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Ultrasound Assessment of the Effectiveness of Cricoid Pressure

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Abstract: ***Background and Aims- The application of cricoid pressure (CP) during rapid sequence induction to prevent regurgitation of gastric contents has been questioned by many studies in the past decade. There is a paucity of randomised controlled trials (RCTs) to support or to refute the application of cricoid pressure. We used real time ultrasound in this study to evaluate the location of oesophagus and its displacement on application of cricoid pressure. Methods-Thirty two healthy volunteers underwent ultrasound examination of the neck with and without CP. The location of oesophagus (measured as distance from mid-cricoid to mid-oesophagus), its displacement with cricoid pressure (measured from mid-cricoid to mid-oesophagus after cricoid pressure) were measured. The subjective assessment of difficulty in swallowing on cricoid pressure was also noted. Results -The oesophagus was located on the left side of the cricoid in all the patients. The mean (SD) distance from mid-cricoid to mid-oesophagus without CPas well as with CP was 1.10(0.25)cm and 1.04(0.46) cm respectively, which was statistically not significant. The mean(SD) antero-posterior diameter of the oesophagus without as well as with CP was 0.67(0.39) and 0.40(0.04)cm respectively, which was statistically significant (p=0.001). Half of the participants reported difficulty during swallowing with CP. Conclusion-In our study, we observed that application of CPdid not displace the oesophagus significantly from its neutral position but effectively reduced its antero-posterior diameter which was significant. This shows that CP is useful and effective in occluding the oesophagus even when it is located away from the mid-line and displaced with CP.***

Keywords: Cricoid pressure, oesophagus, cricoid, ultrasound

1. Introduction

The application of CP for the prevention of aspiration of gastric contents during rapid sequence induction was first described by Sellick BA in 1961[1]. The proposed mechanism is that the cricoid being a complete ring occludes the oesophageal lumen against the vertebral body and prevents the regurgitation and aspiration of the gastric contents. Since then, there has been a widespread practice of applying 30-40 N of cricoid pressure during rapid sequence induction of full stomach patients during anaesthesia, in emergency department and intensive care units.

Unfortunately, this practice doesn't come without complications. The CP hinders the visibility of the vocal cords during intubation and may require release of the pressure to facilitate intubation. The CP can also cause oesophageal disruption, if there is regurgitation due to increase in the oesophageal pressure[2]. Recently, this practice of CP has been questioned and has been claimed that it does not reduce the risk of aspiration.

A magnetic resonance imaging (MRI) study in 2003[1]showed that the CP displaced the oesophagus in about 66% of cases which may make it ineffective. Review articles published in 2005[3]and 2008[2] are also against the efficacy of the Sellick's manoeuvre in preventing the aspiration.

In 2015, the Cochrane database of systematic reviews[4]revealed that there were no RCTs comparing the patients receiving CP to those not receiving the CP and the outcome measure as incidence and prevalence of aspiration.

In 2014, Zeidan et al[5] studied the effectiveness of the CP on oesophageal entrance in anesthetized and paralysed patients with glidescope and concluded that in 95% of cases, the CP successfully occluded the oesophageal opening. Rice MJ and others in 2009[6] studied MRI images in 24 non-sedated individuals and concluded that the oesophageal position was irrelevant for the effectiveness of Sellick's manoeuvre and it is the hypopharynx that gets compressed during CP.A latest review article by Deborah JC in 2017[7] discourages the total abandoning of the CP, as the aspiration is the single most common anaesthesia related cause of deaths.

As per our literature search, we didn't find any study regarding ultrasound evaluation of the oesophageal relation to the CP. Only static radiologic studies using MRI and computed tomography (CT) have been published. Hence we decided to perform this sonographic assessment of the exact location of oesophagus in relation to the cricoid and its displacement with CP. Ultrasound assessment is not only static but also a dynamic study without any radiation hazard. Since there are unresolved controversies around the effectiveness of CP, we assumed that this study might help to understand more about the mechanism and efficacy of CP.

2. Materials and Methods

After approval from the ethics committee and written informed consent, healthy volunteers aged 16 years to 40yrs in the hospital were recruited in the study.

Airway ultrasound was carried out with GE LOGIQ with 11MHz high frequency linear transducer. Volunteers were asked to lie in supine position with the head slightly extended.

1. Probe is placed on the anterior neck over the cricoid and structures were identified. Identification of oesophagus was aided by swallowing movements of the volunteers. The location of oesophagus was noted (right side, left side or posterior to cricoid), the maximum antero-posterior (AP) diameter of the oesophagus was measured pre and post CPby the transducer probe.

