CME

Head and Neck Position for Direct Laryngoscopy

Mohammad El-Orbany, MD,* Harvey Woehlck, MD,* and M. Ramez Salem, MD†

The sniffing position (SP) has traditionally been considered the optimal head position for direct laryngoscopy (DL). Its superiority over other head positions, however, has been questioned during the last decade. We reviewed the scarce literature on the subject to examine the evidence either in favor or against the routine use of the SP. A standard definition for the position should be used (e.g., 35° neck flexion and 15° head extension) to avoid confusion about what constitutes a proper SP and to compare the results from different studies. Although several theories were proposed to explain the superiority of the SP, the three axes alignment theory is still considered a valid anatomical explanation. Although head elevation is needed to achieve the desired neck flexion, the elevation height may vary from one patient to another depending on head and neck anatomy and size of the chest. In infants and small children, for example, no head elevation is needed because the size and shape of the head allow axes approximation in the head-flat position. Horizontal alignment of the external auditory meatus with the sternum, in both obese and non-obese patients, indicates, and can be used as a marker for, proper positioning. Analysis of the available literature supports the use of the SP for DL. To achieve a proper SP in obese patients, the "ramped" (or the back-up) position should be used. The SP does not guarantee adequate exposure in all patients, because many other anatomical factors control the final degree of visualization. However, it should be the starting head position for DL because it provides the best chance at adequate exposure. Attention to details during positioning and avoidance of minor technical errors are essential to achieve the proper position. DL should be a dynamic procedure and position adjustment should be instituted in case poor visualization is encountered in the SP. (Anesth Analg 2011;113:103–9)

Proper positioning of the head and neck is essential for optimal laryngeal visualization during direct laryngoscopy (DL). Inadequate positioning may result in prolonged or failed tracheal intubation attempts because of the inability to visualize the larynx. The sniffing position (SP) is traditionally recommended as the standard head position for optimal glottic exposure.[1] This review was conducted to examine the evidence from the available literature about head and neck positioning for DL. Advocates of the SP maintain that it aligns the oral, pharyngeal, and laryngeal axes, allowing the line of vision to fall directly on the laryngeal inlet.[2] Concerns about the anatomical soundness of the three axes alignment theory (TAAT) were raised, however, during the last decade.[3] Subsequently, the superiority of the SP over other head and neck positions was also questioned.[4] Furthermore, it was found that elevating the head higher than what is needed for a conventional SP may improve laryngeal exposure in some patients.[5] The paucity of clinical research that attempted to investigate the optimal head position for DL is surprising, considering the frequency with which the technique is performed and the complications that may result from difficult laryngeal visualization.[6] The overall goal of this review is to increase the awareness of some preventable technical errors that may lead to poor visualization and that may occasionally result in failure of tracheal intubation.

DEFINITION OF THE SP

In 1936, Sir Ivan Magill recommended placing a pillow under the occiput to raise the head and then to extend it to achieve the best laryngeal exposure. He was the first to describe the optimal head position for DL as the position the head assumes when one wishes to sniff the air.[7] Bannister and Macbeth[2] then introduced the TAAT in 1944 to explain the anatomical reasoning behind the superiority of SP. The authors demonstrated in a series of diagrams and radiographs that neck flexion aligns the pharyngeal and laryngeal axes, and head extension at the atlantooccipital joint aligns the oral axis with these 2 axes allowing the line of vision to fall on the glottis (Fig. 1). These pioneers, however, did not specify the degree of neck flexion or the height to which the head should be elevated to reproduce the desired position. Later, Horton et al.[8] measured the angle of neck flexion and that of head extension that resulted in best laryngeal exposure. The mode value of neck flexion angle was 35° and that of plane of the face extension was −15° to the horizontal (Fig. 2). The authors also measured head elevation when the desired position was achieved. The head had to be raised between 31 and 71 mm (with a mean value of 55 mm) for optimal exposure. This was measured, however, in subjects with no expected airway difficulty. Unfortunately, there was no mention of the angles or head heights from the 9 subjects with difficult airway. This report has established a standard definition as well as the end points for correct head positioning to achieve a proper SP. Although this definition can be used to

From the *Department of Anesthesiology, Medical College of Wisconsin, Milwaukee, Wisconsin; and †Department of Anesthesiology, Advocate Illinois Masonic Medical Center, Chicago, Illinois.

