Original Article

Comparative evaluation of laryngeal view and intubating conditions in two laryngoscopy positions-attained by conventional 7 cm head raise and that attained by horizontal alignment of external auditory meatus - sternal notch line – using an inflatable pillow - A prospective randomised cross-over trial

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Abstract

Background and Aims: We compared the laryngoscopy position attained by a 7-cm-high pillow (Sniffing position-SP) with that attained by horizontal alignment of external auditory meatus-sternal notch (AM-S) line-using variable height inflatable pillow.
Material and Methods: This prospective-randomised-cross-over study included 50 patients in each group. Group-AM-S: A 7 cm uncompressible pillow was used for attaining first laryngoscopy position, followed by horizontal alignment of external auditory meatus-sternal notch (AM-S) line-using an inflatable pillow for attaining second laryngoscopy position followed by intubation. Group-SP: Horizontal alignment of external auditory meatus-sternal notch (AM-S) line-was done using an inflatable pillow for attaining first laryngoscopy position, followed by using 7 cm uncompressible pillow for second laryngoscopy position followed by intubation. The CL-grade, Intubation Difficulty Score (IDS) and time to intubation were compared in both positions. The head raise (in cm) required for attaining AM-S alignment was noted.
Results: CL-grade-I was obtained in significantly larger number of patients with AM-S alignment position than with 7 cm head raise ($P = 0.004$). CL-grade-III was obtained in significantly lesser number of patients with AM-S alignment ($P = 0.002$). Mean IDS with AM-S alignment (1.18 ± 1.69) was significantly less than with 7cm head raise (2 ± 1.59; $P = 0.007$) and time to intubation with AM-S alignment (17.33 ± 4.52 s) was significantly less than that with 7cm head raise (18.94 ± 4.64 s; $P = 0.041$). The mean head rise required to achieve AM-S line alignment was 4.920 ± 1.460 cm.
Conclusion: External Auditory Meatus-Sternal notch (AM-S) line alignment provides better laryngeal view, better intubating conditions and requires lesser time to intubate as compared to a conventional 7-cm-head raise. The size of pillow used for head raise should be individualised.

Keywords: A 7 cm head raise, AM-S line alignment, CL-grade, inflatable pillow

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Introduction

The sniffing position (SP) has traditionally been considered the optimal head position for direct laryngoscopy (DL). It has been credited to Chevalier Jackson in 1913, who simply suggested that the patient be placed on a pillow in a natural position with the head extended.[1]

Sir Ivan Magill, in 1936 was the first to describe the optimal head position for direct laryngoscopy as the position the head assumes when one wishes to sniff the air.[2] Later, in 1944, the Three Axis Alignment theory (TAAT) was introduced to explain the anatomical reasoning behind the superiority of sniffing position.[3]

The 'sniffing position' has been commonly advocated as the standard head position for direct laryngoscopy. In this position, the neck must be flexed on the chest, typically by elevating the head with a cushion under the occiput and extending the head on the atlanto-occipital joint.[4,5] The dictum has rarely been questioned before Adnet *et al.* reassessed the value of sniffing position in their series of clinical investigation.[6-8]

The sniffing position is achieved traditionally by placing 7–10cm uncompressible pillow below the head. Horton *et al.* suggested a 35°mode value for neck flexion and 15°for face plane extension for adequate sniffing to be achieved.[9]

The external auditory meatus and sternal notch relationship in a magnetic resonance imaging (MRI) study was compared with head either in neutral or SP in 10 awake adult volunteers.[10] The study suggested that horizontal alignment of the external auditory meatus with sternum allowed closer alignment of the pharyngeal and laryngeal axes with oral axis.

A suggestion has been made that head elevation beyond the SP, by making the external auditory meatus and sternal notch line (AM-S line) horizontal, may improve visualisation of glottis in a subgroup of patients who have a poor view in the SP.[11] Few authors have used different pillow heights to improve the laryngeal view,[12,13] however, there is no conclusive evidence as to what pillow height leads to alignment of AM-S line.