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Distance of the mid-oesophagus from mid-cricoid was also measures pre and post CP with the transducer (Fig 1). Compression was applied using the transducer probe by the principal investigator. Amount of pressure applied was equivalent to the pressure required to blanch the forehead skin with thumb and index finger. This was practiced several times by the examiner who applied the pressure. The examiner applying the pressure was blinded to the measurements made on the ultrasound screen.

2. Measurement taken from midpoint of cricoid to midpoint of oesophagus.



Figure 1: Relation between oesophagus and trachea

3. The participant was asked to swallow saliva while the examiner was applying CP with the transducer. Subjective assessment of difficulty in swallowing was noted.

Our inclusion criteria were healthy volunteers (doctors, nurses, technicians) between the age of 16 years- 40 years.

Those with thyroid or neck swelling, gastro oesophageal reflux disease (GERD), cricoid fracture were excluded from the study.

3. Results

Thirty two healthy volunteers were included in the study (56.3% were females , 43.8% were males) (table 1).

Table 1: Gender

	Frequency	Percent
Female	18	56.3
Male	14	43.8
Total	32	100.0

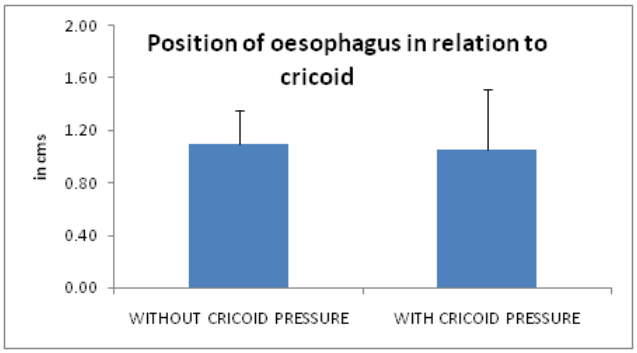
32 participants were included in the study out of which 18 were males and 14 females.

The mean (SD) age was 24.5 (6.47) years. In all the participants, oesophagus was seen on left side of the midline. The mean (SD) distance between the midpoint of cricoid to the midpoint of oesophagus without CP was 1.10 (0.25) cm and with CP was 1.04 (0.46) cm (table 2, graph 1).

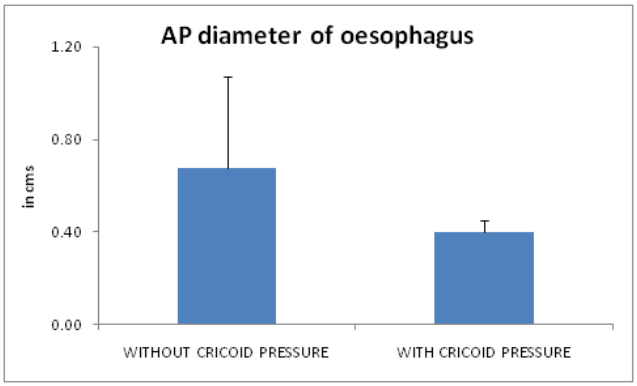
Similarly the mean (SD) outer AP diameter of the oesophagus without CP was 0.67(0.39) cm and with CP was 0.40 (0.04) cm (table 2, graph 2).

Table 2: Relation of oesophagus with respect to cricoid

	Age in years	Position without CP in cm	Position with CP in cm	AP diameter before CP in cm	AP diameter after CP in cm
Mean	24.50	1.1016	1.0484	0.6763	0.4013
Std. Deviation	6.476	0.25561	0.46733	0.39721	0.04924
Minimum	18	0.70	0.27	0.27	0.30
Maximum	40	1.66	1.74	1.97	0.48



Graph 1: Position of oesophagus in relation to cricoid



Graph 2: AP diameter of esophagus on application of CP

50% of the participants expressed difficulty in swallowing during CP (table 3).

Table 3: Difficulty on swallowing with CP

	Frequency	Percent
No	16	50.0
Yes	16	50.0
Total	32	100.0

Subjective assessment of difficulty in swallowing.

Paired sample tests revealed that there was no statistically significant difference in the distance between the midpoint of the cricoid to the midpoint of oesophagus without CP and with CP(p=0.481). Whereas, there was a statistically significant difference in the AP diameter of oesophagus without CP and with CP(p=0.001) (table 4).

