Awake orotracheal fibre-optic intubation: Comparison of two different doses of dexmedetomidine on intubation conditions in patients undergoing cervical spine surgery

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ABSTRACT

Background and Aims: Awake fibre-optic intubation (AFOI) is an integral part of anaesthetic management of difficult airways. Conscious sedation is essential to assist AFOI. This study compared two different doses of dexmedetomidine in combination with topical spray and airway blocks for awake orotracheal fibre-optic intubation in patients undergoing elective cervical spine surgery with rigid cervical collar *in situ*. **Methods:** A randomized, prospective, comparative study design was conducted in sixty patients divided into two groups: Group (L) ($n = 30$) patients received low dose of dexmedetomidine (0.5 μg/kg) along with airway blocks and Group (H) ($n = 30$) patients received standard dose of dexmedetomidine (1 μg/kg) along with airway blocks. Both the groups received dexmedetomidine infusion over 10 min followed by airway block. Quantitative data were analysed by applying Student's *t*-test whereas qualitative data were analysed with Chi-square test. The objectives were to compare patients' Observer's Assessment of Alertness/Sedation scale (OAA/S) as primary outcome and other variables such as endoscopy, intubation condition, tolerance and haemodynamic stability among low and standard doses of dexmedetomidine. **Results:** Group H had more favourable OAA/S score than that of Group L, but endoscopy and intubation time, patient tolerance, vocal cord and limb movement and satisfaction score did not differ significantly between the groups. There were no significant haemodynamic differences between the two groups. **Conclusion:** The 0.5 μg/kg dose of dexmedetomidine was found optimal and effective in combination with topical spray and airway blocks for awake orotracheal fibre-optic intubation for patients undergoing elective cervical spine surgery.

Key words: Airway blocks, awake, conscious sedation, dexmedetomidine, fibre-optic

INTRODUCTION

Awake fibre-optic intubation (AFOI) is an indivisible part of anaesthetic management in patients whose airway access is expected to be difficult.[1] It is also used to assure the patency of airway in several other instances like in unstable cervical spine where manipulation of patient's neck is likely to be difficult. In cervical spine immobility or instability, the application of rigid cervical collar may reduce cervical spine movements and it hampers tracheal intubation with standard laryngoscope.[2] It significantly reduces the mouth opening, rendering laryngoscopy more difficult and it also lifts up the chin and tips the larynx anteriorly.[2] AFOI is very useful in such situations where optimal positioning for conventional laryngoscopy is difficult to achieve.

AFOI is assisted with the attainment of 'conscious sedation'. Conscious sedation is a state which blunts airway reflexes with preservation of a patent airway and spontaneous ventilation. Sedation and topical anaesthesia make most patients calm and comfortable yet responsive for the AFOI.[3]

Many agents including benzodiazepines, opioids, ketamine, propofol and dexmedetomidine have been used alone or in combination to bring the state of conscious sedation.[4-6] Dexmedetomidine, a selective α-2 adrenoceptor agonist, provides conscious sedation, attenuation of sympathoadrenal response, anxiolysis and analgesia without causing clinically relevant respiratory depression in AFOI.[6]

Airway blocks alone have also been used to facilitate AFOI.[7] Dexmedetomidine in higher dose was found to be associated with an increased incidence of hypotension, bradycardia, excessive sedation and sometimes irregular respiration also.[8] There is a scarcity of data comparing the two different doses of dexmedetomidine with airway blocks for awake orotracheal fibre-optic intubation. Therefore, we planned to conduct this study to find the optimal and effective lower possible dose of dexmedetomidine in combination with topical spray and local blocks of airway for awake orotracheal fibre-optic intubation in patients undergoing elective cervical spine surgery with rigid cervical collar *in situ*.

METHODS

After approval from the Institutional Ethics Committee, an informed consent was taken from all the study participants. This randomised, prospective, double-blind and comparative study was conducted among sixty patients of either sex, aged 20–60 years, belonging to the American society of Anesthesiologists' Grade I-II, planned for elective cervical spine surgeries in neurosurgery operation theatre at a tertiary care centre. Exclusion criteria included patient refusal, lack of understanding or psychiatric patients, emergency surgery, severe bradycardia/heart block, pregnant patients, patients having known allergy to any drugs used in the study, patients on long-term opioids or sedative medications and patients with grossly distorted airway anatomy and bleeding disorders.