Thus, we decided to compare the laryngoscopy positions achieved by using a 7cm pillow with that attained by horizontal alignment of AM-S line in adult patients. Our objective was to assess whether the laryngeal view, intubation time and intubation difficulty could improve while performing laryngoscopy using a pillow with altering height to align external auditory meatus and the sternal notch line as compared to a standard 7cm height pillow and if so, determine the ideal height required to achieve this alignment.

Material and Methods

After obtaining institutional ethics committee approval and informed written consent from each patient this prospective, randomised, cross-over study was conducted in 100 adult patients. The study was registered with the clinical trial registry of India (CTRI/2017/07/009142). American Society of Anaesthesiologist (ASA) grade I-II patients, 18-65 years of age, with modified Mallampatti class I-III, of either sex scheduled for elective surgery under general anaesthesia, requiring endotracheal intubation were included in the study. Patients who refused consent, had unstable cervical spine or mouth opening <3 cm and those planned for awake intubation, nasal intubation or rapid sequence induction were excluded from the study [Figure 1].

A detailed pre-anesthetic check-up (PAC) including history, physical and airway examination and routine investigations was carried out in all the patients, who were then randomly allocated by computer generated random number table to one of the two groups comprising of 50 patients each.

In Group AM-S - 7cm uncompressible pillow was placed below the patient's head for attaining first laryngoscopy position, followed by horizontal alignment of external auditory meatus - sternal notch (AM-S) line for attaining second laryngoscopy position followed by intubation.

In Group SP - horizontal alignment of external auditory meatus - sternal notch (AM-S) line was done using an inflatable pillow for attaining first laryngoscopy position, followed by using 7 cm uncompressible pillow for second laryngoscopy position followed by intubation.

We devised an innovative inflatable pillow using two pressure infusion bags connected with a three way to single inflation

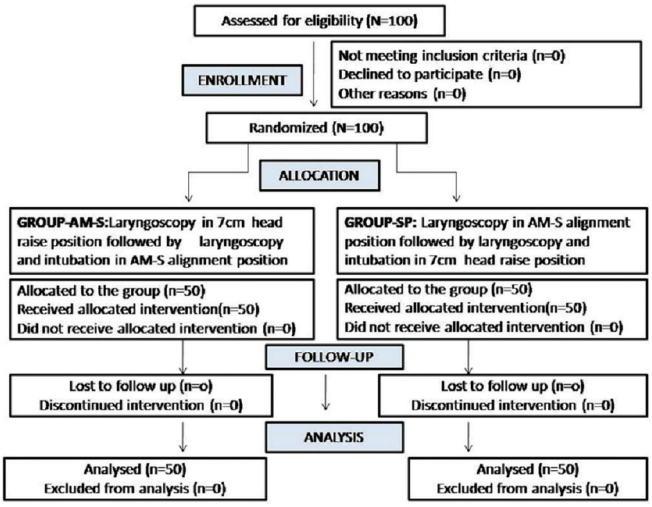

Figure 1: Consort diagram

bulb [Figures 2 and 3]. This assembly was then placed between two firm surfaces (wooden base and stiff plastic sheet on top) and then encased in a cover. This prevented the indentation of the pillow by the patient's head which changes the height of head raise. This assembly allowed the head raise to be adjusted between 3 cm and 10 cm by progressive inflation. The degree of head raise was recorded by a vertical scale fixed to the base of this pillow and the height could be recorded in cm with a least count of 1 mm. The inflation bulb could be controlled easily. Using two pressure bags side by side provided stability and allowed a uniform height of the pillow.

A standard anesthesia protocol was followed. Each patient received oral alprazolam 0.25 mg, the night before surgery. In the operating room, intravenous access and standard monitoring (electrocardiogram, pulse oximetry and non-invasive blood pressure) were established. The patient was made to lie supine with the head at the edge of the OT table. The height of the operating table was adjusted such that the plane of the patient's face in both the groups was at the level of xiphisternum of anesthesiologist performing laryngoscopy and intubation. The OT table was made horizontal by use of spirit level.

Laryngoscopy-intubation was performed by two experienced anesthesiologists with at least 6-year experience in anesthesiology and airway management.

