

Reduction in mouth opening with semi-rigid cervical collars[†]

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Background. Reduced mouth opening may be a major contributing factor to the deterioration in the view obtained at laryngoscopy when a semi-rigid cervical collar is in place. We set out to assess the degree to which mouth opening is restricted by a cervical collar.

Methods. We measured maximal inter-incisor distance in 52 volunteers. It was measured again after application of each of three appropriately sized semi-rigid cervical collars (Stifneck, Miami J, and Philadelphia).

Results. Inter-incisor distance was significantly reduced by the application of a cervical collar [No collar 41 (7) mm—mean (SD); Stifneck 26 (8) $P<0.0001$; Miami J 29 (9) $P<0.0001$; Philadelphia 29 (9) $P<0.0001$]. There was a wide and unpredictable variation between subjects in the reduction in mouth opening and a significant proportion had an inter-incisor distance of 20 mm or less (Stifneck, 25%; Miami J, 21%; Philadelphia, 21%).

Conclusions. Application of a semi-rigid cervical collar can significantly reduce mouth opening. This could hinder definitive airway placement. Our results support removing the anterior portion of the collar before attempts at tracheal intubation.

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A semi-rigid cervical collar is recommended for immobilization of the cervical spine in patients with suspected cervical spine injury.¹ These patients often require tracheal intubation with a degree of urgency, frequently under less than ideal conditions. The presence of a semi-rigid cervical collar has been shown previously to result in a poorer view at laryngoscopy.² It has been suggested that a reduction in mouth opening is the major contributing factor to the deterioration in the view obtained.² This contrasts with a recent article, which showed only a small difference in mouth opening with and without a cervical collar.³ Anecdotal evidence suggests successful tracheal intubation is possible in patients with a semi-rigid collar in place, although this may be more awkward.⁴ The effect a semi-rigid collar has on mouth opening is still uncertain. We set out to further assess this with a variety of semi-rigid cervical collars.

Methods

After obtaining local ethics committee and research and development approval, volunteers were recruited from amongst the staff at our institution. Using previously published data as a guide,² a power calculation was performed. Assuming a mean mouth opening of 50 mm with an SD of

15 mm, 12 subjects would be required to detect a decrease in the mean of 12 mm (~25%) and 51 subjects to detect a decrease of 6 mm (power 80%, 5% significance level). We elected to study the larger sample. In the event, we recruited 52 volunteers. Maximal mouth opening, taken as inter-incisor distance (from the lower border of the upper incisors to the upper border of the lower incisors) was measured with the subject's head held in the neutral position. This was measured using a ruler with a millimetre scale. The ruler was small enough to be placed in direct contact with the subject's teeth. If the subject had dentures or a dental plate, they were asked to keep these in place. Inter-incisor distance was measured again after the application of each of three appropriately sized semi-rigid cervical collars. Averages of three measurements were taken in each situation. Blinding either the subject or observer to the presence or type of collar was not thought to be possible without the use of a screening device around the face and neck. This was rejected as it could possibly interfere with mouth opening. The collars used (see Fig. 1) were the Stifneck (Laerdal Medical Corp., Wappinger's Falls, NY, USA),

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Fig 1 Types of semi-rigid collar used (left to right): Stifneck (Laerdal Medical Corp.); Miami J (Jerome Medical); Philadelphia (Philadelphia Cervical Collar Company).

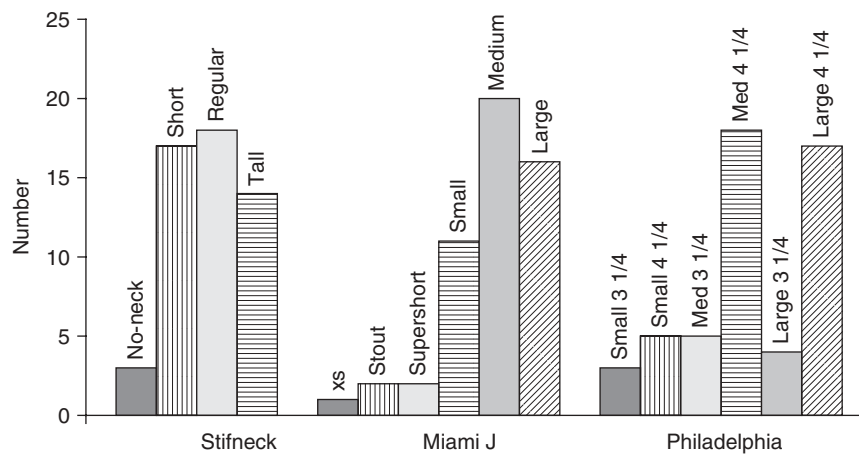


Fig 2 Collar sizes.

