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## Arterial Blood Pressure and Heart Rate Response to Lighted Stylet or Direct Laryngoscopy for Endotracheal Intubation

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Tracheal intubation is accompanied by varying degrees of sympathetic stimulation, as reflected by increases in heart rate and arterial blood pressure.<sup>1,2</sup> Direct laryngoscopy, as well as insertion of the endotracheal tube, contributes to this effect. Various pharmacologic manipulations<sup>1,3,4</sup> and laryngoscope blades<sup>2,5</sup> have been utilized in attempts to attenuate these hemodynamic changes, but no study has been performed comparing the hemodynamic effects of direct laryngoscopy with an indirect means of tracheal intubation. The present study was carried out to determine if using the lighted stylet (light wand), which does not involve direct laryngoscopy,<sup>6,7</sup> would result in less hemodynamic stimulation when compared to intubation using either straight or curved laryngoscope blades.

### MATERIALS AND METHODS

Each patient provided written, informed consent, and the protocol was reviewed and approved by our Human Use Committee of the Department of Clinical Investigation. Fifty-six ASA I patients were assigned to one of three groups: 1) tracheal intubation with a curved laryngoscope blade (No. 3 Macintosh), 2) tracheal intubation with a straight laryngoscope blade (No. 2 Miller), or 3) tracheal intubation with the lighted stylet (Flexi-lum™, Concept Corporation, Clearwater, FL).§ Intubation with the lighted stylet has been previously described.<sup>6,7</sup> Intubations were performed by medical students, interns, residents, and nurse anesthetists. Use of the No. 3 Macintosh and No. 2 Miller blades was determined strictly at random by a computer program. However, the lighted stylet intubations were performed by more experienced (PGY-2 or greater) personnel. In addition to routine monitoring, an arterial catheter was placed in all patients for detection of rapid and transient changes in arterial blood pressure. The arterial trace was continuously recorded on a Siemen's strip chart recorder.

Each patient was premedicated with diazepam 5-10 mg po 1 h prior to surgery. Induction of anesthesia was accomplished by a continuous intravenous infusion of thiopental 1.0 mg · kg<sup>-1</sup> · min<sup>-1</sup>, which was not termi-

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§ As has been discussed, a new lighted stylet (TUBE-STAT™, Concept Corporation, Clearwater, FL), not available at the time of this study, is preferable to the Flexi-lum™ for endotracheal intubation.<sup>8</sup>

TABLE 1. Incidence of Premature Ventricular Contractions (PVC)

	No. 2 Miller	No. 3 Macintosh	"Light Wand"
Induction	0	0	0
Laryngoscopy	0	1	1
Intubation	1	0	0
Cuff inflation	3	3	2
No PVCs	14	16	9
More than five PVCs	2	4	3

nated until endotracheal intubation was accomplished. With loss of the lid reflex, vecuronium bromide 0.2 mg/kg iv was given. Following abolition of the twitch response, tracheal intubation was performed. Mean arterial blood pressure (MAP) and heart rate (HR) were compared at the following times: 1) pre-induction, 2) post-induction, 3) laryngoscopy, 4) intubation, 5) cuff inflation, and 6) 1 min following cuff inflation. Lantz-designed endotracheal tubes were used in all patients for autoregulation of cuff pressure at 24 cm H<sub>2</sub>O. Since heart rate and arterial blood pressure may be greatly altered by ventricular ectopy, any patient who developed more than five premature ventricular contractions was excluded from the study. Similarly, any patient who

required more than 30 s or more than one attempt for intubation was excluded from the study.

All data are reported as the mean and standard deviation. Statistical analysis consisted of analysis of variance to detect differences between the three groups at any specified time. Repeated-measures analysis of variance followed by a Bonferroni *t* test was used to isolate changes in heart rate or arterial blood pressure compared to pre-induction values for each intubation technique. An acceptable probability of making a Type I error was arbitrarily set at 5%.

## RESULTS

Patients ranged in age from 19 to 43 yr. The mean dose of thiopental used was  $7.1 \pm 1.3$  mg/kg,  $6.9 \pm 1.1$  mg/kg, and  $6.0 \pm 1.1$  mg/kg for No. 2 Miller, No. 3 Macintosh, and lighted stylet intubations, respectively.

The distribution of premature ventricular contractions at various times is presented in table 1, and illustrates the equal distribution of dysrhythmias regardless of the intubation technique utilized. Frequent premature ventricular contractions resulted in the exclusion of two, four, and three patients from the No. 2 Miller, No. 3 Macintosh, and "light wand" groups, respectively. Multiple or prolonged attempts at intubation resulted in the exclusion of two, three, and one patients from the No. 2 Miller, No. 3 Macintosh, and "light wand" groups, respectively.

Figures 1 and 2 illustrate the hemodynamic responses to induction, laryngoscopy, intubation, and cuff inflation. The induction technique produced no significant change in heart rate or mean arterial blood pressure in any group. All groups responded to laryngoscopy (or "light wand" placement in the glottis) with significant increases in heart rate. Mean arterial blood pressure was significantly increased by laryngoscopy with the No. 3 Macintosh blade, but not with the No. 2 Miller blade or "light wand" until tracheal intubation. These changes then persisted throughout the time course under study. There were no significant differences in heart rate or mean arterial blood pressure at any given time between the three groups.