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Address correspondence to Mohammad El-Orbany, MD, Department of Anesthesiology, Medical College of Wisconsin, 9200 West Wisconsin Ave., Milwaukee, WI 53226. Address e-mail to elorbany@mcw.edu.

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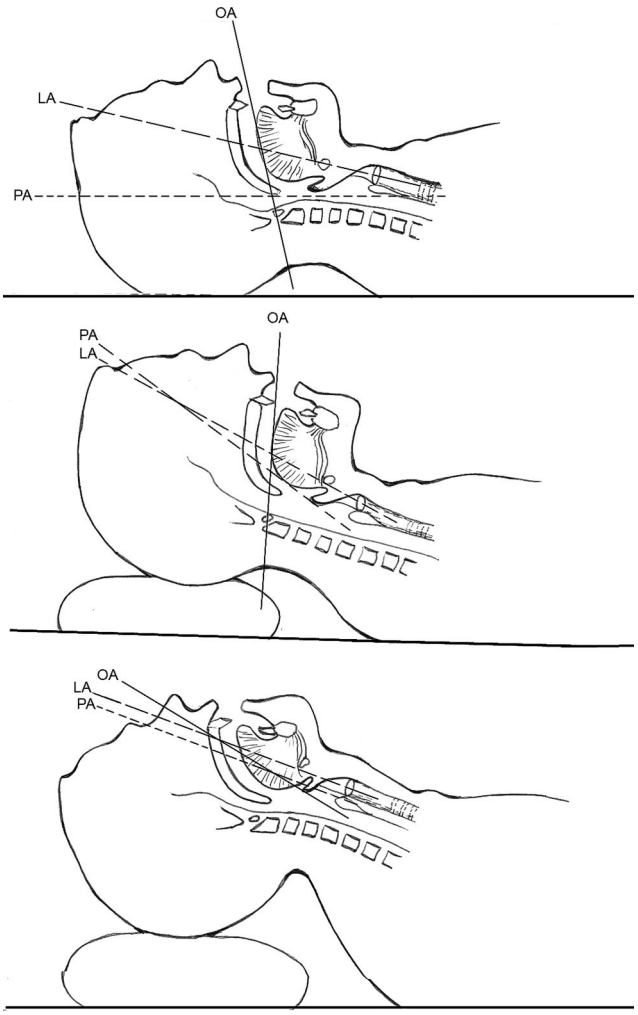

Figure 1. The three axes alignment theory. Upper: position of the 3 axes with the head in the neutral position. Middle: head elevation (neck flexion) aligns the pharyngeal axis (PA) and the laryngeal axis (LA). Lower: extension of the elevated head achieves alignment of the oral axis (OA) with the other axes.

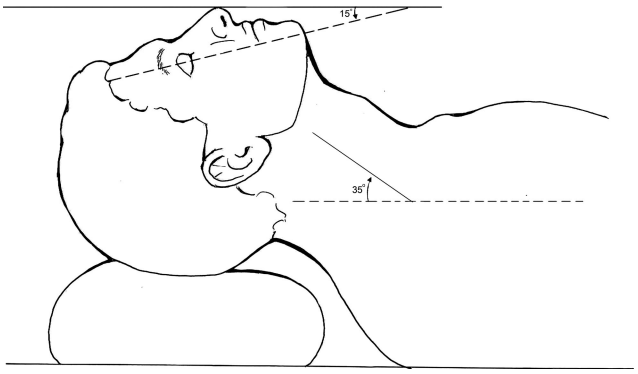

Figure 2. The head in the sniffing position. The neck should be flexed 35° on the torso and the head extended at the atlantooccipital joint to produce a 15° angle between the facial plane and the horizontal. These angles should be used to define the proper sniffing position.

compare the results from the different studies, it may be of limited clinical usefulness because an angle-measuring device is not usually available in the operating room. The question of how high the head should be raised in patients with difficult airways (when head positioning is most relevant) was also left unanswered. It has been suggested that horizontal alignment of the external auditory meatus with the sternum may be a useful clinical end point to ensure a proper SP and subsequently improve laryngeal visualization in obese patients.[9] Recently, Greenland et al.[10] performed a magnetic resonance imaging (MRI) study to evaluate the external auditory meatus–sternal notch relationship as a marker that indicates a proper SP. The authors examined MRI sagittal slices that were taken starting from the external auditory meatus laterally through the midline plane medially with the head either in the neutral or SP in 10 awake volunteers. They found better axes alignment in the SP. The study also confirmed that horizontal alignment of the external auditory meatus with the sternum can be used as an end point for a proper SP (Fig. 3).

