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ARTIGO ORIGINAL

Comparison of Laryngeal Mask Airway versus Endotracheal Intubation in General Anaesthesia for Endovascular Neurosurgery: A Prospective, Randomized Controlled Trial

Comparação da Máscara Laríngea versus Intubação Endotraqueal em Anestesia Geral para Neurocirurgia Endovascular: Um Estudo Prospetivo, Randomizado e Controlado

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Afiliação
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Keywords
Intracranial Aneurysm/surgery; Intubation, Intratracheal; Laryngeal Masks
Palavras-chave
Aneurisma Intracraniano/cirurgia; Intubação Intratraqueal; Máscaras Laríngeas

ABSTRACT

Introduction: Endovascular treatment of intracerebral aneurysms/arteriovenous malformations requires the neuro-anaesthesiologist to control and manipulate the haemodynamic parameters with minimum fluctuations. The aim of this study was to compare the performance of endotracheal intubation versus Laryngeal Mask Airway (LMA) ProSeal with respect to hemodynamic stability and adverse respiratory events in such procedures.

Methods: Ninety patients, with a pre-procedure Hunt and Hess Scale ≤ 2 and Glasgow Coma Scale (GCS) ≥ 13, scheduled for digital subtraction angiography (DSA) guided coiling of intracerebral aneurysms/AV malformations were randomly divided into two demographically comparable groups, namely endotracheal intubation (Group T) and ProSeal LMA (Group L). Heart rate (HR), systolic and diastolic blood pressure (SBP, DBP), mean arterial pressure (MAP) and oxygen saturation (SpO_2) were noted at baseline and compared at 1min, 3min, 5min and 10min after intubation and extubation. Respiratory adverse events if any, were recorded.

Results: With baseline vitals being comparable, a significant difference was seen post intubation in the HR at 1 min (*p*-0.0355) and 3min (*p*-0.0217), SBP at 1min (*p*-0.0164) and 3 min (*p*-0.0008) and MAP at 1min (*p*-0.0001), 3min (*p*-0.0024) and 5min (p-0.0031) after intubation, with Group T showing higher values. Post extubation, the rise in HR and MAP was higher in Group T (*p*-0.0110 and 0.0190 respectively). Respiratory adverse were higher in Group T.

Discussion and Conclusion: ProSeal LMA is an effective alternative in endovascular neurosurgery, providing stable perioperative haemodynamics and fewer respiratory adverse events. In cases where long term ventilation might be anticipated endotracheal intubation may be chosen.

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RESUMO

Introdução: O tratamento endovascular dos aneurismas/malformações arteriovenosas intracerebrais exige que o neuroanestesiologista controle e manipule os parâmetros hemodinâmicos com flutuações mínimas. O objetivo deste estudo foi comparar o desempenho da intubação endotraqueal versus máscara laríngea ProSeal (LMA) no que diz respeito à estabilidade hemodinâmica e aos eventos respiratórios adversos em tais procedimentos.

Métodos: Noventa doentes, com Escala de Hunt e Hess pré-procedimento ≤ 2 e Escala de Coma de Glasgow (ECG) ≥ 13, agendados para angiografia por subtração digital (DSA) guiada por enrolamento de aneurismas intracerebrais/malformações AV foram divididos aleatoriamente em dois grupos demograficamente grupos comparáveis, nomeadamente intubação endotraqueal (Grupo T) e LMA ProSeal (Grupo L). A frequência cardíaca (FC), a pressão arterial sistólica e diastólica (PAS, PAD), a pressão arterial média (PAM) e a saturação de oxigénio (SpO_2) foram anotadas no início do estudo e comparadas aos 1min, 3min, 5min e 10min após a intubação e extubação. Eventos adversos respiratórios, se houver, foram registados.

Resultados: Sendo os sinais vitais basais comparáveis, observou-se uma diferença significativa pós-intubação na FC aos 1 min (p-0,0355) e 3min (p-0,0217), PAS aos 1min (p-0,0164) e 3 min (p-0,0008) e PAM 1min (p–0,0001), 3min (p-0,0024) e 5min (p-0,0031) após a intubação, tendo o Grupo T apresentado valores mais elevados . Após a extubação, o aumento da FC e da PAM foi maior no Grupo T (p-0,0110 e 0,0190 respetivamente). Os efeitos adversos respiratórios foram superiores no Grupo T.

Discussão e Conclusão: A máscara laríngea ProSeal é uma alternativa eficaz em neurocirurgia endovascular, proporcionando uma hemodinâmica perioperatória estável e menos eventos adversos respiratórios. Nos casos em que se possa prever ventilação a longo prazo, pode ser escolhida a intubação endotraqueal.

