões da eminência tênar e I-gel™ em pacientes pediátricos

Resumo
Objetivos: Uma referência anatômica prática pode ser útil para determinar o tamanho adequado dos dispositivos para vias aéreas em pacientes pediátricos. O objetivo deste estudo foi investigar a associação entre as dimensões da eminência tênar e do dispositivo I-gel em crianças.
Métodos: Após aprovação do Comitê de Ética Institucional, 270 pacientes com estado físico ASA I-II, entre 0-12 anos de idade, programados para cirurgias eletivas sob anestesia geral, sem necessidade de intubação traqueal, foram recrutados para o estudo. A escolha do tamanho do I-gel foi baseada no peso corporal do paciente, de acordo com a recomendação do fabricante. Após a inserção bem-sucedida do I-gel, a dimensão da eminência tênar era determinada. O eixo longo (Th-l) foi medido do ponto de junção do polegar ao vinco do pulso e o eixo curto (Th-w) constitui a maior parte da eminência tênar da extremidade lateral do polegar à primeira linha da mão. As dimensões de fábrica do I-gel inserido no paciente foram comparadas com as dimensões obtidas a partir da eminência tênar.
Resultados: As médias (DP) dos valores para (Ig-w) e (Ig-l) foram 2,98 cm (0,53) e 4,54 cm (0,82) e as médias (DP) dos valores para (Th-w) e (TH l) foram 2,99 cm (0,60) e 3,88 cm (0,93), respectivamente. Houve uma correlação estatisticamente significativa entre Th-w e Ig-w ($r = 0,794$, $p < 0,001$) e entre Th-l e Ig-l ($r = 0,820$, $p < 0,001$).
Conclusão: As dimensões da eminência tênar foram ajustadas àquelas do tamanho do I-gel baseado no peso e essa referência anatômica pode ser uma ferramenta prática para avaliar o tamanho apropriado em pacientes pediátricos.

Introduction

The I-gel™ (Intersurgical, Wokingham, UK) is a supraglottic airway management device, made of a medical grade thermoplastic elastomer, which is soft, gel-like and transparent. It was reported that the I-gel seems to be a safe and efficient airway device for paediatric patients.[1] Paediatric I-gel is available in four sizes (1, 1.5, 2, 2.5) on the basis of body weight. In an interesting study, it was stated that the size of the external ear could be used as a proxy for the appropriate size of laryngeal mask airway (LMA) in children.[2] According to the shape of the I-gel's cuff we decided to investigate another anatomical landmark which may have an association with the size of the I-gel. There is a widespread attitude among anaesthesiologists about the size of the little finger of a child. This measurement provides a rough estimation of the size of the tube required.[3] We measured another anatomical region in the hand. The thenar eminence refers to the group of muscles on the palm of the human hand at the base of the thumb. The aim of this study was to investigate the association between thenar eminence and the I-gel's cuff dimensions regarding width and length in paediatric patients.

Methods

The study was approved by the Institutional Ethics Committee and written informed consent was obtained from all the parents. Two hundred and seventy ASA Class I or II patients between 0 and 12 years old, who were scheduled for elective surgery or magnetic resonance imaging of <1 h estimated duration under general anaesthesia not requiring tracheal intubation, were recruited to this prospective, descriptive study during May to September 2013. The study was conducted in accordance with the last version of Helsinki Declaration. Children with risk factors for difficult airway or regurgitation and syndrome or disorders influencing bone or soft tissue growth were excluded. Operation was cancelled in seven patients on the scheduled day due to active respiratory illness (cough, fever, rhinorrhea).