the Miami J (Jerome Medical, Moorestown, NJ, USA), and the Philadelphia (Philadelphia Cervical Collar Co., Thorofare, NJ, USA). Sizing and fitting of the collar was carried out according to the manufacturer's guidelines contained within the product packaging. Sizing and fitting of the collars was carried out by the same investigator (C.M.G.) after receiving appropriate training.

We planned to analyse the paired results with either Student's paired *t*-test (normal distribution) or the Wilcoxon signed rank-test (non-normal distribution). Non-paired results would be analysed with either Student's unpaired *t*-test (normal distribution) or the Mann–Whitney *U*-test (non-normal distribution).

Results

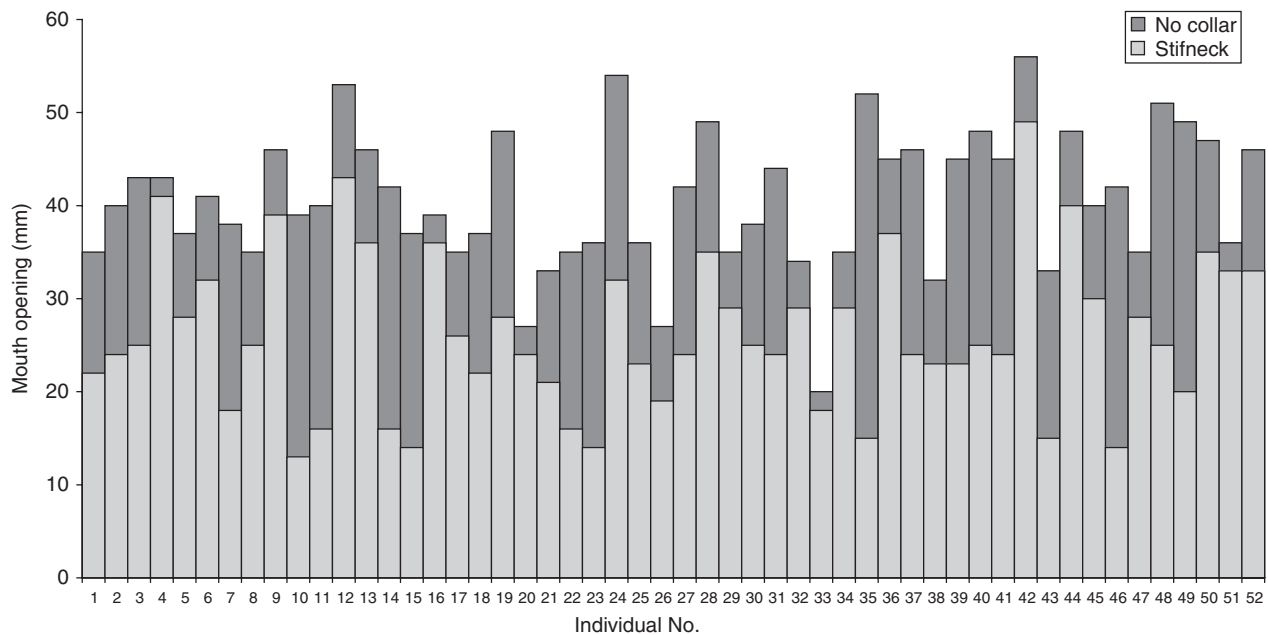
Fifty-two subjects were studied (27 female, 25 male). Paired results were analysed using the Wilcoxon signed-rank test; unpaired results were analysed with the Mann–Whitney *U*-test. All sizes of collars available were represented (see Fig. 2). Mean inter-incisor distance was significantly

