Evaluation of retrograde intubation with different doses of dexmedetomidine infusion: A randomised controlled trial

Tanmay Tiwari^a, Ashish Walian^{b,*}, Vipin Kumar Singh^a, Vinita Singh^a, Sangeeta Chakraborty^a, Amber Rawat^a

^a Department of Anesthesia and critical care, King George's Medical University, Lucknow, India

^b Department of Cardiac Anesthesia, Atal Bihari Vajpayee Institute of Medical Sciences, RML Hospital, New Delhi, India

ARTICLE INFO

Keywords:

Airway management
Awake intubation
Conscious sedation
Dexmedetomidine
Nasal intubation
Retrograde intubation

ABSTRACT

Background: Retrograde intubation is one of the well-described and alternative methods of difficult airway management. It requires effective sedation and patient preparation. Study was done to evaluate intubating conditions during retrograde guided intubation with two different doses of dexmedetomidine.

Methods: This prospective randomized double blind parallel group trial was planned on 60 patients with difficult airway. Patients were divided in two groups to receive either dexmedetomidine 1.0 µg/kg (Group A) or dexmedetomidine 1.5 µg/kg (Group B) by intravenous (IV) route. The Modified Observer Assessment Awareness and Sedation (OAA/S) was measured as primary outcome and ease of intubation, facial grimace score, cough severity, hemodynamic response, patient recall and discomfort were assessed as secondary outcome during awake retrograde intubation.

Results: Groups were comparable in terms of demographic and baseline parameters. OAA/S ($P = 0.001$), cough severity ($P < 0.001$), facial grimace score ($P < 0.001$), grading of discomfort during procedure ($P < 0.001$) and recall of procedure scale ($P = 0.038$) were found significantly better/lower in Group B as compared to Group A. Hemodynamic parameters were better in Group B and showed significant difference during the retrograde intubation. However, ease of intubation scale, intubating time and complications were not significantly different ($P > 0.05$) between the two groups.

Conclusion: Retrograde intubation can be easily learned and performed with minimal complications. Dexmedetomidine in a dose of 1.5 µg/kg IV is optimum and safe for retrograde intubation with clinically manageable side effects.

1. Introduction

Airway management remains the most important aspect of anesthesia and emergency medicine. Availability of flexible fiber-optic bronchoscope may be an issue at some centers with financial restraints. Retrograde intubation is one of the recommended alternative non invasive techniques in the difficult airway algorithm of American Society of Anesthesiologists (ASA) and Canadian Society of anesthesiologists.^{1,2} Retrograde intubation requires a non surgical transalaryngeal airway access to guide orotracheal or nasotracheal intubation. It can be used in both in awake and apneic patients when other methods have failed.^{3,4} Use of sedation increases procedural acceptance and reduces anxiety and discomfort during awake tracheal intubation.⁵ Balancing adequate sedation is one of the key factors during any awake intubation

procedure to avoid any side effects of over sedation and apnea. Multiple drugs have been utilized previously for providing effective sedation during airway management but still the search is continuing. Dexmedetomidine, an α (2)-adrenergic receptor agonist, is used for providing sedation in clinical practice. It has an opioid sparing and anxiolytic effect, which can be benefiting in perioperative scenario. Dexmedetomidine even at dose of 1.5 µg/kg has been found effective in the management of naso-tracheal fiber-optic intubation.⁶ However, there is a lacuna of randomized control trials to provide evidence for conscious sedation in awake retrograde intubation, therefore we utilized the sedative and sympatholytic properties of dexmedetomidine for awake retrograde intubation and evaluated the comfort, recall and hemodynamic parameters between different doses of 1 µg/kg and 1.5 µg/kg dexmedetomidine.

* Corresponding author.

E-mail addresses: tanmayanesthesia@gmail.com (T. Tiwari), walian.ashish10@gmail.com (A. Walian), vipintheazad@gmail.com (V.K. Singh), drvinitasingh70@gmail.com (V. Singh), brightsky@rediffmail.com (S. Chakraborty), amberrawat@gmail.com (A. Rawat).

