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Comparison between ultrasound-guided and digital palpation techniques for identification of the cricothyroid membrane: a meta-analysis

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Editor—Surgical cricothyrotomy is a potentially life-saving procedure in the 'cannot intubate/cannot oxygenate' scenario. As this procedure is not performed frequently, the conventional use of digital palpation to identify the cricothyroid membrane carries the risk of misidentification and failed cricothyrotomy.[1] The recent introduction of ultrasound-guided identification of the cricothyroid membrane could be a potential solution. A few published RCTs have shown the effectiveness of this ultrasound approach for improving the success rate of cricothyroid membrane identification compared with the conventional palpation technique.[2,3] However, most of these trials were small scale and conducted in different settings (e.g. emergency room or anaesthesia care unit),[4–8] and a number of studies failed to show significant differences in the accuracy of cricothyroid membrane identification between the two techniques.[1,3,4,8] Furthermore, there are concerns that the use of ultrasound technique may prolong the procedure time,[1,4,5,8] which can be life threatening in an emergency situation. We conducted this meta-analysis to analyse whether the ultrasound-guided approach is superior to the palpation technique in terms of procedural-related accuracy and procedure time.

Comparative trials that evaluated the accuracy of cricothyroid membrane identification by using ultrasound-guided or digital palpation techniques (i.e. ultrasound group vs palpation group) were identified from electronic databases, including Embase, MEDLINE, Cochrane Central Register of Controlled Trials, Google Scholar, and PubMed, from inception to June 2, 2020. No language restrictions were applied. A sensitive search strategy was conducted combining the following keywords with the

Boolean operators 'AND' and 'OR' ('cricothyrotomy' OR 'cricothyroid membrane' OR 'cricothyroidotomy' OR 'cricoid cartilage' OR 'tracheostomy') AND ('ultrasound' OR 'ultrasonography' OR 'echography' OR 'ultrasound-guided'). Using a pre-standardised data extraction form, data were extracted individually by two authors who independently applied the inclusion criteria to potentially eligible articles. Any disagreements were resolved by discussion or by resorting to a third author. The primary outcome was the failure rate of each technique, whilst the secondary outcome was the procedure time for cricothyroid membrane identification.

All of the statistical analyses were performed with Review Manager software (RevMan 5.3; The Cochrane Collaboration, Oxford, UK). A random-effects model for analysis was used because of the anticipated clinical between-study heterogeneity. For dichotomous outcomes, we calculated the risk ratios (RRs) with 95% confidence intervals (CIs). For continuous outcomes, we used the weighted mean difference (WMD) with 95% CI. The Mantel−Haenszel method was adopted to pool dichotomous data and to compute pooled RRs with 95% CIs. Heterogeneity was examined using the Cochran Q-test and Higgins I^2 test. We predefined heterogeneity as being low, moderate, or high, with I^2 values above 25%, 50%, or 75%, respectively. We considered a two-tailed $P<0.05$ to be statistically significant.

Initially, a total of 196 records were identified. After excluding duplicate records ($n=118$) and other reports by title and abstract ($n=66$), 12 full-text articles were assessed for eligibility. Finally, eight studies published from 2014 to 2020 were considered relevant and were read in full. Of the eight studies, examiners

assigned for cricothyroid membrane identification were anaesthetists and medical students in one study,[3] anaesthetists or anaesthesia trainees in six studies,[1,2,4−7] and postgraduate year trainees in the emergency department in one study.[8] In terms of the subjects whose cricothyroid membranes were to be localised, four studies enrolled patients or volunteers with normal neck anatomy,[2,3,7,8] three studies involved volunteers[5,6] or cadavers[1] with poorly identifiable neck landmarks, and one study recruited paediatric subjects.[4]

A forest plot of the incidence of cricothyroid membrane identification failure based on the technique selected is presented in Figure 1a. The pooled RR was 0.50 (95% CI: 0.33−0.76; $P=0.001$), indicating a significantly lower failure rate of the ultrasound-guided technique compared with the digital palpation technique (Fig. 1a). Nevertheless, there was high heterogeneity amongst the included studies in our primary analysis ($I^2=81\%$; $P<0.00001$). On the other hand, a forest plot of the procedural time (Fig. 1b) showed a longer procedural time for the ultrasound-guided technique compared with the palpation technique, although the difference did not reach statistical significance (pooled WMD=21.8 s; 95% CI: −1.4 to 45.1; $P=0.07$; $I^2=99\%$; $P<0.00001$).

