Background. Nasotracheal intubation typically comprises three distinct stages: (i) nasopharyngeal intubation; (ii) direct laryngoscopy to identify the vocal cords; and (iii) the passage of the tracheal tube into the trachea. The aim of this study was to identify and compare the cardiovascular responses associated with each of these stages.

Methods. Seventy-five ASA I or II patients, aged 16–65 yr, requiring nasotracheal intubation as part of their anaesthetic management, received a standardized general anaesthetic and were allocated randomly to receive either nasopharyngeal intubation or nasopharyngeal intubation plus direct laryngoscopy or full nasotracheal intubation.

Results. There was a significant hypertensive response, compared with pre-induction levels, in all three groups. The maximum mean (SD) mean arterial pressure in the nasotracheal intubation group was 113 (17.1) mm Hg, which was significantly greater than that in the nasopharyngeal intubation (97 (13) mm Hg) \( (P<0.001) \) and in the nasopharyngeal intubation plus laryngoscopy (103 (10.3) mm Hg) \( (P=0.007) \) groups. There was no significant difference between the nasopharyngeal intubation and nasopharyngeal intubation plus laryngoscopy groups \( (P=0.206) \). A similar pattern was seen for both systolic and diastolic arterial pressure. Nasotracheal intubation caused a significant increase in maximum mean (SD) heart rate, compared with pre-induction values, whereas the other two groups caused significant falls. The heart rate in the nasotracheal intubation group (92 (16.5) beats min\(^{-1}\)) was significantly greater than in the other two groups (74 (8.6) \( (P<0.001) \) and 76 (12) \( (P<0.001) \) beats min\(^{-1}\) respectively). There was no significant difference in heart rates between the nasopharyngeal intubation and nasopharyngeal intubation plus laryngoscopy groups \( (P=0.420) \).

Conclusions. Nasopharyngeal intubation causes a significant pressor response. Stimulation of the larynx and trachea by the passage of the tracheal tube, but not direct laryngoscopy, causes a significant increase in this response.

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Stimulation of the upper respiratory tract during tracheal intubation under general anaesthesia causes activation of the sympathoadrenal system and results in hypertension, tachycardia and also an increase in intracranial pressure.\(^1\) It has been shown that different phases of the intubation process cause different degrees of cardiovascular response,\(^2,3\) as indeed does mechanical stimulation of different sites lower down the airway.\(^4\) Orotracheal intubation comprises two distinct phases of airway stimulation. First, direct laryngoscopy is carried out to identify the vocal cords, then the tracheal tube is advanced through the vocal cords into the trachea. Two studies\(^2,3\) have attempted to differentiate the contributions to the pressor response by laryngoscopy alone and laryngoscopy followed by intubation, but they have given conflicting results. Shribman and colleagues\(^2\) concluded that the hypertensive effect of laryngoscopy alone appeared to be similar to that of laryngoscopy followed by intubation, whereas Shinji and
colleagues reported that laryngoscopy followed by intubation produced significantly greater hypertension than did laryngoscopy alone.

Nasotracheal intubation is often necessary in elective or emergency maxillofacial surgery and previous work has suggested that the increase in blood pressure after this procedure is significantly greater than that after orotracheal intubation. Nasotracheal intubation typically comprises three stages: (i) the tracheal tube is advanced through the nose and into the pharynx; (ii) direct laryngoscopy is carried out to identify the vocal cords; and (iii) the tube is passed through the glottis and into the trachea. It is possible that the stimulation of nose and nasopharynx, which does not occur during orotracheal intubation, is responsible for the greater hypertensive response to nasotracheal intubation. However, no attempt has been made to differentiate the contributions made by the three stages of nasotracheal intubation, so there is no information about the relative significance of the nasal/nasopharyngeal response in comparison with nasotracheal intubation. There is also no information about whether the combination of nasal/nasopharyngeal stimulation plus the more prolonged direct laryngoscopy required for nasal intubation produces a similar cardiovascular response to nasotracheal intubation, or less. The objective of this study, therefore, was to identify and compare the haemodynamic responses after the three stages of nasotracheal intubation.

Methods

After local ethics committee approval, 75 ASA group I or II patients, aged between 16 and 65 yr, undergoing elective maxillofacial surgery under general anaesthesia, requiring nasotracheal intubation as part of their anaesthetic management and giving informed written consent, participated in the study. Patients with cardiovascular disease, morbid obesity, oesophageal reflux, bleeding diatheses, diabetes mellitus, taking vasoactive drugs or with a history of nasal obstruction were excluded.

