DOI: 10.7860/JCDR/2024/69743.19411

Original Article

Anaesthesia Section

Comparison of Removal of Laryngeal Mask Airway in Deeply Anaesthetised and Awake Paediatric Patients and their Associated Complications: A Randomised Clinical Study

MONICA CHHIKARA[1], DEEPIKA SEELWAL[2]

ABSTRACT

Introduction: The Laryngeal Mask Airway (LMA) is frequently used for managing paediatric airways for short surgical procedures. While it is easy to insert, it can lead to several complications if not removed at the appropriate plane of anaesthesia.

Aim: To establish better timing for the removal of the LMA in deeply anaesthetised and awake paediatric patients by comparing the complications associated with each approach.

Materials and Methods: The present randomised clinical study, enrolled 90 American Society of Anaesthesiologists (ASA) I and II paediatric patients aged 1 to 12 years, posted for elective short surgical procedures under general anaesthesia with airway management by Classical LMA. The patients were allocated into two groups: Group D (LMA removal under a deep plane/surgical plane of anaesthesia) and Group A (LMA removal in a fully awake state). At emergence from anaesthesia and during LMA removal, both groups were studied for complications including cough, desaturation (SpO_2 < 95%), excessive salivation, vomiting, and laryngospasm. Descriptive statistics were reported using mean±standard deviation or median (range) for continuous variables. Comparison of continuous variables was done using the Student's t-test or Wilcoxon rank sum test.

Results: Demographic data like age, weight, duration of surgery, heart rate, and respiratory rate were comparable in both groups. A significantly higher incidence of cough was found in group A compared to group D (p-value=0.001). The incidences of desaturation (p-value=1.000), excessive salivation (p-value=0.361), vomiting (p-value=1.000), and laryngospasm (p-value=0.142) were comparable between the two groups. Cough was the most frequent complication in group A (16 out of 45 patients), while laryngospasm was the most frequent complication in group D (8 out of 45 patients). The total number of complications (p-value=0.043) was significantly higher in group A compared to group D.

Conclusion: The removal of the Classical LMA in paediatric patients can be safely carried out in a deeply anaesthetised state. Based on the results of present study, the removal of the LMA in deeply anaesthetised paediatric patients is associated with fewer complications compared to its removal in the awake state.

Keywords: Anaesthesia, Cough, Laryngospasm

INTRODUCTION

The LMA is frequently used as an airway device in short surgical procedures under general anaesthesia in paediatric patients. The endotracheal tube is associated with an increased incidence of respiratory complications during emergence from anaesthesia in the paediatric age group compared to adults. Although the introduction of LMA is a very easy procedure, the timing of its removal is critical, as serious catastrophes at emergence from anaesthesia if removal of airway device is not accomplished properly and at the right time. Therefore, it is important to determine the accurate and safe timing of LMA removal after the completion of surgery [1].

The removal of the LMA can be accomplished either during deep anaesthesia or in a fully awake state when protective reflexes have returned [2-4]. It has been recommended by the designer that the LMA should be removed only after the patient's protective reflexes have returned, unless problems arise before this time that require active airway management [5]. However, it has been reported that removing the LMA during lighter planes of anaesthesia in children was associated with laryngospasm, coughing, and gagging. Some studies even suggest that it may be safer to remove the LMA in deeply anaesthetised rather than awake paediatric patients [6-8].

The appropriate timing of LMA removal in paediatric patients is still controversial. This warrants further investigation to find out objective evidence on whether conventional manner is safer than removing it in a deep plane of anaesthesia. The present study aimed to compare the incidence of five complications associated with LMA removal, namely laryngospasm, coughing, vomiting, excessive salivation, and oxygen desaturation in two groups of paediatric patients.

MATERIALS AND METHODS

This was a single-blinded randomised clinical trial conducted during the period of October 2011 to December 2012 at St. John's Medical College and Hospital, Bengaluru, Karnataka, India. The Institutional Ethics and Research Clinical Investigation Committee approved the study under registration number 101-27151-111-1000276. Written and informed consent was obtained from the parents or guardians of each participant.

Inclusion criteria: Ninety patients between one and twelve years of age with a normal airway, adequate neck movements, and mouth opening, admitted for elective minor urogenital, pelvic, and lower limb surgery under general anaesthesia where LMA was indicated for the maintenance of anaesthesia were included in the study.