INTRODUCTION

Intracerebral aneurysms and arteriovenous malformations (AVM) are leading causes of neurological deficits. Minimally invasive endovascular treatment (EVT) of such conditions, involves digital subtraction angiography (DSA), using liquid embolic agents for AVM and controlled detachable coils for aneurysms.[1–4] The rupture of an aneurysm portends an inferior outcome with a mortality rate of up to 75%.[5–7]

Hence, the main goal of an anesthesiologist would be to provide stable hemodynamics throughout the procedure and complete immobility, for which general anesthesia (GA) is the preferred modality.[6–8] Supraglottic airway devices (SGAD), with their notable advantages of reduced hemodynamic fluctuations, have not replaced endotracheal intubation in many centers and there is a paucity of literature comparing the two methods in this clinical setting.[8–11]

We aimed to compare endotracheal intubation with laryngeal mask airway (LMA) ProsealTM, a second-generation SGAD in such patients primarily concerning hemodynamic fluctuations and secondarily for respiratory complications and neurological status.

METHODOLOGY

This was a prospective randomized controlled trial, comparing two specific interventions related to airway management, namely - endotracheal intubation and LMA ProSeal. It was carried out in a tertiary care center after obtaining approval from the Institutional Ethics Committee over a span of eight months. The trial was registered under the Clinical Trials Registry of India (CTRI/2023/05/053289) before patient enrolment. As per the findings of a previously conducted study,[11] the minimum required sample size with 80% power of study and 5% level of significance was 41 patients in each study group. To reduce the margin of error, total sample size taken was 90 (45 patients per group). Block Randomization with Sealed envelope system was done to divide the patients in the two groups, Group T- Endotracheal intubation and Group P- LMA ProSealTM (Teleflex Medical Europe Ltd.).[12] Both the patient and the data analyst were blinded to the device use to secure the airway. The anaesthesiologist who performed airway management and was also the outcome assessor was not blinded. 90 adult patients (18-60 years) of either gender posted for endovascular treatment of intracranial aneurysms or AV malformations, falling under American Society of Anaesthesiologists (ASA) class I, II, or III with a preoperative Hunt and Hess Grade[13] of 1 or 2 were enrolled in the study. Those patients with an anticipated difficult airway, preoperatively intubated patients, having an allergy to any anesthetic agent (Inj. propofol or Inj. lignocaine), pregnant females, any other severe uncontrolled systemic illness or any intraoperative procedural complication were excluded (Fig. 1- CONSORT Flowchart).

A thorough pre-anesthetic evaluation was carried out and because of the nature of the procedure, and written and informed high-risk consent was taken in each case. The patients were kept adequately fasted for 8 hours before the procedure. In the operation theatre, standard monitoring with electrocardiography (ECG), oxygen saturation (SpO_2), non-invasive blood pressure (NIBP), and end-tidal carbon dioxide ($EtCO_2$) were placed and all baseline parameters were noted. An 18-gauge intravenous cannula was secured and the radial artery was cannulated under local anesthesia for beat-to-beat monitoring of blood pressure changes. A baseline activated clotting time (ACT) was measured. Anesthesia was induced with inj. fentanyl 2 µg/kg, inj. propofol 2 mg/kg and muscle relaxation were achieved with inj. vecuronium 0.1 mg/kg. Endotracheal intubation was done by placing the patient's head in the "sniffing the morning air" position. The size of the LMA ProSeal was chosen based on the weight of the patient. It was grasped and inserted by an introducer tool technique, and after insertion, its cuff was inflated with the maximum permissible volume of air as recommended by the manufacturer, with a target tidal volume of 8 mL/kg. Bilateral equal air entry was confirmed on auscultation along with a square wave capnogram and the intracuff pressure of the LMA was measured. In case of manipulation or re-insertion of LMA, a second attempt was allowed, failing which the patient was intubated using an endotracheal tube and the case was excluded from the study. Endotracheal intubation was done in the sniffing position using a direct laryngoscope with a MacIntosh blade and endotracheal tubes of appropriate sizes. Any patient with an unanticipated difficult intubation was excluded from the trial. Anaesthesia was maintained with a 50% mixture of oxygen and nitrous oxide along with Isoflurane to achieve a minimum alveolar concentration of one and intermittent doses of inj. vecuronium 0.025 mg/kg. Inj. xylocard 2% 1 mg/kg or inj. esmolol 0.5 mg/kg was used to control a rise in BP of >20% baseline.

The heart rate (HR), systolic and diastolic blood pressure (SBP and DBP), mean arterial blood pressure (MAP), SpO_2 at baseline, post-intubation (at 1, 3, 5 and 10 minutes), and post-extubation at 1, 3, 5 and 10 minutes were noted.

Intraoperatively a MAP of 50-60 mmHg was maintained. Inj. heparin 3000 IU was given after femoral arterial puncture and while placing the arterial sheath along with hourly boluses of 1000 IU along with continuous flushing of the sheath with heparinized saline 1IU/ml. The ACT was maintained between 200-250 seconds and the subsequent heparin boluses were guided accordingly. The patient was catheterized to monitor the urine output and normothermia was maintained using an in-line fluid warmer.