Oral midazolam 0.3 mg kg^{-1} was given 30 min before induction in patients over one age. Patients in the operating room were monitored for standard electrocardiography (ECG), blood pressure non-invasively and peripheral oxygen saturation (SpO_2). After preoxygenation, anaesthesia induction was performed with 8% sevoflurane in 50% nitrous oxide and oxygen, followed by intravenous access and administration of fentanyl 1 μ kg^{-1}. No muscle relaxants were used. Adequate anaesthetic depth was confirmed by lack of a motor response to jaw thrust. The size of the I-gel selected was based on the patient's body weight according to the manufacturer's recommendation (size 1: 2–5 kg, size 1.5: 5–12 kg, size 2: 10–25 kg, size 2.5: 25–35 kg). Size 1.5 I-gel was inserted in children weighing 10–12 kg, and if there was an audible leak it was decided to change the size 1.5 to size 2. After lubrication with a water-based lubricant, the device was inserted with ''sniffing the morning air'' position, and depending upon the airway manipulations (like neck flexion, head extension, jaw thrust, or deep rotation) required to insert the device.[4] Correct insertion was judged by symmetric chest expansion, square wave of the capnograph trace, and absence of audible leak. A gastric catheter (Charriere 10) was placed through the gastric channel and aspiration

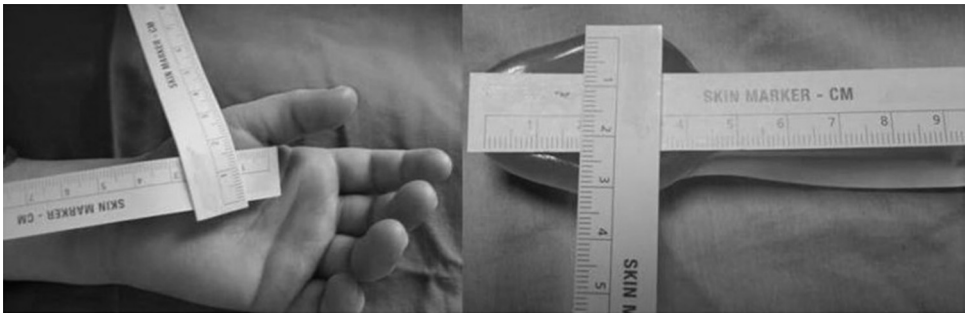

Figure 1 Measuring the vertical and horizontal dimensions of the thenar eminence and the I-gel™ airway device which was inserted into the patient.

was performed in all patients except in those size 1 I-gel was placed. The number of insertion attempts was noted, and it was considered a failure if the insertion was not successful in three attempts. In this case, the patient was intubated and excluded from the study.

After insertion of the I-gel, thenar eminence dimensions were determined with a ruler from left hand while fingers were placed in neutral position. Long axis (Th-l) was measured from junction point of the thumb to wrist curl and short axis (Th-w) constitutes the largest portion of the thenar eminence from lateral end of the thumb to the first hand line. Width (Ig-w) and length (Ig-l) of the I-gel's soft non-inflatable cuff was measured (Fig. 1). The manufacturer's dimensions of the I-gel which was inserted into the patients were compared with the measurements obtained from thenar eminence. Patients were ventilated with pressure-controlled ventilation (Drager Primus, Lubeck, Germany). The respiratory rate was set to maintain an end-tidal CO_2 between 35 and 40 mmHg. Patients received 2%–3% sevoflurane in 50% oxygen with nitrous oxide. After completion of the surgery, inhalation anaesthesia was discontinued. If adequate spontan ventilation (more than 6 mL kg^{-1}) was achieved, the I-gel was removed. Complications after removal of the device such as coughing, laryngospasm, hipoxia (SpO_2 < 90%) and blood staining on the device were noted.

The primary outcome of this study was to determine the association between thenar eminence and I-gel's cuff measurements regarding for width and length. The secondary outcome was the number of the patients in whom the I-gel was placed successfully at the first attempt.

Statistical analysis

A total sample size of 258 was required to detect at least 0.20 correlations between thenar eminence and I-gel's cuff measurements with a power of 90% at the 5% significance level. The 0.20 degree of association was taken from pilot study. Sample size estimation was performed by using NCSS and PASS 2000 (Hintze J. 2001. NCSS and PASS. Number Cruncher Statistical Systems. Kaysville, Utah.) software. This study was designed to enrol 270 patients to allow for potential dropout of subjects.

Data analysis was performed by using SPSS for Windows, version 11.5 (SPSS Inc., Chicago, IL, United States). While metric discrete and continuous variables were shown as mean ± SD (min–max), number of cases and (%) were used for nominal data. Degrees of association between continuous variables were calculated by Pearson's correlation coefficient. Simple Linear Regression analyses were applied for determining the effect of size of the I-gel on differences in both Th-width and also Th-length measurements. Coefficient of regression and 95% confidence intervals were also calculated. A *p*-value less than 0.05 was considered statistically significant.