The statistical finding of no "significant" difference in mean arterial blood pressure during laryngoscopy with the "light wand" and No. 2 Miller blade while the same variable was "significantly" increased during laryngoscopy with the No. 3 Macintosh blade was further examined by comparing the times required for laryngoscopy in each group (table 2). As indicated, Bonferroni *t* tests confirmed a significant difference in duration of laryngoscopy when the No. 3 Macintosh was compared to either the No. 2 Miller or "light wand."

The duration of laryngoscopy was also evaluated in

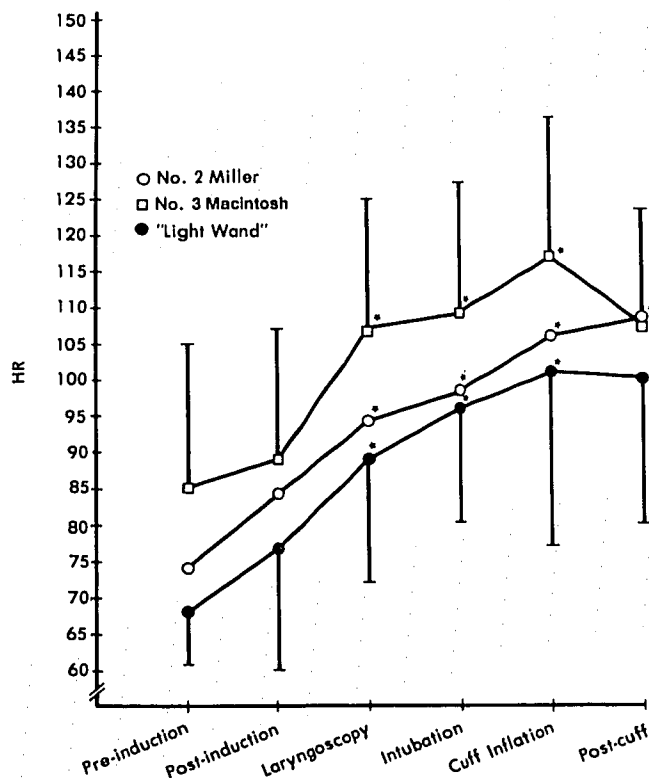


FIG. 1. Mean arterial blood pressure responses to each technique of intubation at the times designated. Standard deviation bars, similar for each group, are omitted from the No. 2 Miller curve for clarity. Asterisk (\*) indicates significant difference from pre-induction value.

patients who developed ventricular ectopy. The mean times required for intubation were  $19 \pm 2$ ,  $22 \pm 9$ , and  $17 \pm 6$  s for the No. 2 Miller, No. 3 Macintosh, and "light wand" groups, respectively. These times were not significantly different from those patients who did not demonstrate dysrhythmias.

Each technique was then categorized according to the level of training of the "laryngoscopist." Although assigned at random, it was found that inexperienced residents primarily utilized the No. 3 Macintosh blade for intubation, while more experienced residents primarily utilized the No. 2 Miller or "light wand" (table 3).

Finally, table 4 combines all three groups, and demonstrates the relationship between duration of laryngoscopy and change in mean arterial blood pressure and heart rate. Doubling the duration of laryngoscopy was associated with a near doubling of the percent increase in mean arterial blood pressure and heart rate during laryngoscopy.

### DISCUSSION

The induction technique of continuous infusion of thiopental combined with vecuronium was selected to minimize hemodynamic changes prior to laryngoscopy.<sup>9,10</sup> No significant changes in MAP or HR occurred with this technique, although MAP trended downward and HR upward in each group. No study patient developed premature ventricular contractions during induction of anesthesia. The overall incidence of dysrhythmias (11 of 50 patients) was 22%, and is not unexpected during intubation of lightly anesthetized patients.<sup>2,3</sup> Of the three techniques of intubation studied, dysrhythmias were provoked to an equal degree by each, implying similar degrees of autonomic stimulation.

Although the study was biased in that only more experienced personnel were permitted use of the "light wand," we could find no evidence that this indirect method of laryngoscopy produced less hemodynamic change than either direct method. Comparison of heart rate and mean arterial pressure between the three groups revealed no significant differences at any given time, suggesting that pharyngeal and glottic stimulation is non-specific in this regard.