HEAD AND NECK POSITION AND LARYNGEAL EXPOSURE: WHAT EVIDENCE DO WE HAVE?

Since the early recommendations, the SP has always been considered the optimal head position for DL and the TAAT provided the anatomical explanation for its superiority. These recommendations, however, were based on clinical observations, experience, and logic and not on actual clinical studies. It is surprising that for almost 70 years only a few studies addressed the issue scientifically.[6] The paucity of clinical investigations may reflect the widespread acceptance of the TAAT and SP as established facts beyond questioning. During the last decade, however, these "facts" have been investigated, and the conclusions from the different studies resulted in a heated debate.

Evidence Challenging the SP and TAAT

Fifty-five years after the introduction of the TAAT, Adnet et al.[3] questioned its anatomical soundness when they could not find axes alignment in a radiograph obtained during intubation in the SP. The authors doubted the original illustrations by Bannister and Macbeth and concluded that the theory is just an anatomical myth. Benumof,[11] however, criticized the authors' comments and attributed their inability to observe the alignment to their failure to position the subject's head in a proper SP. The neck flexion angle in the radiograph used was barely 5°. Had the authors placed the head in a proper SP, they could have observed the alignment. To prove their point, Adnet et al. performed an MRI study in 8 awake volunteers with the head in the neutral, simple extension, or SP. They could not find axes alignment in any of the studied positions and concluded that achieving this alignment is anatomically impossible.[12] This study again was criticized because the subjects were awake volunteers. No anesthesia was administered and no laryngoscopy or tracheal intubation performed.[13] Although the SP may not result in complete axes alignment in awake subjects, DL in anesthetized subjects achieves this goal, and it does this best in the SP.[14] Neck flexion, head extension, and laryngoscopy are all needed for complete alignment. Kitamura et al.[15] supported this statement when they found that DL induced a craniofacial structural arrangement that facilitated laryngeal exposure in anesthetized patients more in the SP than with other

