Emergency intubation of infants: does laryngoscope blade design make any difference?

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Abstract

Objective—To compare intubation times and ease of use for a range of infant laryngoscope blades in the hands of accident and emergency (A&E) personnel.

Methods—Seven different blades were compared in terms of intubation times and ease of use scores in the hands of 30 A&E senior house officers (SHOs) and nurses using a standard infant manikin.

Results—There was a significant difference in intubation times between the seven blades ($p < 0.001$). Intubation with two blade designs (Seward and Soper) took almost twice as long as for the other blades ($p < 0.05$). Subjective ease of use scoring also identified the Seward and Soper blades as being the most difficult to use ($p < 0.05$). There were no significant differences between SHO and nurse intubation times or ease of use scoring. Successful intubation was achieved within 30 seconds in 90% of attempts. All but two of the subjects used an incorrect levering technique for intubation despite all having previously received training in infant intubation.

Conclusions—No current standard exists regarding the utilisation of infant laryngoscope blades in the A&E department. The first line blade available should be a C shaped blade (Miller, Oxford, Robertshaw, or Wisconsin). Other blade designs should be kept for use only by more experienced personnel or in difficult intubation situations. Intubation training must focus on correct technique and regular assessment is essential.

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Figure 1 Laryngoscope blade designs chosen; side and cross section views.

Emergency intubation of infants in the accident and emergency (A&E) department is rarely necessary but when required may need to be undertaken by relatively inexperienced staff. Intubation must be accomplished quickly and safely, a skill only possible with a combination of regular training and essential equipment. Infants have a relatively large and floppy epiglottis and so a straight laryngoscope blade is used to lift it forwards to provide a clear view of the larynx. The design of the straight blade has been modified many times but at no stage have the different designs been formally compared for ease of use. The aim of this study was to compare intubation times and subjective ease of use with a range of infant laryngoscope blades in the hands of A&E personnel.

Method

Six different fiberoptic laryngoscope blades were selected to represent the major design variables (fig 1). As one design (Wisconsin) was unavailable with a fiberoptic light source, two Robertshaw blades were compared, one with a standard and one with a fiberoptic light source. All blades were of a similar size (length 88–105 mm) as deemed appropriate for an infant manikin. The study was conducted with 30 subjects from three A&E departments. Subjects were either A&E senior house officers (SHOs) or nurses who had not previously worked in anaesthesia. Only nurses who had achieved provider status in Advanced Paediatric Life Support (APLS) or Paediatric Advanced Life Support were included.

The subjects were asked to intubate a standard Laerdal infant manikin using each one of the seven blades attached to a slim "AA" size laryngoscope handle. The manikin was intubated a total of three times with each blade using a standard 3.5 mm inside diameter uncuffed tube. The first attempt enabled the subject to familiarise themselves with the

Figure 2 Mean intubation times for each laryngoscope blade design.

Figure 3 Ease of use scores for each laryngoscope blade design.

equipment, the next two attempts were used for data collection. Data collected were both objective (time to intubation) and subjective (relative ease of use measured on a 10 point visual analogue scale). Time to intubation was measured by a single observer taken from a standard starting position to a confirmation that successful intubation had been completed by inflating the "lungs". An average time was calculated from the two timed attempts with each blade. Ease of use was assessed on the final intubation attempt. Subjects were asked to assess the blade on a scale of 1 to 10: a score of 1 was labelled "very easy" and 10 "very difficult".

It was anticipated that there would be considerable experience gained from repeated intubation attempts. To attempt to minimise the effect of this learning curve each blade was used in a non-consecutive randomised order. The order was determined by use of a standard randomisation chart devised before the study started. No assistance or tutoring was given at any time and subjects were told to ignore the "30 second rule"¹ and to continue attempts at intubation until successful.

Data analysis was performed with Minitab statistical software. Statistical methods used were analysis of variance and Fisher's least significant difference test.

Results

A total of 30 subjects were assessed: 22 SHOs and eight nurses. Time to successful intubation ranged from 7 seconds to 300 seconds. One subject was unable to intubate the manikin on one attempt and timing was stopped at 300 seconds. Mean intubation times for each blade are shown in fig 2. There was a significant difference in intubation times between the blades ($F = 4.67, p < 0.001$) and intubation times with the Seward and Soper blades were significantly longer when compared with each of the other blade designs (table 1). Mean ease of use rating scores for each blade are shown in fig 3. Analysis showed a statistically significant difference in the rating scores ($F = 9.35, p < 0.001$) with the Seward and Soper blades being rated more difficult to use when compared with each of the other blade designs ($p < 0.05$). There was no significant difference between the standard and fiberoptic Robertshaw blades in either time to intubation or ease of use rating.

Analysis of the SHO and nurse subgroups mirrored the overall findings with no differences apparent in either measured parameter.

