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Comparison of conventional awake extubation with endotracheal tube – laryngeal mask airway exchange extubation for evaluation of respiratory and hemodynamic parameters during emergence in neurosurgical patients

Amit Vyas[1], Kamalraj Singh Baghel[2], Pawan Nandurkar[3], Sonali Tripathi[4]

[1]Ex-Resident, Department of Anesthesiology, NSCB Medical College, [2]Assistant Professor, Department of Anaesthesiology, Super Speciality Hospital, NSCB Medical College, Jabalpur, [3]Assistant Professor, Department of Pediatrics, [4]Assistant Professor, Department of Anaesthesiology, Chhindwara Institute of Medical Sciences, Chhindwara, Madhya Pradesh, India

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ABSTRACT

Background: Emergence from general anesthesia and tracheal extubation may be associated with tremendous physiological and metabolic stress in patients which could be major concern for the anesthesiologist in patients especially with neurosurgical patients. **Aims and Objectives:** The study was designed to find a novel method to achieving a smooth extubation in neurosurgery by compare the respiratory complications and hemodynamic stress response between conventional awake extubation of an endotracheal tube (ETT) and that following exchange extubation of ETT using a laryngeal mask airway (LMA) in craniotomy surgeries. **Materials and Methods:** A total of 60 patients of American Society of Anesthesiologists physical status I and II between ages 18 and 60 years undergoing neurosurgery were evaluated for respiratory events such as bucking, coughing, desaturation, and hemodynamic changes due to sympathetic stimulation such as tachycardia, hypertension, and any other complications that have occurred in any of the two extubation methods. **Results:** In Group A, 86.67% patients have shown significant events of bucking and coughing while desaturation events were comparable between two groups. Manipulation events, that is, chin lift and jaw thrust had to perform in 66.67% and 21.67%, respectively, in patients of Group A compared to only 03.33% patients in Group L. (P<0.05). In Group A, 97.33% patients shown tachycardia compared to 30% in Group L where only 30%. Similarly, mean arterial pressure after extubation found to be significantly high in 63.33% of the patients in Group A with 63.33% as compared to13.33% of patients in Group L (P<0.05). **Conclusion:** ETT/LMA exchange is the most effective technique for achieving the clinical endpoints of the study, that is, prevention of emergence hypertension and respiratory complications compared to awake extubation methods. The exchange of ETT with LMA in deeper plane of anesthesia significantly reduces emergence related the hemodynamic and respiratory unwonted events.

Key words: Emergence; Extubation; Hemodynamic parameters; Neurosurgical patients; Respiratory parameters

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INTRODUCTION

Emergence from general anesthesia and tracheal extubation may be associated with tremendous physiologic and metabolic stress in patients. These stress-induced alterations in physiologic parameters may be harmful to patients as they can exacerbate preexisting disease or produce medical or surgical complications in the recovery period. It is

Address for Correspondence:
Dr. Sonali Tripathi, Assistant Professor, Department of Anaesthesiology, Chhindwara Institute of Medical Sciences, Chhindwara - 480 001, Madhya Pradesh, India. **Mobile:** +91-9818966968. **E-mail:** dr.sonali.tripathi@gmail.com

important therefore, to implement measures that minimize these stress-induced changes during emergence from anesthesia, particularly in patients at higher risk or after procedures, where complications may result in significant morbidity or even mortality.[1]

Preventing coughing at extubation is not always important but in certain types of surgery (e.g., head and neck surgery and neurosurgery), both intubation and extubation are associated with various cardiovascular and airway responses, leading to tachycardia, hypertension, arrhythmias, myocardial ischemia, coughing, agitation, bronchospasm, increased bleeding, raised intracranial, and intraocular pressure.[2] These transitory changes are of little consequences in American Society of Anesthesiologists (ASA) Grade I and II patients going for general surgical procedures, but could be of major concern for the anesthesiologist in patients, especially with intra-cerebral space occupying lesions, where a sudden hypertension during or in immediate post-extubation phase could lead to raised cerebral blood flow (CBF), intracranial pressure (ICP), and decreased cerebral perfusion pressure resulting into increased intracranial bleeding, high morbidity, and mortality.[3,4] Up to 76–96% incidence of post-extubation bucking and coughing has been reported in the literature.[2,5,6]