Patients were randomly allocated by a computer-generated random number table and were divided into two groups: Group L (n = 30) patients received low dose of dexmedetomidine (0.5 µg/kg) along with airway blocks and Group H (n = 30) patients received standard dose of dexmedetomidine (1 µg/kg) along with airway blocks. For this study, two experienced anaesthesiologists, who were skilled to perform AFOI, clinically managed the trial. One anaesthesiologist performed fibre-optic intubation, while the other managed the drug infusion. Anaesthetic data and post-operative visit were documented by a study observer. Endoscopy and intubating conditions were graded by the anaesthesiologist who was performing the fibre-optic intubation. The intubating anaesthesiologist, patients and the study observer were blinded to the study.

All patients fasted for 8 h before the surgery. On arrival in the operation theatre, standard monitoring including electrocardiography, arterial oxygen saturation (SpO_2) and non-invasive blood pressure was applied and baseline parameters were recorded. Intravenous (IV) lines with 18/20-gauge cannula were secured and IV fluid was started. Patients were pre-medicated with glycopyrrolate 0.2 mg IV, midazolam 0.05 mg/kg IV, ondansetron 4 mg IV and ranitidine 50 mg IV given 15 min before the procedure. Nasal oxygenation through nasal prongs with oxygen 2–3 L/min was administered. Topical anaesthesia of tongue and oropharynx was performed with 2 puffs of 10% lignocaine spray to the throat.

Dexmedetomidine was prepared at the concentration of 2 µg/ml (100 µg diluted to 50 ml with 0.9% normal saline) and was administered over 10 min using an infusion pump. IV bolus dose of dexmedetomidine 0.5 µg/kg (Group L) or dexmedetomidine 1 µg/kg (Group H) was administered, over 10 min. After administrating the bolus doses of dexmedetomidine, airway blocks were performed (cervical collar was removed for performing airway block and then was applied again). Superior laryngeal nerve was blocked with 2 ml 2% lignocaine bilaterally (using an external approach, direct infiltration performed using 25-gauge needle at the level of thyrohyoid membrane inferior to cornu of hyoid bone). Transtracheal spray was performed with a 22 G needle attached to a 5 ml syringe containing normal saline is passed through the cricothyroid membrane, after piercing the membrane air is aspirated and 4 ml of 4% lignocaine is injected.

The Observer's Assessment of Alertness/Sedation scale (OAA/S) was used to assess sedation by measuring four component categories.[9] Once

the OAA/S scale <15–17 was achieved, airway manipulation was started through oral approach by placing a slit oral airway with a bronchoscope loaded with appropriate size-cuffed endotracheal tube (for males 8.5 mm ID and for females 7.5 mm ID). After successful passage of the tube through the vocal cord and after identification of the carina, the endotracheal tube was secured, and general anaesthesia (GA) with IV propofol and rocuronium was administered and mechanical ventilation was established.

The primary outcome measurement was the level of sedation, and for it, the OAA/S [Table 1] was assessed at three intervals: (i) Baseline (before the start of study medication), (ii) At the end of study drug infusion and (iii) Before introduction of fibrescope into the oral cavity.

Other parameters assessed were: (1) Intubation scores as assessed by (i) Vocal cord movement; 1 = open, 2 = moving, 3 = closing and 4 = closed. (ii) Coughing 1 = none, 2 = slight, 3 = moderate and 4 = severe. (iii) Limb movement; 1 = none, 2 = slight, 3 = moderate and 4 = severe. (2) Patient tolerance as assessed by a 5-point fibre-optic intubation comfort score; 1 = no reaction, 2 = slight grimacing, 3 = heavy grimacing, 4 = verbal objection and 5 = defensive movement of head and hands. (3) 3-point assessment post-intubation score, immediately after orotracheal intubation; 1 = cooperative, 2 = restless/minimal resistance, 3 = severe resistance/GA required immediately. (4) Endoscopy time (time interval between insertion of fibrescope in the oral cavity and visualization of carina). (5) Intubation time (time taken for insertion of tracheal tube till confirmation of tracheal intubation by capnography).

