Study of the "Sniffing Position" by Magnetic Resonance Imaging

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Background: The "sniffing position" is widely considered essential to the performance of orotracheal intubation and has become the cornerstone of training in anesthesiology. However, the anatomic superiority of this patient head position has not been established.

Methods: Eight healthy young adult volunteers underwent magnetic resonance imaging scanning in three anatomic positions: head in neutral position, in simple extension, and in the "sniffing position" (neck flexed and head extended by means of a pillow). The following measurements were made on each scan: (1) the axis of the mouth (MA); (2) the pharyngeal axis (PA); (3) the laryngeal axis (LA); and (4) the line of vision. The various angles between these axes were defined: α angle between the MA and PA, β angle between PA and LA, and δ angle between line of vision and LA.

Results: Both simple extension and sniffing positions significantly improved ($P < 0.05$) the δ angle associated with best laryngoscopic view. Our results show that the β value increases significantly ($P < 0.05$) when the head position is shifted from the neutral position ($\beta = 7 \pm 6°$) to the sniffing position ($\beta = 13 \pm 6°$), and the α value slightly (but significantly) decreases (from $87 \pm 10°$ to $63 \pm 11°$; $P < 0.05$). Anatomic alignment of the LA, PA, and MA axes is impossible to achieve in any of the three positions tested. There were no significant differences between angles observed in simple extension and sniffing positions.

Conclusions: The sniffing position does not achieve alignment of the three important axes (MA, PA, and LA) in awake patients with normal airway anatomy.

THE ability to obtain a good glottic visualization during direct laryngoscopy is probably the main determinant of easy tracheal intubation in the operating-room setting. The anesthesiology literature is rich with articles describing methods for improving glottic visualization. Placing the patient's head and neck in an optimal position is the first and perhaps the most important maneuver to routinely and predictably improve laryngoscopy and intubation outcome.[1] The first study of optimal patient posi-

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tioning for orotracheal intubation was published in 1913 by Jackson,[2] stressing the importance of anterior flexion of the lower cervical spine, in addition to the more obvious extension of the atlanto-occipital joint. In 1944, Bannister and Macbeth[3] described the axial alignment of mouth, pharynx, and larynx obtained by extension of the head on the atlanto-occipital and upper cervical joints. This position, they proposed, might be obtained by a slight flexion of the neck on the chest, whereas the optimal head position is extension of the plane of the face from the horizontal. This head position resembles a person "sniffing the morning air." Thus, the very common anesthetist's expression, "sniffing position," was born.

Horton *et al.*[4] studied the ideal angles for neck flexion and face extension, determining that 35 and 15°, respectively, represent the optimal angles. The sniffing position for tracheal intubation is usually obtained by elevating the head with a blanket or pillow before induction. This maneuver is currently universally recommended, taught, and used throughout the anesthesia community.[5–10] We recently pointed out that the "three-axis alignment theory" obtained through use of the sniffing position is probably an anatomic error.[11] There is no objective evidence that the sniffing position aligns the upper airway axes. We thus tested the hypothesis in awake patients with normal airway anatomy that the sniffing position aligns these axes.

Methods

Eight healthy volunteers (aged 18 yr and older) without predictive factors of intubation difficulty were recruited to participate in the study. Informed consent was obtained after subjects received an explanation of the purpose and the procedure for imaging. Subjects were then scheduled for magnetic resonance imaging (MRI). Standard preoperative examination was performed to exclude anatomic factors of intubation difficulty. The following factors were recorded: (1) weight, height, and age; (2) interincisor gap; (3) classification of the oropharyngeal view according to the Mallampati criteria[12]; (4) the distance in centimeters between the thyroid prominence and the most anterior part of the chin; and (5) maximum head extension. Three head positions were studied by MRI: (1) the neutral head position, obtained by having the subject lie on a flat surface (stretcher) without head extension or neck flexion; (2) head extension without a cushion; and (3) the sniffing position, obtained by extending the neck and inserting a cushion

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under the head. All subjects had their mouth opened maximally. Confirmation of neck flexion (approximately 35°) and face plane extension (approximately 15°) was measured using a protractor. The cushion height was 7 cm, which is standard in our operating rooms. All of the MRI studies were performed with a 0.5 Tesla system (Vectra; General Electric, Milwaukee, WI) with an ear–nose–throat coil. The acquisition technique was a spin-echo sequence with a repetition time of 450 ms and echo time of 25 ms. T1-weighted images were obtained in the sagittal plane. All MRI scans were interpreted by an experienced radiologist (J. L. D.) who was blinded to the aims of the study. The following measurements were made on each MRI scan: (1) the axis of the mouth (MA), defined as a straight line drawn parallel to the hard palate; (2) the pharyngeal axis (PA), defined as a line passing through the anterior portion of the atlas and of C2; (3) the laryngeal axis, defined as a straight line passing through the centers of the inferior (cricoid cartilage) and superior (base of epiglottis) orifices; and (4) the line of vision (LV), defined as a straight line passing through the inferior extremity of the superior incisors and the posterior extremity of the superior portion of the cricoid cartilage. The various angles between these axes were defined: α angle between AM and PA, β angle between PA and LA, δ angle between LV and LA. All of these lines and angles are represented in figure 1.