Systemic and cerebral hemodynamic changes caused by extubation and emergence from anesthesia may endanger neurosurgical patients and increase the risk of post-operative intracranial hemorrhage and cerebral edema and may even result in the requirement of reoperation.[7]

Endotracheal intubation induces more intense hemodynamic effects and physical stress than those caused by the use of a laryngeal mask airway (LMA). During emergence from anesthesia and extubation, these differences are even more intense that can lead to increases in CBF, ICP, and regional brain oxygen saturation (rSO_2).[8]

Awake extubation of an endotracheal tube (ETT) is associated with complications such as bucking, coughing, bronchospasm, hypertension, tachycardia, myocardial ischemia, arrhythmias, and increased intracranialpressure.[9] Deep extubation of ETT leads to upper airway obstruction and hypoventilation. Replacing the ETT with a LMA when the patient is deep and performing an awake extubation of the LMA was shown to decrease the above described respiratory and hemodynamic complications.[10]

The exchange of an ETT for laryngeal mask air way at the end of a long surgical procedure provides an excellent airway during emergence from anesthesia. Paul Bailey, Consultant anesthetist at the Royal National Throat, Nose, and Ear Hospital in London, first recognized and described this exchange.[9,11] The LMA, when properly inserted, provides a clear airway without desaturation, coughing, bucking or staining and with a minimal cardiovascular response that facilities a smooth return to consciousness.[12,13]

The study was planned to find a novel method to achieve a smooth extubation in neurosurgery and compare the respiratory and hemodynamic responses and associated complications following conventional awake extubation of a ETT and that following exchange extubation of ETT using a LMA in neurosurgery.

Aims and objectives

Focused aims of the study

The study was designed to find a novel method to achieving a smooth extubation in neurosurgery.

Primary objectives

The objectives of this study were to compare the respiratory complications and hemodynamic stress response between conventional awake extubation of an ETT and that following exchange extubation of ETT using a LMA in neurosurgeries.

Secondary objectives

The objectives of this study were to reduce the chance of sympathetic stimulation such as tachycardia and hypertension and respiratory complication such as bucking, coughing, and desaturation, which lead to complication after neurosurgery such as an intracranial hematoma and major cerebral edema.

MATERIALS AND METHODS

After obtaining approval of the Institutional Ethics Committee, the study was carried out in the neurosurgery operation theater by the Department of Anesthesiology, in a Medical College and Hospital of central India.

Sixty patients of ASA physical status I and II between ages 18–60 years undergoing craniotomy surgery who were satisfying and fulfill the inclusion criteria were included in this study. Those patients who had difficult intubation or aspiration risk, Glasgow coma score <8, ASA physical status III, IV, and V, signs of raised ICP, significant midline shift (>5 cm), history of congestive heart failure, diabetes mellitus, hypertension, acute respiratory distress syndrome, chronic obstructive pulmonary disease, psychiatric illness, bleeding disorder, hepatic or renal dysfunction, and patients who may need elective mechanical ventilation postoperatively were excluded from the study.

A written informed consent was taken from all the selected patients.

A detailed history of patient was taken. General and physical examination, routine investigations, and any special if needed were done.

Sample size calculation

$n=z^2pq/d^2$ formula was used to estimate the adequate required sample size, where n=sample size, z=1.96 (considering 0.05 alpha, 95% confidence limits and 80% beta), p=Assumed probability of occurrence or concordance of results, q=1 – p, and d=marginal error (precession).

To calculate the adequate required sample size, we had taken assumptions that 50% difference of indicators variables between the treatment groups and 20% absolute precession could be targeted. This accumulates 24.01 using above mentioned formula. Therefore, minimum 25 patients in each treatment groups will be adequate numbers. The selected 60 patients were randomly allocated into two groups using computer generated random table.

