Perceived versus actual cricothyroid membrane landmarking accuracy by emergency medicine residents and staff physicians

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CLINICIAN'S CAPSULE

What is known about the topic?
Physicians demonstrate lower rates of success when attempting to landmark cricothyroid membranes in female patients.
What did this study ask?
Can emergency physicians predict their likelihood of successfully landmarking the cricothyroid membrane of healthy volunteers?
What did this study find?
This study found no correlation between confidence, perceived likelihood of success, and actual success of cricothyroid landmarking attempts.
Why does this study matter to clinicians?
A physician's inability to predict cricothyroid membrane landmarking accuracy may increase cricothyrotomy complications and necessitates further research into improving training techniques.

ABSTRACT

Objectives: Cricothyrotomy is an intervention performed to salvage "can't intubate, can't ventilate" situations. Studies have shown poor accuracy with landmarking the cricothyroid membrane, particularly in female patients by surgeons and anesthesiologists. This study examines the perceived versus actual success rate of landmarking the cricothyroid membrane by resident and staff emergency physicians using obese and non-obese models.
Methods: Five male and female volunteers were models. Each model was placed supine, and a point-of-care ultrasound expert landmarked the borders of each cricothyroid membrane; 20 residents and 15 staff emergency physicians were given one attempt to landmark five models. Overall accuracy and accuracy stratified by sex and obesity status were calculated.
Results: Overall landmarking accuracy amongst all participants was 58% (SD 18%). A difference in accuracy was found for obese males (88%) versus obese females (40%) (difference = 48%, 95% CI = 30–65%, $p < 0.0001$), and non-obese males (77%) versus non-obese females (46%) (difference = 31%, 95% CI = 12–51%, $p = 0.004$). There was no association between perceived difficulty and success (correlation = 0.07, 95% CI = −0.081–0.214, $p = 0.37$). Confidence levels overall were higher amongst staff physicians (3.0) than residents (2.7) (difference = 0.3, 95% CI = 0.1–0.6, $p = 0.02$), but there was no correlation between confidence in an attempt and its success ($p = 0.33$).
Conclusion: We found that physicians demonstrate significantly lower accuracy when landmarking cricothyroid membranes of females. Emergency physicians were unable to predict their own accuracy while landmarking, which can potentially lead to increased failed attempts and a longer time to secure the airway. Improved training techniques may reduce failed attempts and improve the time to secure the airway.

RÉSUMÉ

Objectif: La cricothyrotomie est une intervention de dernier recours qui se pratique dans les cas où il est impossible d'intuber ou de ventiler un patient. D'après des études, l'exactitude du repérage de la membrane cricothyroïde par les chirurgiens et les anesthésistes est peu élevée, surtout chez les femmes. L'étude visait donc à comparer le taux de réussite pressentie ou réelle du repérage de la membrane cricothyroïde par des résidents et des urgentologues, sur des modèles obèses et non obèses.
Méthode: Cinq hommes et femmes se sont prêtés au rôle de modèle; ceux-ci étaient en décubitus dorsal, et un spécialiste de l'échographie au chevet a repéré les bords de la membrane cricothyroïde sur chacun d'eux. Les résidents et les urgentologues participants, au nombre de 20 et de 15 respectivement, ne pouvaient tenter qu'une seule fois de repérer la membrane

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sur les 5 modèles. Les degrés d'exactitude globale et d'exactitude répartie selon le sexe et le degré d'obésité ont ensuite été calculés.

Résultats: Le taux global d'exactitude du repérage de la membrane a atteint 58% (écart type : 18%). Toutefois, un écart d'exactitude a été relevé entre les hommes obèses (88%) et les femmes obèses (40%) (écart : 48%; IC à 95% : 30-65%; $p < 0{,}0001$) ainsi qu'entre les hommes non obèses (77%) et les femmes non obèses (46%) (écart : 31%; IC à 95% : 12-51%; p : 0,004). Il n'y avait pas d'association entre le degré pressenti de difficulté et le degré de réussite (corrélation = 0,07; IC à 95% : -0,081-0,214; p : 0,37). Le degré de confiance, dans l'ensemble, était plus élevé chez les membres du personnel médical (3,0) que chez les résidents (2,7) (écart : 0,3; IC à 95% : 0,1-0,6; p : 0,02), mais il n'y avait pas de corrélation entre le degré de confiance dans la tentative de repérage et le degré de réussite (p : 0,33).