At the end of the procedure, the inhalational agent was turned off, and the residual neuromuscular block was reversed using inj. neostigmine 50 µg/kg and inj. glycopyrrolate 10

μg/kg. The time to extubation and neurological assessment was noted in both groups. Adverse respiratory events like laryngospasm, bronchospasm, desaturation, sore throat, or need to reposition the device were noted post-intubation and extubation.

Statistical analysis

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by the Kolmogorov-Smirnov test. If the normality was rejected then non-parametric test was used.

Statistical tests were applied as follows

1. Quantitative variables - compared using Unpaired t-test/ Mann-Whitney Test (when the data sets were not normally distributed) between the two groups.
2. Qualitative variable- compared using the Chi-Square test / Fisher's exact test.

A *p*-value of <0.05 was considered statistically significant.

The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

RESULTS

Each of the ninety enrolled patients completed the study. They were randomly allocated into 2 groups, Group T (endotracheal intubation) and Group L (LMA ProSealTM). Since the outcome measurements were hemodynamic changes to be noted within 10 minutes after intubation/ extubation there was no attrition or loss to follow-up in the study. The demographic profile (age, gender distribution), ASA grade, Preoperative Hunt and Hess class and Mallampati grade have been shown in Table 1. The baseline vital parameters (HR, SBP, DBP, MAP, SpO_2) were comparable in both groups (Table 2). After induction of anesthesia and muscle relaxation, bag-mask ventilation the pre-intubation vital parameters showed a fall in HR by 9.9% to 13.87%, SBP by 14.67% to 17.26%, DBP by 3.48% to 5.75%, MAP by 9.63% to 10.03%. The rise in HR was significantly higher at 1 minute (*p*-0.0355) and 3 minutes (*p*-0.0217) post-intubation and at 1 minute (0.0110) post-extubation in Group T. The SBP also showed a similar trend and rose significantly at 1 minute (*p*-0.0164) and 3 minutes (0.0008) after intubation in Group T. DBP remained comparable throughout both groups. The MAP was again much higher in Group T at 1 minute (*p*-0.0001), 3 minutes (*p*-0.0024) and 5 minutes (*p*-0.0031) after endotracheal intubation than after LMA placement, and at 1 minute (*p*-0.0190) after extubation. The *p* values of these results have been tabulated in Table 2. Figs. 1-3 shows a trend in the mean values of the HR, SBP and MAP in both groups. No significant difference was seen in the diastolic BP or saturation.

The average time to extubation and neurological assessment in both the groups was comparable, *p*-0.451 and *p*-0.176 respectively.

Sixteen out of 45 patients in group T experienced coughing and sore throat after extubation and one patient experienced bronchospasm, which was relieved with nebulization with appropriate bronchodilators. This was significantly less than in group L, in which only four patients experienced coughing and the two patients needed repositioning of the device. The average duration of surgery was also comparable in both groups. These results have been tabulated in Table 3.

DISCUSSION

The introduction of supraglottic airway devices has revolutionized airway management due their notable advantages like ease of insertion, avoidable neuromuscular blockade, lesser incidence of respiratory adverse events and reduced stress response than seen with endotracheal intubation. Second generation SGADs having higher airway sealing pressures and separate gastric and airway channels provide higher safety with more effective positive pressure ventilation. These devices have now replaced routine endotracheal tubes in a variety of elective surgeries, along with their use in emergency prehospital trauma care and as an integral part of all difficult airway carts.

Goals of anesthetic management for endovascular neurosurgery include maintaining hemodynamic stability, avoidance of surges in arterial pressures, maintaining adequate cerebral perfusion, and anticoagulation along with immobilization of the patient and a quick, smooth recovery for allowing post-operative neurological evaluation.

Any sudden surge in the mean arterial pressure or fall in the intracranial pressure will result in a rise in the transmural gradient,[14] thus increasing the risk of aneurysmal bleeding (incidence-1.4%).[15] Again, very low perfusion pressure might result in cerebral ischemia. The use of LMA ProSealTM is still limited in neurosurgical procedures probably due to the risk of prolonged surgery, higher chances of major blood loss, lack of immediate access to the airway and risk of post-operative mechanical ventilation. The number of prospective trials comparing the use of LMA versus endotracheal tube in endovascular neurosurgery is limited and due to this paucity of literature, we undertook this study. This was a prospective randomized controlled trial in a demographically comparable population. The authors found a statistically significant rise in the heart rate in Group T than in Group L at 1 minute and 3 minutes after intubation and at 1 minute after extubation (*p* value -0.0355, 0.0217 and 0.0110). In a retrospective observational study by Ozhan *et al*,[11] an endotracheal tube was compared to LMA for evaluating airway security, hemodynamic changes, complications and recovery times.