1. Group A: Conventional awake extubation group (n=30)
2. Group L: ETT/LMA exchange extubation group (n=30).

Patients in the either group were induced and maintained under anesthesia using isoflurane (EtIso 0.5–0.6%) in oxygen and nitrous oxide. Relaxation was achieved using intermittent boluses of vecuronium. The observational period of the study was initiated at the end of surgery (EOS) with the two subsets of patient through different method of emergence. In Group A, at the end of the surgical procedure, isoflurane and nitrous oxide were discontinued and effect of vecuronium was reversed. If the patients were able to resume spontaneous respiration with generating tidal volume of >4 ml/kg and $EtCO_2$ <45 mmHg and were responding to verbal commands, extubation was performed.

In Group L, the oropharynx was suctioned under direct vision. Before extubation, a LMA was placed behind the tracheal tube, while the lungs were ventilated with the maintenance mixture, and end-tidal isoflurane concentration was maintained at 0.6–1.2%. The tracheal tube was removed, and muscle relaxation was reversed allowing the patient to breathe spontaneously through the LMA. When adequate spontaneous respiration generating tidal volume of >4 ml/kg, $EtCO_2$ <45 mmHg and was responding to verbal commands, fully awake, at that point LMA was removed.

The occurrence of straining, bucking, coughing, LMA repositioning, desaturation to SpO_2 <95%, chin lift, jaw thrust, and need for bag and mask ventilation were recorded in both the study groups. The heart rate (HR), systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded at the following times baseline – before induction, EOS just after exchange, just after extubation (E0), 5 min after extubation (E5), 10 min after extubation (E10), and 15 min after extubation (E15).

Statistical analysis

The data of the present study were recorded into the computers and after its proper validation, check for error, coding, and decoding was compiled and analyzed with the help of SPSS 20 software for windows. Appropriate univariate and bivariate analysis and ANOVA for comparing more than two means were carried out and the use of Student's t-test and χ^2 test for categorical data was applied to check the hypothesis according to the type of data, that is, continuous and categorical. The Glasgow coma scale scores in two groups were analyzed using a non-parametric test, namely, Mann–Whitney U-tests. All means were expressed as mean±standard deviation and the proportion as in percentage (%). The critical value for the significance of the results was considered at 0.05 levels.

RESULTS

Demographic data

The age, weight, and duration of surgery were comparable in both groups (Table 1).

Mean pre-operative vitals

There was no statistically significant difference between the two groups (P>0.05) (Graph 1).

Respiratory parameters

In Group A, 86.67% of the patients had shown significant event of bucking as compared to 10% in Group L (P<0.0001); similarly, coughing was shown in 93.33% and 23.33% of Group A and L, respectively (P<0.0001).

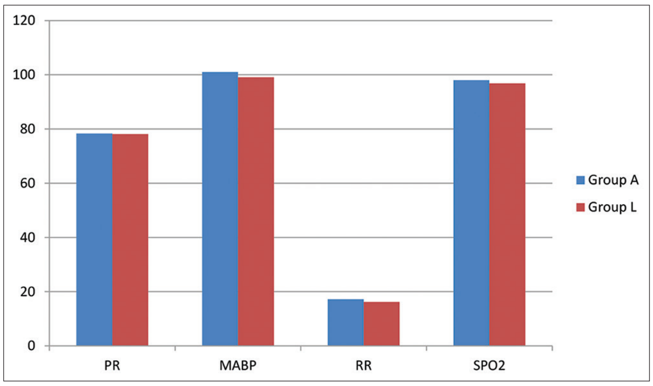
There was no statistically significant difference regarding desaturation event (10% in Group A vs. 6.67% in Group L) between the two groups (P>0.64).

Chin lift had to perform in 66.67% patients of Group A compared to only 3.33% patients in Group L (P<0.0001).

Table 1: Demographic data

Variables	Group A (mean±SD)	Group L (mean±SD)	P-value
Age (years)	42.83±10.33	37.60±11.10	0.075 (NS)
Weight (Kg)	64.43±6.36	65.87±5.26	0.350 (NS)

NS: Not significant (P>0.05)



Graph 1: Comparison of pre-operative vitals between the two groups

In Group A, 21.67% patients have shown significant event of jaw thrust as compared to only 3.33% patients in Group L. (P=0.0008) (Table 2).