Exclusion criteria: Patients with abnormal airways, gastroesophageal reflux, reactive airway disease, or a history of respiratory tract infection within the preceding six weeks, as well as

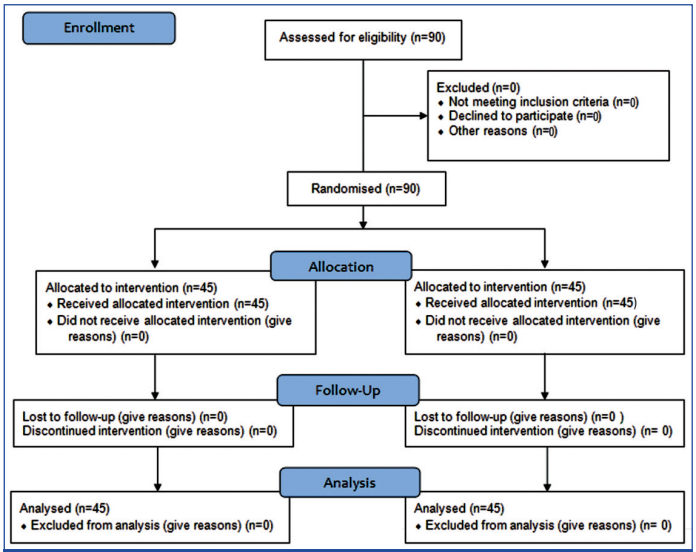
those who required more than one attempt at LMA insertion, were excluded from the study.

Sample size: The sample size was calculated using the comparison of two proportion formulas with reference to the study by Kitching AJ et al., [6]. Considering a study power of 80% and a significance level of 5%, 45 patients were required in each group.

Study Procedure

In the operating room, monitoring consisted of Electrocardiogram (ECG), non invasive blood pressure, oxygen saturation (SpO_2), and End-Tidal Carbon Dioxide ($ETCO_2$). General anaesthesia was induced with an injection of glycopyrrolate 0.01 mg/kg, ondansetron 0.1 mg/kg, fentanyl 2 µg/kg, and propofol 1-2 mg/kg. After attaining adequate jaw relaxation, Classical LMA of appropriate size (based on weight) was inserted after application of 2% lignocaine jelly with a fully deflated cuff. The number of insertion attempts was noted, and the cuff was inflated with an air volume corresponding to the size of the LMA used. Anaesthesia was maintained with oxygen, nitrous oxide, and isoflurane at a Minimum Alveolar Concentration (MAC) of 1.0 to 1.5. Assisted ventilation continued until the patient exhibited sufficient spontaneous breathing efforts. Analgesia was provided through caudal epidural block with 0.25% bupivacaine at a volume of 0.5 mL/kg wherever indicated and paracetamol suppositories at 20 mg/kg.

Patients were randomised into two groups using computer-generated sequences, each consisting of 45 patients: Group D, where the LMA was removed in an anaesthetised state, and Group A, where it was removed in an awake state [Table/Fig-1]. The study was single-blinded to the participants.



[Table/Fig-1]: CONSORT 2010 flow diagram.

Group D or the deep group (45 patients): Five minutes before the anticipated end of surgery, the depth of anaesthesia was deepened with twice the MAC of isoflurane (adjusted for age) in a mixture of nitrous oxide and oxygen. The depth of anaesthesia was confirmed using the Evan's score or PRST score (blood pressure, heart rate, sweating, tears) [9]. An adequate depth was considered when the PRST score was less than three. After the procedure, the LMA was removed and replaced with a Guedel's airway and face mask. The inhalational agent was cut-off, and the child was placed in the left lateral position with the face mask held with a chin lift. Breathing movements were observed in the reservoir bag of the Jackson Rees circuit, and the child was observed until fully awake for any of the complications under study.

Group A (45 patients): The inhalational agent was discontinued immediately after the procedure, and the LMA was removed after cuff deflation when the child was fully awake, spontaneously opening eyes, moving limbs, and responding to commands.