Conclusion: Le degré d'exactitude du repérage de la membrane cricothyroïde, par les médecins, était significativement plus faible chez les femmes. Les urgentologues n'étaient pas en mesure de prévoir leur propre degré d'exactitude pendant le repérage de la membrane, hésitation qui peut conduire à un nombre accru d'échecs et à une prolongation du temps nécessaire au rétablissement de la perméabilité des voies respiratoires. Aussi une amélioration des techniques de formation permettrait-elle de corriger ces deux lacunes.

Keywords: Emergency medicine, education, residents, cricothyroid

INTRODUCTION

Cricothyrotomy is an intervention performed to salvage "can't intubate, can't ventilate" situations. Access to the airway is gained through the cricothyroid membrane to insert a tracheal tube. It is vital for physicians to be able to quickly and accurately landmark the cricothyroid membrane.

Studies have shown poor accuracy when landmarking the cricothyroid membrane, particularly in females.[1,2,3,4,5] While landmarking accuracy has been well studied in the anesthesia literature, data on emergency physician (EP) success rates are sparce.[6] EPs and anesthesiologists have different skillsets and therefore may have different landmarking success. Ultrasonography is an accepted modality for identification of the cricothyroid membrane in controlled and research settings,[7] though studies have not shown ultrasonography to be superior in clinical settings.[4,5] There have been no studies examining perceived EP cricothyroid membrane landmarking accuracy or the correlation of their landmarking confidence with their actual attempt accuracy.

Our objective was to compare the perceived and actual success rate of landmarking the cricothyroid membrane by resident and staff EPs using obese (body mass index [BMI] > 30)[8] and non-obese (BMI < 30) males and females.

METHODS

We performed a prospective study using five non-obese and five obese volunteers, determined by self-reported height and weight, and five volunteer assessors (trained laypeople and physicians). We recruited a convenience sample of resident and staff EPs to participate in the study.

Each model was positioned supine with their necks in a neutral alignment. An experienced EP and point-of-care ultrasound expert landmarked the superior and inferior borders of each model's cricothyroid membrane with an invisible marker that becomes visible under black light (Supplemental Appendix 1). A 6-cm × 7-cm clear plastic dressing was placed over the site to protect the invisible markings. All assessors were provided training to standardize their assessments.

Participants were grouped into cohorts of up to 10. Each participant was assigned an anonymous identifier and completed a pre-test survey (Supplemental Appendix 2). Data were collected on each participant's level of training and perceived clinical ability for first pass success for performing a cricothyrotomy on an average male, average female, and obese person.

Each participant was subsequently assigned to five models (combination of obese, non-obese, male, and female). Participants were instructed to landmark each model's cricothyroid membrane as quickly and accurately as possible. They were given one attempt per model to landmark and place a single invisible pen mark at the site of the perceived cricothyroid membrane. Assessors recorded each participant's result using black lights and measuring tapes. Any distance greater than 5 mm from the outer borders of the cricothyroid membrane was considered a missed landmarking.[3] The clear plastic dressing was wiped clean after each attempt for the next participant. Following each attempt, participants

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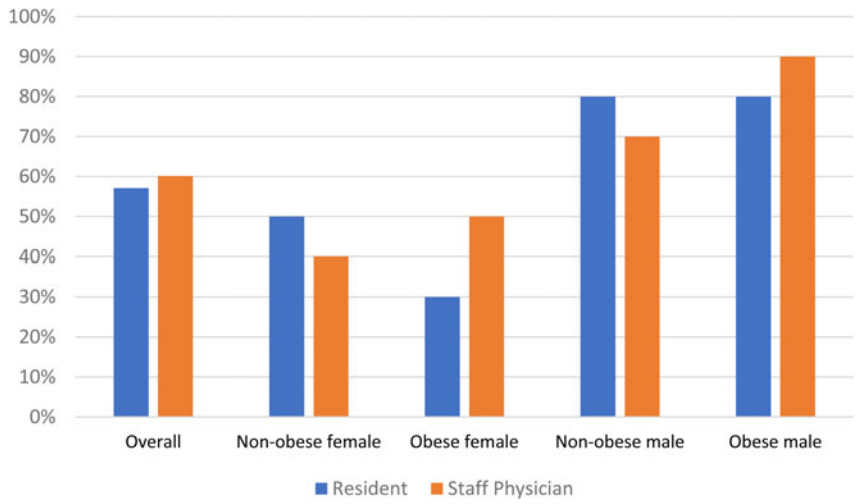

Figure 1. Participant attempt accuracy stratified by level of training.

completed an in-test survey (Supplemental Appendix 3) to assess their perceived attempt difficulty and confidence in their accuracy. Landmarking confidence was measured on a 10-cm visual analogy scale from "likely unsuccessful" to "successful." Participants repeated the procedure until they had performed an attempt on five different models.