Table 1. Comparison of demographic parameters

Parameters	Group T	Group L	*p* Value
Age (years) Mean ±SD	43.977±13.927	46.644 ± 11.378	0.3224
Gender			
Female	18	24	0.2048
Male	27	21	
ASA Grade			
I	19	16	0.766
II	19	20	
III	7	9	
Preoperative Hunt and Hess Scale			
1	29	25	0.3894
2	16	20	
Post-operative Hunt and Hess Scale			
1	33	29	0.362
2	12	16	
Mallampati Grade			
1	20	21	0.832
2	25	24	

Table 2. Comparison of vital parameters in between two groups at baseline and different time points

Parameters		Group T (Mean ± SD)	Group L (Mean ± SD)	*p* Value
Heart Rate (bpm)	**Post-intubation 1 min**	**97.28 ± 18.74**	**90.22 ± 11.39**	**0.0355**
	Post-intubation 3 min	**94.91 ± 18.74**	**87.31 ± 11.17**	**0.0217**
	Post-intubation 5 min	86.13 ± 15.99	86.6 ± 15.81	0.8896
	Post-intubation 10 min	84.33 ± 20.18	79.97 ± 17.65	0.2789
	Post-extubation 1 min	**108.4 ± 21.94**	**96.44 ± 21.76**	**0.0110**
	Post-extubation 3 min	100.82 ± 19.46	102.4 ± 15.28	0.6700
	Post-extubation 5 min	91.311 ± 16.78	91.44 ± 8.05	0.9630
	Post-extubation 10 min	86.24 ± 15.29	86.4 ± 6.61	0.9488
Systolic Blood pressure (mmHg)	**Post-intubation 1 min**	132.6 ± 23.19	123.06 ± 12.08	0.0164
	Post-intubation 3 min	129.37 ± 20.81	117.53 ± 9.41	0.0008
	Post-intubation 5 min	117.088 ± 9.49	117.5333 ± 9.418	0.7564
	Post-intubation 10 min	113.77 ± 8.58	110.2444 ± 8.929	0.594
	Post-extubation 1 min	139 ± 13.52	134 ± 19.24	0.1575
	Post-extubation 3 min	135.9556 ± 13.235	132.488 ± 15.087	0.2502
	Post-extubation 5 min	127.5333 ± 11.46	125.8 ± 12.64	0.4974
	Post-extubation 10 min	126.5778 ± 11.244	131.3556 ± 16.26647	0.1086
Systolic Blood pressure (mmHg)	**Post-intubation 1 min**	**99.33 ± 16.60**	**93.84 ± 6.94**	**0.0001**
	Post-intubation 3 min	**97.377 ± 11.34**	**91.133 ± 7.138**	**0.0024**
	Post-intubation 5 min	**91.51 ± 7.02**	**87 ± 7.06**	**0.0031**
	Post-intubation 10 min	89.800 ± 6.28	87.911 ± 8.98	0.2507
	Post-extubation 1 min	**105.4222 ± 10.712**	**99 ± 14.50235**	**0.0190**
	Post-extubation 3 min	105.0667 ± 8.33503	108.8889 ± 17.81243	0.1957
	Post-extubation 5 min	98.222 ± 8.72	99.644 ± 7.96	0.4213
	Post-extubation 10 min	97.8 ± 8.66	99.377 ± 11.29	0.4592

Table 3. Comparison of duration of surgery, time to extubation, time to neurological assessment and adverse respiratory events

Parameters	Group T	Group L	*p* Value
Duration of surgery (min) Mean ± SD	85.355 ± 15.309	81.755 ± 15.87	0.2764
Time to extubation (min) Mean ± SD	10.111± 1.861	10.377 ± 1.449	0.451
Time to neurological assessment (min) Mean ± SD	11.911 ± 1.893	11.422 ± 1.483	0.176

