Original Article

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Comparative Analysis of Different Techniques of Airway Management in View of Hemodynamic Stability and Postoperative Complication in Patients Undergoing Atlantoaxial Joint Dislocation Surgery

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Abstract

Background: An ideal technique of intubation of the trachea in patients of atlantoaxial joint dislocation surgery remains unclear. This study was undertaken with the primary objective to compare the three different techniques of airway management, in view of hemodynamic stability in patients undergoing atlantoaxial joint dislocation surgery. The secondary objective was to assess the association of postoperative airway complications and the technique of intubation. **Subjects and Methods:** Adult patiënts aged >18years, American Society of Anaesthesiologists grade I-III, undergoing elective atlantoaxial joint dislocation surgery requiring tracheal intubation were included in the study. Patients with anticipated difficult airway, previous history of cervical spine injury or surgery were excluded from the study. Patients were divided into 3groups, Group1: conventional laryngoscopy, Group 2: video laryngoscopy, Group 3: fiberoptic intubation. Hemodynamic and postoperative neurological status was assessed. **Results:** 90 patients were studied. The mean age of patients of Group 1, Group 2 and Group 3 was 45.23±10.29, 46.8±6.8 and 44.73±9.97 years respectively. At baseline MAP, HR and SpO2 were comparable in all three groups with insignificant intergroup difference (P>0.05). After securing the airway, significant increase in MAP(P= 0.016), HR (p=0.001) was seen on comparing the three groups. No significant association was seen between postoperative airway complications and the intubation technique. Among the 90 patients included, 24(26.67%) patients developed postoperative neurological deficit (quadriparesis, n=18 and upper limb paresis, n=6). 15(16.67%) patients required postoperative mechanical ventilation. 8(53.33%) out of 15 were tracheostomized. No correlation was observed between time duration of securing the airway and postoperative neurological deficit (P=0.7224). **Conclusion:** No corrélation was observed between the technique or duration of intubation and neurological deterioration in patients undergoing AAD surgery. Conventional laryngoscopy is associated with maximum hemodynamic perturbations and number of reattempts.

Keywords: Airway, Atlantoaxial Joint, Shoulder Dislocation

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Introduction

Atlantoaxial dislocation (AAD) refers to instability and disorder of the atlas and axis vertebrae (C1–C2) that results in loss of normal articulation. The etiology of AAD varies from congenital anomalies like Klippel-Fleil and Down's syndrome, to acquired causes like infection (tuberculosis), metabolic diseases, trauma and rheumatoid arthritis. Depending on severity and grade of cervical cord involvement, the spectrum of symptoms of patients of AAD stretches from isolated pain in neck to quadriparesis with respiratory muscle weakness.[1] These patients often undergo surgery for stabilization of cervical spine, during which it is necessary to secure the airway by endotracheal intubation.

During the procedure of endotracheal intubation, any maneuver causing motion at already compromised upper cervical joint could extend the degree of dislocation and further spinal cord injury. Thus the airway management in these patients requires careful consideration.[2] The aim in management of unstable cervical spine patients is to avoid any new neurological deficit or further neurological injury by preventing exaggerated movements at cervical spine. Currently, different airway management options are available for securing the airway of such patients, however there is limited literature to show superiority of one method over the another. The best technique for endotracheal intubation in patients with AAD remains debatable.[3–8] Also, the availability, proficiency and the characteristics of patient guides the choice of airway equipment used while securing the airway in such patients.

Since most of the published literature is on traumatic cervical spine injury patients, for patients undergoing surgery for atraumatic cervical spine the agreement on the most suitable intubation technique is lacking. Current literature reports fiberoptic bronchoscopy (FOB), direct laryngoscopy with manual in line stabilization and blind nasal intubation as intubation techniques.[9] Video laryngoscopy which has been shown to be advantageous over conventional direct laryngoscopy in terms of better ease of intubation has not been studied in this group of patients.[10] There is no reliable evidence comparing the technique of airway management to the incidence of postoperative neurological complications owing to injury of cervical spinal cord.

This study was undertaken with the primary objective to compare three different techniques of airway management in view of hemodynamic stability in patients undergoing atlantoaxial joint dislocation surgery. The secondary objective was to evaluate the association between postoperative airway complications and the technique of endotracheal intubation used.