<https://doi.org/10.1016/j.jobcr.2020.06.002>

Received 2 March 2020; Received in revised form 12 June 2020; Accepted 13 June 2020

Available online 18 June 2020

2212-4268/ © 2020 Published by Elsevier B.V. on behalf of Craniofacial Research Foundation.

2. Materials and methods

This prospective randomized double blind parallel group trial (CTRI registration: CTRI/2018/04/013244) was conducted after attaining proper institutional ethical clearance (ECR/262/Inst/UP/2013/RR-16, no.104/Ethics/R.Cell-17). 60 patients of either sex, in the age group of 15–60 years with difficult airway (with mouth opening < 2 cm, thyromental distance < 6.5 cm, and Mallampati Class III and IV) and in the category of American Society of Anesthesiologists Physical Status (ASA PS) I–II, scheduled for head and neck surgery were enrolled for the study after written and informed consent. Study was conducted in the operating rooms of King George's Medical University, Lucknow.

Patients with nasal mass, bleeding tendency, reduced platelet counts, abnormal coagulation profile, heart rate (HR) < 50/min, any level of heart block, and uncooperative patients were excluded from our study.

All patient were assessed and counseled for the awake retrograde intubation approach a day before surgery and premedication were not given to any patients. Fasting for solids for 6 h and clear liquids for 2 h was advised to all patients on the preoperative assessment.

In the preoperative room on the day of surgery topical anesthesia of the airway in all patients (n = 60) was achieved using nebulization with 2 ml lignocaine 4% for 10 min. On arrival in the operating room (OR), a 20-gauge IV catheter was placed in the non-dominant hand of the patient. Required monitoring like 5-lead electrocardiogram (ECG), heart rate (HR), noninvasive blood pressure (NIBP), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO₂) were placed and continuously recorded. Injection Glycopyrrolate 0.2 mg IV was given to all patients after the application of routine monitoring.

The Consolidated Standards of Reporting Trials (CONSORT) flow diagram was used for patient enrollment and allocation (Fig. 1).

Using modified Sedation using modified (OAA/S) scale as the primary outcome measure sample size was estimated keeping alpha error of 5% (confidence interval 95%) and power of study of 80%. Finding a difference of 10% change in mean sedation score values was regarded as clinically significant difference. Standard deviation (SD) for the sedation parameter was based on a previous published study.⁶ Sample size of 30 patients in each group was calculated using the given formula

$$n = (Z_{\alpha} + Z_{\beta})^2 \times 2 \sigma^2 / d^2$$

Where;

Z_{α} = 1.96 at alpha error of 5%, Z_{β} = 0.84 at power of 80%, σ = 0.69 (SD derived from previous study),⁶ d = 0.5 (expected difference of 10% in mean sedation scores)

$$n = (1.96 + 0.84)^2 \times 2 \times 0.69^2 / 0.5^2$$

$$n = 29.8 \text{ (rounded off to 30).}$$

Patients were randomly allocated using computer generated randomization table into following two groups of 30 patients each. Allocation concealment was provided using sequentially numbered, sealed, opaque envelopes.

- **Group A** (30 patients) received loading dose of 1 µg/kg IV dexmedetomidine over 10 min in normal saline
- **Group B** (30 patients) received loading dose of 1.5 µg/kg IV dexmedetomidine over 10 min in normal saline

The patient as well as the anesthesiologist performing retrograde intubation was not aware of the group to which the patient belonged and the study drug was prepared by an operating room technician who was not participating in the study. Hence, our study was double-blinded. A trainee anesthesiologist, who was unaware of the study drug preparation, collected and analyzed the data.

Patients in Group A and B received dose of dexmedetomidine at

1 µg/kg and 1.5 µg/kg IV respectively, over 10 min in 10 ml normal saline. Oxygen supplementation with nasal prongs at 4L/min was continued throughout the procedure and the skin puncture site for entry to the laryngeal lumen was infiltrated with 2% lignocaine.

Post infusion of study drugs, sedation score by modified Observer Assessment of Alertness/Sedation (OAA/S) scale⁷ was assessed as following- 5 = responds readily to name spoken in the normal tone, 4 = lethargic response to the name spoken in normal tone, 3 = responds only after name spoken loudly or repeatedly, 2 = response only after mild prodding or shaking, and 1 = does not respond to mild prodding or shaking.