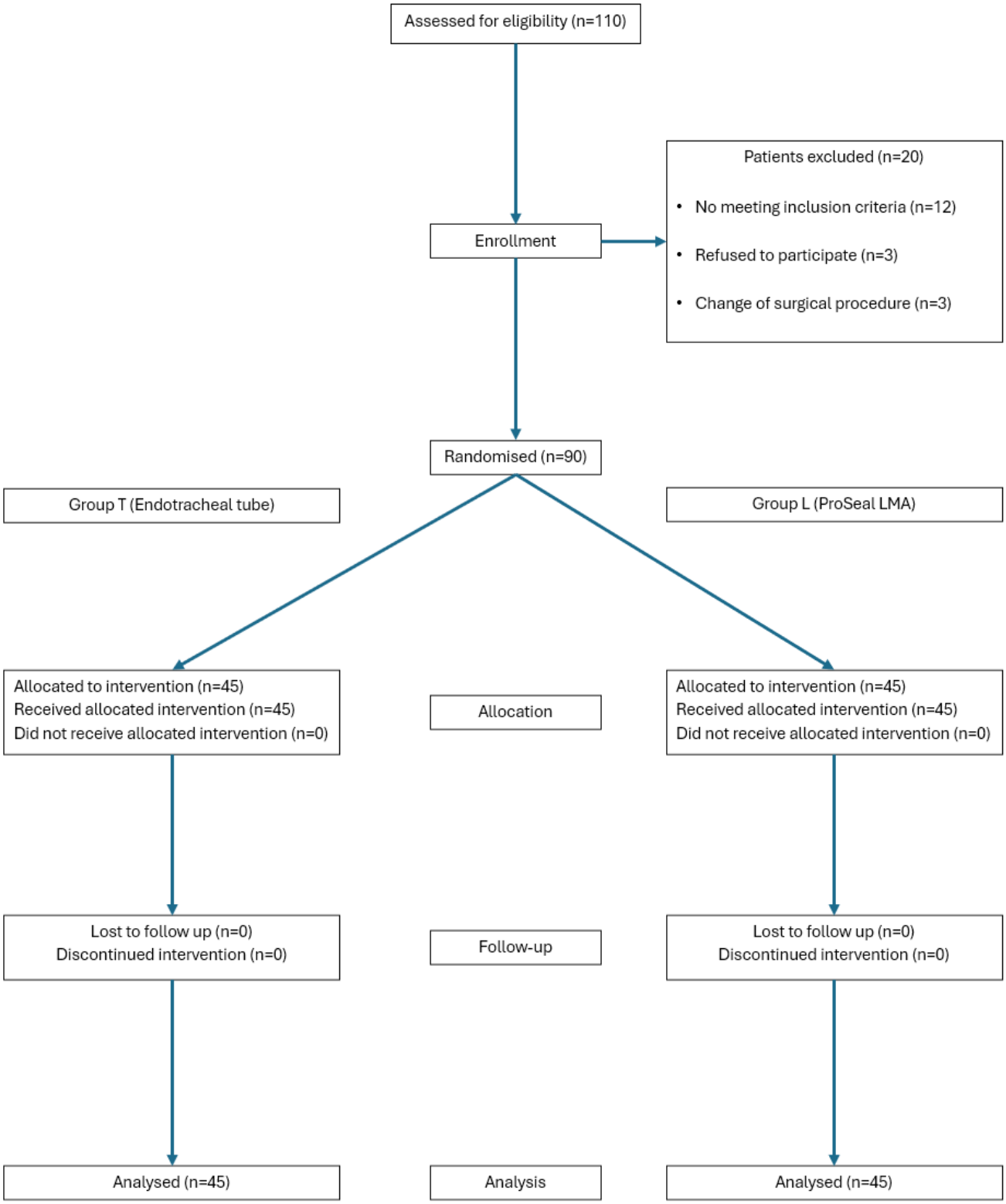

Figure 1. CONSORT Flowchart
(CONSORT - Consolidated Standard of Reporting Trials , n - Number of patients, Group T - Endotracheal tube, Group P - ProSeal LMA)

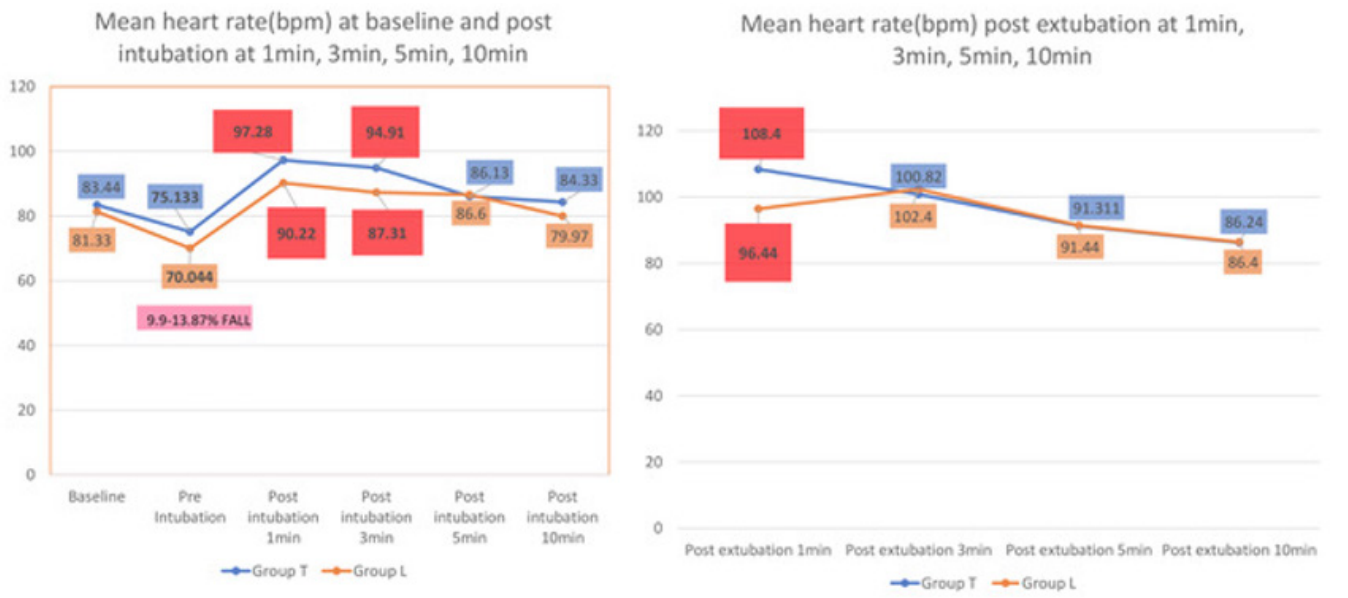

Figure 2. Mean heart rate (bpm) at baseline and post intubation and post extubation

