intubation in noncardiac surgery.\textsuperscript{1,5} Likewise, we found that prolonged ventilation was associated with acquired laryngotracheal stenosis. However, time to first extubation attempt was not different between cases and controls. As time to extubation and duration of ventilation are linked somehow, we could not confirm that prolonged ventilation was more a risk factor than a consequence for laryngotracheal stenosis after surgery. Greater ETT size and repeated intubation attempts were also associated with acquired laryngotracheal stenosis. The fact that the traditional aged-based formula, used to choose ETT size in our institution, overestimates the correct ETT size in more than one in four cases\textsuperscript{6} may explain that too large ETTs might have been used in some children. Leak tests are not routinely performed in our centre, so we could not determine the presence or absence of a leak during and after surgery. In addition, we were not able to evaluate whether the use of cuffed or uncuffed ETT played a role, because this information was poorly reported in the medical charts. Finally, given the retrospective design of our study, it was not possible to determine if the greater number of intubation attempts was a cause or a consequence of airway injury.

Specific risk factors associated with SGS after cardiac surgery included young age and prolonged CPB.\textsuperscript{3,4} Because of our study design, we were not able to detect if younger age could affect airway injury. However, in our population, history of prematurity was found more frequently with the development of acquired laryngotracheal stenosis. In contrast to Kruse et al.\textsuperscript{3} we did not find significantly longer CPB time in children developing acquired SGS. A larger sample size is probably necessary to definitively confirm or exclude this finding.

The main strength of our study is the matched comparison between patients and controls for a large number of peri-operative variables. Nevertheless, because of the retrospective design of our study, we could not determine cause-and-effect relationships, but only associations.

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References

1. Jefferson ND, Cohen AP, Rutter MJ. Subglottic stenosis. Semin Pediatr Surg 2016; 25:138–143.
2. Holzki J, Laschat M, Puder C. Iatrogenic damage to the pediatric airway. Mechanisms and scar development. Paediatr Anaesth 2009; 19 (Suppl 1): 131–146.
3. Kruse KE, Purohit PJ, Cadman CR, et al. Subglottic stenosis following cardiac surgery with cardiopulmonary bypass in infants and children. Pediatr Crit Care Med 2017; 18:429–433.
4. Mossad E, Youssef G. Subglottic stenosis in children undergoing repair of congenital heart defects. J Cardiothorac Vasc Anesth 2009; 23:656–662.

5. Pashley NRT. Risk factors and the prediction of outcome in acquired subglottic stenosis in children. Int J Pediatr Otorhinolaryngol 1982; 4:1–6.
6. Brambrink AM, Braun U. Airway management in infants and children. Best Pract Res Clin Anaesthesiol 2005; 19:675–697.

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Calculation improves the estimation of needle depth from skin to thoracic epidural space in infants

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Editor,

Epidural anaesthesia in major surgery in infants and children is advantageous due to excellent pain relief and reduction of length of stay on the ICU.\textsuperscript{1} The process is challenging and potentially hazardous due to the risk of spinal puncture. To minimise the risk, the use of ultrasound-guided epidural catheter insertion has been propagated by several authors.\textsuperscript{2} However, the authors mainly investigated the advantages of identifying anatomical structures and estimating the depth of the epidural space. Here, we investigated the thoracic spine and examined whether a combination of ultrasound-guided measurement of the perpendicular depth of the epidural space corrected by a trigonometric ratio equation is superior in predicting the skin to thoracic epidural space distance compared with estimation by the perpendicular depth. Therefore, 24 children aged 5 to 148 months (median 40 months), body weight 5.7 to 39.5 kg (median 14 kg), undergoing elective surgery with a thoracic epidural catheter (Th 7/8 to Th 11/12) planned for peri-operative pain control were included in a retrospective single group observational study. Ethical approval for this study was provided by the University of Tuebingen Ethical Committee (Chairperson Prof D. Luft) on 15 May 2018 with the project number 302/2018BO2 after written consent of the parents. After induction of general anaesthesia, all patients were placed in a flexed left-sided position. The perpendicular distance to the epidural space was measured by an ultrasound linear probe and a Tuohy needle (BBraun Inc., Melsungen, Hessen, Germany) was

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inserted. After insertion of the Tuohy needle, the angle (α) between the needle and the skin surface above the spinous processes was defined by use of a sterile protractor and the distance to the epidural space was calculated using Pythagorean triangle geometry [distance to loss of resistance (LOR) = perpendicular distance (ultrasound) / cos (α)]. The epidural needle was then advanced in a midline approach that was verified by ultrasound until loss of resistance to saline was achieved. The distance on the needle from the needle tip to the skin level was read according to the 5 mm graduation on it, compared with the mm graduation of the protractor, and noted in the anaesthesia chart. All ultrasound examinations were performed by the same experienced anaesthesiologist. Correct placement of the epidural catheter was confirmed by either visualisation of the catheter in the epidural space and/or by observation of the local anaesthetic spread. The comparison between the ultrasound-derived distance corrected by a trigonometric ratio equation (calculated epidural depth), the ultrasound-measured perpendicular skin to epidural space distance, and the actual depth of the thoracic epidural space was analysed using Microsoft Excel (version 2013; Microsoft, Redmond, Washington, USA). Subsequently, both groups were compared with linear regression analysis with goodness-of-fit (adjusted R²) by application of SAS JMP (version 13.1.0; SAS Institute Inc., Cary, North Carolina, USA). The distribution of data was tested for normality using the χ² test. The data were expressed as mean (± SD) with 95% confidence intervals. A value of P less than 0.05 was considered to be statistically significant.