The retrograde intubation procedure commenced only if OAA/S score was equal or less than 3. If OAA/S was more than 3, then incremental dose of Ketamine + Propofol (premixed in single syringe of 10 ml in 1:1 ratio) was given to patients in both the groups to get adequate sedation.

When the score was found to be adequate, then under strict aseptic precaution, the crico-tracheal membrane was punctured with an 18G needle and the laryngeal lumen was confirmed with free aspiration of air through a fluid filled syringe. Sterile ureteral DJ stent wire (Turmo, length 150 cm, size 0.18 mm) as a guide wire was directed cephalad to be retrieved from the nasal route. Once retrieved successfully flexible bougie was railroaded over the guide wire with distal end of guide wire carefully secured with the help of an artery forcep. Flexometallic endotracheal tube (ETT) was then railroaded over the bougie and guide-wire. After visual confirmation the end tidal CO₂ (EtCO₂) waveform for six consecutive waves after ETT cuff inflation, guide wire and bougie were removed and anesthesia was induced as per common hospital policy.

Sedation using modified (OAA/S) scale was the primary outcome measure and secondary outcome measured were multiple in terms of:

- Hemodynamic parameters: HR, SpO₂, SBP, DBP
- Ease of intubation (1 = easy, 2 = moderate, 3 = difficult)
- Cough severity: 1 = none, 2 = slight (one gag/cough only), 3 = moderate (more than 1 gag/cough but acceptable), 4 = severe (unacceptable)
- Facial grimace score (FGS): 1 = no reaction, 2 = slight grimacing, 3 = severe grimacing 4 = verbal objection, 5 = defensive movements of head, hands or feet.
- Intubating time: Time taken from laryngeal puncture to a visible EtCO₂ waveform.
- Ketamine + Propofol dose: Additional dose to bring modified OAA/S less than or equal to 3 during the procedure.

On the post operative day 1 patients were assessed for.

- Recall of procedure: 1 = no recall, 2 = Partial recall of procedure, 3 = Full recall of procedure
- Discomfort during procedure: 1 = no discomfort, 2 = mild (just comfortable), 3 = moderate (tolerable), 4 = severe (completely intolerable)

Any hypoxic episode, hypotensive episode (SBP < 90), and bradycardia during the procedure (HR < 50/min) was also taken into account.

Statistical analysis was done by SPSS (Statistical Package for the Social Sciences) version 17.0 (IBM Inc, Chicago, USA). Continuous data was summarized as Mean ± SD (standard deviation) while discrete (categorical) in number and %. Continuous data were compared between two groups using independent *t*-test. Categorical data were compared between two groups using Chi-square test. *P* < 0.05 was considered statistically significant.

Fig. 1. Consort flow diagram.

3. Results

Retrograde guided awake intubation was successful in all the patients of both the groups. The baseline hemodynamics and demographic profile were comparable in both the groups [Table 1].

Sedation was measured in between groups using modified OAA/S and tolerance to intubation in terms of FGS and cough. Patients of

Table 1

Distribution of participants according to demographic profile and baseline hemodynamic parameters.

	GROUP A (N = 30)	GROUP B (N = 30)	P VALUE
AGE (YEARS)	46.43 ± 9.04	46.17 ± 9.74	0.913
SEX F/M	3/27	2/28	0.640
WEIGHT (KG)	61.83 ± 4.47	62.00 ± 7.24	0.915
BMI (KG/M ²)	21.16 ± 1.88	21.54 ± 2.40	0.494
MOUTH OPENING (CM)	1.72 ± 0.36	1.73 ± 0.39	0.864
THYROMENTAL DISTANCE (CM)	3.37 ± 0.49	3.30 ± 0.60	0.63
ASA PS I/II	18/12	19/11	0.79
BASELINE HR	75.80 ± 8.73	81.83 ± 10.06	0.796
BASELINE SBP	130.63 ± 11.84	126.67 ± 14.70	0.999
BASELINE DBP	81.80 ± 9.10	77.43 ± 9.32	0.895

The values are mean ± SD or number of patients. P < 0.05 is statistically significant. ASA PS: American Society of Anesthesiologists Physical Status, HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BMI: Body mass index, SD: Standard deviation.

group B were deeply sedated (P = 0.001), had lesser episode of cough and better FGS as compared to group A (P < 0.001). Intubating time between the two groups was insignificant (P = 0.521) but significantly higher Ketamine + Propofol was required in Group A as compared to Group B (P = 0.02). There was no difference in terms of ease of intubation in between two groups (P = 0.129). There was a single episode of bradycardia as side effect in-group B and was insignificant in between two groups (P = 0.313) (Table 2).