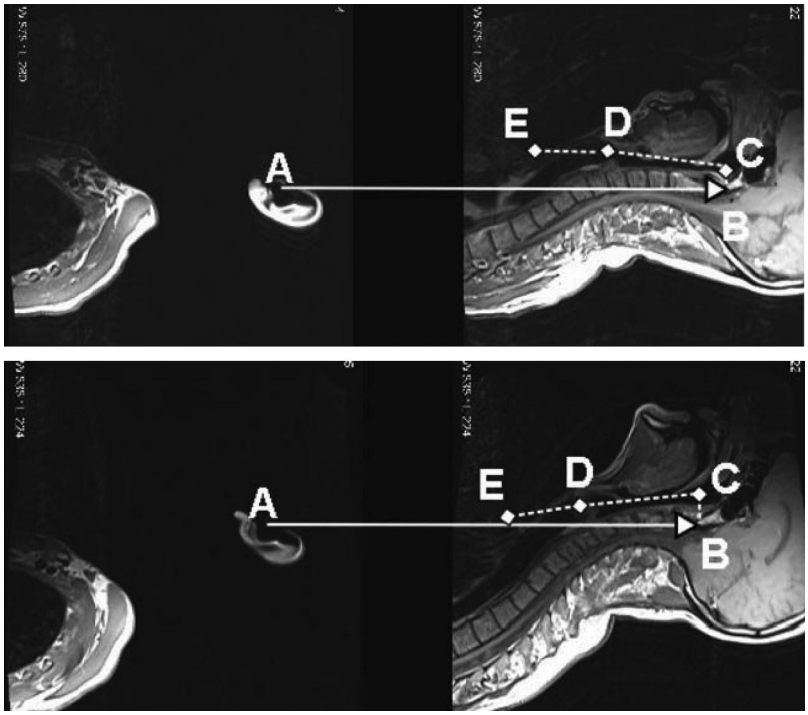

Figure 3. Magnetic resonance imaging slices through the external auditory meatus (left) and midline (right) with the head in the neutral (upper) and sniffing (lower) positions. The meatus (A) laterally overlies the clivus medially (B). The clivus lies immediately behind the nasopharynx (C). Whereas the line between the nasopharynx and glottis (D) is sloping upward in the neutral position, it slopes downward in the sniffing position allowing better axes alignment. Note that the line connecting the clivus to the sternal notch (E) is horizontally aligned in the sniffing position. (Reproduced from Greenland et al.,[10] with permission from Oxford University Press.)

head positions. To address these points, Adnet et al.[16] conducted a subsequent study to compare the DL views in anesthetized subjects with the head either in simple extension or SP. The authors found no significant advantage in the SP when compared with simple head extension for tracheal intubation. They found the SP, however, advantageous in obese patients and in patients with limited head extension. Again, this study was criticized because of design flaws that made the results inconclusive. Among these flaws were the failure to place the head in a proper SP,[17] avoidance of neuromuscular blocking drugs that could have affected the laryngoscopic views, and the unblinded nature of the study.[18] The most powerful argument against the authors' conclusions was that the authors could not prove the inferiority of the SP.[6] On the contrary, their data proved its superiority in obese patients and in patients with limited neck mobility.[19] Perhaps a less than optimal positioning would not pose any problems when performing DL for tracheal intubation in patients with normal airways. Head position would be most relevant, however, in patients with difficult airways, whether anticipated or not, similar to the 2 groups of patients mentioned by the authors.[16]

Alternative Theories to Explain the Superiority of the SP

In addition to the TAAT, 3 other theories have been proposed to explain the superiority of the SP. Chou and Wu[20] pointed out that the TAAT described the airway as a line or a surface, whereas it is actually a space. It also did not include start or end points for the 3 axes. They recommended excluding the laryngeal axis and considering only the oral and pharyngeal axes with the larynx as the end point of the pharyngeal axis. Isono[6] proposed the "obstacle theory" to explain the benefit of the SP. He indicated that 2 obstacles anterior and posterior to the oral airway prevent the line of vision from reaching the glottis. Head elevation in the SP moves both obstacles upward, its extension moves the posterior obstacles downward, and laryngoscopy moves the anterior obstacles upward and caudad allowing the line of vision to pass through the created space. Recently, Greenland et al.[21] performed an MRI study in 42 normal adult volunteers to evaluate the airway configuration in the neutral, extension, head lift, and SP. They proposed a 2-curve theory, wherein the airway is divided into 2 curves: a primary oropharyngeal curve and a secondary pharyngo-glotto-tracheal curve. The authors found a reduction in the area between the line of sight and the airway curve in the SP compared with the neutral position. They proposed the 2-curve theory, rather than the TAAT, as an explanation for the superiority of the SP. It is to be noted that none of these alternative theories denied the superiority of the SP; on the contrary, they all endorsed its use. They were only proposed to provide alternative explanations, other than the TAAT, for its superiority. However, the TAAT is still considered to be the correct anatomical explanation by the majority who argue that even if the SP does not bring complete alignment on its own, it brings the axes as close as possible in preparation for complete alignment to be achieved by the laryngoscope blade.[14] Lastly, doubting the anatomical soundness of any of these theories does not mean that the SP is not the best position for DL. It only means that there are different opinions on the explanation of its superiority.

Evidence Supporting the Use of SP

Hochman et al.[22] studied the effect of blade size and head position on the force required for optimal laryngeal exposure. Head elevation increased the incidence of full laryngeal exposure with the least required force. Although the