reduced after application of all three types of collar. Mean inter-incisor distance was 41 mm without a collar. This was reduced to 26 mm with the Stifneck collar ($P < 0.0001$), 29 mm with the Miami J collar ($P < 0.0001$), and 29 mm with the Philadelphia collar ($P < 0.0001$). Further details are given in Table 1. The reduction in mouth opening was greater with Stifneck collars than with either the Miami J or Philadelphia collars ($P = 0.0001$ and $P = 0.0005$, respectively). Inter-incisor distance was significantly smaller in female subjects than in male (37 vs 45 mm, $P = 0.0002$).

There was marked variability in the degree to which a cervical collar reduced mouth opening. In some subjects, inter-incisor distance was markedly reduced, whereas in others there was little change (see Figures 3–5). This variability could not easily be explained. In particular, there appeared to be no correlation with either the collar size or the sex of the subject, as shown by the overlap in 95% confidence intervals (see Table 1). In addition, we analysed the variance between sizes within each collar group using the Kruskal–Wallis test. The results were non-significant (see Table 1). The degree of mouth opening before application of

Table 1 Inter-incisor distance before and after collar application

	No. subjects	Mean (mm)	Median (mm)	SD (mm)	Range (mm)	95% Confidence intervals (mm)	Kruskal–Wallis test values
No Collar							
Total	52	41	40	7	20–56	39–43	
Male	25	45	46	6	33–56	42–47	
Female	27	37	37	6	20–49	34–39	
Stifneck							
Total	52	26	25	8	13–49	24–28	
Male	25	28	28	9	14–49	24–31	
Female	27	24	24	7	13–41	21–27	
Individual sizes:							H=2.5, df 3
Tall	14	29	27	9	14–43	24–34	
Regular	18	25	24	10	14–49	20–30	
Short	17	26	26	6	13–36	23–29	
No-neck	3	24	23	6	19–30	10–38	
Miami J							
Total	52	29	29	9	10–49	27–32	
Male	25	31	32	8	20–49	28–35	
Female	27	26	27	8	10–42	23–30	
Individual sizes:							H=4.3, df 5
Large	16	29	29	9	13–42	24–34	
Medium	20	29	28	9	10–49	25–33	
Small	11	29	29	7	16–39	24–33	
Stout	2	39	39	6	34–43	–19–96	
Super-short	2	23	23	9	16–29	–60–105	
XS	1	32	32	n/a	n/a	n/a	
Philadelphia							
Total	52	29	29	9	13–52	27–32	
Male	25	31	32	10	13–52	28–36	
Female	27	27	28	8	15–42	24–30	
Individual sizes:							H=8.5, df 5
Large 4¼	17	33	33	10	16–52	28–39	
Large 3¼	4	29	27	9	20–42	14–44	
Medium 4¼	18	29	29	7	17–42	25–32	
Medium 3¼	5	29	30	7	19–36	20–37	
Small 4¼	5	22	23	7	13–42	12–31	
Small 3¼	3	22	19	9	15–32	0–44	