Mean arterial pressure (MAP), heart rate (HR) and SpO_2 were noted specifically at baseline, at the end of study drug infusion and immediately after intubation and later on monitored throughout the procedure. Hypoxic episode (SpO_2 <90%) and need of atropine administration for bradycardia (HR <50) were also recorded. A post-operative visit (on the first post-operative day) was undertaken by the study observer who was blinded to the study. The level of recall (memory of pre-anaesthetic preparations, topical anaesthesia, airway blocks, endoscopy and intubation), adverse events (hoarseness, sore throat) and satisfaction scores (1 = excellent, 2 = good, 3 = fair and 4 = poor) were also noted.

We calculated our sample size from a pilot study done on ten patients in each group. The result of pilot study showed relatively better OAA/S score in Group H. The difference between the mean of OAA/S was found to be 1.25. Taking power of 0.80 and alpha error of 0.05, our sample size was calculated as 27 in each group. Considering dropouts, the required sample size was enhanced to 30 in each group. The power of study for patient tolerance score using *post hoc* power calculator was 0.87.

All the statistical analyses of data were done with statistical programming software IBM SPSS (Statistical Package for the Social Sciences) version 23.0. The continuous variables (quantitative data) such as age, weight, blood pressure, HR, endoscopy and intubation time were presented as mean ± standard deviation and analyzed by applying Student's *t*-test. Paired *t*-test was used for comparison of data within the groups and unpaired *t*-test for comparison of data between the groups.

The categorical variables (qualitative data) were analyzed with Chi-square test. $P < 0.05$ was considered statistically significant in all the analyses.

RESULTS

Sixty patients scheduled for elective cervical spine surgery were enrolled in the study and assigned to

Table 1: Observer's Assessment of Alertness/Sedation scale				
Responsiveness	Speech	Facial expression	Eyes	Score
Responds readily to name spoken in normal tone	Normal	Normal	Clear, no ptosis	5
Lethargic response to name spoken in normal tone	Mild slowing or thickening	Mild relaxation	Glazed or mild ptosis (less than half the eye)	4
Responds only after name is called loudly and/or repeatedly	Slurring or prominent slowing	Marked relaxation (slack jaw)	Glazed or marked ptosis (half the eye or more)	3
Responds only after mild shaking or prodding	Few recognisable words	-	-	2
Does not respond to mild shaking or prodding	-	-	-	1

Group L (*n* = 30) and Group H (*n* = 30). There were no clinically significant differences in both the groups with respect to demographic characteristics [Table 2].

Level of sedation was assessed using the OAA/S score during the three stages of intubation procedure. Statistically significant lower scores were obtained in Group H as compared to Group L in Stage-II and Stage-III, indicating a higher level of sedation (*P* = 0.0000 and 0.0001, respectively, using an unpaired *t*-test) with high dose of dexmedetomidine [Table 3]. Intubation scores for vocal cord movement, limb movement and cough were not statistically significant in both the groups though the movements were lesser in Group H. Six patients in Group L while four patients in Group H had moderate limb movement during the procedure [Table 3].

As far as fibre-optic intubation comfort score is concerned, slight grimacing was found in 15 patients in Group L and 16 patients in Group H, while six patients and four patients in Group L and Group H, respectively, had severe grimacing. Defensive movements of head and hands were found in three patients in Group L while one patient in Group H, although the differences were not statistically significant. When the post-intubation score was compared between the two groups, the difference was statistically not significant and 16 and 18 patients were cooperative in Groups L and H, respectively [Table 3].