authors called this position the "flexion-flexion" position, their illustration clearly revealed a position similar to the standard SP with the external auditory meatus horizontally aligned with the sternum. In another study, Levitan et al.[23] performed DL with the Henderson laryngoscope straight blade to determine the effect of head elevation on the quality of laryngeal view in 7 fresh human cadavers. Laryngoscopy was initiated with the head-flat, then the head was progressively elevated by the laryngoscopist's right hand until maximal elevation was achieved. The laryngeal views were imaged and later analyzed in the head-flat, full-elevation, and mid-elevation positions. Percentage of glottic opening scores increased from 31% in the head-flat position to 64% in the mid-elevation position to 87% with maximal elevation. Although the study indicated that head elevation improves laryngeal exposure, no subject had a score of zero in the head-flat position. All cadavers could have their tracheas successfully intubated in that position, because 31% of the glottic opening was visible. Whether head elevation improved laryngeal visualization if the exposure was difficult in the head-flat position was thus not investigated. To specifically address this point, Schmitt and Mang[5] investigated the effect of head elevation in 21 patients with difficult visualization placed in the SP. When difficult visualization was encountered, head elevation, optimal external laryngeal manipulation, and an increase in the laryngoscope lifting force were simultaneously performed to improve the view. Head elevation improved laryngeal visualization in 19 patients, and maximal elevation beyond the SP enabled cord visualization in 6 patients. Again, although the study illustrated that head elevation, in general, improves visualization, it is not known whether optimal external laryngeal manipulation and the increase in the lifting force had contributed to this improvement or not, nor to what extent. In another study, Lee et al.[24] examined laryngeal exposure in the head-flat position and in the 25° back-up position in 40 non-obese adult patients. The authors reported an improvement in the percentage of glottic opening score from 42.2% in the head-flat position to 66.8% in the back-up position. The 25° back-up position was also found, in another study, to improve laryngeal exposure in obese patients and was recommended as an alternative to placing blankets or other devices under the upper body.[9] Recently, Park et al.[25] compared the laryngoscopic views in the neutral position and with different pillows of 3-, 6-, and 9-cm heights in 50 adult patients. Each patient acted as his/her own control. The laryngoscopic view with 9-cm elevation was superior to that achieved in the other groups. In 5 patients who had short necks, however, the view was better with either the 3- or 6-cm elevation pillows. The authors found significant correlation between neck length and the pillow height needed to provide the best view. In another recent study, 10 awake volunteers had MRI scans of the head placed in both the neutral and SP.[10] Unlike the Adnet et al.[16] study, a proper SP was verified by using the accepted end point (flexing the neck 35° and extending the head 15°). The authors reported better alignment of the axes in the SP (Fig. 3). The study also showed that when the end point of the SP was achieved, the external auditory meatus was horizontally aligned with the sternum, providing the imaging proof for using this clinical marker as an end point for correct positioning.

Figure 4. The optimal head position in the morbidly obese patient is achieved by supporting and elevating the shoulders and upper torso. Horizontal alignment of the external auditory meatus with the sternal notch should be used as an end point for correct positioning. (Reproduced with permission from Airway Cam Technologies, www.airwaycam.com.)

In view of the strong criticism against the studies that challenged the use of SP and the weight of evidence from the multiple studies that favored its use, it is safe to conclude that the preponderance of evidence is in favor of using the SP for DL.

Head and Neck Position for DL in Specific Patient Populations

As noted by Park et al.,[25] the head elevation needed to reproduce the correct SP may vary from one individual to another depending on neck length. Other factors that may control the head elevation height are the anteroposterior diameter of the chest and the size and shape of the head in relation to the chest.

Obese Patients

Head elevation in the supine obese patient does not alone guarantee a proper SP.[26] In this patient population, the anteroposterior diameter of the chest is increased so that it is almost impossible to obtain a neck flexion angle of 35° unless the shoulders and upper torso are also raised (Fig. 4). The so-called "ramped" position can be achieved either by a stack of blankets or by using one of the commercially available pillows designed for this purpose. Collins et al.[27] studied the laryngeal view in 60 obese patients with and without the ramped position and found a statistically significant improvement in the laryngeal view in the ramped position. Another way of recontouring

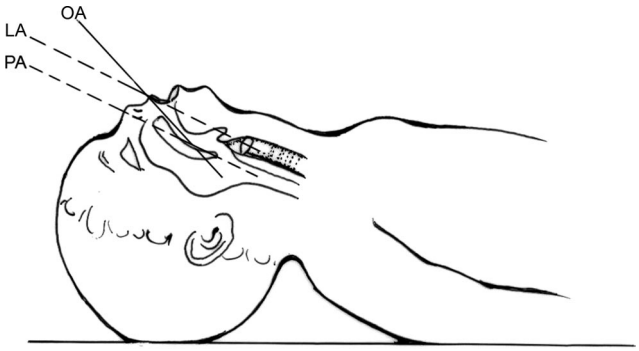

Figure 5. Optimal head position for direct laryngoscopy in infants. No head elevation is required. Head extension at the atlantooccipital joint approximates the axes and complete alignment can be easily achieved with the laryngoscope's straight blade. OA = oral axis; LA = laryngeal axis; PA = pharyngeal axis.