The child was observed at the removal of the LMA for any complications. A different anesthesiologist, who did not remove the LMA, recorded all the details. Variables including cough, desaturation (SpO_2 <95% on pulse oximetry), laryngospasm, vomiting, and excessive salivation were noted after LMA removal until the patient was fully awake. Laryngospasm (breathing movements were not transmitted to the reservoir bag and compliance of the bag was found to be decreased) if mild (not associated with desaturation) was treated by giving 100% oxygen and positive pressure ventilation, and severe cases (associated with desaturation) were treated with propofol 1-2 mg/kg along with 100% oxygen and positive pressure ventilation. If laryngospasm was not resolved after this, succinylcholine in the dose of 0.5 mg/kg was administered. Vomiting was treated by placing the head low and in a left lateral position with immediate suctioning of the oral cavity. Ondansetron 0.1 mg/kg was given intravenously. Excessive salivation was recognised by gurgling sounds or secretions in the oral cavity, following which suctioning of the oral cavity was done. All patients received a facemask with 100% oxygen after the removal of the LMA and were transferred to the Post-Anaesthesia Care Unit (PACU) for further monitoring.

STATISTICAL ANALYSIS

Descriptive statistics were reported using mean±standard deviation or median (range) for continuous variables. Continuous variables were compared using a Student's t-test or Wilcoxon rank sum test. The Statistical Package for Social Sciences (SPSS) package and statistical software STATA/IC version 12.0 were used for statistical analysis. A p-value <0.05 was considered significant.

RESULTS

The demographic data like age, weight, duration of surgery, heart rate, and respiratory rate in both groups were comparable [Table/Fig-2]. All patients belonged to ASA I and II physical status. Cough observed on LMA removal was more frequent in the awake group than in the deep group, and the difference was statistically significant with p-value=0.001. The incidence of desaturation (SpO_2 <95%), excessive salivation, vomiting, and laryngospasm were comparable in both groups [Table/Fig-3]. Although not statistically significant, laryngospasm was the most frequent complication in the deep group, followed by desaturation, cough, excessive salivation, and vomiting. Among the complications in the awake group, cough was the most frequent, followed by desaturation, excessive salivation, and vomiting, with laryngospasm was least common. Out of eight patients experiencing laryngospasm in the deep group, four had

Parameters	Group D Mean±SD	Group A Mean±SD
Age (years)	4.51±2.94	5.16±3.19
Weight (Kg)	15.26±6.25	17.07±6.89
Duration of surgery (min.)	41.11±12.96	45.89±13.28
Heart rate (beats per minute, at removal of LMA)	129±21	126±21
Respiratory rate (per minute, at removal of LMA)	28±4	29±11

[Table/Fig-2]: Demographic data.

Complication	Group D (N=45)	Group A (n=45)	p-value
Cough	3 (6.7)	16 (35.6)	0.001
SpO_2 <95%	4 (8.9)	4 (8.9)	1.000
Excessive salivation	1 (2.22)	4 (8.9)	0.361
Vomiting	1 (2.2)	2 (4.4)	1.000
Laryngospasm	8 (17.8)	3 (6.7)	0.142
Total	17 (37.8)	29 (64.4)	0.043

[Table/Fig-3]: Comparison of complications in two groups of patients studied. Continuous variables were compared using Student's t-test or Wilcoxon rank sum test

mild and four had severe spasms. Three patients in the awake group had severe laryngospasm. The percentage of complications was significantly higher in the awake group with a p-value of 0.043. The number of patients having complications was 10 (22.2%) in group D and 21 (46.7%) in group A, with a p-value of 0.015, which was also statistically significant.