It was evident from the results that endoscopy time (64.23 ± 16.83 and 61.93 ± 15.30 s in Groups L and H, respectively) and intubation time (17.20 ± 4.51 and 16.80 ± 4.29 s in Groups L and H, respectively) were almost similar in both the groups [Table 3]. Haemodynamic parameters (HR and MAP) were also comparable between the groups at all the three stages [Table 4 and Figures 1, 2]. Recall of pre-anaesthetic preparation and topical anaesthesia was 96.67% and 93.33% in Group L and Group H, respectively. Recall of airway block and endoscopy with intubation in Group L (20% and 13.33% respectively) was compared to those of Group H (13.33% and 10%, respectively) which did not differ in both groups. Adverse effects (sore throat and hoarseness) did not differ between the two groups.

DISCUSSION

The mainstay of difficult airway management remains flexible fibre-optic laryngobronchoscopic

Table 2: Demographic parameters

Characteristics	Group L (*n*=30)	Group H (*n*=30)
Age (years)		
Mean±SD	44.67±13.25	45.17±12.93
Range (minimum–maximum)	20-56	23-58
Sex (%)		
Male	14 (47)	15 (50)
Female	16 (53)	15 (50)
Weight (kg)		
Mean±SD	53.63±6.29	53.30±8.47
Range (minimum–maximum)	44-68	40-73
ASA class (%)		
I	16 (53)	15 (50)
II	14 (47)	15 (50)

Data are expressed as mean±SD and as *n* (%). SD – Standard deviation; ASA – American Society of Anesthesiologists

Table 3: Primary outcome measurements

Characteristics	Group L (*n*=30)	Group H (*n*=30)	P
OAA/S score (mean±SD)			
Stage-I	20.00±0.00	20.00±0.00	
Stage-II	13.33±1.56	11.53±1.25	0.0000*
Stage-III	10.93±1.41	9.67±0.76	0.0001*
Vocal cord movement *n* (%)†			
Open	11 (36.67)	13 (43.33)	
Moving	17 (56.67)	16 (53.33)	0.5068
Closing	2 (6.67)	1 (3.33)	
Closed	0	0	
Coughing *n* (%)†			
None	9 (30.00)	11 (36.67)	
Slight	13 (43.33)	14 (46.67)	0.3615
Moderate	6 (20.00)	4 (13.33)	
Severe	2 (6.67)	1 (3.33)	
Limb movement *n* (%)†			
None	7 (23.33)	11 (36.67)	
Slight	17 (56.67)	15 (50.00)	0.2550
Moderate	6 (20.00)	4 (13.33)	
Severe	0	0	
Fibre-optic intubation comfort score, *n* (%)†			
No reaction	6 (20.00)	9 (30.00)	
Slight grimacing	15 (50.00)	16 (53.33)	0.1619
Heavy grimacing	6 (20.00)	4 (13.33)	
Verbal objection	0	0	
Defensive movement of head and hands	3 (10.00)	1 (3.33)	
Post-intubation score, *n* (%)†			
Cooperative	16 (53.33)	18 (60.00)	
Restless, minimal resistance	9 (30.00)	10 (33.33)	0.3605
Severe resistance, GA required immediately	5 (16.67)	2 (6.67)	
Endoscopy time (s), mean±SD	64.23±16.83	61.93±15.30	0.5818
Intubation time (s) mean±SD	17.20±4.51	16.80±4.29	0.7259

*P≤0.001 is highly statistically significant; †Values are expressed as *n* (%). SD – Standard deviation; OAA/S – Observer's Assessment of Alertness/Sedation scale; GA – General anaesthesia

Characteristics	Group L (mean±SD)	*P* within group	Group H (mean±SD)	*P* within group	*P* between groups
Table 4: Haemodynamic variables					
MAP (mmHg)					
Baseline	95.24±7.72		95.09±7.58		0.9375
Infusion	89.92±7.17	0.00003**	88.40±6.85	0.0000**	0.4040
Intubation	92.59±6.21	0.01111	91.36±8.05	0.00314	0.5094
HR (/min)					
Baseline	84.20±14.40		87.27±13.67		0.4011
Infusion	74.73±15.47	0.0000**	73.47±12.51	0.0000**	0.7287
Intubation	79.03±13.04	0.0018**	79.83±10.83	0.00029**	0.7929