Even though use of No. 2 Miller and No. 3 Macintosh blades was determined at random, by chance, relatively inexperienced personnel primarily used the No. 3 Macintosh blade for intubation. This introduced an unintended bias into the study, in that this group required significantly more time for laryngoscopy. The longer duration of laryngoscopy was clearly associated with larger increases in heart rate and mean arterial blood pressure. Nevertheless, this does not alter our conclusion that indirect laryngoscopy offers no advantage

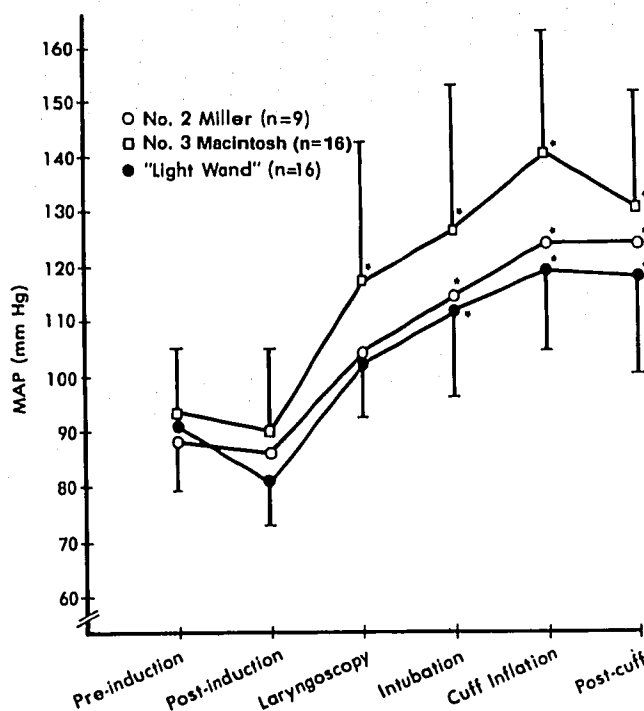


FIG. 2. Heart rate responses to each technique of intubation at the times designated. Standard deviation bars, similar for each group, are omitted from the No. 2 Miller curve for clarity. Asterisk (\*) indicates significant difference from pre-induction value.

TABLE 2. Duration of Laryngoscopy (Seconds)

Technique	Duration (Seconds)
No. 2 Miller (n = 16)	15 ± 6
No. 3 Macintosh (n = 16)	23 ± 8*
"Light Wand" (n = 9)	14 ± 6

Values are mean ± SD.

\* Indicates significant difference from No. 2 Miller or "Light Wand" groups.

TABLE 3. Duration of Laryngoscopy (Seconds) as a Function of Experience of Laryngoscopist and Intubation Technique

Technique	Level 1	Level 2
No. 2 Miller	29 (n = 1)	12 ± 6 (n = 15)
No. 3 Macintosh	26 ± 8 (n = 12)	17 ± 6 (n = 4)
"Light Wand"	(n = 0)	14 ± 6 (n = 9)

Values are mean ± SD. Level 1 = medical student, PGY-1, or non-anesthesia resident; level 2 = anesthesia resident (PGY-2, PGY-3, PGY-4) or nurse anesthetist.

TABLE 4. Duration of Laryngoscopy Versus Percent Increase in Pre-induction Mean Arterial Blood Pressure and Heart Rate

Duration (Seconds)	% Increase MAP	% Increase HR
0-15 (n = 20)	15 ± 18	12 ± 13
16-30 (n = 21)	39 ± 21	21 ± 15

Values are mean ± SD.

over direct laryngoscopy in terms of hemodynamic stability, because the duration of laryngoscopy and experience of the personnel involved were identical in the No. 2 Miller and "light wand" groups, as were the responses to laryngoscopy. Any advantage or disadvantage of the No. 3 Macintosh blade compared to either the No. 2 Miller or "light wand" cannot be discerned from the present study.

In conclusion, we have found that indirect laryngoscopy with the lighted stylet compared to direct laryngoscopy offers no advantage or disadvantage in terms of hemodynamic stability. Rather, the duration of laryngoscopy is an important variable associated with the magnitude of the increase in heart rate and mean arterial pressure. Endotracheal intubation then provides a further non-specific autonomic stimulus. Indirect laryngoscopy should be selected for anatomic, rather than hemodynamic, considerations.

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### Postoperative Neuromuscular Blockade: A Comparison Between Atracurium, Vecuronium, and Pancuronium

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Reports from Denmark<sup>1</sup> and Australia<sup>2</sup> have shown that postoperative residual neuromuscular blockade is common. On arrival in the recovery room, 30 of 72 patients (42%) in Copenhagen and 21 of 100 (21%) in Victoria had train-of-four ratios of less than 0.7.

However, anesthetic practice in North America differs in several respects from that described in those reports. First, neuromuscular activity was not moni-

tored during surgery in any patient in the two studies. Secondly, both investigations were completed before the intermediate-acting muscle relaxants, atracurium and vecuronium, were available, so that only long-acting nondepolarizing neuromuscular blocking drugs were used, often in high doses. Third, halothane was the most commonly used anesthetic agent. Supplementation of anesthesia with agents such as enflurane and isoflurane, which produce greater potentiation of neuromuscular relaxants<sup>3,4</sup> and impaired recovery,<sup>5,6</sup> was used less frequently<sup>1</sup> or not at all.<sup>2</sup>

The present study was designed to determine the incidence of residual neuromuscular blockade in 150 unselected patients who had received nondepolarizing muscle relaxants during surgery. Attempts were made to identify causative factors in patients demonstrating a persistent neuromuscular blockade.

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