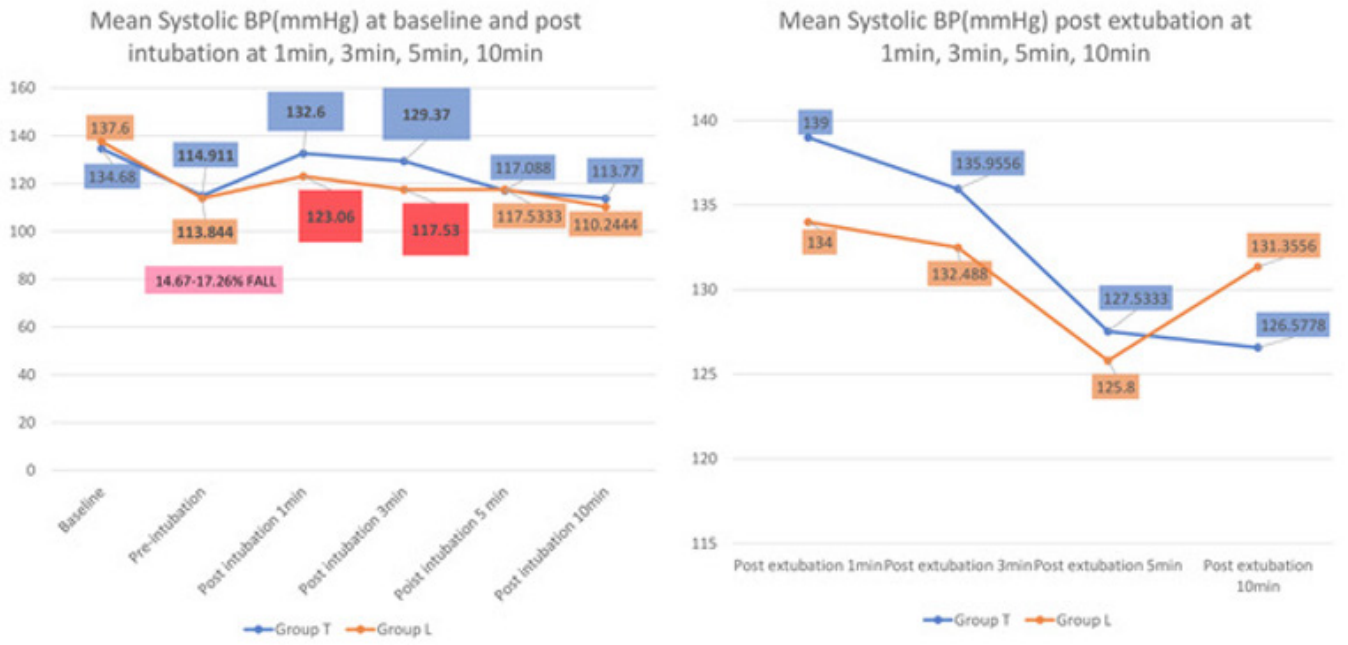

Figure 3. Mean Systolic BP (mmHg) at baseline and post intubation and post extubation

Post-intubation, they found significantly higher values in HR (17.4% *vs* 7.1%) and MAP (30.4% vs 0%) in patients with endotracheal intubation. Suzer et al11 also conducted a retrospective observational study and found significantly higher HR post-intubation (70.7% patients with tracheal tube versus 23.1% patients with LMA) and extubation (65.9% with tracheal tube versus 7.7% patients with LMA). Concerning MAP, in their study, the group with a tracheal tube showed MAP>20% in 56.1% of patients post-intubation and 26.8% of patients post-extubation as compared to the LMA group (15.4%-post-intubation and 5.1%-post-extubation). Karwacki *et al,*[8] used LMA in 26 patients undergoing endovascular treatment of intracranial aneurysms and noted the vital parameters at different time points throughout the procedure and found no significant hemodynamic changes after insertion/removal of LMA. Tan *et al,*[9] concluded that LMA and propofol provided stable hemodynamics in patients undergoing endovascular coil embolization. In contrast to aneurysmal clipping, endovascular coiling of aneurysms involves lesser blood loss and is much less painful. Also, the position of the patient remains supine and hence, securing the airway with an ETT is not a must. The procedure lasted throughout 45-119 minutes with an average of approximately 81-85 minutes. Gast *et al,*[16] reported a mean duration of 57.3 minutes and in a study of over 600 patients, they concluded that the procedure could mostly be done in 1-2 hours. The safe use of second-generation LMAs has been advocated for this duration in previous studies.[17,18] Neurological recovery