Patient was pre-medicated with i.v fentanyl 2 microgram/kg 5 min before induction. After pre-oxygenation with 100% O_2 for 3 min, anesthesia was induced with i.v. propofol 2 mg/kg. Ability to mask ventilate was checked. Muscle relaxation was achieved using i.v. vecuronium 0.1 mg/kg. The patient was ventilated via facemask with 2% isoflurane in oxygen for 3 minutes before attempting laryngoscopy in either group.

After induction in group-AM-S, a 7cm uncompressible pillow was placed underneath patient's head. Head was extended and laryngoscopy was performed using an appropriate size Macintosh laryngoscope blade [Figure 4]. Laryngoscopic view was graded as per modified Cormack and Lehane grading and laryngoscope removed.[14] Thereafter, the 7 cm pillow was removed and the inflatable pillow kept under the patient's head. This pillow was used to raise the head until a horizontal alignment of AM-S line was achieved. This alignment was confirmed by using a spirit level [Figure 5]. The patient was mask ventilated again for 1 min. The head was extended, second laryngoscopy performed and view graded and the patient was intubated with a cuffed endotracheal tube of size 7mm ID for females and 8 mmID for males [Figure 6]. No external laryngeal manipulation was done while grading the laryngoscopic view.

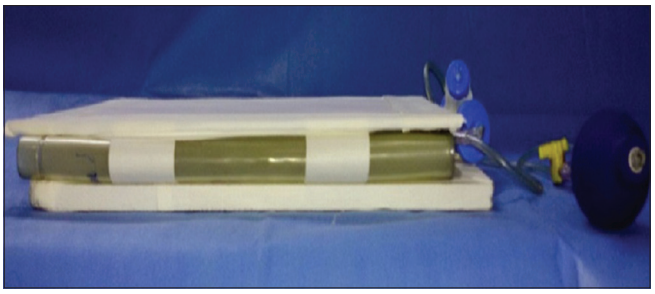

Figure 2: Deflated pillow-without cover

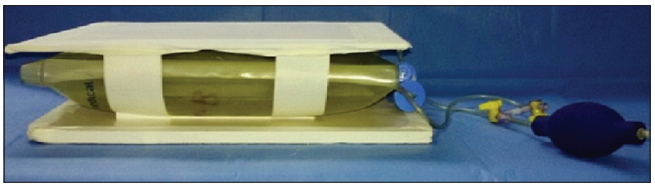

Figure 3: Inflated pillow-without cover

Figure 4: Laryngoscopy in 7 cm head raise position

In group-SP, after induction and mask ventilation, horizontal alignment of AM-S line was achieved as described above. The head was extended, laryngoscopy performed, laryngoscopic view graded and laryngoscope removed. The patient was again mask ventilated for 1 min and a 7 cm uncompressible pillow was placed underneath patient's head. The head was extended, second laryngoscopy performed, laryngoscopic view graded again and intubation with cuffed endotracheal tube performed as above.

In both the groups, the ease of intubation was assessed by IDS (Intubation difficulty score).[15]

The maximum time allowed for an intubation attempt was 40 sec. If the patient was not intubated within this time

or the oxygen saturation dropped to less than 94%, the laryngoscope was removed, and the patient mask ventilated with 100% oxygen for 30 sec after which a second attempt to intubate was made. If the patient was not intubated in two attempts, the case was recorded as failure and standard institutional protocol for managing difficult airway was to be followed.

The time to intubate was recorded from the introduction of laryngoscope blade into the mouth till the appearance of square wave capnograph trace (only during second laryngoscopy in each group).

Statistical analysis

The percentage of patients with CL grade I was reported as 62.2% with 7cm head raise by Prakash *et al.*[16] To the best of our knowledge, there is no study where AM-S line alignment has been studied. Thus, we hypothesized that our new technique of attaining AM-S line alignment with inflatable pillow will increase the number of patients with CL grade I by 25%. Considering power of study as 80% and alpha error of 0.05, atleast 47 patients were required to reject the null hypothesis. So, considering a drop out of 5%, $n = 100$ patients were recruited in the study, 50 patients in each group.

Sample size was calculated using openepi statistical software.

For comparing qualitative variables, which are expressed as percentages, we have used Chi-square test.