Results

Two hundred and seventy patients were initially screened for this study. Operation was cancelled in seven patients on the scheduled day. Patient characteristics and type of the procedures are presented in Table 1. The mean (SD) age was 47.3 months (34.7) and mean (SD) weight was 16.4 kg (8.0). The most commonly used LMA size was 2, inserted in 127 (48.8%) patients, followed by LMA size 1.5, inserted in 61 (23.4%). LMA size 2.5 and 1 were used in 40 (15.3%) and 32 (12.3%), respectively.

Table 1 Demographic data and type of the procedures (n = 260).

Age (month)	47.3 ± 34.7 (0–144)
Weight (kg)	16.4 ± 8.0 (2–36)
Gender	
Male	158 (61%)
Female	102 (39%)
ASA classification	
1	223 (86%)
2	37 (14%)
Type of the procedures	
Herniotomy	130 (50%)
Circumcision	37 (14%)
Ophthalmology operations	40 (15%)
Minor orthopaedic procedures	19 (7%)
Reconstruction of minor limb deformities	13 (5%)
Magnetic resonance imaging under general anaesthesia	21 (8%)

Values are mean ± standard deviation (minimum–maximum) or number of patients (%).

Figure 2 Thenar eminence of a 7-year-old boy weighing 24 kg and size 2 I-gel™ airway device that is compatible with the patient's weight.

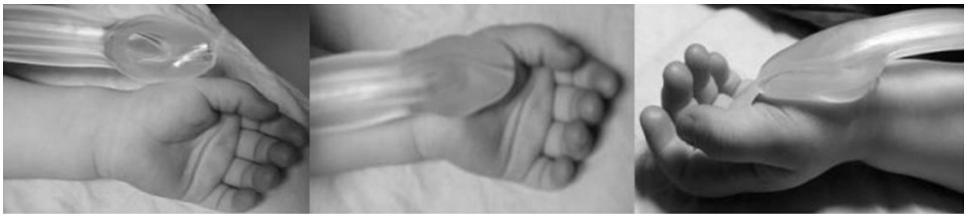

Figure 3 Thenar eminence of a 19-month-old girl weighing 11 kg and size 1.5 I-gel™ airway device that is compatible with the patient's weight.

The mean (SD) values for (Ig-w) and (Ig-l) were 2.98 cm (0.53) and 4.54 cm (0.82), and the mean (SD) values for (Th-w) and (Th-l) were 2.99 cm (0.60) and 3.88 cm (0.93), respectively. There was a statistically significant correlation between Th-w and Ig-w ($r = 0.794$, $p < 0.001$). A statistically significant correlation was also observed between Th-l and Ig-l ($r = 0.820$, $p < 0.001$) (Figs. 2 and 3). According to the simple linear regression analyses, each 1 cm increase in Ig-w measurement resulted in 0.906 cm increase in Th-w measurement (95% confidence interval, 0.821–0.991; $p < 0.001$), and each 1 cm increase in Ig-l measurement resulted in 0.925 cm increase in Th-l measurement (95% confidence interval, 0.846–1.004; $p < 0.001$),

Successful insertion of the I-gel was achieved in 250 (95.0%) patients on the first attempt. Ten patients (3.8%) required second attempt. Failure was observed in 3 (1.1%) patients (2 children from size 1.5 and 1 from size 2). The device could not be advanced in the mouth in 2 patients (1 from size 1.5 and 1 from size 2), and sufficient ventilation (tidal volume > 6 mL kg^{-1}) could not be achieved in one patient from size 1.5. In 34 children weighing 10–12 kg size 1.5 I-gel was successfully inserted on the first attempt. The results for 260 patients were included in the study. Success rates and causes of failure of insertion of the I-gel on first attempt were shown in Table 2. A gastric catheter was placed through the gastric channel successfully in all patients except in those size 1 I-gel was placed.