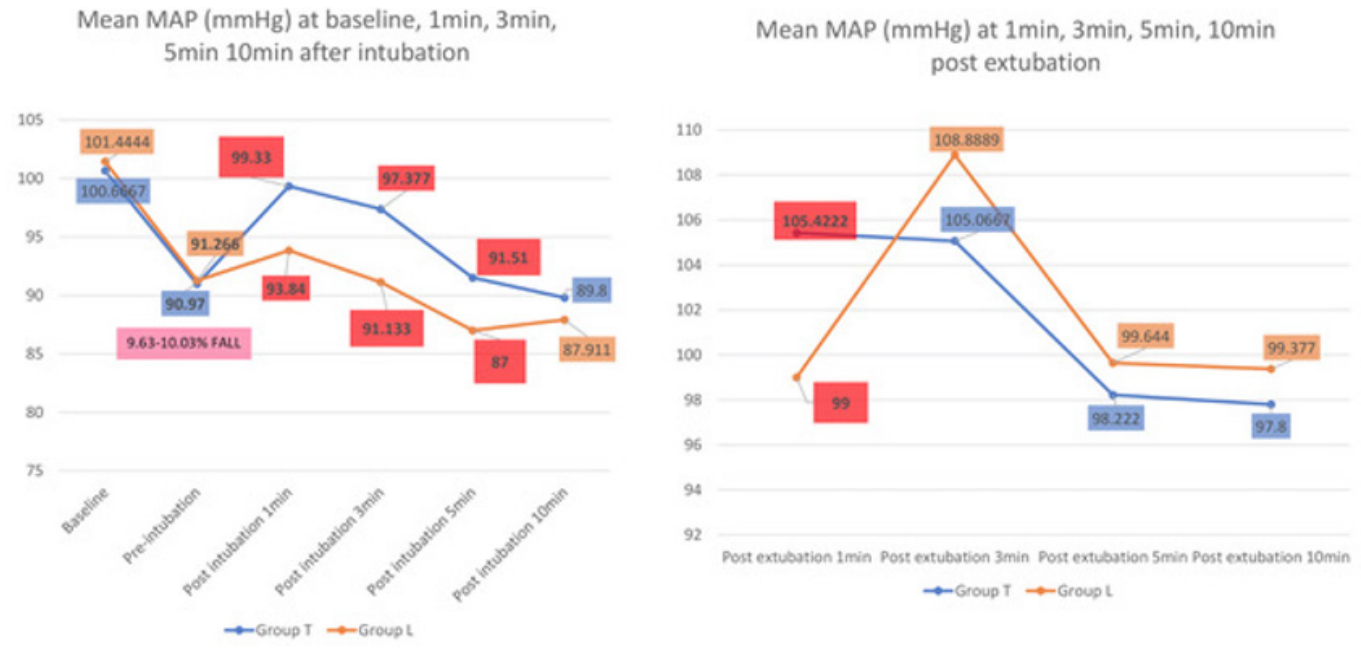

Figure 4. Mean MAP (mmHg) at baseline and after intubation and post extubation

is the most crucial aim of this procedure, for which rapid neurological assessment is a must. The use of short-acting anesthetic agents allows for a faster recovery and assessment. The time to extubation and neurological assessment was similar in both the groups in our study and was also comparable to that of Ozhan *et al*,[10] although they used a total intravenous anesthetic technique. With respect to the post-operative adverse respiratory events, the performance of LMA ProSealTM was much superior than endotracheal intubation with a significantly lesser number of patients experiencing post-operative sore throat. This is a well-known advantage of supraglottic airway devices.[19] The findings are also consistent with those reported by Hurtado *et al*,[20] and Ozhan *et al*.[10] The strength of this study is that it is a prospective randomized trial on this subject and at the time of CTRI registration, no other such trial was available to the best knowledge of the authors. One limitation of the study was the lack of monitoring of anesthetic depth, which would have helped in the earlier identification of cerebral ischemia/intracerebral hemorrhage. Also, this was a single-center study with a limited sample size. Patients of pediatric age group and those above 60 years were not included. Only a single supraglottic airway device, the LMA ProSealTM was used in the study. A myriad of SGADs, including intubating LMAs which can be used in cases with difficult airways are now available. Further multicentric trials with a larger sample size are needed to evaluate the true usefulness of these devices in these procedures.

CONCLUSIONS

The reduced number of hemodynamic changes associated with the use of LMA ProSealTM may prove its usefulness as an effective device for airway management endovascular neurosurgeries. It can be an equally effective alternative to conventional endotracheal intubation as the procedure usually lasts for a duration in which an LMA ProSeal can be safely used along with the patient remaining supine throughout. There is an added advantage of lesser respiratory adverse events with LMA. For patients with preoperative poor GCS, who have a higher chance of needing post operative ventilatory support, endotracheal intubation might be a better choice.

DECLARAÇÃO DE CONTRIBUIÇÃO / *CONTRIBUTORSHIP STATEMENT*

DKK, BK: Conceção, desenho, pesquisa bibliográfica, preparação do manuscrito, edição e interpretação dos resultados.

SK, MJ: Conceção, desenho, aquisição de dados, preparação do manuscrito.

