



Selecting an Appropriate Cuffed Endotracheal Tube Using Ultrasound of the Cricoid in a Child with Down Syndrome

Down Sendromu Olan Bir Çocukta Krikoid Ultrasonu Kullanılarak Uygun Bir Kaflı Endotrakeal Tüpün Seçilmesi

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A 7-year-old girl (height, 94 cm; weight, 15.1 kg) with Down syndrome was scheduled for right patellar dislocation repositioning. The ultrasonographically measured internal transverse width of the cricoid before intubation was 7.8 mm. Attempted insertion of a cuffed Mallinckrodt® endotracheal tube (ETT) (internal diameter, 5.0 mm; deflated cuff portion, 8.4 mm diameter) failed. In contrast, the insertion of a cuffed Microcuff® ETT (5.0 mm ID; deflated cuff portion, 7.3 mm diameter) was successful. Thicker folds in the deflated cuff of the Mallinckrodt ETT could have hindered passage through the vocal cord, including the cricoid region. It is becoming standard to use the ultrasonographically measured internal width of the cricoid when choosing cuffed paediatric ETTs, and this approach may be suitable for patients with Down syndrome as well. In these children, approximately 20% of uncuffed ETTs inserted were one or two sizes smaller in diameter than those predicted for the same age. We may choose the ETT size in reference to an ultrasonographically obtained internal transverse width of the cricoid, stated outer diameter (OD) by the producer, and the actual OD depending on the cuff bulk instead of a tube size calculation in patients with growth retardation.

Keywords: Endotracheal tube size, Down syndrome, cuffed endotracheal tube, paediatric

Yedi yaşındaki (boy: 94 cm, ağırlık: 15,1 kg) Down sendromlu bir kız çocuğu için, sağ patellar dislokasyon pozisyonu planlandı. Entübasyon öncesinde ultrasonografik olarak ölçülen internal transvers krikoid genişliği 7,8 mm idi. Kaflı Mallinckrodt® endotrakeal tüp (ETT) (iç çap, 5,0 mm; sömük kaf çapı 8,4 mm) uygulama denemesi başarısız oldu. Ancak, kaflı Microcuff® ETT (5,0 mm iç çap; sömük kaf çapı, 7,3 mm) başarıyla yerleştirildi. Mallinckrodt ETT'nin sömük kafındaki daha kalın katlar, krikoid bölgesi de dahil vokal korttan geçişi engellemiş olabilir. Kaflı pediatrik ETT'leri seçerken ultrasonografik olarak ölçülen internal transvers krikoid genişliğinin kullanılması standartlaşmaktadır ve bu yaklaşım Down sendromlu hastalar için de uygun olabilir. Bu çocuklarda yerleştirilen kafsız ETT'lerin yaklaşık %20'si, aynı yaştaki diğer çocuklar için öngörülenlerden, çap olarak bir ya da iki ebat daha küçüktü. Gelişme geriliği olan hastalarda ETT büyüklüğünü ultrasonografik olarak elde edilen internal transvers krikoid genişliği, üretici tarafından belirtilen dış çap (DÇ) ve tüp ebatı hesaplaması yerine kaf kütesine bağlı olarak gerçek DÇ'a göre seçebiliriz.

Anahtar Kelimeler: Endotrakeal tüp büyüklüğü, Down sendromu, kaflı endotrakeal tüp, pediatrik

Introduction

In selecting an adequately sized paediatric endotracheal tube (ETT), age-based formulas using the internal diameter (ID) may not be uniformly accurate owing to variations in the outer diameter (OD) and cuff bulk of ETTs, despite the same ID (1). The measurement of internal transverse width of the cricoid has been established as a useful method for selecting appropriate ETTs in children (2-4). In this report, we describe a girl with Down syndrome in whom we failed to intubate a paediatric cuffed ETT predicted for age.

Case Presentation

A 7-year-old girl (height, 94 cm; weight, 15.1 kg) with Down syndrome was scheduled for right patellar dislocation repositioning. Written informed consent was obtained from the patient's parent for publication of this report.