Data analysis

Data were analysed to determine landmarking accuracy, correlation between actual and perceived accuracy, types of prior training received, perceptions of that training, and comfort with performing the procedure. We performed a subgroup analysis to compare resident and staff EP perceptions versus performance with obese, non-obese, male, and female models. Correlations were calculated as Pearson's correlation coefficient, except between confidence and actual success, which used Fisher's exact test.

RESULTS

Residents from PGY1 to PGY4 and staff EPs composed the participant pool. There were 35 total participants, 20 of which were residents (PGY1 = 7, PGY2 = 4, PGY3 = 5, PGY4 = 4) and 15 staff. The average BMI for non-obese female models was 26.5 (range 25–28), obese female models was 34.1 (33–35.1), non-obese male models was 24.7 (23.6–25.8), and obese male models was 36.0 (32.4–39.5).

The overall mean accuracy was 58% (SD = 18%) (Figure 1). A significant difference in accuracy was found for obese males (88%) versus obese females (40%) (difference = 48%, 95% CI = 30–65%, $p < 0.0001$); and non-obese males (77%) versus non-obese females (46%) (difference = 31%, 95% CI = 12–51%, $p = 0.004$). No difference between accuracy in obese and non-obese models of the same gender (males: difference = 11%, 95% CI = −7–28%, $p = 0.24$; females: difference = 6%, 95% CI = −25–13%, $p = 0.52$) was observed. A subgroup analysis of residents and staff found that they performed similarly.

The perceived attempt difficulty was not associated with success (correlation = 0.07, 95% CI = −0.081–0.214, $p = 0.37$). This finding remained consistent in our subgroup analysis of both residents and staff physicians. Confidence levels overall were higher amongst staff physicians (3.0) than residents (2.7) (difference = 0.3, 95% CI = 0.1–0.6, $p = 0.02$), but, despite this confidence difference, there was no correlation between attempt confidence and success (Fisher's exact test, $p = 0.33$).

DISCUSSION

Our study demonstrated no correlation between participants' perceptions of landmarking difficulty or confidence and landmarking success rates. Furthermore, while staff physicians demonstrated more confidence in their landmarking, they did not outperform residents in regard to accuracy. This may be because this is an

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uncommon procedure. Our results suggest that physicians are not able to discriminate between patients in which it will be difficult to landmark the cricothyroid membrane and those who will not be. The overestimation of success in female patients and the poor correlation between confidence and success suggest that additional steps are needed. One potential solution is to use a larger than traditionally taught vertical incision, regardless of perceived difficulty or physician confidence. This is supported by a recent study that recommended an 8- to 10-cm vertical incision to account for all potential cricothyroid membrane locations.[9]

Given the lack of ability of EPs in this study to predict their accuracy in landmarking cricothyroid membranes, improved training modalities would be useful for refining this skill. One modality that has shown to improve landmarking accuracy employed instant feedback on cricothyroid landmarking accuracy by ultrasound.[10] While not definitively studied, it stands to reason that more accurate landmarking would reduce the time to secure the airway and improve chances for success.

Limitations

Each model's neck was kept in a neutral position instead of an extended position, as would be customary for a cricothyrotomy. This was done both for the comfort of the models and to maintain consistency. This neutral positioning could have made landmarking models more difficult, resulting in a higher miss rate, but would be typical of patients in C-spine precautions.

Participants were recruited as a convenience sample of available residents and staff physicians. This may have introduced selection bias. While this could not be controlled for, our results appear to correlate with previous research. The smaller size of the participant group was chosen based on feasibility.

The assessors were not blinded to the attempts. While a lack of blinding can introduce bias, the distance from the invisible marking of the borders of the cricothyroid membrane is objective and less prone to bias than subjective measures.

CONCLUSION

This study supports the finding that physicians demonstrate significantly lower levels of accuracy when landmarking cricothyroid membranes of female models. EPs appear unable to predict their own accuracy while landmarking, which can potentially lead to increased failed attempts and a longer time to secure the airway. Improved training techniques, such as using ultrasound to provide instant landmarking feedback, as well as using larger initial incisions, may reduce the risk of failed attempts and improve the time taken to secure the airway.

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Author contributions: NS participated in the study concept and design, acquisition of the data, analysis and interpretation of the data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, and statistical analysis. MYW participated in the acquisition of the data, interpretation of the data, and critical revision of the manuscript for important intellectual content. AP and WJC participated in the study concept and design, acquisition of the data, and critical revision of the manuscript for important intellectual content. JJP participated in the study concept and design, analysis and interpretation of the data, and critical revision of the manuscript for important intellectual content.

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