KM: Conceção, desenho, pesquisa bibliográfica, aquisição e análise de dados, análise estatística, preparação do manuscrito e edição.

SC: Conceção, desenho, edição do manuscrito e revisão crítica do manuscrito.

Todos os autores aprovaram a versão final a ser publicada.

DKK, BK: Concept, design, literature search, manuscript preparation, editing and interpretation of results.

SK, MJ: Concept, design, data acquisition, manuscript preparation.

KM: Concept, design, literature search, data acquisition and analysis, statistical analysis, manuscript preparation, and editing.

SC: Concept, design, manuscript editing and critical review of the manuscript.

All authors approved the final version to be published.

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REFERENCES

1. Plasencia AR, Santillan A. Embolization and radiosurgery for arteriovenous malformations. Surg Neurol Int. 2012;3:S90–104.
2. van Rooij WJ, Sluzewski M, Beute GN. Brain AVM Embolization with Onyx. AJNR Am J Neuroradiol. 2007;28:172–7.
3. Brilstra EH, Rinkel GJ. Treatment of ruptured intracranial aneurysms by embolization with controlled detachable coils. Neurologist. 2002;8:35.
4. Tsementzis SA, Hitchcock ER. Outcome from "rescue clipping" of ruptured intracranial aneurysms during induction anaesthesia and endotracheal intubation. J Neurol Neurosurg Psychiatry. 1985;48:160–3.
5. Beatty RA. Intraoperative aneurysms rupture during the predissection stage. J Neurol Neurosurg Psychiatry. 1990;53:711–2.
6. Batjer H, Samson D. Intraoperative aneurysmal rupture: incidence, outcome, and suggestions for surgical management. Neurosurgery. 1986;18:701–7.
7. Golshevsky J, Cormack J. Laryngeal mask airway device during coiling of unruptured cerebral aneurysms. J Clin Neurosci. 2009;16:104–5.
8. Karwacki Z, Witkowska M, Niewiadomski S, Wiatr A, Bukowski P, Wierzchowska J, et al. Anaesthetic management for endovascular treatment of unruptured intracranial aneurysms. Anaesthesiol Intensive Ther. 2013;45:145–8.
9. Tan WF, Jiang YH, Ma H, Wang JK. Sevoflurane, Laryngeal Mask Airway and Single-Dose Dexmedetomidine: A Better Choice for Patients Undergoing Endovascular Coil Embolization. J Anesth Perioper Med. 2015;2:153–7.
10. Ozhan MO, Eskin MB, Atik B, Suzer MA, Capalar CO. Laryngeal mask airway for general anesthesia in interventional neuroradiology procedures. Saudi Med J. 2019;40:463–8.
11. Süzer MA, Özhan MÖ, Çaparlar CÖ, Eşkin MB, Atik B. Airway management in general anesthesia for endovascular treatment of cerebral arteriovenous malformation: a retrospective observational study. Braz J Anesthesiol. 2022;72:359–64.
12. Teleflex® | LMA® [Internet]. 2013 [cited 2023 Nov 1]. LMA® ProSealTM Airway. Available from: https://www.lmaco.com/products/lma%C2%AE-proseal%E2%84%A2-airway
13. Hunt WE, Hess RM. Surgical Risk as Related to Time of Intervention in the Repair of Intracranial Aneurysms. J Neurosurg. 1968;28:14–20.
14. Lakhani S, Guha A, Nahser HC. Anaesthesia for endovascular management of cerebral aneurysms. Eur J Anaesthesiol. 2006;23:902–13.
15. Kawabata S, Imamura H, Adachi H, Tani S, Tokunaga S, Funatsu T, et al. Risk factors for and outcomes of intraprocedural rupture during endovascular treatment of unruptured intracranial aneurysms. J Neurointerventional Surg. 2018;10:362–6.
16. de Gast AN, Soepboer A, Sluzewski M, van Rooij WJ, Beute GN. How long does it take to coil an intracranial aneurysm? Neuroradiology. 2008;50:53–6.
17. Verghese C, Brimacombe JR. Survey of laryngeal mask airway usage in 11,910 patients: safety and efficacy for conventional and nonconventional usage. Anesth Analg. 1996;82:129–33.
18. Bernardini A, Natalini G. Risk of pulmonary aspiration with laryngeal mask airway and tracheal tube: analysis on 65 712 procedures with positive pressure ventilation. Anaesthesia. 2009;64:1289–94.
19. Rameshkumar E, Ajayakumar P. Postoperative sore throat in patients undergone head and neck surgeries under endotracheal intubation and laryngeal mask anaesthesia. Int J Otorhinolaryngol Head Neck Surg. 2017;3:371–5.
20. Hurtado P, Garcia-Orellana M, Amaro S, Carrero E, Zarco F, Lopez A, et al. Use of second generation supraglottic airway device for endovascular treatment of unruptured intracranial aneurysms: a retrospective cohort. Braz J Anesthesiol. 2021;71:408–12.