

**Original Communication****EMERGENCY CRICOTHYROIDOTOMY PROCEDURE: LECTURE ON SURGICAL ANATOMY AND BRIEFING OF THE PROCEDURE FOLLOWED BY SKILL ASSESSMENT IN FIRST SEMESTER MEDICAL STUDENTS****Anasuya Ghosh<sup>1</sup>, Subhramoy Chaudhury<sup>2</sup>**<sup>1</sup>*Department of Anatomy, All India Institute of Medical sciences, Kalyani, India*<sup>2</sup>*Department of Anatomy, Medical University of the Americas Charlestown St Kitts Nevis***ABSTRACT**

**Introduction:** Emergency Cricothyroidotomy (ECT) is a life-saving procedure where the cricothyroid membrane is incised to access the larynx to establish breathing in "can't intubate, can't ventilate" situations. This procedure can be taught along with midline neck anatomy to the first semester medical students and their understanding and application of knowledge could be assessed on cadavers. **Materials and methods:** Total three sessions were organized to expose and assess the first semester medical students about the Emergency Cricothyroidotomy (ECT) procedure. In each session, a two hour long integrated lecture was delivered regarding the surgical anatomy and the procedure. After that, randomly selected students were assigned a cadaver to locate and puncture the cricothyroid membrane with a sharp pointed wide probe. The time was recorded and pre and post session questionnaires were distributed and replies were analysed. **Results:** The total study participants were 154. Analysis revealed knowledge and confidence of performing the procedure was statistically significantly increased ( $p < 0.005$ ) among the participants after the session. Ninety percent participants successfully pierced the cricothyroid membrane as a team and the average time was 2 minutes 35 seconds. The most students gave a 'good' or 'very good' rating of this session. **Conclusions:** The medical students should be exposed to emergency life-saving procedures in relation to their anatomy course in earlier days of medical school. This could make them aware and oriented about the procedures which could be beneficial during their clinical training.

**Key words:** Medical students, Emergency Cricothyroidotomy, cadavers, hands on skill

**RESUMEN**

**Introducción:** La cricotiroideotomía de emergencia (TEC) es un procedimiento que salva vidas, en el que se realiza una incisión en la membrana cricotiroidea para acceder a la laringe y establecer la respiración en escenarios de "no se puede intubar, no se puede ventilar". Este procedimiento se

puede enseñar junto con la anatomía de la línea media del cuello a los estudiantes de medicina del primer semestre y su comprensión y aplicación del conocimiento podría evaluarse mediante la práctica de habilidades en cadáveres. **Materiales y métodos:** Se organizaron tres sesiones en total para exponer y evaluar a los estudiantes de medicina del primer semestre sobre el procedimiento de cricotiroideotomía de emergencia (TEC). En cada sesión se impartió una charla integrada de dos horas sobre la anatomía quirúrgica y el procedimiento. Después de eso, a los estudiantes seleccionados al azar se les asignó un cadáver para localizar y perforar la membrana cricotiroidea con una sonda ancha puntiaguda y afilada. Se registró el tiempo y se distribuyó el cuestionario pre y post sesión y se analizó la respuesta. **Resultado:** El total de participantes del estudio fue de 154. El análisis reveló que el conocimiento y la confianza en la realización del procedimiento aumentó de manera estadísticamente significativa ( $p < 0.05$ ) entre los participantes después de la sesión. El 90% de los participantes fueron perforados con éxito la membrana cricotiroidea como equipo y el tiempo promedio fue de 2 minutos y 35 segundos. La mayoría de los estudiantes calificaron esta sesión como "buena" y "muy buena". **Conclusión:** Los estudiantes de medicina deben estar expuestos a procedimientos de emergencia que salvan vidas en relación con su curso de anatomía en los primeros días de la escuela de medicina. Esto podría sensibilizarlos y orientarlos sobre los procedimientos que podrían ser beneficiosos durante su formación clínica.