Hemodynamic variables were measured in terms of mean HR, SBP and DBP and are depicted in Table (3–5).

Mean HR (Table 3) in both the groups showed declining trend from baseline values till 10 min of drug infusions, but increased during the retrograde procedure starting from laryngeal puncture after the infusion of study drugs. The difference in between group was statistically significant and better in Group B, during the step of bougie and ETT railroading over the guidewire and ETT in trachea (P = 0.016, P = 0.001).

Similarly, mean SBP (Table 4) in both the groups showed declining trend from baseline till 10 min of drug infusion and then increased during the retrograde intubation procedure starting from laryngeal puncture till 2 min after intubation. The difference in between groups was statistically significant and better in Group B at all times of procedure (P = 0.019, P < 0.001).

Similarly, mean DBP (Table 5) in both the groups showed declining trend from baseline till 10 min of drug infusion and then increased during the retrograde intubation procedure starting from laryngeal puncture till 2 min after intubation. The difference in between groups

Table 2
Parameter during retrograde Intubation.

	GROUP A	GROUP B	P VALUE
Modified OAAS 1,2,3,4,5	0,5,18,7,0	0,19,9,2,0	0.001*
Ease of Intubation (Easy, Moderate, Difficult)	0,23,7	1,27,2	0.129*
Cough severity (None, Slight, Moderate, Severe)	0,11,16,3	8,20,2,0	< 0.001*
Facial Grimace Score (None, Slight, Severe, Verbal objection, Defensive movement)	0,7,16,6,1	0,25,3,2,0	< 0.001*
Intubating time (min)	4.03 ± 0.72	3.93 ± 0.45	0.521
Ketamine + Propofol requirement in ml	6.50 ± 0.58	4.50 ± 0.71	0.020
Bradycardia (HR < 50/min)/Hypotension (SBP < 90 mmHg)/Desaturation (SpO ₂ < 94%)/Arrhythmia	0/0/0/0	1/0/0/0	0.313*

The values are number of patients or mean ± SD, P < 0.05 is statistically significant, *Chi-square test.

Table 3
Comparison of HR during the retrograde intubation procedure.

Time	Group A (n = 30)	Group B (n = 30)	P value
Baseline	75.80 ± 8.73	81.83 ± 10.06	0.796
5 min after infusion	74.87 ± 7.96	69.33 ± 8.74	0.739
10 min after infusion	71.50 ± 10.45	67.67 ± 10.55	0.992
Cricotracheal membrane puncture	71.97 ± 10.41	68.20 ± 10.43	0.865
Guide-wire in pharynx	82.70 ± 10.45	74.93 ± 11.20	0.057
Bougie & ETT railroaded over guide-wire	87.33 ± 8.75	76.53 ± 9.50	0.001
ETT in Trachea	84.50 ± 7.28	75.63 ± 9.64	0.016
2 min after intubation	81.30 ± 7.19	73.63 ± 8.05	0.064

The values are mean ± SD, P < 0.05 is statistically significant.

Table 4
Comparison of SBP during the retrograde intubation procedure.

Time	Group A (n = 30)	Group B (n = 30)	P value
Baseline	130.63 ± 11.84	126.67 ± 14.70	0.999
5 min after infusion	128.17 ± 12.71	118.00 ± 13.52	0.201
10 min after infusion	121.60 ± 10.66	112.67 ± 7.55	0.423
Cricotracheal membrane puncture	121.93 ± 10.42	113.50 ± 7.53	0.019
Guide-wire in pharynx	131.60 ± 8.79	118.37 ± 8.74	< 0.001
Bougie & ETT railroaded over guide-wire	133.13 ± 10.26	120.67 ± 9.06	< 0.001
ETT in Trachea	132.07 ± 9.32	118.07 ± 9.53	< 0.001
2 min after intubation	130.57 ± 8.32	116.47 ± 8.76	< 0.001

The values are mean ± SD, P < 0.05 is statistically significant.