Subjects and Methods

Patients

This prospective observational study was carried out in the operation theatre setting of a tertiary care center. Institutional ethical committee approval was taken for data collection. Informed consent was taken from all patients prior to inclusion. All adult patiënts aged >18years, American Society of Anaesthesiologists grade I-III, undergoing elective atlantoaxial joint dislocation surgery requiring endotracheal intubation were included in the study. Patients with anticipated difficult airway, past history of cervical spine injury or surgery were excluded from the study.

Groups

Patients meeting the inclusion criteria were enrolled in the study and were divided into 3 groups: (1) Group 1 (n=30), conventional laryngoscopy group: Laryngoscopy was performed using Macintosh blade, No.3 for females and no. 4 for males (2) Group 2 (n=30), video laryngoscopy group: Laryngoscopy was done using video-laryngoscope (Glidescope video laryngoscope; Saturn Biomedical Systems, Burnaby, BC, Canada) (3) Group 3 (n=30), Fiberoptic intubation group: Fiberoptic bronchoscope (Pentax Medical, Orangeburg, New York, USA) guided intubation was done in this group through nasal route. The standard flexible fiberoptic scope (FFS) with attached video screen was used. Stylet was used with endotracheal tube in Group 1 and Group 2, while in Group 3, endotracheal tube was slipped over bronchoscope. Portex cuffed tracheal tube with Murphy eye was used. To reproduce the standard of care in patients with unstable cervical spine, the whole procedure of endotracheal intubation was carried out with the manual inline stabilization (MIS) of cervical spine in all the three groups.

Patients were divided into 3 groups based on computer generated random sequence. Sealed randomization card for each patient was opened by the concerned anaesthesiologists just prior to surgery in the preoperative room, after completion of complete preoperative assessment.

Procedure

Preoperative assessment of every included patient was done by the intubating anaesthesiologists in the preoperative area. Complete airway examination in sitting position was also performed for each patient. All patients were given injection midazolam (1-2mg) intravenously (IV) to allay anxiety.

In the operation theatre standard monitoring was attached which included, non-invasive blood pressure, electrocardiogram, pulse oximetry. On the operation table, position of all patiënts was supine with head and neck supported on a noncompressive pad. One of the assistant performed MIS by putting both hands of either side of head of patient without putting unnecessary axial traction. MIS was done to keep the cervical spine in midline and neutral position. The assistant who provided MIS stood on the left side of intubation anaesthesiologists.

Preoxygenation was done with 100% oxygen for 3minutes in all patients, followed by induction of anesthesia by injection fentanyl (2μg/kg) IV and injection propofol (2 mg/kg). After confirming bag mask ventilation injection rocuronium (1 mg/kg) IV was given. Injection lignocaine (1.5mg/kg) IV was given to blunt the pharyngeal reflexes. Additional bolus dose of injection propofol (20-30mg) was given IV if patient showed indication of lighter plane of anaesthesia. Bag mask ventilation was continued for at least 1minute after giving rocuronium and until the initiation of endotracheal intubation technique. Complete muscle relaxation was confirmed by using neuromuscular monitoring (loss of response to train-of-four stimulation) before the start of the procedure of laryngoscopy.

Measurements and follow-up

Patients were followed from the preanesthetic evaluation until discharge from the hospital. The data which is collected perioperatively include: (1) demographic data; (2) procedure time from the passage of the intubating device between the teeth to correct placement of the endotracheal tube; (3) hemodynamic parameters [mean arterial pressure (MAP), heart rate (HR), and peripheral oxygen saturation (SpO2)] recorded at baseline before induction, after induction and 5 minutes after successful tracheal intubation (post intubation); (4) etiology of AAD and surgical approach (anterior, posterior or combined); (5) adverse events during the procedure including the number of intubation attempts, bleeding due to trauma, increase in HR/MAP>15% of baseline were noted; (6) Intraoperative complications noted were surgical bleeding, episodes of hypotension or hypoxia (>15% drop in MAP/SpO2 from baseline); (7) finally, postoperatively after 4 hours of completion of surgery, an airway assessment was done by a coinvestigator who was blinded to the technique used for securing airway. Patient will be examined for the presence of postoperative complications like a sore throat, dysphagia, quadriparesis, upper limb paresis (defined by reduction in power of muscle by one grade when compared to preoperative). Need for mechanical ventilation (respiratory muscle weakness requiring intervention) postoperatively was also assessed.