There are several limitations to the current meta-analysis. First, although all studies evaluated the efficacy of an ultrasound-guided technique for identifying the cricothyroid membrane, cricothyroidotomy was performed in only one cadaveric study. Therefore, it remains unclear whether the use of an ultrasound-guided technique would decrease the incidence of airway complications compared with the palpation
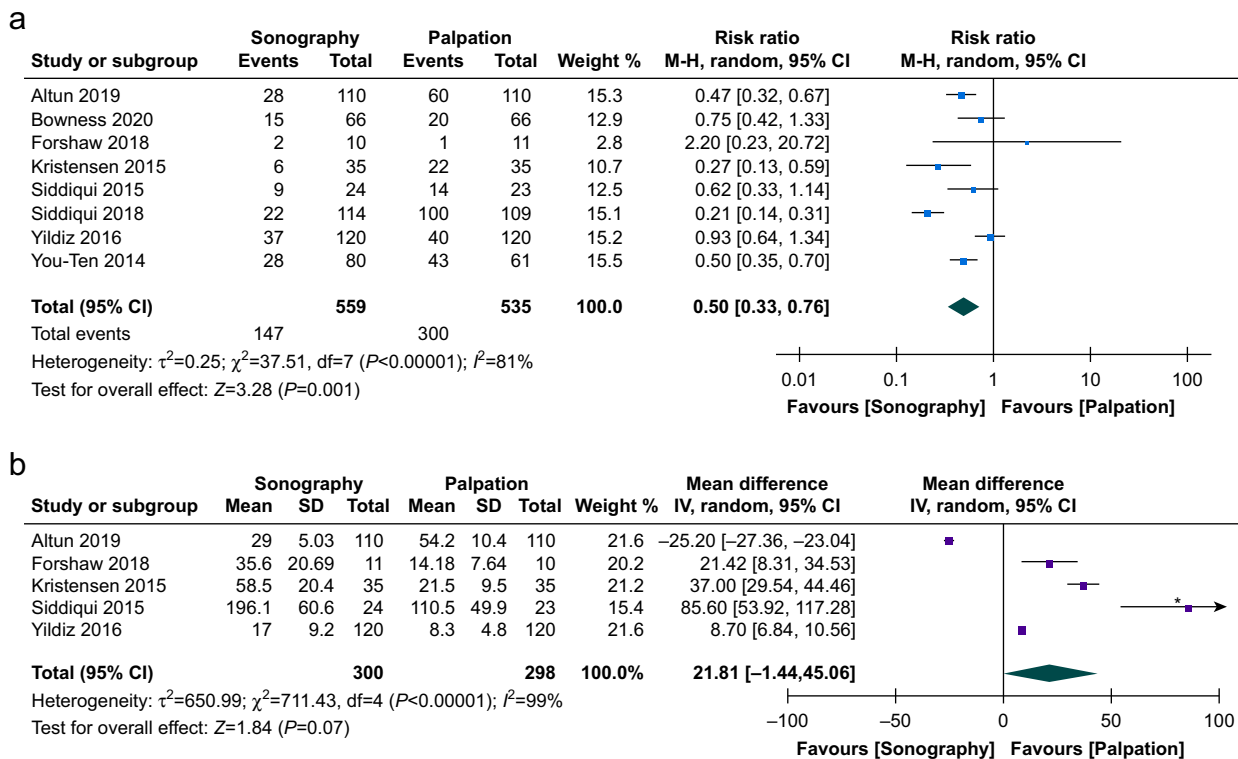

Fig 1. Forest plots for comparison of (a) failure rate of cricothyroid membrane identification and (b) procedural time between the ultrasound-guided and digital palpation techniques. CI, confidence interval; IV, inverse variance; M-H, Mantel−Haenszel; RR, risk ratio; SD, standard deviation. *Time in this study includes the time for cricothyrotomy.

technique. Second, the number of examiners, characteristics of subjects to be examined (e.g. those with abnormal neck anatomy), and study design (e.g. crossover vs randomised controlled studies) may contribute to a high heterogeneity amongst the included studies. Third, the issue of whether the insignificant prolongation in procedural time associated with the use of an ultrasound-guided technique was partly attributable to heterogeneity of the included studies needs to be addressed by further large-scale studies.

In conclusion, the results of the current study show that the ultrasound-guided approach offered a significantly higher success rate in identification of the cricothyroid membrane than that using the palpation technique. However, we did not find significant differences in time for the two procedures. Nevertheless, because both techniques can be time consuming and because palpation often fails, our findings support that identification of the cricothyroid membrane should be done during the preoperative evaluation whenever possible and that examination of the patient should be performed with ultrasonography if landmarks are not clear.[9,10]

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Declarations of interest

The authors declare that they have no conflicts of interest.

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Entrainment of brain network oscillations in anaesthesia. Comment on Br J Anaesth 2020; 125: 330–335

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