Values are expressed as mean±SD. **Highly significant. SD – Standard deviation; MAP – Mean arterial pressure; HR – Heart rate
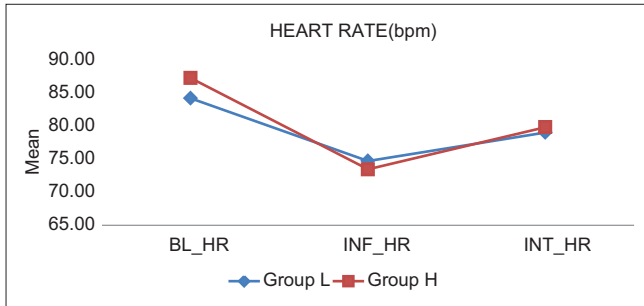

Figure 1: Heart rate trend at different time intervals between the groups. BL – baseline, INF – after infusion, INT – after intubation

Figure 2: Mean arterial pressure trend at different time intervals between the groups. BL – baseline, INF – after infusion, INT – after intubation

intubation, especially in anticipated difficulty with direct laryngoscopy or where manipulation during laryngoscopy may be hazardous to patients as in cervical spine injury patients.[2,10,11] During AFOI, anaesthesiologists may find it difficult to provide sufficient sedation for patients to be comfortable and cooperative, while at the same time avoiding airway compromise from excessive sedation. The ideal drug regimen should provide comfort to the patients and maintenance of spontaneous respiration without affecting airway function.

Dexmedetomidine has been shown to offer adequate conscious sedation for the fibre-optic intubation of patients with anticipated difficult airway.[12-14] These challenging patients may be benefited from dexmedetomidine, which is a highly selective α2-adrenergic agonist, and its sedative (easily arousable), anxiolytic, sympatholytic, analgesic, amnestic and antisialogogic effects make it suitable for AFOI. Dexmedetomidine can be used as either sole agent or an adjunct to other drugs or techniques that facilitate awake intubation in patients with anticipated difficult airway.[14] Dexmedetomidine activates the post-synaptic α2-adrenal receptors in the locus coeruleus and induces sedation by activation of the endogenous sleep-promoting pathway without the risk of airway obstruction and respiratory depression.[15]
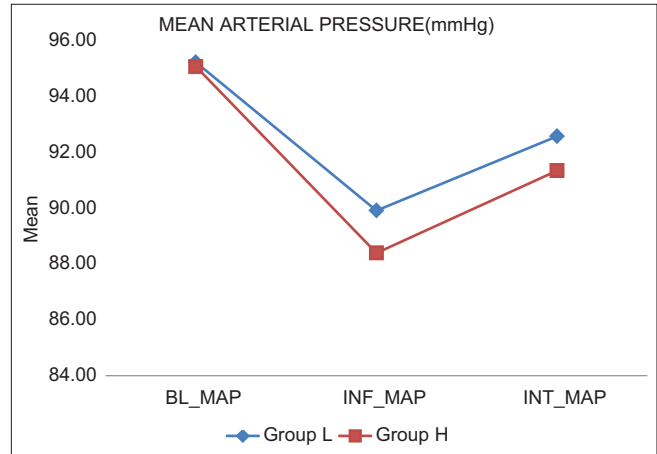
Dexmedetomidine has been used as a sedative for a series of fibre-optic intubations in patients with difficult airways.[6] It has been ishown that the IV dexmedetomidine caused respiratory complications such as irregular ventilation and apnoea episodes with large and rapid initial loading doses (1–2 μg/kg over 2 min).[8] To avoid these untoward complications with high doses of dexmedetomidine, we performed airway blocks along with low doses of dexmedetomidine. The importance of local anaesthetic has been reported for fibre-optic intubation to improve the visualisation of vocal cords.[16] Different methods of local anaesthesia for fibre-optic bronchoscopy has been studied and transtracheal block was found to produce better local anaesthesia of the airway passage.[17]