General anaesthesia was slowly induced with inhaled sevoflurane and intravenous administration of 10 mg rocuronium. A short-axis view of the cricoid was obtained prior to intubation using an ultrasound apparatus equipped with an L12-

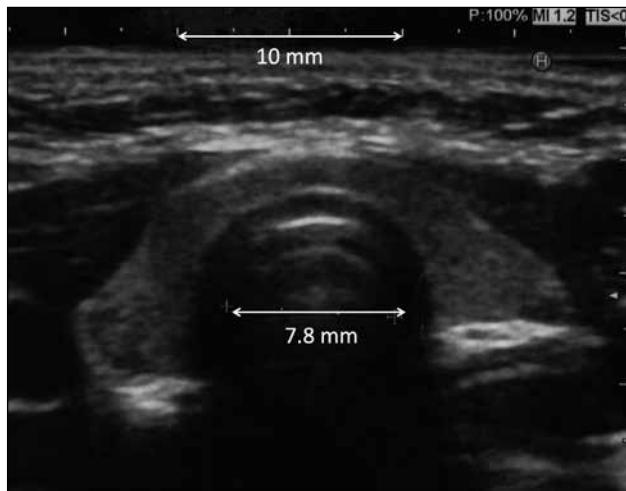


Figure 1. Ultrasound image of the cricoid in a 7-year-old girl with Down syndrome. The internal transverse width of the cricoid is approximately 7.8 mm

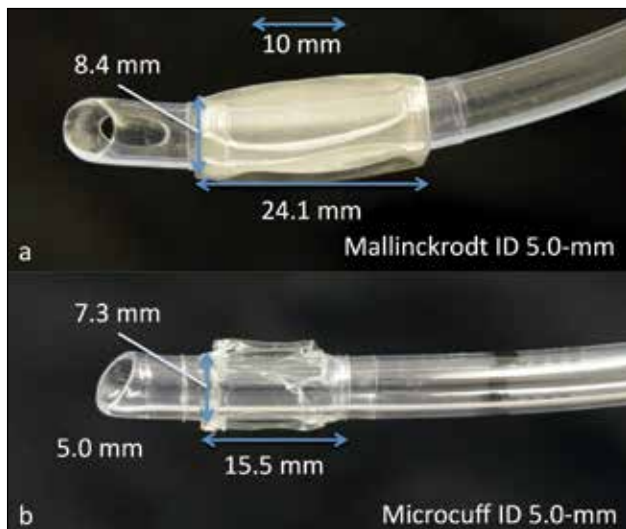


Figure 2. a, b. (a) The Mallinckrodt and (b) Microcuff cuffed endotracheal tubes, both with internal diameter of 5.0 mm. The cuff of the Mallinckrodt (24.1 mm) is longer than that of the Microcuff (15.5 mm). The outer diameter at the deflated cuff portion, including folds, is 8.4 mm in the Mallinckrodt and 7.3 mm in the Microcuff, measured using a sliding calliper while compressing the folds of the deflated cuff with the caliper arms

2 MHz probe (L441, Noblus; Hitachi Aloka Medical Ltd., Tokyo, Japan), which was placed on the neck with the beam advancing vertically to the neck axis and longitudinal surface of the probe parallel to the line connecting both clavicular heads. The internal transverse width of the cricoid was 7.8 mm (Figure 1). A senior resident with 3 years of experience in anaesthesiology determined that the patient had a Cormack–Lehane Grade I glottic opening using a Macintosh Size 2 laryngoscope blade. The senior resident could not insert a cuffed Mallinckrodt® ETT (ID, 5.0 mm; OD, 6.9 mm; deflated cuff portion, 8.4 mm; Mallinckrodt, Dublin, Ireland, Figure 2a) because of resistance at the level of the