**Palabras clave:** Estudiantes de medicina, cricotiroideotomía de emergencia, cadáveres, habilidades prácticas

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## INTRODUCTION

Emergency cricothyroidotomy (ECT) is a life-saving procedure where the larynx is accessed by piercing or incising the cricothyroid membrane and inserting airway tube in a compromised and otherwise inaccessible airway (DiGiacomo et al., 2003). ECT is done in rare clinical emergencies where anaesthesiologists cannot establish mask ventilation or endotracheal intubation or in pre hospital set up where larynx has to be accessed quickly and effectively with whatever instrument is available (Battefort et al., 2006, Helm et al., 2012). Though there is lack of consensus regarding when ECT has to be done, some of the situations include severe facial trauma and haemorrhage, acute foreign body related obstruction, cervical spinal injury, terminal carcinoma related scenarios, severe altered anatomy leading to intubation failure and acute 'can't ventilate, can't intubate' situation (Carvey et al., 2020; Tokarz et al.,). The procedure needs sound knowledge of anatomy, and confidence in palpating the surgical landmark at midline of neck (Boon et al., 2004). There are many methods to perform ECT (DiGiacomo et al ,2003; Melkar and Gabrieli, 2005; Schober et al, 2008; Hill et al,

2010; Helm et al, 2012; Carvey et al, 2020) with a wide range of instruments. (Helm et al, 2012; Carvey et al, 2020).

In some medical schools, this procedure is mentioned during head neck anatomy course (Carvey et al, 2020), but in many medical schools it is not included during undergraduate teaching (Quintana et al., 2009; Spiers et al., 2019; Mayer et al., 2020). Moreover, the residency programs often do not offer skill training related to ECT or tracheostomy procedure or details about care of tracheostomy (Yelverton et al., 2015). There is limited literature about exposure and perception of undergraduate medical students to emergency procedures including ECT.

So, we wanted to introduce ECT procedure to first semester medical students at our institution. The main objectives were-

1. To expose the first-year medical students about the ECT as a life-saving procedure in a two-hour long interactive lecture session in relation to anatomical landmarks and surgical anatomy of midline structures of neck
2. To assess their knowledge / understanding (pre and post session)
3. To assess their application of knowledge by means of hands-on skill assessment on cadavers

Age range	Number	Gender			Previous work experience			Exposure to ECT procedure	
		Male	Female	Others	Student doing bachelors	Working as nurse/ paramedic	Others	Yes	No
21-25	26								
26-35	99	82	71	1	108	31	15	5	149
36-45	29							Health set up- 3	
								Movie - 1	
								Subway train journey - 1	

Table 1-: Demography of participants

## MATERIALS AND METHODS

This study was organized during 2018 -19 at our institution across three different batches of first semester students at the end of their gross anatomy course. Total three sessions were organized to expose and assess the first semester students' knowledge and skill related to ECT procedure. In each session, a two hour long integrated lecture was delivered by an anatomy instructor (the lecture material was prepared by consultation with one general surgeon, one ENT surgeon and one anaesthetist and was approved by all after two rounds of revision) gross and

topographical anatomy, surgical anatomy of larynx and trachea, the probable indications of standard ECT, anatomical aspect of ECT and planned tracheostomy procedures. The lecture session included power point presentation with suitable diagram and oral explanation to students' questions related to the material. Before the session, a pre-test question-naire was distributed to the students to assess their previous knowledge and exposure about ECT. After the session, 21 medical students were randomly selected by a table of random numbers based on the class roll numbers. They were divided into 7 groups and each group with 3

participants was given a cadaver to puncture cricothyroid membrane using a wide bore pointed probe (probe diameter approximately 3 mm). Seven cadavers' un-dissected head-neck were utilized for each session. The time to complete the procedure -starting from palpation of anatomical landmarks of neck to the end of piercing the target area by the wide bore pointed probe -was recorded by staffs of anatomy department. In a later date, dissection was conducted by an anatomist to assess if the pointed probe pierced the cricothyroid membrane and was placed within the lumen of larynx, was midline in position, and if it damaged any adjacent structures indicating complication.

At the end of each the session, same questionnaire was distributed to assess if the students learned from the session and to obtain their feedback about the session. The questionnaire had four components:

- Purpose of the study with informed consent
- Demography- age, gender, previous work/training, previous exposure to ECT
- Questionnaire- close ended
- Feedback- rating the session and open comments/ suggestion

The questionnaire was prepared by literature search and by consultation with three external experts in the field of anatomy and otolaryngology. One of the authors worked as a moderator and final decision maker to address the variation of opinion. Finally, a brief peer

review of the questionnaire was conducted by the other faculty members before distribution to the participants.