Table 5
Comparison of DBP during the retrograde intubation procedure.

Time	Group A (n = 30)	Group B (n = 30)	P value
Baseline	81.80 ± 9.10	77.43 ± 9.32	0.895
5 min after infusion	78.97 ± 8.56	72.33 ± 7.80	0.219
10 min after infusion	75.00 ± 8.20	68.40 ± 5.73	0.226
Cricotracheal membrane puncture	75.30 ± 7.64	68.57 ± 5.95	0.007
Guide-wire in pharynx	80.47 ± 6.62	71.93 ± 6.86	< 0.001
Bougie & ETT railroaded over guide-wire	82.23 ± 6.91	73.23 ± 6.69	< 0.001
ETT in Trachea	81.20 ± 6.84	72.13 ± 6.46	< 0.001
2 min after intubation	80.50 ± 6.72	70.67 ± 5.54	< 0.001

The values are mean ± SD, P < 0.05 is statistically significant.

was statistically significant and better in Group B at all times of procedure (P = 0.007, P < 0.001).

On the first post operative day patients were assessed for recall, discomfort and episode of hoarseness and sore throat (Table 6). Patient in-group B had lesser recall of events (P = 0.038) and was more comfortable during the procedure of retrograde intubation (P < 0.001) as compared to Group A and showed statistically

Table 6
Parameters measured during the first postoperative day.

	GROUP A	GROUP B	P VALUE
Patients recall (None, Partial, Full)	0,22,8	0,28,2	0.038^a
Discomfort during procedure (None, Mild, Mod, Severe)	0,6,18,6	0,28,2,0	< 0.001^a
Hoarseness/Sore-throat	20/5	18/7	0.512 ^a

The values are number of patients, P < 0.05 is statistically significant.

^a Chi-square test.

significant difference. Hoarseness and sore throat did not show any significant difference in between groups.

4. Discussion

Flexible fiber-optic intubation is the method of choice for management of anticipated difficult airway, but its availability cannot be assured because of the cost involved. Also flexible fiber-optic is technically demanding and requires a learning curve and training.

Retrograde intubation also require training, but most of the steps used during procedure like local anesthetic infiltration to the upper airway, sedation, needle cricothyrotomy and guide wire assisted blind tracheal intubation over an introducer are familiar to anesthetist and can be successful in situations where visibility from fiber-optic bronchoscope may be an issue (bleeding and excessive secretions). We conceptualized the present study keeping in mind about the non-availability of the flexible fiber-optic bronchoscope at various centers.

Butler and Cirillo,⁸ first described retrograde intubation in 1960 as a mean to clear the surgical field of neck. Since then it has been described in multiple case reports and review articles.^{9–11} Retrograde intubation is a safe and reliable technique in experienced hands,¹² but is under-utilized and not often preferred both during emergency and elective situation.¹³ It can be done both in conscious sedation¹⁴ and under general anesthesia with muscle relaxants.¹⁵ A better understanding and patient preparation are the prerequisites for the successful conduct which require a conscious sedation. Use of dexmedetomidine for conscious sedation during an awake fiber-optic intubation is fairly popular in the situation of anticipated difficult airway.¹⁶ It induces sedation by activating postsynaptic α_2 receptors in the locus coeruleus, and activation of the endogenous sleep-promoting pathway.

We used a single drug regime of dexmedetomidine at two different doses for performing the retrograde procedure, which was similar to dose, used by Dhasmana⁶ in a previous study on awake fiber-optic intubation. In our study, group B was better sedated with 93% (28/30) patients compared to 76% (23/30) of group A, achieving the target OAA/S of ≤ 3 which was statistically significant (P = 0.001), unlike the study by Dhasmana⁶ in which both the groups were adequately sedated for awake fiber-optic bronchoscopy. Also patients of group B had better tolerance to tube as shown by lower FGS and reduced incidence of cough than group A, which was statistically very significant (P < 0.001). Jorden et al.,¹⁷ also reported oversedation as the side

effect in three cases during accidental overdose of dexmedetomidine during perioperative period.