For cross-tabulation of data, we have used Chi-square test.

For comparing quantitative variables which are expressed as mean+/-SD, we have used unpaired *t*-test.

$P \leq 0.05$ was taken as level of statistical significance.

The data were analysed by using SPSS software, version 17.00.

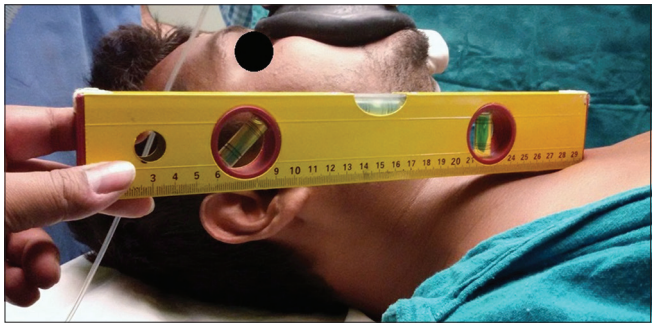

Figure 5: AM-S alignment using a spirit level

Results

The demographic profile of both the groups was comparable [Table 1].

Airway examination including mouth opening, dentition, thyromental and hyomental distance and neck movements were normal and modified Mallampati class was either I or II in all 100 patients.

Laryngoscopic view

CL grade I was obtained in significantly larger number of patients with AM-S alignment position than with 7cm head raise. CL grade III was obtained in significantly lesser number of patients with AM-S alignment. The number of patients with CL grade II were comparable between the two positions [Table 2].

Pillow height

The average pillow height required for AM-S alignment was 4.920 ± 1.460 cm [Table 3].

Table 1: Demographic variables in both the groups

	Group AM-S (*n*=50)	Group SP (*n*=50)	*P*
Age (yrs) (Mean±SD)	33.68±10.51	31.10±9.96	0.105
Weight (kg) (Mean±SD)	51.06±12.36	50.00±8.78	0.311
Female/Male *n* (%)	37/13 (74/26)	40/10 (80/20)	0.0635

SD=Standard deviation; n=Number of patients

Table 2: Comparison of CL grading between the two head positions

CL grade	AM-S alignment (*n*/100)	7 cm head raise (*n*/100)	*P*
I	45	27	0.004*
II	50	55	0.198
III	5	18	0.002*

*CL grade=Cormack Lehane grade, n/100=Number of patients having a particular CL grade out of total 100 patients, *Statistically significant*

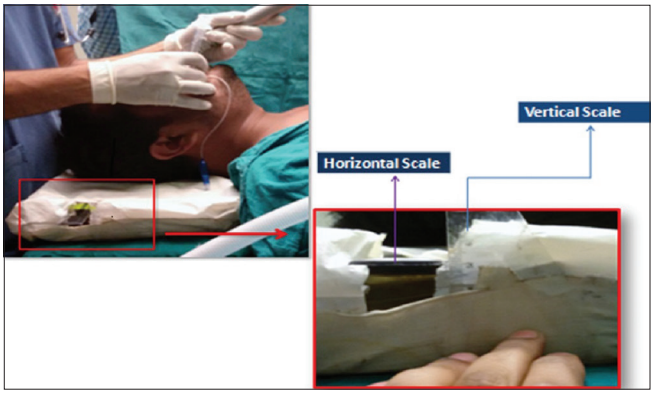

Figure 6: Laryngoscopy and Intubation in AM-S alignment position

Table 3: Time to intubation, Intubation Difficulty Score & Head rise for AM-S Alignment

	Group AM-S (Mean±SD)	Group SP (Mean±SD)	*P*
Time to intubate (sec)	17.33±4.52	18.94±4.64	0.041*
Mean IDS	1.18±1.69	2.00±1.59	0.007*
Head rise for AM-S Alignment (cm)	**GroupAM-S (Mean±SD)**	**Group SP (Mean±SD)**	**Overall (Mean±SD)**
	5.20±1.55	4.60±1.33	4.920±1.460

*IDS=Intubation difficulty score; SD=Standard deviation; *Statistically significant, AM-S alignment=External auditory meatus-sternal notch line alignment*

Time to intubation and ease of intubation

The time to intubation and mean of total IDS was significantly less in group AM-S [Table 3].

