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Relationship between severe obesity and depth to the cricothyroid membrane in third-trimester non-labouring parturients: a prospective observational study

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Abstract

Background: Severely obese parturients have increased 'cannot intubate, cannot oxygenate' risk during Caesarean section under general anaesthesia. Front-of-neck access (FONA) at the cricothyroid membrane (CTM) is definitive management; however, attempted FONA can fail. Point-of-care ultrasonography may provide useful information about CTM depth to aid FONA in obesity. This study determined the difference in CTM depth between severely obese and non-obese parturients, utilising ultrasonography.

Methods: In this prospective observational study, two anaesthetists performed airway ultrasonography on 15 severely obese (BMI >45 kg m^{-2}) and 15 normal-weight (BMI ≤25 kg m^{-2}) parturients in the third trimester, using the transverse and longitudinal planes, sniffing and extended head positions, and nil and firm transducer pressures. The primary outcome was CTM depth (millimetres) measured in the transverse plane with the head extended and nil transducer pressure. Secondary outcomes included CTM depth measurements using other factor configurations. Intra-class correlation coefficients assessed the inter-observer reliability.

Results: CTM depth measured in the transverse plane with head extended and nil transducer pressure was significantly greater in severely obese parturients, mean 18.0 mm (95% confidence interval 16.3–19.8), *vs* 10.6 mm (8.81–12.4) in non-obese ($P<0.001$); mean difference 7.4 mm (4.9–9.9; $P<0.001$). CTM depths were increased in the severely obese group regardless of scanning plane, head and neck position, or transducer pressure (all $P<0.001$). There was excellent inter-observer reliability.

Conclusions: Cricothyroid membrane depth is significantly increased in severely obese *vs* normal-weight parturients independently of scanning plane, head and neck position, or transducer pressure.

Keywords: airway management; intubation; oxygen inhalation therapy; pregnancy; ultrasonography

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Editor's key points

- In the situation of 'cannot intubate, cannot oxygenate', front-of-neck access may be required, but identification of the cricothyroid membrane can be difficult in obese pregnant women.
- Front-of-neck access might be more difficult in severely obese pregnant women since the cricothyroid membrane is deeper from the skin than in lean pregnant women.

Front-of-neck access (FONA) to the airway, also known as surgical airway access, is definitive management for 'cannot intubate, cannot oxygenate' (CICO) events.[1] However, success can be variable, particularly in obese parturients where percutaneous devices can be inadequate in length or kink.[1–3] Airway guidelines of the Obstetric Anaesthetists' Association therefore recommend all parturients to undergo assessment to predict potential FONA difficulty.[1] As anaesthetists have poor accuracy with localisation of the cricothyroid membrane (CTM) by palpation for this assessment in obesity, ultrasonography is useful.[1,4,5] Given the overlying soft tissues of the larynx have varying proportions, ultrasonography could additionally provide valuable information at the point of care regarding CTM depth in severely obese parturients.[4]

Although it is recognised that the CTM is deeper in obese than non-obese patients, the difference in CTM depth between severely obese and normal-weight parturients has not been quantified.[4] This further information may be useful to plan needle or scalpel insertion if emergency FONA is required. We sought to quantify, using ultrasonography, if CTM depth, the distance between the skin and the CTM's air–tissue border, is significantly greater in severely obese compared with normal-weight parturients, using different scanning planes, head and neck positions, and transducer pressures.

Methods

Study design

After receiving the University of Tasmania Human Research Ethics Committee's approval (H0014787), a prospective observational study was performed at the Royal Hobart Hospital between July 2015 and February 2016. Written informed consent was obtained from all participants. The study protocol and reporting were according to the Strengthening the Reporting of Observational Studies in Epidemiology statement.[6]

Participants

Parturients in their third trimester were recruited at the Women's Services Clinic and the Obstetric Ward at the Royal Hobart Hospital. The inclusion criteria were age over 18 yr, gestation over 30 weeks, and either severe obesity with BMI >45 kg m^{-2} or normal weight with BMI ≤25 kg m^{-2}. Every eligible severely obese parturient was approached for recruitment during the study period. The recruitment of every eligible normal-weight parturient was impractical because of the high frequency of eligible patients; therefore, they were recruited by convenience sampling. The exclusion criterion was abnormal neck anatomy affecting the airway.

Study procedures

The study participants' height (metres) and weight (kilograms) were measured immediately before the ultrasound examinations and the BMI (kilograms per metre squared) was calculated. Whilst the participants were seated, their neck circumference (centimetres) was measured with a tape measure by an experienced anaesthetist infraglottically, just below the level of the larynx, keeping the tape taut with the skin circumferentially whilst the measurement was performed.

Ultrasonography procedures were standardised for all women and performed at the Women's Services Clinic and the Obstetric Ward at the Royal Hobart Hospital, using a SonoSite X-Porte™ (Brookvale, NSW, Australia) ultrasound machine with a 13–6 MHz (HFL38XP) linear transducer. The same two anaesthetists performed all scans and ultrasound measurements, and are from here on referred to as ultrasonographers. To reduce bias, each ultrasonographer had at least 5 yr experience with ultrasonography in clinical practice and performed a minimum of 20 infraglottic airway ultrasound examinations on non-study patients before the study recruitment.

Each participant's scans were performed using the same positioning in quick succession on a single day. A small wedge was placed for the duration of scanning under the right pelvis to provide left lateral tilt to prevent aortocaval compression. For scans performed with nil transducer pressure, the ultrasound gel had to be visible on the scanning image between the transducer and the participant's skin to ensure that the least amount of pressure possible was applied.

Ultrasonography in the transverse plane

For airway ultrasonography, the participants were initially positioned supine, in the sniffing position with their head on a pillow. The ultrasonographers stood to the participants' left, with the transducer held in their left hand. Both anaesthetists were present for initial ultrasound scanning to identify the CTM in the transverse plane. The presence of a bright hyperechoic line indicated the CTM's air–tissue border. The CTM's air–tissue border was located between the thyroid cartilage (overlying the vocal cords) proximally and the cricoid cartilage distally.[7,8] The transverse level of the CTM was then marked on the participant's skin using ultrasonography.

Each ultrasonographer, blinded to the other's CTM depth measurements, then independently performed transverse-plane scanning at the marked level using both nil and firm transducer pressures. The order of the ultrasonographers performing the scans was not randomised, as they took it in turns to be the first to perform the scans on any given parturient. The CTM depth measurements were captured on the scans using the inbuilt calipers of the machine. This process was repeated with the participants' heads in the extended position, by removing the pillow from under their heads. Figure 1 depicts a transverse-plane sonogram using nil transducer pressure in a severely obese parturient.

Ultrasonography in the longitudinal plane

For scanning in the longitudinal plane, the two ultrasonographers were no longer blinded to assist each other because of the increased difficulty of scanning in this plane. The scans were performed with the head in the extended position only, using both nil and firm transducer pressures. Using a modified