Our study was carried out to compare two different doses of dexmedetomidine along with airway blocks for awake orotracheal fibre-optic intubation and haemodynamic stability under conscious sedation in patients of cervical spine surgery. The patients were randomly allocated to two groups. Group L received 0.5 μg/kg over 10 min and Group H received 1 μg/kg

over 10 min followed by airway blocks. Haemodynamic stability was achieved in most of the patients in both the groups. Haemodynamic stress response was attenuated during the procedure in both the groups, and no intervention (like administration of atropine or abandonment of the procedure) was required. SpO_2 was maintained throughout the procedure. Our study was also supported by a previous study, which determined that intraoperative dexmedetomidine infusion (initial loading dose of 1 µg/kg over 10 minutes followed by continuous infusion of 0.5 µg/kg/h) was effective for blunting the haemodynamic stress response and did not increase the incidence of bradycardia or hypotension.[18] Another study used dexmedetomidine for awake fibre-optic bronchoscopy and did not find bradycardia, which can be explained by the use of glycopyrrolate prior to starting dexmedetomidine infusion, as done in our study also.[19]

Level of sedation was assessed using the OAA/S score during the three stages of intubation procedure. Significantly lower scores were obtained in Group H as compared to Group L in Stage II and Stage III, indicating a higher level of sedation with high dose of dexmedetomidine.

In another study, two doses of dexmedetomidine for AFOI were used i.e., 1.5 µg/kg and 1 µg/kg, and the group receiving the higher dose of dexmedetomidine (Group H) was found to have more favourable OAA/S score than the group receiving the lower dose (Group L).[9] Similarly, in our study also, the higher dose group (the dose 1 mcg/kg was used, which was used as the lower dose group in previous mentioned study) had more favourable OAA/S score than that of lower dose group, but the lower dose group (0.5 mcg/kg) also had a satisfactory sedation score. This might be explained by simultaneous use of airway blocks with dexmedetomidine in our study.

Intubation scores in terms of the vocal cord, cough and limb movement were better in Group H; however, the differences were not statistically significant as indicated by $P > 0.05$ [Table 3]. A better intubation score in Group H may be attributed to its additional analgesic and antisialogogic properties because of relatively higher dose. Similar findings were reported by another study in which two different doses of dexmedetomidine (0.5 µg/kg and 1 µg/kg) were studied on controlling haemodynamic responses to tracheal intubation.[20]

Even though the higher dose of dexmedetomidine provided better endoscopy and intubation conditions (measured by endoscopy and intubation time and number of intubation attempts), there was no statistically significant difference between the two groups in terms of time taken for the procedures ($P = 0.5818$ and 0.7259, respectively) [Table 3]. This may be due to the use of glycopyrrolate premedication to improve the visualisation by reducing oropharyngeal secretions and the effect of local anaesthesia of the airway in minimising cough and localisation. Glycopyrrolate has also been used as an antisialogogic in previous study before the bronchoscopy.[19]

Although higher dose of dexmedetomidine provided superior endoscopy and intubation conditions, the difference in the satisfaction score between the two groups was not statistically significant ($P = 0.0932$), similar to astudy done before.[9] The recall of airway block (20%) and endoscopy with intubation (13.33%) in Group L were higher as compared to Group H (13.33% and 10.0%, respectively) but they were statistically insignificant. The incidence of sore throat (93.33% and 96.67% in Group L and Group H, respectively) and hoarseness (16.67% of patients in Group L and 10.0% in Group H) did not differ significantly between the groups.

As our study was carried out in smaller population and patients of cervical spine surgeries exclusively, further larger clinical trials are required to enlighten its role.

CONCLUSION

We conclude that dexmedetomidine appears to be a useful pharmacological agent for conscious sedation during awake orotracheal fibre-optic intubation when combined with airway blocks. The 0.5 µg/kg dose of dexmedetomidine was found to be optimal and effective in combination with topical spray and airway blocks for awake orotracheal fibre-optic intubation for patients undergoing elective cervical spine surgery in terms of endoscopy and intubation conditions, level of sedation, amnesia and patient satisfaction.

Conflicts of interest
There are no conflicts of interest.

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