Of the 50 patients intubated in group-AM-S, 48% ($n = 24$) patients had IDS = 0, thus having easy intubation according to IDS. However, only 18% ($n = 9$) patients out of 50 had IDS = 0 in group-SP. This difference was statistically significant with $P = 0.001$.

Discussion

In our study, we found that AM-S line alignment position led to better glottis view, lower intubation difficulty score and lesser time to intubate when compared to the 7 cm head raise position. Average pillow height of 4.9 ± 1.5 cm was required to achieve this position.

Many commercially manufactured, fixed height pillows are available to place the patients in sniffing position. These include the sniff position pillow (Popitz Pillow, Alimed, Dedham, MA), and Pi's Pillow (American Eagle Medical, Holbrook, NY).[17] However, what pillow height leads to AM-S line alignment is not clear. Hence, we devised an inflatable pillow of adjustable height to achieve this alignment. Al-Jadidi *et al.* had also devised a variable height pillow using a single infusion bag with a head ring placed in it for finding optimal sniffing position.[18] We found that their infusion bag assembly was unstable and indentation would occur when patient's head was placed on it. So, we devised our innovative inflatable pillow using two pressure infusion bags placed side to side between two firm surfaces (wooden base and stiff plastic sheet on top) and then encased in a cover. This prevented indentation of the pillow by the patient's head which changes the height of head raise.

In our study, we found that C.L grade I was found in significantly larger number of patients and CL grade III in significantly lesser number of patients during laryngoscopy in AM-S alignment position than the 7cm head raise position. Thus, glottic view was better in AM-S alignment position. Our findings were consistent with those of Al-Jadidi *et al.*,[18] who also used an inflatable pillow. However, they did not measure the height at which AM-S alignment was attained, which was done in our study by the vertical scale incorporated in the pillow. Also, their sample size was too small (24 patients), which would have led to decreased power of the study and hence inflated false discovery rate.

The mean head raise required for AM-S alignment in our study was 4.920 ± 1.460 cm.

Similarly, Sinha *et al.* in their study found that 4.5 cm pillow provided best laryngeal view, compared to 9 and 13.5 cm pillow.[13] However, in contrast Park *et al.* found best possible laryngeal view with 9 cm pillow.[12] Schmitt *et al.* suggested that elevation of the head and neck beyond the sniffing position may improve visualisation of the glottic structures in case of difficult laryngoscopy, leading to better intubation performance.[19] Possible explanation is the difference in study population. While our study and that done by Sinha *et al.* were conducted in Indian population, the latter mentioned studies were conducted on population of western countries.

In our study, we found that mean IDS was significantly less in the AM-S alignment position as compared to the 7 cm head raise position, and this was mainly due to lesser lifting force required for laryngoscopy in AM-S alignment position.

Prakash *et al.* in their study reported that lesser lifting force (IDS) was required in sniffing position than in simple head extension.[16] While we found that lifting force was even lesser in AM-S alignment position than in sniffing position (7 cm head raise).

The time necessary to complete an intubation was an integral part of an old consensus definition, as defined by ASA.[20] Clearly, more difficult an intubation, greater is the time necessary for its completion. In our study, lesser time was required for intubation ingroup-AM-S (AM-S alignment position) than in group-SP (7 cm head raise).

None of the patients developed any episode of desaturation during intubation attempts.

There were a few limitations to our study. First, blinding the laryngoscopist was practically not possible. Second, radiological imaging of the patients in the two head positions

was not done. MRI was not feasible in surgical suits where the study was undertaken and X-rays were not done to avoid radiation exposure to patients. This could have provided further data regarding alignment of bony structures as well as the airway axes.

Conclusion

Laryngoscopy performed using External Auditory Meatus-Sternal notch line alignment (AM-S line alignment) provides better laryngeal view, better intubating conditions and requires lesser time to intubate as compared to the conventional sniffing position with 7 cm head raise. The size of the pillow needs to be individualised to achieve this position. In our study an average pillow height of 4.9 ± 1.5 cm was required to achieve this position.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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