DISCUSSION

In this study, complications of LMA removal were studied in two groups, and it was observed that 10 out of 45 patients had complications in the deep group. Eight patients had laryngospasm, out of which four patients had mild laryngospasm attributed to excessive saliva irritating the larynx, which required suctioning, and the spasm was relieved by positive pressure ventilation. The other four patients had severe laryngospasm with desaturation; in two patients, it occurred following cough, and in the other two, it was attributed to saliva irritating the larynx during emergence while the child was in a lighter plane of anaesthesia. This was resolved by administering O_2 and positive pressure ventilation along with propofol and succinylcholine. Laryngospasm can be prevented by determining the plane of anaesthesia accurately. One patient vomited 10 minutes after the removal of LMA. It was immediately suctioned, and the patient was turned to a lateral position. This may be attributed to abdominal distension caused by assisted ventilation during maintenance. It can be avoided by gentle assisted ventilation to prevent the stomach from getting distended. In the awake group, 21 out of 45 patients had complications. It was observed that out of three patients having laryngospasm, two had severe laryngospasm following cough, and among them, one had associated desaturation and excessive salivation. The mask was held with 100% oxygen, and positive pressure ventilation was given. The spasm was relieved by propofol and succinylcholine. The third patient who had laryngospasm desaturated to an SpO_2 of 92% and was treated in a similar manner. Two other patients desaturated, with one of them having associated cough but no laryngospasm. Excessive salivation was seen in three other patients, with one having a cough. Vomiting was observed in two patients. One of them had a cough and vomited afterward. The other patient vomited after two minutes of LMA removal. This can be attributed to abdominal distension during assisted ventilation. The rest of the 11 patients had a cough as soon as they were awake as a response to the LMA in situ. The cough subsided as soon as the LMA was removed after deflating its cuff.

A total of 35.6% of patients (16 patients out of 45) in group A had a cough in this study, which was significant compared to group D, where only 6.7% of patients had a cough. In a similar study done by Kitching AJ et al., in 60 paediatric patients, 17 children out of 33 had a cough, which was significant compared to the deep group, where cough was only present in two patients out of 27 [6].

Incidence of other parameters was comparable in both groups. It was found that failure to prevent coughing in the recovery period can be a problem after plastic surgery procedures. The cough-induced increase in venous pressure can lead to oozing from the wound edge, and even haematoma formation, which could impair the viability of tissue flaps and grafts. Therefore, in older infants and young children, they advocated the removal of LMA at a deep plane of anaesthesia to remove the stimulating effect on the airway [6]. In a similar study done in children by Park JS et al., the frequencies of cough, desaturation, excessive secretion, and LMA biting were found to be significantly lesser in the deeply anaesthetised group compared with those who were awake [7]. Laffon M et al., found results coherent with this study regarding the incidence of respiratory complications on LMA removal and found that deep removal was safer than removal when patients were awake after comparing both [8]. Two other studies by Koo CH et al., and Vitale L et al., studied the complications of airway removal in the paediatric age group and arrived at findings similar to those of this study [10,11].

In this study, coughing was significant in the awake group, while other complications like excessive salivation, laryngospasm, vomiting, and desaturation were statistically similar in both groups. Upper airway obstruction due to laryngospasm was observed in eight patients in the deeply anaesthetised group compared with three patients in the awake group. Although the difference was not statistically significant, in a similar study using the Laryngeal Tube (LT), Lee J et al., observed upper airway obstruction more frequently in the deeply anaesthetised group, but it was easily resolved by chin or jaw lifting [12]. They observed that other complications like coughing, hypersalivation, desaturation, and LT dislocation during emergence related to the patient's movement occurred more frequently in the awake group. Finally, they concluded that LT removal in deeply anaesthetised patients is safer, as found in present study. Gataure PS et al., assessed the incidence of gastric regurgitation and found that it is safer to remove the LMA while the patients are deeply anaesthetised in the operating room than when they are awake in the recovery room [13]. Young PC et al., also observed that maintenance of the LMA until the patient can open his or her mouth on command increases the incidence of gastroesophageal reflux [14]. In contrast to these two studies, Numez J et al., found that the incidence of regurgitation during or after the removal of the laryngeal mask was significantly greater in the anaesthetised group [15].

Though this study has not studied gastric reflux as a separate parameter, present study observations were in concordance with these studies [13,14]. Although this study has depicted that LMA removal in deeply anaesthetised paediatric patients was better, a study by Dolling S et al., found a higher incidence of desaturation (SpO_2 < 95%) and more number of patients who coughed when the LMA was removed at deeper planes [16]. Sun R et al., also concluded that the removal of the LMA in an awake state was better, but only after the topical application of lignocaine [17]. Parry M et al., removed the LMA in all patients in a fully awake state and found that 90% of patients had an uneventful recovery [1]. The results of these two studies were contradictory to this study.