Total 154 participants from the first semester were involved in three sessions. Randomly selected 63 participants in 21 groups were assessed if they could palpate the midline anatomical landmarks and pierce the cricothyroid membrane successfully on 21 human cadavers. The performance result was tabulated.

The questionnaire-responses were collected and statistically analysed using Microsoft excel and SPSS (version 22) software.

This study was conducted after obtaining ethical approval from the institution.

## RESULTS

Total 180 first semester medical students across three semesters were enrolled for this study, although 154 students participated in the study and submitted completed questionnaire. Among the study participants, 82 were male, 71 were female, and one transgender student. Thirty-one students had previous work experiences in health set up as a nurse or a paramedic. Three of them were exposed to ECT in health set ups and two of them observed it outside health set-up (Table1).

Question	Pre-session positive/ YES response	Post session positive /YES response	P -value
			(Chi- squared test)
Do you know the indications of Emergency Cricothyrotomy procedure?	31 (20.13%)	144 (93.51%)	P< 0.0001
Are you confident to palpate the anatomical landmarks related to the procedure?	29 (18.83%)	150 (97.40%)	P< 0.0001
Do you know the exact site where the ECT is performed?	52 (33.77%)	154 (100%)	P< 0.0001
Are there chances of complication?	27 (17.53%)	154 (100%)	P< 0.0001
Will you be able to perform ECT in cadaver?	24 (15.58%)	154 (100%)	P< 0.0001

**Table 2:** Questionnaire related to knowledge and skill for ECT

Analysing the pre and post session questionnaire responses regarding ECT, it was seen that the knowledge regarding the surgical anatomy, indications, complication, and confidence of performing the procedure was statistically significantly increased ( $p < 0.0005$ ) among the participants after the session (Table 2).

After dissection and sagittal section of the cadavers, it was seen that 19 teams (90%) were able to pierce the cricothyroid membrane at midline by the sharp pointed wide probe (Fig.1) successfully while two teams placed it over the upper trachea. In most of the cases, the tip of pointed probe was placed within the lumen of



larynx below the vocal cord while in one case the pointed probe pierced the posterior wall of trachea and punctured the oesophagus. The average time taken for puncturing the cricothyroid membrane was 155 second (2 minutes 35 second). (Table 3)

Most of the students rated the session as good to very good. Some of them suggested including more such sessions on other emergency life-saving procedures, in depth live videos of the actual procedure and more hands-on practice options. (Graphic 1 and Table 4)



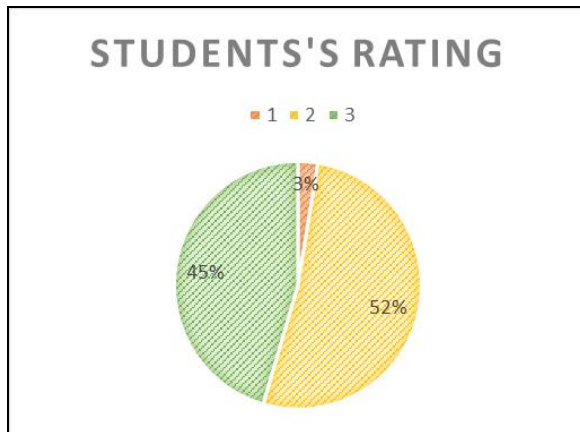
**Figure 1-** Position of pointed probe placed by students observed after dissection of the cadaver. TC- Thyroid cartilage. CC- Cricoid cartilage. CTM – Cricothyroid membrane

Success	Failure	Time taken	Observed complication
19 cases (90%)	2 cases (10%)	75 sec- 180 sec	1 case

**Table 3-** Team Performance analysis (n=21) on cadavers

Feedback Comments (open ended)
More such sessions on other emergency management topics should be arranged
I learned about an essential emergency procedure
It could be better if each of us given a chance to perform the procedure on cadaver
It could be better if a live demonstration of the procedure was available
I had a false notion from a movie that such procedure is very easy and anyone can do it, but today I learned the truth

**Table 4-** Significant feedback received after the session



**Graphic 1-** Pie diagram showing rating of the session by students. 1 Average, 2 Good, 3 Very Good

## DISCUSSION

In present study we found that the knowledge regarding indication, surgical anatomy, complication, and confidence of performing ECT was statistically significantly increased in first semester medical students following the session. They could locate and puncture the cricothyroid membrane successfully in 90% cases in a team-based approach following the session within 75-180 seconds. Only one complication was observed where the pointed probe pierced the posterior wall of trachea and punctured oesophagus. Most of the students rated the session as 'good' followed by 'very good'.