Statistical analysis was performed using analysis of variance (Stat-View version 5.0; Abacus Concepts, Berkeley, CA). A *P* value less than 0.05 was considered statistically significant.

Results

The volunteers were aged 32 ± 3 yr (range, 28–36 yr). All included patients were Mallampati classes I–II (class I, 38%; class II, 62%); none had a thyromental distance less than 65 mm (mean ± SD, 98 ± 11 mm) or a mouth opening less than 35 mm (mean ± SD, 46 ± 3 mm). Each patient had a range of motion of the neck superior to 90°, and no other predictive factor of intubation difficulty was identified. The mean of the angles representing each position (*i.e.*, neutral, extension, sniffing) is shown in table 1. The sniffing position does not permit alignment of the LA, buccal axis, and PA. The alignment of PA with LA implies β approaching 0, whereas the alignment of AM with PA implies a value of α near 0. On the contrary, our result show that the β value increases significantly when the head position is shifted from neutral to "sniffing" and the α value slightly (but significantly) decreases. There is no significant difference of the angles measured (α, β, or δ) between the extension and sniffing positions. However, the angle between the LV and the LA decreased significantly when the subject
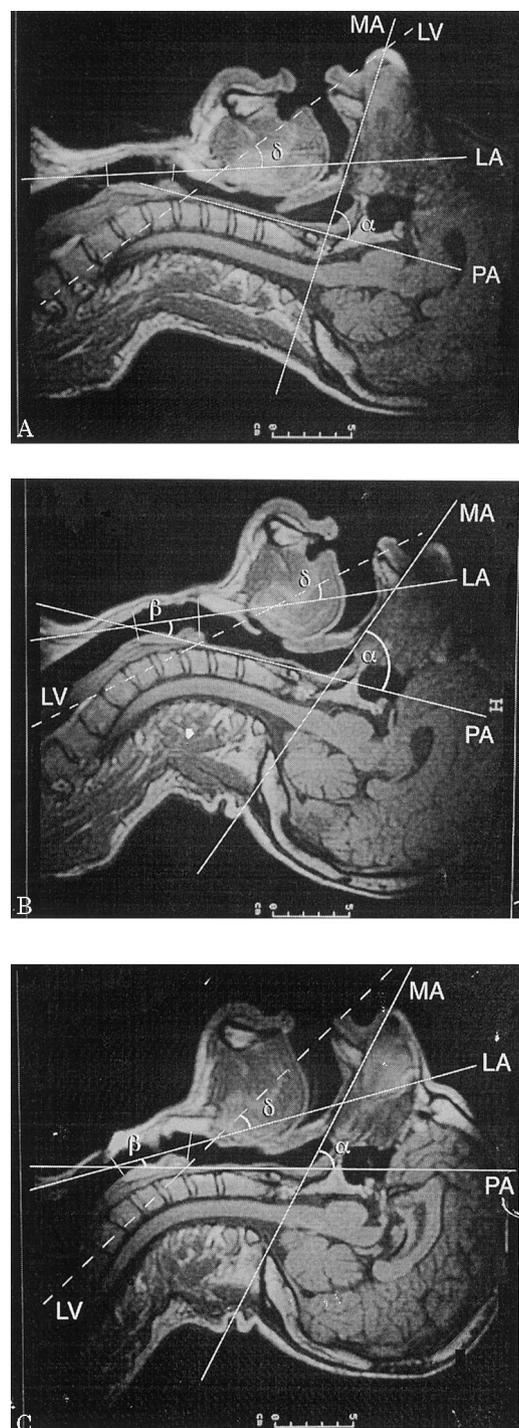

Fig. 1. Evolution of the four axes (mouth axis [MA], pharyngeal axis [PA], laryngeal axis [LA], line of vision [LV]) and the α, β, and δ angles in the three head positions. The magnetic resonance images are shown for patient no. 5. (*A*) Neutral position; (*B*) simple head extension; (*C*) "sniffing" position.

switched from the neutral to extension position or from the neutral to sniffing position.

The angles of neck flexion and face plane extension (angle between the plane of the face and the horizontal axis) were measured on the MRI image for each position and are summarized in table 2. There was a significant

Table 1. Variability of the Angles of Anatomic Axes Important to Orotracheal Intubation Observed with Modification of the Position of the Patient's Head

Positions	α	β	δ
Neutral	87 ± 10*	7 ± 6*	42 ± 12*
Extension	69 ± 13	15 ± 3	29 ± 9
Sniffing	63 ± 11	13 ± 6	29 ± 10

Values are degrees ± SD.

*$P < 0.05$ *versus* other positions.

($P < 0.001$) increase of the neck flexion angle when the subject changed from the neutral position to simple head extension and from simple head extension to the sniffing position. An example MRI image in each position is shown in figure 1.