Hemodynamic parameters

The HR and mean blood pressure (MBP) in both Groups A and B at the EOS were nearly identical (P>0.05).

Just after extubation (E0), 97.33% patients shown significant rise (>20% rise from base line) in HR in Group A as compared to 30% in Group L (P=0.001).

Similarly, MBP just after extubation was found to be significantly higher in Group A with 63.33% patients as compared to only 13.33% in Group L (P=0.0002).

Hemodynamic changes became insignificant 10 and 15 min after extubation (P>0.05) (Tables 3 and 4).

DISCUSSION

The respiratory complications and hemodynamic responses associated with extubation are often overlooked during the conduct of general anesthesia.[5-7] The neurosurgical patients are subset of patients, in which extubation and emergence from anesthesia are met with hemodynamic perturbation which, in turn, may lead to disastrous complication such as risk of post-operative intracranial hemorrhage and cerebral edema and may even result in the requirement of reoperation.[8] Rapid emergence lead to phenomenon of emergence hypertension and this may lead to formation of intracranial hematoma, cerebral edema, and post-operative delirium.[5-8] In the face of a poorly auto regulating cerebral vasculature, hypertension also has the potential, through vascular engorgement, to contribute to an increase in ICP. Much of the concern with coughing and straining has a similar basis. The sudden increases in intra-thoracic pressure producing transient increases in both cerebral arterial and venous pressure, with the same potential consequences: Edema formation, bleeding, and elevation of ICP. Thus smooth emergence is essential in neurosurgeries.

Table 2: Differences in respiratory parameters

Parameters	Group A (%)	Group L (%)	χ^2 Analysis	P-value
Bucking	86.67	10	32.303	<0.0001 (SS)
Coughing	93.33	23.33	27.429	<0.0001 (SS)
Desaturation	10	6.67	0.2182	0.6404 (SS)
Chin lift	66.67	3.33	23.736	<0.0001 (SS)
Jaw thrust	21.67	3.33	11.273	0.0008 (SS)

SS: Statistically significant (P<0.05)

Table 3: Differences in hemodynamic parameters (rise in heart rate>20% from the baseline)

Time	Group A n (%)	Group L n (%)	χ^2 analysis	P-value
At the EOS	2 (6.67)	1 (3.33)	0.3509	0.5536 (NS)
Just after extubation (E0)	22 (97.33)	9 (30)	9.610	0.001 (SS)
5 min after surgery (E5)	24 (80)	3 (10)	8.208	0.0042 (SS)
10 min after surgery (E10)	14 (46.67)	6 (20)	3.675	0.0552 (NS)
15 min after surgery (E15)	0 (0)	2 (6.67)	0.517	0.47 (NS)

SS: Statistically significant (P<0.05), NS: Not significant (P>0.05), EOS: End of surgery

Two controversial thoughts exist for emergence and extubation of a neurosurgical patient.One is wake-up from anesthesia, although the presence of an ET tube in the trachea and the larynx presents an intense stimulus to the patient and invariably causes a cough as well as a gag reflex. In fact, coughing and gagging with the ET tube *in situ* are reassuring signs that a patient is "ready" for extubation, but in case of neurosurgeries, it may lead to disastrous complication such as formation of intracranial hematoma. Another is "deep" extubation; the ET tube is removed before wake-up, before the return of upper airway reflexes. However, it has theoretical risk of losing the airway, before the patient is fully conscious and requires airway manipulations.

The present study was planned to evaluate and compare the respiratory complications and hemodynamic stress response between conventional awake extubation of an ETT and that following exchange extubation of ETT using a LMA in neurosurgeries.

The demographic profile and mean pre-operative vitals were comparable in both the study groups.