Study design, study participants, subjects and instruments used: In present study, the knowledge, understanding, and skills of the students regarding ECT improved statistically significantly following the lecture session. Similarly, another study (Spiers et al., 2019), showed medical students' understanding on surgical anatomy and confidence of performing skills related to ENT surgery improved statistically significantly following a one-day workshop. In another study on medical students and residents (Tokarz et al., 2020), after lectures

on surgical anatomy of trachea, tracheostomy tube components and tracheostomy care, the participants could answer clinical scenario related to tracheostomy and laryngectomy much better than they did before the session. The knowledge and confidence both increased statistically significantly post-lecture.

In previous studies different sample population were tested for their hands on skill on cadaver to perform ECT. A study (Carvey et al, 2020) showed that randomly selected medical students and faculty members of a medical college made cricothyrotomy opening on cadavers with scalpel, steak knife or available percutaneous cricothyrotomy kit. In another study (Hall AB, 2011) emergency air-force personnel, after a short training, were invited to perform ECT with standard cricothyrotomy instrument in cadavers. In a study by Kattan et al. (2021), the simulator trained residents performed tracheostomy in cadavers without complication. Helm et al. (2012) compared the standard surgical ECT procedure versus indicator guided puncture technique of ECT in cadaver by first year anaesthesia residents. Untrained medical students performed ECT on manikin with Melker cricothyrotomy kit (Hwang K et al., 2014) after training and practice. Success rate, complications and average time taken: In present study, the success rate to pierce the cricothyroid membrane was 90% while it was 75% in a previous study conducted by trained air-force personnel in cadavers (Hall AB, 2011), 100% by simulator trained residents (Kattan et al., 2021), 100% versus 67% in standard surgical ECT procedure versus indicator guided puncture technique respectively (Helm et al., 2012), 70% by both faculty members and medical students in cadavers (Carvey et al, 2020), and 100% by medical students on manikins (Hwang K et al., 2014).

The complications noted after the procedure included posterior tracheal wall penetration, fracture of thyroid and cricoid cartilage, laceration of blood vessels in previous studies (Schober P et al., 2008; Helm M et al., 2012; Carvey et al., 2020) while present study found posterior tracheal wall penetration in only one case.

The time taken to complete the procedure varied from 1 minute 35 seconds to 5 minutes in previous studies including various approaches and wide range of participants (Schober P et al., 2008; Hall AB, 2011; Hwang K et al., 2014; Carvey et al., 2020) whereas in present study, the medical students took 1 minute 15 seconds to 3 minutes to puncture the cricothyroid membrane with the sharp pointed wide bore probe working in a group of three.

Limitations: Our study had certain limitations. The ECT kit, tracheotomy tube or ideal instruments could not be used, formalin fixed cadavers were used instead of ideal soft embalmed cadavers and almost half of the participants could not be allowed to perform the procedure individually or in a team as there were limited number of available cadavers. Still, we conducted the study on a larger number of populations (medical students) than previous studies and we could arrange an integrated lecture session which significantly increased students' knowledge and confidence regarding the emergency, life-saving procedure.

In conclusion, it can be said the medical students should be exposed to emergency life-saving procedures in relation to their anatomy course in earlier days of medical school. This could make them aware and oriented about the procedures which will help during their residency and future clinical career.

#### Conflict of Interest

No conflict of interest was present

#### Financing

None

#### Ethical approval

Approved by institutional Ethics committee

#### Informed consent

Taken from the study participants

#### Contributions

Research plan, data acquisition, calculation, drafting manuscript, revision of final manuscript: AG. Research idea, drafting questionnaire, preparation of lecture material, data acquisition, revision of final manuscript: SC

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