**Fig 3** Variation in mouth opening after application of a Stifneck collar ($P<0.0001$).

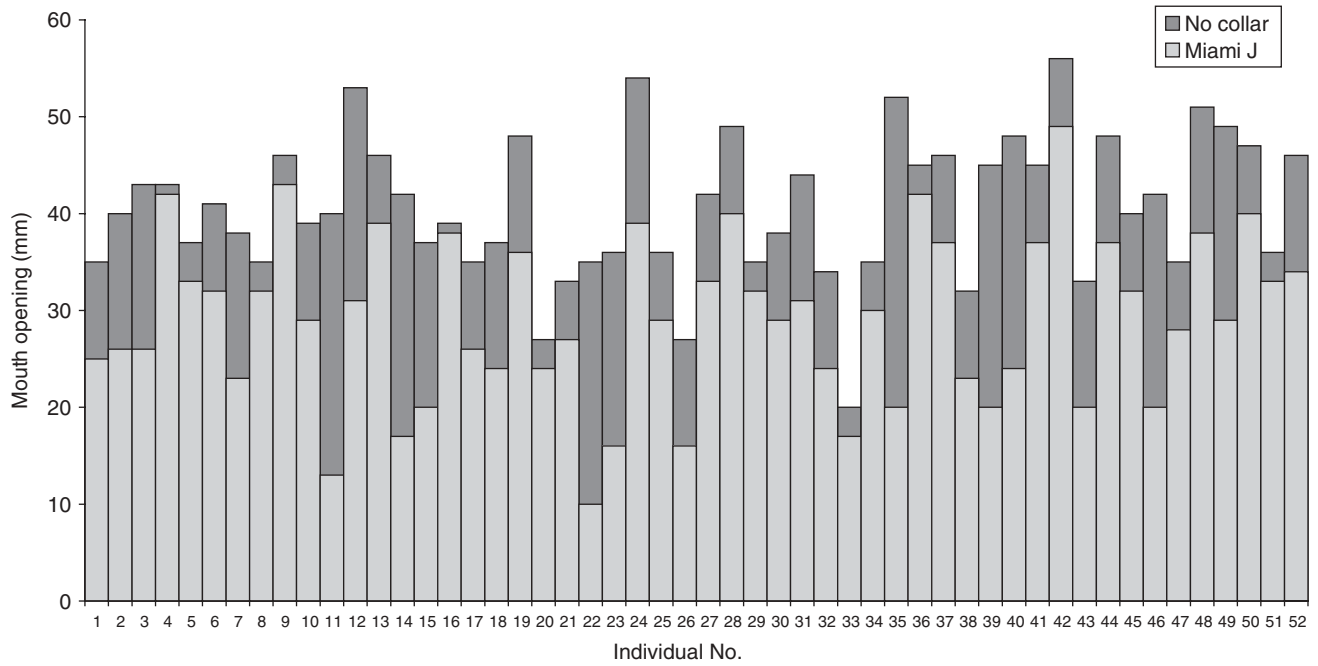


Fig 4 Variation in mouth opening after application of a Miami J collar ($P<0.0001$).