Figure 6. Optimal positioning of a hydrocephalic baby before laryngoscopy. The proper position is achieved by elevating the shoulders and upper body with no head elevation.

the upper back is to use the operating table 25° back-up position or the "table-ramp" method.[9] Regardless of the method used to position the obese patient before DL, horizontal alignment of the external auditory meatus with the sternum should be used as an end point for correct positioning.[9,27]

Pediatrics

Infants and young children have a larger head and smaller chest diameter relative to the adult patient. This anatomical relationship allows optimal visualization when the head is positioned flat on the bed. No head elevation is needed[28] because a proper neck flexion angle is achieved and only a slight extension at the atlantooccipital joint is required for axes alignment (Fig. 5). Vialet et al.[29] studied the effect of head posture on axes alignment in infants and young children. MRI head scans from 30 subjects were evaluated either in the neutral or simple extension positions. Slight head extension was found to improve the alignment of the line of vision with the laryngeal axis. Older children may require some head elevation to achieve a proper SP. The literature is very scarce on the subject of head posture for laryngoscopy in pediatrics,[30] and it is not precisely known at which age head elevation should be instituted. Because of an even larger head size, a hydrocephalic baby may have extreme head flexion when the head is positioned flat. In this situation, the shoulders and upper body (and not the head) should be elevated to achieve the proper position (Fig. 6).

Head and Neck Position for DL: Technical Considerations

Although the available literature supports the use of SP, it clearly indicates that some technical errors may be responsible for the erroneous interpretation of its lack of superiority. It also seems that these errors (which mainly stem from failure to achieve a proper SP) are common in everyday practice.[31] Review of the literature highlighted the importance of considering the following points to obtain the best possible exposure with DL:

- Placing a blanket under the head does not ensure a proper SP. The head should be elevated so that the angle of neck flexion over the chest is 35°. The height of head support needed to achieve this degree of flexion may vary from one individual to another depending on head and neck anatomy and its relationship with the chest diameter. In the majority of normal-sized adults, it is possible to achieve this degree of flexion with 7- to 9-cm head elevation.[17,25]
- The end point of the position should be verified by checking the horizontal alignment of the external auditory meatus with the sternum from the profile view. This is true in both normal-sized as well as obese subjects.[9,10]
- The head sags by its weight when the pillow or head support is compressible.[17] Head sagging decreases the angle of neck flexion and results in a partial SP. An uncompressible head support is preferred to maintain the desired degree of elevation.[32]
- Elevating the head 7 to 9 cm in obese patients does not result in achievement of SP. Adequate padding should be placed to support and raise the upper back, shoulders, head, and neck. This can be accomplished by using either a stack of blankets or one of the commercially available elevation pillows (Fig. 7) to position the patient in the so-called "ramped" position. The Troop Elevation Pillow (Mercury Medical, Clearwater, FL) has been successfully used to facilitate proper positioning before laryngoscopy in obese and large-framed patients.[33] Similar pillows, such as the Oxford Head Elevating Laryngoscopy Pillow (Alma Medical, Oxford, UK), are also available in the United Kingdom. The Rapid Airway Management Positioner (AirPal, Center Valley, PA) is an inflatable pillow that has also been used successfully for the same purpose.[34] If these devices are not available, then a stack of blankets should be placed on the operating room table before positioning the patient and then adjusted to achieve the desired position. Alternatively, adjusting the operating table to a 25° back-up position has been found to achieve the same purpose. Horizontal alignment of the external auditory meatus with the sternum should be observed before anesthesia induction.[9,27]
- The SP has 2 components, neck flexion (achieved by head elevation) and head extension. Head elevation alone is not sufficient to achieve a proper SP. The head must also be extended at the atlantooccipital joint.