glottic opening. Another leading anaesthesiologist with 23 years of experience attempted oral tracheal intubation but failed because of resistance at the glottic opening. Both anaesthesiologists did not apply unusual force to advance the ETT. Finally, the senior resident successfully placed a cuffed Microcuff ETT (ID, 5.0 mm; OD, 6.7 mm; deflated cuff portion, 7.3 mm; Halyard Health Inc., Alpharetta, GA, Figure 2b) without any resistance at the glottis or cricoid. Bilateral respiratory sounds were confirmed by auscultation. A tidal volume of 132 mL was obtained at 18 cm H₂O peak airway pressure without cuff inflation. Breathing sounds were heard around the cuffed ETT with an ID of 5.0 mm at 25 cm H₂O. The total operative, endotracheal intubation and anaesthesia times were 105, 182 and 199 minutes, respectively. No complications, including a sore throat or hoarseness, were observed postoperatively.

Discussion

In our 7-year-old female patient with Down syndrome reported herein, a smaller size cuffed ETT (ID 4.5 mm or 4.0 mm) could have been used instead of one with an ID of 5.0 mm during the first intubation. The cuffed Mallinckrodt ETT (ID 5.0 mm) could not pass the glottis or subglottis, including the cricoid, which had an internal transverse width of 7.8 mm. The presence of thicker folds on the deflated cuff of the Mallinckrodt ETT could have hindered passage.

According to Motoyama's formula for calculating the appropriate size of a cuffed tube (5), the ETT with an ID of 5.0 mm was suitable. Breathing sounds were heard around the ETT at 25 cm H₂O, and the Microcuff ETT was inserted without resistance; thus, the ETT with an ID of 5.0 mm seemed appropriate in this patient. However, it was difficult to apply an age-based formula using the ID for our patient who had a short stature and Down syndrome, as well as a wide trachea and standard internal transverse width of the cricoid for her age.

Microcuff ETTs with an ID of 5.0 mm have been used in patients with an average height of 122 cm and age of 6.8 years (6). Our patient was 94 cm tall, which is equivalent to the height of a Japanese girl who is 3 years and 3 months old. For 3-year-old patients, a cuffed ETT with an ID of 4.0 mm is usually appropriate. This factor may have been considered in selecting an appropriately sized ETT. According to a formula that uses the width of the cricoid in a normal population (7), the OD of this patient was 6.0 mm, which was equivalent to Microcuff and Mallinckrodt ETTs with an ID of 4.5 mm (OD 6.3 mm) or ID of 4.0 mm (OD, 5.6 mm). An ETT one size smaller (ID, 4.5 mm) may have been better for the present patient.

In children with Down syndrome, 23% of uncuffed ETTs inserted are one or two sizes smaller in diameter than those predicted for the same age (8). The initial intubation of a child with Down syndrome can be performed with an ETT

at least two sizes smaller than that for a child of the same age without Down syndrome (9). The deflated cuff portion of the 8.4 mm Mallinckrodt ETT with an ID of 5.0 mm could not pass through the glottic opening above the cricoid because of the internal transverse width of 7.8 mm in our patient. We could clearly observe that resistance occurred at the glottic opening during the first and second intubation attempts. The glottis, rather than the cricoid, was the narrowest portion of the paediatric airway (10, 11). The maximum OD of the deflated cuff portion should be carefully considered in paediatric anaesthesia (4).

Our study has a limitation. We might have underestimated the inner width of the cricoid because the ruler did not pass the centre of the circle in the cricoid, which was almost round. The longitudinal surface of the probe was almost parallel to the line connecting both clavicular heads, and we could obtain the image of half of the almost round-shaped cricoid, as presented in Figure 1. Thus, we might not have overestimated the distance.

Conclusion

We may choose an ETT size in reference to an ultrasonographically obtained internal transverse width of the cricoid, stated OD by the producer, and the actual OD depending on the cuff bulk instead of a tube size calculation in patients with growth retardation.

Informed Consent: Written informed consent was obtained from patients' parents who participated in this study.

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