Statistical analysis

Results are presented in mean±SD. Categorical variables between the groups were compared using the Chi-square test. Continuous variables between the groups were compared using the unpaired-t test. Repeated measures of analysis of variance was used to find the effect of time in the change in the vital events from baseline to subsequent time periods. The p-value of <0.05 was considered significant. All analysis were carried out on SPSS 16.0 version (Chicago, Inc., USA).

Results

General characteristics

A total of 98 patients undergoing atlantoaxial joint dislocation surgery were included consecutively over a period of 24 months. Eight patients were already intubated or tracheostomized prior to surgery and were eliminated from the data analysis. The total number of patients included were 90. All patients were successfully intubated. [Table 1] shows the baseline demographic and details of patient characteristics, etiology and surgical approach of patients in different groups who underwent AAD surgery. There was no significant difference in patients among the 3 categories of intubation techniques. The mean age of patients of Group 1, Group 2 and Group 3 was 45.23±10.29, 46.8±6.8 and 44.73±9.97 years respectively. More than half of patients of Group 1(70%), Group 2(56.67%) and Group 3(60%) were males. Groups were comparable in regards to age and gender (p.0.05) [Table 1]. The etiology of AAD was congenital in more than 50% of all the three groups and the main surgical approach followed in all the three groups was predominantly posterior.

Hemodynamic characteristics

At baseline MAP, HR and SpO2 were comparable in all three groups with insignificant intergroup difference (P>0.05). [Table 2] depicts the hemodynamic variables across three different groups and their statistical significance. After induction of anaesthesia, the MAP, and HR decreased slightly across all three groups, however, this decrease was statistically insignificant. Pairwise comparison by post Hoc Tukey HSD also showed no difference between groups at baseline and after induction.

After securing the airway, significant increase in MAP (P= 0.016), HR (p=0.001) was seen on comparing the three groups. Post hoc analysis revealed significant difference between group 1 and group 3 for MAP (p=0.013) and HR (P=0.007), but insignificant difference between Group 1, Group 2 (MAP P=0.583, HR P=0.093) and Group 2, Group 3 (MAP P=0.145, HR P=0.209).

Perioperative complications

Complications observed during intubation procedure, intraoperative and postoperatively are shown in [Table 3]. There was no association between postoperative airway complications and the method used for intubation. Among the 90 patients included, 24 (26.67%) patients developed postoperative neurological deficit (quadriparesis, n=18 and upper limb paresis, n=6). 15 (16.67%) patients required postoperative mechanical ventilation. 8 (53.33%) out of 15 were tracheostomized and 7 (46.67%0 were successfully extubated later. Out of 12 patients who developed episode of Intraoperative hypotension 6 (50%) developed postoperative neurological deficit.

Characteristics of patients developing postoperative neurological deficit is depicted in [Table 4]. There was no association between the gender, etiology, type of surgery, and neurological deterioration.

Correlation between time of intubation and post-operative neurological deficit

Total time taken for securing the airway was maximum in Group 2 (56.77±10.09 seconds), when compared to Group 1(33.07±15.04 seconds) and group 3 (41.33±7.42 seconds) as mentioned in [Table 2]. This difference in time was statistically significant (p<0.05). [Figure 1] shows the scatter plot depicting no correlation between time duration of securing the airway and postoperative neurological deficit (P=0.7224).

Figure 1: Scatter plot showing correlation between neurological deficit and time of intubation

Discussion

In this prospective observational study, we studied 90 patients who underwent AAD surgery. All patients were successfully intubated. We observed significant hemodynamic

Table 1: Demographic and general characteristics of patients in different groups who underwent AAD surgery

Variable		Group A (n=30)	Group B (n=30)	Group C (n=30)	P-Value
Age		45.23±10.29	46.8±6.8	44.73±9.97	0.661
Sex N(%)	Females	9 (30)	13 (43.33)	12 (40)	0.541
	Males	21 (70)	17 (56.67)	18 (60)	
Etiology N(%)	Congenital	19 (63.33)	22 (73.33)	23 (76.67)	0.495
	Acquired	11 (36.67)	8 (26.67)	7 (23.33)	
Surgical approach	Anterior	3 (10)	4(13.33)	3 (10)	0.768
	Posterior	21 (70)	17 (56.67)	17 (56.67)	
	Anterior + Posterior	6 (20)	9 (30)	10 (33.33)	