Discussion

The sniffing position is universally recommended for orotracheal intubation in the operating room. The classical rationale for this position is that the alignment of the MA, PA, and LA is facilitated, permitting successful direct laryngoscopy. This alignment may be hypothetically obtained by flexing the neck on the chest and by elevating the head approximately 7–10 cm with a pad under the occiput (shoulders ordinarily remaining on the table). According to the theory, to bring the MA in line with both the PA and LA, the head must also be extended on the neck (extension of the junction of the spine and skull (atlanto-occipital joint).[7] This maneuver appears to be the fundamental first step before direct laryngoscopy. The article by Bannister and MacBeth[3] is the only published experimental study to our knowledge that has attempted to provide an anatomic explanation and justification for use this position. Nonetheless, the concept of three-axis alignment has been almost universally accepted.

Clearly, our MRI results demonstrate that the MA, PA, and LA cannot be aligned by the sniffing position. Alignment of the LA, PA, and MA axes was impossible to obtain for several reasons: first, it is impossible for the hard palate (MA axis) to align itself with the LA or PA

Table 2. Values of Neck Flexion and Head Extension Angles in Each Head Position

Head Position	Neck Flexion	Face Plane Extension
Neutral	8 ± 5*	4 ± 2*
Head extension	17 ± 4†	18 ± 2
Sniffing	32 ± 4	16 ± 3

Values are degrees ± SD.

*$P < 0.001$ neutral *versus* head extension or sniffing. † $P < 0.001$ head extension *versus* sniffing.

because of the limitation of atlanto-occipital extension. Thirty-five degrees of extension (amplitude of movement of the hard palate) is possible in the normal atlanto-occipital joint from the neutral position to the maximum head extension according to Bellhouse and Dore.[13] In the neutral position, the angle between PA and MA was 87°, so that even if the PA remains unchanged during head extension, the α value cannot approach 0, the theoretical minimum value being $87 - 35 = 52°$. Second, during atlanto-occipital extension, the PA tips posteriorly, whereas the LA is minimally modified, *i.e.*, there is no change in direction but a shift upward. Thus, the β angle increases and the α angle is modified (but less so than the β angle), because the MA and PA axes have the same direction of rotation but not the same amplitude (fig. 1).

As suggested by Cormack and Lehane,[14] the principal determinant of good visualization of the glottis during direct laryngoscopy is alignment of the visual axis of the operator with the glottic axis (or LA). We defined the LV as the line joining the upper incisors and the corniculate cartilage, as has been previously described.[13,14] We observed that simple extension of the atlanto-occipital joint, in a patient lying on the table, permits a significant decrease in the angle between LV and LA. The δ-angle evolution is shown in figure 1. This minimization of the angle may explain the benefit obtained in terms of glottic exposure through this maneuver. However, the δ angle was not modified by the addition of a cushion under the occiput.

We observed that simple head extension is associated with increased neck flexion (table 2). This fact may be explained by examination of the kinesiology of rotation of the head (extension of the atlanto-occipital joint) while abutted against the rigid flat surface. In the neutral position, the neck remains in contact with the surface whereas in head extension, the occiput was in contact with the surface, leading to neck flexion (as the axis of rotation is not in the center of the skull).

White and Kander[15] and Bellhouse and Dore[13] stressed the importance of mandibular dimensions in difficult laryngoscopy. Using the same definition of "mandibular space" as Bellhouse and Dore (line perpendicular from the genial tubercle of the mandible to the LV), we found no modification between the extension and sniffing positions (results not shown).

The present study is limited by the fact that no subjects were anesthetized; however, the original study was also performed in unanesthetized patients.[3] In fact, anesthesia induces a slight modification of the LA. Sivarajan *et al.*[16,17] studied the position and the occurrence of upper airway changes during general anesthesia and muscle paralysis. They found that during anesthesia, there is anterior displacement of the upper airway structures. In particular, when the patient is in head extension, induction of anesthesia and paralysis significantly

increases the distance from the horizontal plane to the epiglottis (mean, +3.6 mm) to the hyoid (mean, +6.4 mm) and to the thyroid cartilage (mean, +3.8 mm).[17] Interestingly, they found no change of the angle between the line joining C2–C4 and the horizontal plane. The anterior movement of laryngeal structures caused by anesthesia displaces the LA vertically without modification of the angle. In contrast, the LV is slightly affected by this change (the cricoid cartilage is displaced upward by approximately 3 mm); thus, a slight decrease of the δ angle can be expected. The PA is defined by two bony landmarks and consequently is not affected by anesthesia. Thus, we may postulate that the α and β angles defined in this study would not be affected by induction of anesthesia and paralysis.

One other potential limitation to our study is that we were unable to evaluate these positions with a laryngoscope blade in place. However, the angle between the LA and the LV were not significantly different between the extension and sniffing positions. Thus, we would anticipate that any forward displacement of soft tissues by the laryngoscope would induce comparable alterations in either the extension or sniffing position.

Our results do not support the widely held assumption that the sniffing position improves anatomic alignment of the important axes in laryngoscopy. Only a prospective, randomized study comparing the sniffing position with simple head extension will provide a definitive answer as to the superiority of the sniffing position over simple extension and justification for its systematic application.

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