To maintain the OAA/S values post the study drug infusion to acceptable values ketamine + Propofol requirement was more in Group A and was statistically significant ($P = 0.020$).

Retrograde intubation is more invasive than the fiber-optic intubation and also requires a cricotracheal membrane puncture, which can explain the better tolerance and sedation showed by patients in group B and additional requirement of ketamine and propofol in Group A.

All patients were successfully intubated using the retrograde technique and the average intubating time was short and comparable to previous studies by Hung & Qatari,⁴ and showed no statistically different results (Group A 4.03 ± 0.72 & Group B 3.93 ± 0.45 , $P = 0.521$). In our experience guide wire comes out from one of the nostrils, which can be explained by the path of least resistance taken by guide-wire and also because of the better suitable curvature offered by nasal passage as reported earlier.¹¹

Hemodynamic parameters (HR, SBP, DBP) in our study showed a declining trend from the baseline values in both the groups till 10 min of drug infusion and there was no statistically significant difference between the two groups. The decrease in HR with dexmedetomidine occur most commonly during a bolus or within 10 min of the start of an infusion,¹⁸ which stands true with our study also. While, hypertension during loading dose of dexmedetomidine is well documented, but it occurs in only 20% of the patients,¹⁷ which can explain the associated fall in blood pressures in both groups in our study. The haemodynamic response to retrograde intubation was significantly reduced and better in the Group B than Group A. None of our patients developed desaturation, arrhythmia and hypotension in both the group and only single episode of bradycardia was observed in group B. The low incidence of bradycardia can be explained by the pre medication with anticholinergic in all of our patients. Loading infusions of dexmedetomidine up to $2 \mu\text{g/kg}$ over short duration have been previously administered in healthy individuals with no serious adverse events.^{19,20}

In our study, 27% (8/30) patients in Group A as compared to only 7% (2/30) patients of group B completely recalled the procedure on post operative day 1, which was statistically significant ($P = 0.038$), unlike the study by Dhasmana.⁶ High incidence of recall in our study can be explained by no premedication with benzodiazepine, and also by the fact that drug infusion was given for duration of 10 min in our study protocol. 93% (28/30) patients in group B had only mild discomfort during procedure as compared to 20% (6/30) patients in Group A which was statistically very significant ($P < 0.001$). Incidence of hoarseness/sore throat was similar and statistically insignificant ($P = 0.512$) in between the groups and matched the previous published literature.^{10,21}

Relatively small sample size and use of a single drug regime in patients with normal Body mass index could be the limitation of present study.

5. Conclusion

Retrograde guided intubation can be an attractive option of airway management in the absence of flexible fiber-optic bronchoscope, and dexmedetomidine in a dose of $1.5 \mu\text{g/kg}$ can be used to provide better intubating condition, lesser patient reaction to intubation, lower recall and less requirement of rescue therapy with clinically manageable hemodynamic side effects. We suggest inclusion of retrograde intubation as a part of curriculum of anesthesiology and emergency medicine training, especially at centers with absence of flexible fiber-optic bronchoscope like it is included in the training curriculum of the Royal College of Anesthetists in the United Kingdom.²²

We suggest further larger clinical trials to find the optimal and effective lowest dose of dexmedetomidine in combination with topical spray/nebulization of the airway with or without local blocks and other pharmacological agents to minimize the hemodynamic side effects

during awake retrograde intubation.

Financial support and sponsorship

none to declare

Previous presentation

Data for this study were presented as a podium presentation at the ISACON meeting, 26–29 November, Bangalore 2019.

No potential conflict of interest relevant to this article.

IRB number

King George's Medical University, Lucknow. (Reg. No. ECR/262/Inst/UP/2013/RR-16, no.104/Ethics/R.Cell-17).

Clinical trial registration number.

(CTRI registration: CTRI/2018/04/013244).

CRedit authorship contribution statement

Tanmay Tiwari: Conceptualization, Methodology, Writing - review & editing. **Ashish Walian:** Data curation, Writing - original draft. **Vipin Kumar Singh:** Visualization, Investigation. **Vinita Singh:** Supervision. **Sangeeta Chakraborty:** Software, Validation. **Amber Rawat:** Software, Writing - review & editing.