The calculated needle depth from skin to epidural space showed a higher correlation coefficient (R² = 0.82) compared with the measured distance to LOR than the ultrasound perpendicular distance (R² = 0.46) (Fig. 1). Deviation from the measured distance to LOR was calculated in percentage. The deviation increased with steepness of the angle of the Tuohy needle. When the needle was inserted at an angle of more than 20° the median deviation can be expected to be approximately 60% of the measured distance. Incidents of dural puncture or postoperative complications were not reported with the epidural cannulation.

The large R found in this study (R² = 0.82) implies that this combination of methods is a useful tool to estimate the depth of loss of resistance prior to insertion. The R is in the same range as previously described (R² = 0.78) for use of a Computed Tomography-derived method for adults. Furthermore, a correction of ultrasound-guided perpendicular measurement is essential as demonstrated by the poor correlation with the actual depth of loss of resistance (R² = 0.46). The results differ from findings published on epidural cannulation in the lumbar region where the authors described an excellent correlation between the distance measured on ultrasound and the calculated perpendicular epidural depth. Another drawback of not using ultrasound-guided method is that ultrasound can detect anatomical abnormalities such as myelomeningocele before puncture.
In conclusion, the correction of the ultrasound-guided perpendicular measurement of the depth of the thoracic epidural space allowed a better estimation of the distance before loss of resistance occurs and is invaluable when the peridural needle is inserted at a steep angle.

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References
1 Moriarty A. Pediatric epidural analgesia (PEA). Paediatr Anaesth 2012; 22:51–55.
2 Lam DK, Corry GN, Tsui BC. Evidence for the use of ultrasound imaging in pediatric regional anesthesia: a systematic review. Reg Anesth Pain Med 2016; 41:229–241.
3 Cane J, Boden J, Gao Smith F. Prediction by computerised tomography of distance from skin to epidural space during thoracic epidural insertion. Anaesthesia 2002; 57:701–704.
4 Kim HK, Cho JE, Kim WO, et al. Precupuncture ultrasound-measured distance: an accurate reflection of epidural depth in infants and small children. Reg Anesth Pain Med 2007; 32:102–106.

Use of the Totaltrack VLM as a rescue device following failed tracheal intubation
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Editor,
The inability to intubate the trachea and secure the airway is the leading cause of anaesthesia-related injury.1 Difficult direct laryngoscopy is associated with the failure and several attempts of tracheal intubation, which are in turn associated with trauma, airway oedema, hypoxia, aspiration, cardiac arrest, ‘cannot intubate, cannot oxygenate’ situation (CICO) or death.1,2 Likewise, the failure of one technique increases the risk of failure of successive techniques, which raises the number of attempts and also the risk of progression to a CICO situation.2 Therefore, limiting the number of interventions without undue repetitions of a failed technique is the main goal in the safe management of the airway.3,4 Thus, it is important to have effective rescue techniques in all situations in which the airway is managed to achieve a timely nontraumatic tracheal intubation.3 Video laryngoscopy, extraglottic airway devices and fibreoptic bronchoscopy are the main rescue techniques to secure the airway. However, no single airway instrument is perfect in all circumstances. This case series documents the successful use of the Totaltrack VLM (Medcomflow S.A., Barcelona, Spain) as a rescue device following failed tracheal intubation. Written informed consent was obtained from all patients, who acknowledged the description of their case in this report.

The eleven cases registered during a 2-year period are summarised in Table 1. Initial ventilation proved adequate and an optimal view of the vocal cords was achieved at the first attempt in all patients allowing successful tracheal intubation in all of them after the failure of the primary airway device (Macintosh laryngoscope (Optima; Timesco Ltd, London, UK) and the rescue technique (video laryngoscope, second-generation supraglottic airway device, intubating laryngeal mask airway and fibreoptic bronchoscopy) in some cases. First-time, second-time and overall intubation success rates were 54, 82 and 100%, respectively. The Totaltrack distal position required readjustment (up-down manoeuvre) to improve ventilation (two patients) or visualisation of the vocal cords (nine patients) without complete reinsertion. The main manoeuvres/adjuvants used to assist intubation after an initial failure were the back-wards-upwards-right-pressure technique (three cases), use of a Frova airway intubation catheter (two cases) or fibreoptic bronchoscopy (two cases) and tracheal tube change. Securing the airway took only a few seconds. No patient experienced oxygen desaturation or any other complications. We have not registered any cases of a failed rescue of a difficult airway with Totaltrack.

Totaltrack combines the properties of an intubating laryngeal mask and a video-assisted laryngoscope.5 It allows one to establish adequate ventilation in a simple way and optimal oxygenation can be maintained throughout the process of tracheal intubation, promoting the shortest apnoeic time. The seal created by the inflated cuff protects the airway from aspiration and preserves a clear airway until intubation is accomplished. An adequate view of the glottis leads to a high first-attempt tracheal intubation rate. Thus, this device simplifies plan A and plan B of the difficult airway algorithm in a single-step facilitating progression through the airway pathway at an appropriate speed. This is mandatory in airway management since the delayed transition from the beginning of the algorithm to the point at which a Front Of Neck Airway is required is a greater cause of morbidity.3,4 A visual description of the use of the Totaltrack VLM can be found on Youtube (https://youtu.be/jSWMs4x7Mak).

These cases suggest that the Totaltrack might find a place in the difficult airway armamentarium and has the...