Thirty minutes before the induction of anaesthesia, two sprays of xylometazoline were applied to the nasal mucosa of each nostril as the patient inhaled. Electrocardiogram, indirect arterial pressure, arterial oxygen saturation and carbon dioxide concentrations were monitored in the anaesthetic room. All patients were investigated with the same calibrated and checked indirect arterial pressure machine, and an appropriately sized cuff was selected for each individual. After a stabilization period of at least 5 min, baseline recordings were made and the patient was given oxygen 100%. Anaesthesia was induced with fentanyl 1 μg kg⁻¹ and propofol 2.5 mg kg⁻¹ followed by atracurium 0.5 mg kg⁻¹, and the patient’s lungs were ventilated with oxygen 30%, nitrous oxide 70% and isoflurane by means of a face mask attached to a circle system. Ventilator settings were adjusted to maintain the end-expired carbon dioxide concentration at 4.5–5% and the isoflurane vaporizer was adjusted to maintain the end-tidal isoflurane concentration at 0.6%. Indirect arterial pressure measurements were taken at 1 min intervals.

After 4 min ventilation, patients were allocated to one of two groups using block randomization. Patients in Group 1 underwent nasopharyngeal intubation only. Patients in Group 2 were alternately allocated to one of two subgroups: in Subgroup 2a they underwent nasopharyngeal intubation followed by direct laryngoscopy, and in Subgroup 2b they underwent full nasotracheal intubation. In these two subgroups, it was important to ensure that the direct laryngoscopy times were identical, as the duration of laryngoscopy may have affected the pressor response. Therefore, the first patient randomized to Group 2 underwent nasotracheal intubation and the laryngoscopy time was recorded. Then the next patient randomized to group 2 had nasopharyngeal intubation and direct laryngoscopy, and the laryngoscopy time used was the same as that during the previous nasotracheal intubation, and so on. After group allocation, the oscillotonometer was switched to standby mode and the appropriate procedures were carried out. Preformed, cuffed RAE™ nasal tubes were used for all the intubations, size 6 mm for females and size 7 mm for males. In the two groups having nasopharyngeal intubations, the tubes were shortened to 5 cm for females and to 6 cm for males. The nostril used for the first attempt at intubation was selected randomly. If undue resistance was encountered in this nostril, the other nostril was used instead. The ease of navigability through the nostril used was assessed as no significant resistance, minor resistance or moderate resistance. After the completion of the intubation procedures, and the re-establishment of ventilation, the oscillotonometer was switched to automatic mode and four further arterial pressure determinations were made at 1 min intervals. The lungs were ventilated by means of the tracheal tube in the nasotracheal intubation group or with a face mask in the other two groups. The intubation time was taken as the interval between the start of the insertion of the tube through the nostril and the removal of the laryngoscope from the mouth, and the laryngoscopy time was taken as the interval between inserting the laryngoscope through the mouth and the removal of the laryngoscope from the mouth. If any difficulty was encountered in performing mask ventilation after the induction of anaesthesia or if significant epistaxis occurred after any intubation, the patient was withdrawn from the study and treated appropriately. After completing the cardiovascular recordings, the shortened tubes used in Groups 1 and 2a were removed and the trachea was intubated normally with the aid of a Macintosh laryngoscope.

Between group data were analysed using ANOVA and t-tests with the Student–Newman–Keuls method. Within group data were analysed using Friedman’s repeated measures ANOVA on ranks, with multiple comparisons vs control using Dunnett’s method. A power analysis indicated that if the minimum clinically important difference in mean arterial pressure was deemed to be 12 mm Hg, then a sample
The size of 25 patients in each group would be required when $\alpha$ is 0.05 and $\beta$ is 0.2. Statistical analysis was performed using SigmaStat (v2).

**Results**

The three groups were similar with respect to age, weight and sex distribution (Table 1). The numbers of smokers and non-smokers in each group were similar (Table 1). Six patients were withdrawn from the trial because satisfactory mask ventilation could not be maintained without a Guedel airway after the induction of anaesthesia. On direct laryngoscopy, 41 patients were found to have minor nosebleeds, either with small amounts of blood present on the posterior pharyngeal wall or with blood visible only on the tube. No patient had significant epistaxis and no patient was withdrawn from the study because of this complication. The number of times the second nostril was used, after undue resistance had been encountered in the first nostril, was similar in each group (Table 2). The mean intubation time in the nasotracheal intubation group and the mean laryngoscopy times in the nasotracheal intubation group and the nasopharyngeal intubation plus laryngoscopy group are shown in Table 2.