Some studies show equivocal results and describe that both awake and deeply anaesthetised states are equally good for LMA removal in paediatric patients. Samarkandi AH concluded that there was no significant difference in the incidence of airway complications whether the LMA was removed in the anaesthetised or awake child [18]. Similarly, Splinter WM and Reid CW Ramgolam A et al., and Hika A et al., found that the removal of the LMA during anaesthesia and after the return of airway reflexes results in a similar incidence of airway problems in children [19-21]. In view of these findings, which showed that LMA removal in awake and deeply anaesthetised groups was comparable with respect to airway complications, further studies are warranted.

In this study, the percentage of patients having complications in the deep group was only 22.2% (10 out of 45 patients) compared to the awake group, in which it was 46.7% (21 out of 45). Therefore, the number of patients having complications, the total number of complications, as well as their statistical significance, was more in the awake group. Cough in the awake group was statistically significant compared to the deep group and was the most frequent finding in the awake group. This can have implications for surgeries on vital organs that require a smooth emergence, like ophthalmic, Ear, Nose and Throat (ENT), neurosurgeries, vascular surgeries, etc. [6]. Cough associated with airway obstruction like laryngospasm can also cause other problems like pulmonary oedema and may cause atelectasis at the end of anaesthesia [22]. Thus, the removal of the LMA in the deeply anaesthetised group was found to be safer and associated with lesser number of complications than the awake group in paediatric patients [23].

Limitation(s)

The results of this study cannot be extrapolated to paediatric patients with hyperreactive airway disease and a recent history of upper respiratory tract infection. These patients may have an increased risk of complications like cough and laryngospasm at the time of emergence and transition from a deep to awake state.

CONCLUSION(S)

The removal of the classical LMA in paediatric patients aged one to twelve years in a deeper plane of anaesthesia is safe and is associated with fewer complications than removing it in a fully awake state. Cough is the major disadvantage of removing the LMA in the awake state. It is advisable to remove the LMA in a deep plane of anaesthesia, especially in surgical procedures where cough can have counterproductive effects on the outcome. The removal of the classical LMA in paediatric patients can be safely carried out in a deeply anaesthetised state.