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Table 4: Paired Samples Test

		Paired Differences					t	Df	p-value
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Position without CP - Position with CP	0.05312	0.42083	0.07439	-0.09860	0.20485	0.714	31	0.481
Pair 2	AP diameter before CP - AP diameter after CP	0.27500	0.40471	0.07154	0.12909	0.42091	3.844	31	0.001

The p value of AP diameter of oesophagus is significant after application of CP.

The approximate time taken to complete the examination in each volunteer was less than 3 min. All patients tolerated the procedure well. Adverse events like bradycardia, nausea, vomiting, damage to cricoid were experienced in none of the participants.

4. Discussion

In our study, the main result obtained using the real time ultrasound on healthy volunteers was that the CP did not displace the oesophagus significantly away from its original neutral position and at the same time, was effective in reducing the AP diameter of the oesophagus.

Although the oesophagus was situated on the left side of the midline in all patients, its position did not change further on application of the CP. Further, the AP diameter significantly reduced on application of the CP as compared to no CP application. Again, it should be noted that this shortening of the AP diameter was significant despite the initial leftward position of the oesophagus in neutral (without CP) position. These findings challenge the various radiological studies which are against the practice of application of CP, where they found the oesophagus being displaced after the application of CP.

Many studies have been published in the past two decades questioning the effectiveness of the CP originally described by Sellick to prevent the aspiration of the gastric contents. Many studies including Smith KJ et al[1] (2003) where MRI was used, Utschigg EE et al[8] (2016) where ultrasound was used to study the location of oesophagus in relation to cricoid stated that in majority of cases, the oesophagus was located on the left side of cricoid and not in the midline. The oesophagus was further laterally displaced with the application of CP. But none of these studies measured the extent of lateral displacement and whether it was significant enough to make the CP ineffective. In our study, we also observed that the oesophagus was located on the left side of the cricoid and was displaced further laterally on application of CP. But this displacement was insignificant statistically refuting the importance of the findings observed in the previous studies.

Our findings were supported by the studies conducted by Rice et al[6] and Zeidan AM[5]. Rice et al[6] in their MRI study of healthy volunteers found that the position of oesophagus was not relevant for the effectiveness of Sellick's manoeuvre. They stated that it is the hypopharynx which lies behind the cricoid cartilage and both these two structures move as a single unit. With the application of CP, the AP diameter of hypopharynx decreased by 35%. These results were consistent with our findings where the mean AP diameter with CP was 0.40cm as compared to the mean AP diameter without CP which was 0.67 (40.3% reduction in AP diameter). These findings clearly indicate that the CP is effective in occluding the oesophagus even when it is not in the midline or laterally displaced.

Our findings were similar to the results of the study conducted by Zeidanet al[5], where they objectively investigated with the help of videolaryngoscope, the effectiveness of CP in preventing the insertion of nasogastric tube. In their study also, the oesophagus was not in the midline in majority of the patients but still the CP prevented the passage of nasogastric tube in all patients. Further they also noted that the oesophageal lumen was obliterated in all patients with the application of CP. Thus, just radiologic evidence of location and displacement of the oesophagus as mentioned in the various studies are insufficient to say that the Sellick's manoeuvre is ineffective.

Another finding observed in our study was about 50% of the volunteers experienced difficulty in swallowing with CP. This again shows that the CP is effective in obliterating the oesophageal lumen despite its left sided location and lateral displacement.

Further, many complications of CP have also been described including fracture of cricoid, difficulty in ventilation, intubation and so on. These complications are bound to occur when the CP is not applied properly and without proper prior training. Sellick's manoeuvre is effective only when applied correctly with recommended force of 30-40 N and this requires periodic training. In a study conducted by Connor et al[9], in 2013concluded that the simulation based training improved the technique of CP among the participants. This finding would raise the doubt regarding the correctness of the Sellick's technique in those studies where CP was ineffective in preventing aspiration.

Limitations of our study were, small sample size, no objective measurement of the amount of CP applied was made and the subjective nature of the swallowing difficulty complained by the volunteers during CP application.

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5. Conclusion

In our study, we found that the CP was effective in reducing the AP diameter of the oesophagus irrespective of its position in relation to the cricoid cartilage. The lateral displacement of the oesophagus on application of CP was insignificant and did not reduce the effectiveness of CP. Nearly half of the volunteers experienced difficulty in swallowing with the application of CP. Thus we strongly recommend the use of CP during rapid sequence induction to prevent aspiration of gastric contents.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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