Before the induction of anaesthesia (pre-induction) and immediately before the test procedure was carried out (pre-procedure), there was no significant difference in mean arterial pressure (MAP) between the three groups. After induction of anaesthesia, MAP decreased significantly in all three groups (Fig. 1). One minute after the test procedure had been completed, MAP was significantly higher than both the pre-procedure and the pre-induction levels in all three groups. At 1 min after the procedure, there was a significant difference in MAP between the nasotracheal intubation group and both the nasopharyngeal intubation group and the nasopharyngeal intubation plus laryngoscopy
group. However, there was no significant difference between the nasopharyngeal intubation and the nasopharyngeal intubation plus laryngoscopy group. A similar pattern was seen for both systolic and diastolic arterial pressure (Tables 1 and 2).

At pre-induction and pre-procedure, there were no significant differences in heart rates between the three groups. After induction of anaesthesia, there were no significant changes in heart rate (Fig. 2). After the test procedure had been carried out, the heart rate in the nasopharyngeal intubation and nasopharyngeal plus laryngoscopy groups fell and at 4 min post-procedure, the heart rate was significantly lower than pre-induction heart rates in these two groups. After nasotracheal intubation, the heart rate increased, and at 2 min after procedure, was significantly greater than pre-induction level. At 2 min after procedure, the heart rate in the nasotracheal intubation group was significantly greater than in the other two groups. There was no significant difference in heart rates between the nasopharyngeal intubation and the nasopharyngeal intubation and laryngoscopy group.

Discussion
This investigation has shown that the nasopharyngeal intubation stage of nasotracheal intubation produces a significant hypertensive response. Applying direct laryngoscopy for a clinically appropriate time immediately after passing the tube into the pharynx does not add significantly to this response. Advancing the tube from the pharynx into the larynx and trachea adds substantially to the hypertensive response generated by the first two stages of nasotracheal intubation. These changes were observed even after the administration of fentanyl, a drug that is known to reduce the pressor response to intubation. Fentanyl was used in this investigation in order that the anaesthetic induction would reflect a technique that is widely used in clinical practice.

The brisk pressor response to nasopharyngeal intubation has not been reported previously and may have important clinical consequences. It could have an adverse effect in patients with poorly controlled hypertension, critical myocardial ischaemia or those with raised intracranial pressure. In particular, the Advanced Life Support guidelines recommend the use of a nasopharyngeal airway as an adjunct in maintaining a compromised airway in patients with a depressed conscious level, whether attributable to anaesthesia, intracranial pathology or metabolic abnormalities. Resuscitators should, however, be aware of the possibility that the pressor response to the insertion of a nasopharyngeal airway may be associated with an increase in intracranial pressure, which could result in significant morbidity or even mortality in patients with head injury or other intracranial pathology. It is possible that the application of lidocaine to the nasal mucosa, by means of a spray or drops, before nasopharyngeal intubation might attenuate cardiovascular responses, but there is no evidence to confirm this at the present time.

It is not clear why the extra stimulus of direct laryngoscopy, applied in patients of Group 2a, did not add significantly to the hypertensive response to nasopharyngeal intubation. Laryngoscopy alone is known to be a potent airway stimulus that produces significant hypertension and, in addition, in the technically more difficult nasotracheal intubations, the mean laryngoscopy time probably exceeded that normally associated with orotracheal intubation.
possible that there may be a ceiling effect associated with this response, a ceiling that is not breached even when the stimulus of laryngoscopy is added to the stimulus of nasopharyngeal intubation.

Tracheal intubation, however, produced a marked hypertensive response, significantly greater than the response to the first two stages. This finding concurs with the results of Shinji and colleagues, in their orotracheal intubation studies, and contrasts with those of Shribman and colleagues who found that oral intubation did not add significantly to the hypertensive response of laryngoscopy. It is difficult to explain the discrepancy between these two publications, but Shribman and colleagues did, in fact, find that the response to laryngoscopy and intubation was greater than the response to laryngoscopy alone, but the increase did not achieve statistical significance. The explanation may therefore be that a type 2 error occurred in their study, which involved 12 patients in each group.

This investigation has shown that the heart rate after nasotracheal intubation was significantly greater than that after either nasopharyngeal intubation or nasopharyngeal intubation plus laryngoscopy. Similarly, both Shribman and colleagues and Shinji and colleagues found that heart rate after laryngoscopy plus intubation was significantly greater than laryngoscopy alone when studying orotracheal intubation. Shribman and colleagues hypothesized that laryngoscopy produced balanced stimulation of vagal and cardiac accelerator fibres, whereas intubation produced less vagal stimulation. This explanation could also account for some of the findings in our study. However, in the orotracheal intubation studies, there were increases in the heart rate after laryngoscopy alone whereas in this investigation there were decreases in heart rate after both nasopharyngeal intubation and nasopharyngeal intubation plus laryngoscopy. It might be hypothesized that the nasocardiac reflex accounted for increased vagal activity in the first two stages of nasotracheal intubation.

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