Discussion

Since the first description of the anaesthetic laryngoscope by Magill in 1926² many different modifications have been made to the basic design.³⁻⁶ Arguably the most significant alteration was made by Macintosh in 1943 who introduced a curved blade and consequently a different technique for visualisation of the larynx.⁷ By indirectly lifting the epiglottis, far less stimulation of the vagally innervated dorsal surface occurs. Whereas the Macintosh laryngoscope blade has become a standard tool for the intubation of adults in this country, there is

Table 1 Mean differences (with 95% confidence intervals) between intubation times for all combinations of blade designs

	Robertshaw standard	Oxford	Seward	Robertshaw fiberoptic	Miller	Wisconsin
Oxford	2.11 (-8.01 to 12.24)					
Seward	-15.13* (-25.26 to -5.01)	-17.25* (-27.37 to -7.13)				
Robertshaw fiberoptic	1.91 (-8.21 to 12.04)	-0.20 (-10.32 to 9.92)	17.05* (6.93 to 27.17)			
Miller	-0.53 (-10.66 to 9.59)	-2.65 (-12.77 to 7.47)	14.6* (4.48 to 24.72)	-2.45 (-12.57 to 7.67)		
Wisconsin	3.185 (-6.94 to 13.31)	1.06 (-9.06 to 11.19)	18.31* (8.18 to 28.44)	2.53 (-8.86 to 11.39)	3.71 (-6.41 to 13.84)	
Soper	-12.76* (-22.89 to -2.64)	-14.88* (-25.01 to -4.76)	2.36 (-7.76 to 12.49)	-14.68* (-24.81 to -4.56)	-12.23* (-22.36 to -2.11)	-15.95* (-26.07 to -5.83)

* Significant at $p < 0.05$.

no consensus regarding the ideal blade for infant intubation. The straight laryngoscope blade is still recommended¹⁸ as the relatively large size of the epiglottis in infants makes direct elevation the technique of choice. At the present time there are several infant blades available but no studies of the effectiveness of each blade. Descriptions of the performance of laryngoscope blades are anecdotal and controlled studies rare.⁹⁻¹⁰ Due to the many individual factors McIntyre commented that "...detailed evaluations of the performance of any particular laryngoscope blade are extremely rare and critical analysis virtually non-existent".¹¹ We could find no published studies of infant blade comparisons.

The laryngoscope blade designs chosen for this study represent the major design differences seen. They are also all commercially available in the UK. The cross section of the blade is used to divide the blades into two broad categories. There are C shaped (Miller,¹² Oxford,¹³ Robertshaw,¹⁴ Wisconsin) and Z shaped blades (Seward¹⁵ and Soper¹⁶). The blades vary in degree of curvature from the predominantly straight (Soper) to the gently curved (Robertshaw). Other variables in blade design are the depth of the blade which may be constant (Miller) or variable (Wisconsin) and the type of light source. In recent years the advent of fiberoptic cable has led to its incorporation in laryngoscope blades. All blade designs except the Wisconsin were fiberoptic. Two Robertshaw blades were compared, one with a standard light source and one with a fiberoptic source in an attempt to validate the use of the Wisconsin blade.

The intubation times for five of the seven blades were well within the 30 second limit suggested by national and APLS guidelines.¹⁷ However, intubation with the Seward and Soper blades took approximately twice as long as with the other blades. When one considers that this study was conducted in a controlled and relaxed environment this is worrying. When confronted with a seriously ill infant, times would surely be longer and therefore only four designs of blade could be recommended to achieve intubation within 30 seconds. Individual ease of use ratings of the blades appears to confirm the findings of the intubation times—two blades were rated as being more difficult to use. No significant difference was found in either intubation times or ease of use rating scores for the two Robertshaw blades. This validates the comparison of the Wisconsin blade for this study and should not be used to compare fiberoptic and standard light sources in general.

The clear finding of two designs of laryngoscope blade being subjectively and objectively more difficult to use is related to a combination of factors. The difficult blades are both Z shaped and many subjects felt intubation was not as easy due to the lack of blade depth and the absence of a clear channel to guide the endotracheal tube. It was also apparent from observation that the vast majority of subjects were using an incorrect technique for intubation. Only two subjects, both doctors, lifted the

blade in an upward and forward direction. In these two subjects the average times to intubation did not significantly vary across the blades. In the other 28 subjects where the incorrect method of blade leverage on the lower gum and lip was used, intubation time differences were apparent. All doctors had received training on paediatric intubation within the previous six months and all the nurses had completed an APLS training course. This preponderance of poor technique reflects a natural tendency to revert to an "easier" method of leverage rather than the less traumatic and more correct method of lifting the laryngoscope blade. This issue can only be addressed by regular supervised training.

There are several limitations that must be taken into account when interpreting the results of this study. By using a manikin, it could be argued that the findings are not applicable to humans. It was felt that to conduct the same study on infants would not only be unethical but would also introduce many new, uncontrolled variables. A previous study validating manikin only intubation training showed that intubation success rates were the same as for subjects trained on human subjects alone.¹⁸ A manikin was therefore felt to offer a valid method of measuring intubation skills.

A learning curve for intubation of the manikin was apparent in all the results, the second intubation attempt being faster than the first in the vast majority of cases. However there was still remarkable consistency among the blades—the Seward and Soper designs producing the longest intubation times in both first and second attempts in all subjects.

The study subjects chosen were purposely relatively inexperienced doctors and nurses for two reasons. Firstly, it was felt that it would be more difficult to identify a difference between the blades using experienced subjects. An anaesthetist or senior A&E doctor should have few problems intubating a manikin with any straight blade. Secondly, in the scenario of a sick infant being brought into the A&E department at night, the SHO or nurse may have to attempt intubation before any senior help arrived. In this study 96% of intubation attempts with a C shaped blade were successful within 30 seconds. We can therefore be reassured that in this aspect of resuscitation, a high level of competence exists.

Conclusion

Intubation of infants should be carried out using a straight laryngoscope blade. In this study intubation with two of the blade designs took significantly longer than the others. It is recommended that A&E departments have either a Miller, Oxford, Robertshaw, or Wisconsin blade readily available for emergency intubation of infants. Other blades should be available but used only as a second line by more experienced personnel or in difficult intubation situations. Training of paediatric intubation must concentrate on a correct technique and this must be regularly reassessed in order that intubation continues to be successful and safe.

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