Table 2: Hemodynamic characteristics of patients in different groups

Variable		Group 1	Group 2	Group 3	P
MAP	Baseline	88.64±10.5	89.9±10.37	89.74±10.21	0.883
	After induction	82.96±10.63	82.77±8.88	83.34±8.67	0.972
	After intubation	107.79±21.3	102.92±19.65	93.62±14.55	0.016
HR	Baseline	76.18±7.85	75.17±8.69	75.4±8.9	0.896
	After induction	69.82±8.26	68.76±9.05	68.23±8.81	0.781
	After intubation	92.93±17.12	83.83±16.88	76.47±15.2	0.001
SpO2	Baseline	98.61±0.57	98.45±0.74	98.53±0.73	0.681
	After induction	99.61±0.5	99.45±0.63	99.5±0.63	0.588
	After intubation	99.46±0.58	99.55±0.57	99.43±0.68	0.746
Total time of procedure		33.07±15.04	56.77±10.09	41.33±7.42	<0.05

variations in terms of MAP and HR, across the three groups after endotracheal intubation, maximum in conventional laryngoscopy group. Though the number of reattempts were higher in conventional laryngoscopy group, we did not observe any significant impact of airway management technique on the incidence of neurological deterioration or need for mechanical ventilation postoperatively. Time taken for securing the airway was maximum in video laryngoscopy group, but there was no correlation of duration of intubation procedure with the postoperative neurological outcome.

Management of airway in a patient with AAD poses special challenges for the anaesthesiologists owing to instability of upper cervical spine (C1-C2). Depending on the technique of airway management, the movement at atlantoaxial-occipital while securing airway joint varies. The literature widely differs on the ideal way of airway management in AAD patients. Literature has shown that extension occurs at occiputo-atlanto-axial (O-C2) joints during conventional laryngoscopy and this movement puts an already unstable cervical cord (as in patients of AAD) at risk of further neurological injury.[11,12] Other studies advocates that the procedure of direct laryngoscopy and endotracheal intubation should be carried out after the induction of general anaesthesia in patients with cervical spine injuries.[6,7]

It has been suggested that, fiberoptic bronchoscopy doesn't lead to much cervical cord movements if performed either under general anaesthesia or under appropriate topical anaesthesia of airway and thus, should be used in patients with unstable cervical spine to prevent stress on the cervical spine.[4] There are other studies that recommends awake intubation in patients with cervical spine injury because in awake techniques, little movement at cervical spine occurs owing to neu-

Table 3: Perioperative complications

	Group 1		Group 2		Group 3	
	N	**%**	**N**	**%**	**N**	**%**
Reattempt	12	40	3	10	0	0
Oral bleeding	3	10	0	0	0	0
Increase in HR/MAP>15% of baseline	17	56.7	11	36.7	4	13.3
Surgical bleeding	1	3.3	4	13.3	2	6.7
Intraoperative hypotension	4	13.3	5	16.7	3	10
Hypoxia	1	3.3	0	0		0
Dysphagia	12	40	8	26.7	7	23.3
Sore throat	17	56.7	15	50	12	40
Quadriparesis	6	20	7	23.3	5	16.7
Upper limb paresis	3	10	1	3.3	2	6.7
Mechanicalventilati	5	16.7	6	20	4	13.3

Table 4: Characteristics of patients developing neurological complications

		Neurological deterioration		P-Value
		N	**Total**	
Sex	Female	9	34	0.832
	Male	15	56	
Etiology	Congenital	16	64	0.863
	Acquired	8	26	
Surgical method	Anterior	5	10	0.312
	Posterior	11	55	
	Anterior+ Posterior	8	25	
Intraoperative hypotension		6	12	

tral position of the head and neck and preserved protective reflexes of the patient.[6,7] Loss of splinting and support of muscles of cervical spine as seen with induction of general anaesthesia and especially with use of muscle relaxant might be a point of concern, however, there is not enough evidence to support this rationale. Although there is little literature to support that awake techniques of airway management are associated with better neurological outcomes, still assessment of neurological status after intubation and after positioning of the patient is feasible if the patient is awake.[7] Also, keeping the patient awake for positioning of the patient after securing airway cannot assure an intact postoperative neurological status. Hemodynamic fluctuations perioperatively, surgical manipulation and instrumentation of cervical cord during surgery can lead to aggravation of neurological injury. Intraoperative neurophysiological monitoring might be a means to prevent any neurological deterioration while surgical manipulation or instrumentation.