Laryngospasm occurred in 5 (1.9%) patients after removal of the device and resulted in brief episodes of hypoxia (1.9%). Blood staining on the device was observed in 2 (0.7%) patients in whom the device could be inserted at the second attempt. Cough occurred in 10 (3.8%) children in the recovery room, and resolved spontaneously.

Discussion

This study shows that the dimensions of thenar eminence were fitted to that of weight based size of the I-gel. Although size selection on a weight basis should be applicable to the majority of patients, individual anatomical variations mean the weight guidance provided should always be considered in conjunction with a clinical assessment of the patient's anatomy. Zahoor et al. suggested that physicians can apply ear-size method when using LMA in children.[2] The I-gel differs from the LMA for its shape, dimensions and weight-based scale. According to our first observation, shape and size of the thenar eminence were similar to that of the I-gel's cuff. Therefore we decided to investigate this anatomical region. We chose the size of the I-gel according to the patient's weight to prevent a bias raised from investigator's observation. After successful insertion and adequate ventilation were confirmed, we measured the thenar eminence dimensions of the patient.

In previous studies, it was seen that only the performance of the I-gel was investigated or its performance was compared with that of the other supraglottic devices. Size 1 I-gel was not evaluated in these studies.[1,5–9] Similarly, children under the age of 6 months were not recruited to the study in which ear-sized method was suggested when using LMA in children.[2] An advantage of our study compared to others was that all paediatric sizes of I-gel were investigated.

Table 2 Success rates and causes of failure of insertion of the I-gel.

Success rate	
First attempt	250 (95%)
Second attempt	10 (3.8%)
Failure	3 (1.1%)
Causes of failure on first attempt	
Incorrect placement and inadequate ventilation	11 (84.6%)
Failure of insertion of the device in the mouth	2 (15.3%)

Values are number of patients (%).

In addition, there were no data in the literature about an alternative method for size selection of the I-gel in children. According to our results, a statistically significant correlation between the dimension of the thenar eminence and the manufacturer's dimensions of the I-gel which was inserted into the patients was found. Therefore, we can say that thenar eminence may be used as a landmark when choosing the size of the I-gel in paediatric patients.

The success rate of the insertion at the first attempt in the study was comparable with the reported rates in previous studies.[5,6,8] Successfully insertion of the nasogastric tube in all patients in whom size 1.5, 2 and 2.5 I-gel were inserted confirmed the place of the device. Easy insertion of a nasogastric tube is correlated with good positioning of the device, and so fibreoptic confirmation is not required.[10] Correct placement of the size 1 I-gel was evaluated by symmetric chest expansion, square wave of the capnograph trace, and absence of audible leak because size 1 I-gel has no gastric channel. According to our success rate we can state that size selection based on patient's weight is a reliable method, but an additional method to confirm the appropriateness of the selected size may be useful especially in emergency situations. Supraglottic airway devices could be a good substitute for airway management during cardiopulmonary resuscitation. Gatward et al. reported that time taken for I-gel insertion was approximately 50% that of other airway devices, such as the tracheal tube, classic LMA and ProSeal LMA during chest compression for cardiopulmonary resuscitation.[11] Clinicians who use the I-gel in seldom when compared to anaesthesiologists may doubt about size selection. Thenar eminence may also be helpful in this situation.

Complication rates observed in this study were comparable with that of previous studies.[8,9] I-gel has a soft, non-inflatable cuff. This characteristic offers advantage for maintaining the blood supply to laryngeal and perilaryngeal framework. Cuff inflation can cause tissue injuries or ischaemia that may be observed as a complication in the management of the supraglottic airway devices with inflatable cuff.[12]

One limitation of this study is that we investigated this anatomical region in healthy children and it may not be a landmark in children with syndrome or disorders influencing bone or soft tissue growth.

Summary

This descriptive study in children evaluating the association between sizes of the thenar eminence and I-gel's cuff shows that this anatomical region may be used as a landmark when using all paediatric sizes of the I-gel. The reliability of the weight-based method and the performance of the I-gel in paediatric patients were approved once again. A simple method like thenar eminence dimension may be especially relevant for ambulance staff and emergency physicians.

Conflicts of interest

The authors declare no conflicts of interest.

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