REFERENCES

[1] Parry M, Glaisyer HR, Bailey PM. Removal of LMA in children. Br J Anaesth. 1997;78(3):337-44.
[2] Dorsch JA, Dorsch SE. Supraglottic airway devices. In: Dorsch JA, Dorsch SE, editors. Understanding anesthesia equipment. 5th edition. Philadelphia: Lippincott William and Wilkins; 2008;5:461-518.
[3] Brimacombe JR. In: Laryngeal mask anesthesia: Principles and practice. 2nd edition. Philadelphia: Saunders; 2005;2:25-26.
[4] Pollack CV. The laryngeal mask airway: A comprehensive review for the emergency physician. J Emerg Med. 2001;20(1):53-66.
[5] Polverino M, Polverino F, Fasolino M, Andò F, Alfieri A, De Blasio F. Anatomy and neuropathophysiology of the cough reflex arc. Multidisciplinary Resp Medicine. 2012;7(1):05.
[6] Kitching AJ, Walpole AR, Blogg CE. Removal of the laryngeal mask airway in Children: Anaesthetized compared with awake. Br J Anaesth. 1996;76(6):874-76.
[7] Park JS, Kim KJ, Oh JT, Choi EK, Lee JR. A randomized controlled trial comparing laryngeal mask airway removal during adequate anesthesia and after awakening in children aged 2 to 6 year. J Clin Anesth. 2012;24(7):537-41.
[8] Laffon M, Plaud R, Dubosset AM, Ben Haj'Hmida KE, Coffey C. Removal of laryngeal mask airway: Airway complications in children, anaesthetized versus awake. Paediatric Anaesthesia. 1994;4(1):35-37.
[9] Smajic J, Praso M, Hodzic M, Hodzic S, Srabovic-Okanovic A, Smajic N, et al. Assessment of depth of anesthesia: PRST score versus bispectral index. Med Arh. 2011;65(4):216-20.
[10] Koo CH, Lee SY, Chung SH, Ryu JH. Deep vs. awake extubation and LMA removal in terms of airway complications in pediatric patients undergoing anesthesia: A systemic review and meta-analysis. J Clin Med. 2018;7(10):353. Doi: 10.3390/jcm7100353. PMID: 30322192; PMCID: PMC6210687.
[11] Vitale L, Rodriguez B, Baetzel A, Christensen R, Haydar B. Complications associated with removal of airway devices under deep anesthesia in children: An analysis of the wake up safe database. BMC Anesthesiol. 2022;22(1):223. Doi. org/10.1186/s12871-022-01767-6.
[12] Lee J, Kim J, Kim S, Kim C, Yoon T, Kim H. Removal of the laryngeal tube in children: Anaesthetized compared with awake. Br J Anaesth. 2007;98(6):802-05.
[13] Gataure PS, Latto IP, Rust S. Complications associated with removal of the laryngeal mask airway: A comparison of removal in deeply anaesthetized versus awake patients. Can J Anaesth. 1995;42(12):1113-16.
[14] Young-PC, Soo-K P, Yong S, Kang-C L. Comparison of incidence of gastroesophageal reflux and regurgitation associated with timing of removal of the laryngeal mask airway: On appearance of signs of rejection versus after recovery of consciousness. J Clin Anesth. 1999;11(8):657-62.
[15] Numez J, Huges J, Wareham K, Asai T. Timing of removal of the laryngeal mask airway. Anaesthesia. 1998;53(2):126-30.
[16] Dolling S, Anders N, Rolfe S. A comparison of deep vs. awake removal of the laryngeal mask airway in paediatric dental daycase surgery. A randomised controlled trial. Anaesthesia. 2003;58(12):1224-28.
[17] Sun R, Bao X, Gao X, Li T, Wang Q, Li Y. The impact of topical lidocaine and timing of LMA removal on the incidence of airway events during the recovery period in children: a randomized controlled trial. BMC Anesthesiol. 2021;21(1):10. Available from: https://doi.org/10.1186/s12871-021-01235-7.
[18] Samarkandi AH. Awake removal of the laryngeal mask airway is safe in paediatric patients. Can J Anaesth. 1998;45(2):150-52.
[19] Splinter WM, Reid CW. Removal of the laryngeal mask airway in children: Deep anesthesia versus awake. J Clin Anesth. 1997;9(1):04-07.
[20] Ramgolam A, Hall GL, Zhang G, Hegarty M, Ungern-Sternberg BS. Deep or awake removal of laryngeal mask airway in children at risk of respiratory adverse events undergoing tonsillectomy- A randomised controlled trial. BJA. 2018;120(3):571-80. Doi: 10.1016/j.bja.2017.11.094.
[21] Hika A, Ayele W, Aberra B, Aregawi A, Bantie AT, Mulugeta S, et al. A comparison of awake versus deep removal of laryngeal mask airway in children aged 2 to 8 years who underwent ophthalmic procedures at menilik II hospital: A prospective observational cohort study. Open Access Surgery. 2021;14:09-15. Doi. org/10.2147/OAS.S287507.
[22] Lumb AB, Bradshaw K, Gamlin FM, Heard J. The effect of coughing at extubation on oxygenation in the post-anaesthesia care unit. Anaesthesia. 2015;70(4):416-20. Doi: 10.1111/anae.12924. Epub 2014 Nov 5. PMID: 25376328.
[23] Abbasi S, Siddiqui KM, Qamar-Ul-Hoda M. Adverse respiratory events after removal of laryngeal mask airway in deep anesthesia versus awake state in children: A randomized trial. Cureus. 2022;14(4):e24296. Doi: 10.7759/cureus.24296. PMID: 35607531; PMCID: PMC9123356.

PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Anaesthesia, PGIMS, Rohtak, Haryana, India.
2. Associate Professor, Department of Anaesthesia, PGIMS, Rohtak, Haryana, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Monica Chhikara,
Associate Professor, Department of Anaesthesia, PGIMS, Rohtak-124001, Haryana, India.
E-mail: chhikara.monica@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jan 23, 2024
- Manual Googling: Mar 11, 2024
- iThenticate Software: Apr 04, 2024 (15%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Jan 22, 2024**
Date of Peer Review: **Feb 19, 2024**
Date of Acceptance: **Apr 08, 2024**
Date of Publishing: **May 01, 2024**