Declaration of competing interest

None

Acknowledgement

Late Satish Dhasmana, Professor, Department of Anesthesia, King George's Medical University, Lucknow, India.

References

1. American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway. An updated report by the American society of anesthesiologists task force on management of the difficult airway. *Anesthesiology*. 2003;98:1269–1277.
2. Crosby ET, Cooper RM, Douglas J, Doyle J, et al. The unanticipated difficult airway with recommendations for management. *Can J Anaesth*. 1998;45:757–776.
3. Rosenblatt WH, Wagner PJ, Ovassapian A, et al. Practice patterns in managing the difficult airway by anesthesiologists in the United States. *Anesth Analg*. 1998;87(1):153–7.
4. Hung OR, al-Qatari M. Light-guided retrograde intubation. *Can J Anaesth*. 1997;44(8):877–882.
5. Johnston KD, Rai MR. Conscious sedation for awake fiberoptic intubation: a review of the literature. *Can J Anesth*. 2013;60:584–99.
6. Dhasmana SC. Nasotracheal fiberoptic intubation: patient comfort, intubating conditions and hemodynamic stability during conscious sedation with different doses of dexmedetomidine. *J Maxillofac Oral Surg*. 2014;13:53–58.
7. Shimabukuro A, Satoh K. Airway management with dexmedetomidine for difficult airway. *Masui*. 2007;56:681–4.
8. Butler FS, Cirillo AA. Retrograde tracheal intubation. *Anesth Analg*. 1960;39:333–338.
9. Waters DJ. Guided blind endotracheal intubation. For patients with deformities of the upper airway. *Anaesthesia*. 1963;18:158–62.
10. Dhara SS. Retrograde tracheal intubation. *Anaesthesia*. 2009 Oct;64(10):1094–1104.
11. Marchello V, Corso RM, Piraccini E, Del Gaudio A, Mincolelli G, Cattano D. The retrograde tracheal intubation technique for difficult airway management: old but still working. *Journal of Head and Neck Anesthesia*. 2019 May 1;3(2):e16.
12. Levitan RM, Kush S, Hollander JE. Devices for difficult airway management in academic emergency departments: results of a national survey. *Ann Emerg Med*. 1999;33:694–698.
13. Benumof JL. Management of the difficult adult airway. *Anesthesiology*. 1991;75:1087–1110.
14. Dhara SS. Retrograde intubation-a facilitated approach. *Br J Anaesth*. 1992;69:631–633.
15. Bissinger U, Guggenberger H, Lenz G. Retrograde-guided fiberoptic intubation in patients with laryngeal carcinoma. *Anesth Analg*. 1995;81:408–410.
16. Abdelmalak B, Makary L, Hoban J, Doyle DJ. Dexmedetomidine as sole sedative for

- awake intubation in management of the critical airway. *J Clin Anesth.* 2007;19:370–373.
17. Jorden VS, Pousman RM, Sanfor MM, Thorborg PA, Hutchens MP. Dexmedetomidine overdose in the perioperative setting. *Ann Pharmacother.* 2004;38:803–807.
 18. Peden CJ, Cloote AH, Stratford N, Prys-Roberts C. The effect of intravenous dexmedetomidine premedication on the dose requirement of propofol to induce loss of consciousness in patients receiving alfentanil. *Anaesthesia.* 2001;56:408–413.
 19. Bloor BC, Ward DS, Belleville JP, Maze M. Effects of intravenous dexmedetomidine in humans. II. Hemodynamic changes. *Anesthesiology.* 1992 Dec;77(6):1134–1142.
 20. Belleville JP, Ward DS, Bloor BC, Maze M. Effects of intravenous dexmedetomidine in humans. I. Sedation, ventilation, and metabolic rate. *Anesthesiology.* 1992 Dec;77(6):1125–1133.
 21. Burbulys D, Kiai K. Retrograde intubation. *Emerg Med Clin.* 2008 Nov 1;26(4):1029–1041.
 22. Royal College of Anaesthetists. CCST in Anaesthesia III. *Section 7: Generic Knowledge and Skills Page III – 11–13.* second ed. April, 2003; April, 2003 accessed <http://www.rcoa.ac.uk>, Accessed date: May 2006.