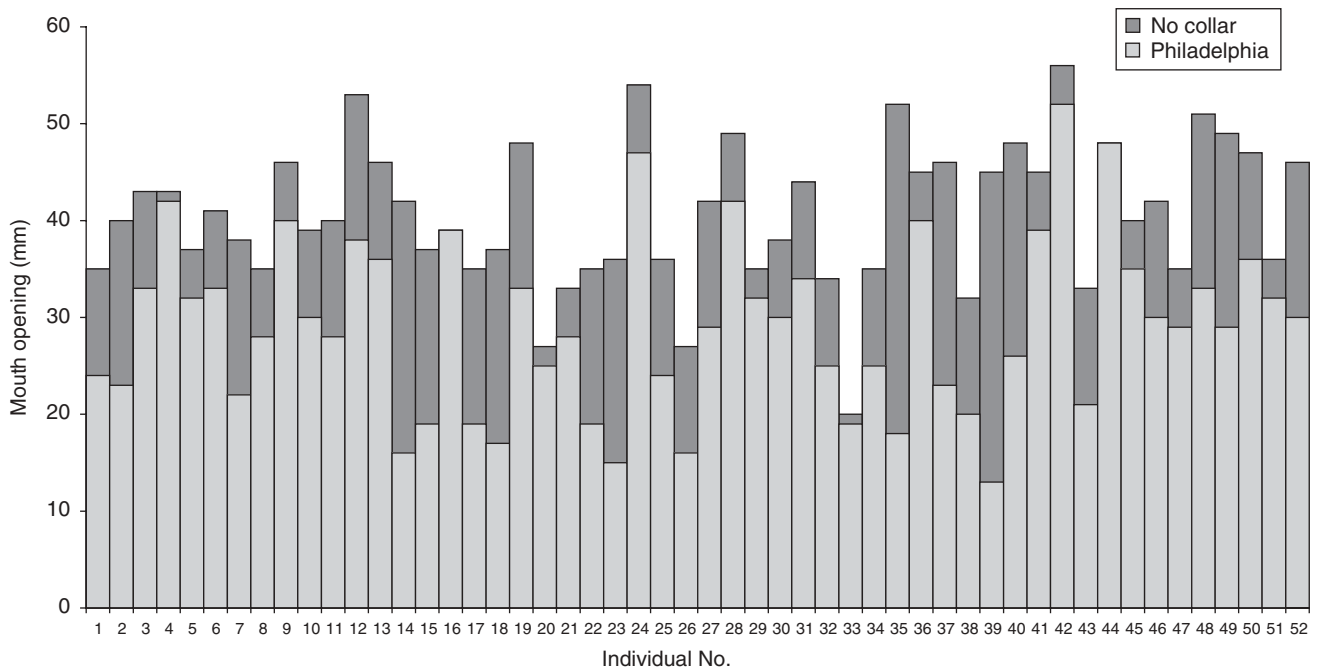


Fig 5 Variation in mouth opening after application of a Philadelphia collar ($P<0.0001$).

the collar could not be used to predict mouth opening afterwards (see Figs 3–5). Although detailed subject characteristics were not recorded, all subjects were healthy adults with a normal body mass index.

The restriction to mouth opening could reach levels where it could be of clinical significance. Twenty-five per cent of subjects with an appropriately sized Stifneck collar and 21% of those with either a Miami J or Philadelphia collar had an inter-incisor distance of 20 mm or less.

Discussion

The optimal method for securing tracheal intubation in patients with potential cervical spine injuries remains the subject of debate. The Advanced Trauma Life Support (ATLS) protocol mentions several options: direct laryngoscopy with manual in-line stabilization, blind nasotracheal intubation, and fibre-optic intubation.¹ Alternative strategies have been suggested by other authors: direct laryngoscopy with the aid of a gum elastic bougie,⁵ direct laryngoscopy

using McCoy's laryngoscope,⁶ the Bullard laryngoscope,^{7,8} and recently, blind intubation through an intubating laryngeal mask.⁵ Most of these airway strategies require some degree of access to the oropharyngeal cavity.

Our study supports the findings by Heath,² who showed that the view obtained with direct laryngoscopy was inferior when a cervical collar was in place, mainly because of a reduction in mouth opening. Our results show this reduction in inter-incisor distance with all three types of collar, and also show the unpredictable nature of this reduction. There was much variability with some subjects having little change in their inter-incisor distance whilst others had a marked reduction. The reason for this difference is not immediately obvious.

A substantial proportion of subjects had mouth opening reduced to the point where inter-incisor distance was less than or equal to 20 mm. This may be relevant in the event of a failed intubation attempt. Both the laryngeal mask and the intubating laryngeal mask have been suggested as devices to be considered in the event of failure to secure tracheal intubation.⁹ The maximum external diameter of the intubating laryngeal mask is 20 mm.¹⁰ Reduced mouth opening has been shown to contribute to either difficulty with insertion or failure of insertion of both the laryngeal mask and the intubating laryngeal mask.^{11,12}

In the elective patient with a potential cervical spine injury the final choice for airway management would depend on individual experience and availability of equipment. In the elective patient, it may be reasonable to assess mouth opening with the collar on prior to induction of anaesthesia. If this was judged acceptable, the collar could be left in place during intubation. If tracheal intubation turned out to be difficult, other strategies could be used at that point.

Emergency patients with a potential cervical spine injury often require urgent intubation and cannot be approached in the same manner. The results suggest that attempting tracheal intubation with a collar in place could be difficult in a significant number of patients. These patients are often uncooperative or comatose and therefore unable to demonstrate adequate mouth opening. We would suggest that keeping the collar in place could result in failure to intubate the trachea at the first attempt in a large proportion of these patients, regardless of the method of intubation chosen. Direct laryngoscopy when the anterior part of the collar has been removed, together with manual in-line stabilization of the cervical spine has been demonstrated to be safe and

effective.¹³ We would recommend this approach from the outset in the emergency patient.

In summary, semi-rigid cervical collars significantly reduce mouth opening in an unpredictable manner. We recommend that patients with potential cervical spine injury who require definitive airway placement should have manual in-line stabilization of the spine maintained whilst the anterior part of the collar is removed before tracheal intubation is attempted.

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