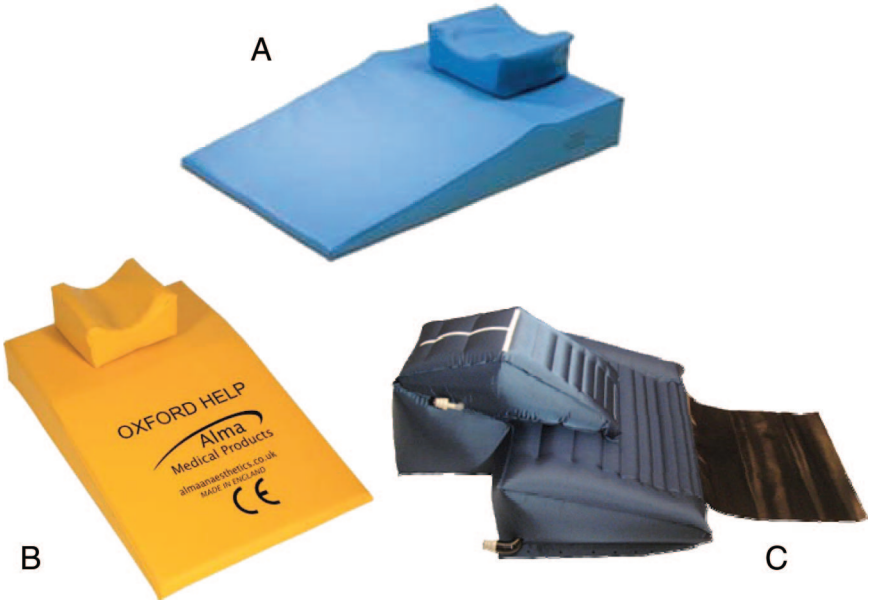

Figure 7. Some commercially available elevation pillows for positioning obese patients before direct laryngoscopy. A, Troop Elevation Pillow. B, Oxford Head Elevating Laryngoscopy Pillow (HELP). C, Rapid Airway Management Positioner (RAMP).

Failure to extend the head in patients with limited neck extension may result in poor visualization.[35] Head elevation is useful because it increases atlantooccipital angulation, allowing more extension than that with lower head positions.[36]

- DL may result in a poor glottic view in some patients despite the use of the SP. Elevating the head higher than what is needed for a conventional SP was found to improve visualization in some patients.[5,23]
- Although the SP is considered the optimal head position for DL, it does not guarantee a perfect exposure in all patients.[37] Many other factors interact to affect the final degree of exposure. These factors include the type and size of the blade,[38] laryngoscope lifting force,[39] operator experience,[40] and most importantly, the patient's airway anatomy.[41] Although multiple maneuvers may be used to improve the view, adjusting the head position is recommended as an early remedial step in situations of difficult exposure.[42]
- Finally, the elevation height that yields the best exposure is not, and should not be, the same for all patients because it depends on the particular head and neck anatomy as well as chest dimensions. It is therefore recommended to consider DL a dynamic procedure and to adjust the head position to obtain the best view when it is unfavorable in the SP.[43]

In summary, the literature supports the use of the SP for best laryngeal exposure with DL. No evidence was found in the literature indicating the inferiority of the SP, and most evidence found it superior to other positions. Proper positioning should always be verified by observing the horizontal alignment of the external auditory meatus and sternum. Head elevation beyond the SP may improve visualization in a subgroup of patients who have a poor view in the SP. Attention to details during positioning is instrumental in avoiding the minor technical errors that may affect the resultant view. DL is a dynamic process that should start with properly positioning the patient in the SP, but may require further position adjustment in search for the best exposure.

DISCLOSURES

Name: Mohammad El-Orbany, MD.
Contribution: This author helped design the study and write the manuscript.
Attestation: Mohammad El-Orbany approved the final manuscript.
Name: Harvey Woehlck, MD.
Contribution: This author helped write the manuscript.
Attestation: Harvey Woehlck approved the final manuscript.
Name: M. Ramez Salem, MD.
Contribution: This author helped write the manuscript.
Attestation: M. Ramez Salem approved the final manuscript.

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