Not only the airway management techniques, but maneuvers like jaw thrust and chin lift can cause significant movement of upper cervical spine.[13] All patients in our study were intubated after anaesthesia induction and cervical spine was stabilised in all patients by manual in-line stabilization technique irrespective of the device used for the airway management and that provided a safety margin. The manual in-line stabilization might prevent any unintentional movement of the head and neck. In this study, the neurological evaluation could not be performed after intubation or patient positioning due to induction of general anaesthesia. Thus, it is difficult to say whether the postoperative neurological deterioration is attributable to airway management technique or to the surgical procedure.

Most of the published evidence on management of unstable cervical spine airway is on trauma patients. But our study focused on AAD due to both congenital and traumatic reasons. All the surgeries performed in this study were electively planned surgeries, hence patients were assessed and optimized preoperatively. Since airway was secured without any rush, so intubation techniques were successful in all patients.

We observed no significant association between neurological deterioration after cervical spine surgery and airway management technique. Sagi et al,[14] observed a complication rate of 6.1% and reintubation rate of 1.9% in patients undergoing cervical spine surgery with anterior approach. They reported airway complications postoperatively but no patient in their study with airway complications had difficult intubation. However, they did not mention the technique of airway management used in their study. These authors also reported an incidence of airway complications to be 2.4% with 9 deaths in a review of 20 previous articles on patients undergoing anterior cervical spine surgery. Pharyngeal oedema and hematoma were reported as the most common causes of postoperative airway obstruction. Similar postoperative complication rate in terms of neurological deterioration is reported in a review by Emery et al,[15] who mentioned upper airway obstruction in 7 (5.2%) patiënts undergoing cervical spine surgery by anterior approach and neurological injury in 24 patients. Neurological deterioration has various risk factors such as preoperative poor neurological status, prolonged surgery duration, surgery on upper cervical spine, incidences of hypotension decreasing perfusion of spinal cord and multilevel instrumentation of cervical spine.[16] We studied the correlation between the duration of airway management procedure and postoperative neurological deterioration and found no significant correlation. Postoperative neurological deterioration could be attributed theoretically to spinal cord ischemia, due to intraoperative hypotension and blood pressure fluctuations. Autonomic nervous system involvement in cervical injury patients make them more prone to such perioperative hemodynamic fluctuations.[17,18] We observed that 50% of patients developing intraoperative hypotension, developed postoperative neurological deficit.

A study has demonstrated that surgical technique involving both anterior and posterior approaches in the same sitting for cervical spine surgery is associated with higher incidence of postoperative airway problems.[19] But in our study we found no effect of type of surgical approach on the postoperative airway issues.

Sore throat and hoarseness of voice are the other complaints of patients postoperatively.[14] We too observed a high incidence of sore throat and dysphagia, more in conventional laryngoscopy group. Clinical studies report postoperative hoarseness in up to 51% of patients and postoperative dysphagia in up to 60% of patients. The etiology behind postoperative dysphagia is not the procedure of intubation alone.[14,20,21] The incidence of post-surgery neurological complications in patients of cervical spine injury has been reported to be 1.04%.[22] In 327 patients who underwent surgery on cervical spine, Fuchs et al,[23] demonstrated no neurological complication that could be attributed to intubation technique. There are reports of neurological deficits or complications reported directly due to intubation technique in patients with cervical injury, however they are not common and are mainly reported in cervical spine injury patients.[2,24]

Conclusion

To conclude, no correlation was observed between the airway management technique or duration of intubation and neurological deterioration in patients undergoing AAD surgery. Conventional laryngoscopy is associated with maximum hemodynamic perturbations and number of reattempts. Future studies with bigger sample size should be done to provide a good quality evidence and to identify the subgroups where particular airway management technique could be attributed safe in regards to lesser incidence of postoperative neurological deterioration.

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