In Group A, 86.67% of the patients had shown significant event of bucking as compared to 10% in Group L (P<0.0001); similarly, coughing was shown in 93.33% and 23.33% of Group A and L, respectively (P<0.0001). There was no statistically significant difference regarding

Table 4: Differences in hemodynamic parameters (Rise in mean arterial pressure>20% from the baseline)

Time	Group A n (%)	Group L n (%)	χ^2 Analysis	P-value
At the EOS	6 (20)	3 (10)	0.5229	0.4696 (NS)
Just after extubation (E0)	19 (63.33)	4 (13.33)	13.81	0.0002 (SS)
5 min after surgery (E5)	8 (26.67)	1 (3.33)	4.706	0.0301 (SS)
10 min after surgery (E10)	7 (23.33)	2 (6.67)	2.092	0.1481 (NS)
15 min after surgery (E15)	8 (2.67)	2 (6.67)	3.000	0.0833 (NS)

SS: Statistically significant (P<0.05), NS: Not significant (P>0.05), EOS: End of surgery

desaturation event (10% in Group A vs. 6.67% in Group L) between the two groups (P>0.64).

Chin lift had to perform in 66.67% patients of Group A compared to only 3.33% patients in Group L (P<0.0001). In Group A, 21.67% patients have shown significant event of jaw thrust as compared to only 3.33% patients in Group L (P=0.0008).

The HR and MBP in both Group A and B at the EOS were nearly identical (P>0.05). Just after extubation (E0), 97.33% patients shown significant rise (>20% rise from base line) in HR in Group A as compared to 30% in Group L (P=0.001). Similarly, MBP just after extubation was found to be significantly higher in Group A with 63.33% patients as compared to only 13.33% in Group L (P=0.0002). Hemodynamic changes became insignificant 10 and 15 min after extubation (P>0.05).

Nair and Bailey[11] had suggested that the use of the laryngeal mask after tracheal extubation may minimize the stress response while providing a patent airway during emergence from anesthesia.

Asai et al., and Dob et al.,[14,15] improvised on this method by inserting the LMA behind the ETT and then removing the ETT, thereby avoiding the loss of airway.

Study conducted by Perelló-Cerdà et al.,[16] had been concluded that replacing the ETT with the LMA before neurosurgical patients emerge from anesthesia results in a more favorable hemodynamic profile, less cerebral hyperemia, and a lower incidence of cough.

Ma et al.,[17] concluded in their study that exchange of tracheal tube for LMA under deep anesthesia during recovery stage can decrease the stress response and attenuate the harmful response of airway. It was suitable for elderly patients with hypertension.

Sheta et al.,[18] showed that awake "no touch" technique for tracheal extubation produces less airway related complications during emergence from general anesthesia.

Popat et al.,[10] concluded that the emergence profile of LMA/ETT exchange was superior to either awake or deep extubation and was useful in cases, where there was a risk of disruption of surgical repair due to the cardiovascular stimulation resulting from the presence of a tracheal tube.

Osborn and Aljohani[19] concluded that SGA devices can be a useful airway alternative for neurosurgical patients, which provided that there is appropriate patient selection and careful management.

Anam et al.,[20] also concluded that LMA supreme exchange extubation is a suitable and safe alternative to cuffed ETT for airway management in elective controlled hypertensive patients undergoing surgery under general anesthesia.

The studies conducted by Suppiah et al.,[21] and Kathor et al.,[22] were observed similar finding as present study.

Limitations of the study

The limitations of the study include a small sample size and a single centric study. Furthermore, we did not compare the post extubation objective Glasgow Coma Score between the two study groups.

CONCLUSION

The present study concluded that the exchange of ETT with LMA in deeper plane of anesthesia significantly reduces emergence related the hemodynamic and respiratory unwonted event. Comparing the two different procedures for emergence, it seems reasonable to infer that ETT/LMA exchange is the most effective technique for achieving the clinical endpoints of the study, that is, prevention of emergence hypertension and respiratory complication.

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Authors’ Contributions:
AV- Concept and prepared first draft of manuscript; **KSB**- Design of the study; **PN**- Reviewed the literature; **ST**- Concept, coordination, interpreted the results, preparation of manuscript and revision of the manuscript.

Work attributed to:
NSCB Medical College, Jabalpur, Madhya Pradesh, India.

ORCID ID:
Dr. Kamalraj Singh Baghel - https://orcid.org/0000-0002-4404-1256
Dr. Pawan Nandurkar - https://orcid.org/0000-0002-3255-6682
Dr. Sonali Tripathi - https://orcid.org/0000-0003-1575-3956

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