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Assessment of Safety and Efficacy of Anesthesia using Sevoflurane with Supraglottic Airway Device In Pediatric Patients Undergoing Magnetic Resonance Imaging

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ABSTRACT

Objectives: To determine the safety and efficacy of Sevoflurane anaesthesia with a supraglottic airway device for MRI.

Study Design: Prospective longitudinal study.

Place and Duration of Study: Department of Anaesthesiology, of Pak Emirates Military Hospital, Rawalpindi Pakistan, from Jul to Dec 2019.

Methodology: A sample size of 152 patients were calculated, including both genders from birth to 12 years. After applying inclusion and exclusion criteria, patients were chosen to undergo inhalational anaesthesia with Sevoflurane, including supraglottic airway device (SAD) insertion. After MRI, SAD was removed upon awakening and patients were shifted to the post-anaesthesia care unit (PACU) for further monitoring.

Results: The mean age of patients was 4.07±2.312 years. Out of 152 patients, ninety (60%) were males, and sixty patients (40%) were females. Hypoxemia was seen in 1.3% cases, laryngospasm in 1.3%, and apnoea in 8% and coughing in 5% patients. There were no any other complications.

Conclusion: The study concluded that Sevoflurane anaesthesia with SAD is a safe and reliable technique for artefact-free MRI of paediatric patients.

Keywords: General anaesthesia, Magnetic resonance imaging (MRI), Non-operating room anaesthesia (NORA), Postanaesthesia care unit (PACU), Supraglottic airway device (SAD).

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INTRODUCTION

Non-operating room anaesthesia (NORA) refers to the conduct of anaesthesia outside the operating room in remote locations. One of such locations is the MRI suite, which is becoming increasingly popular. Incorporating MRI technology into the operating theatre brings additional challenges for anaesthetists,[1] and they must be aware that conducting anaesthesia or sedation outside the operating room increases the risk of adverse events.[2] The standard of care, however, remains the same as offered in the operating theatre, that is, ASA standards.[3] In addition, a trained anesthesiologist provides anaesthesia in remote locations, and full back-up of resuscitation equipment is required when these services are provided.[4]

Magnetic resonance imaging is a very sophisticated imaging technique. It provides high standard image resolution, tissue characterization, and functional assessment of various organs and systems.[5] An average MRI study usually consists of multiple imaging sequences, each taking up to 5-10 min, and image resolution is sometimes enhanced with contrast agents such as gadolinium. It is generally safe, but severe anaphylactoid reactions have been reported with an incidence of up to 0.01.[4]

Though MRI is a non-invasive and painless procedure but is lengthy and time-consuming, any movement during the procedure produces a profound distortion of the final images, referred to as motion artefact. The higher the image resolution, the higher the sensitivity to motion artefacts which can prolong scan time and aggravates movement artefacts.[6] Acoustic noise also makes it cumbersome, and ear protectors are routinely recommended for all patients during MRI testing.[7] This provision is particularly important for anaesthetised patients who cannot alert the operators to hearing discomfort.[2] Claustrophobic adults and non-cooperative patients cannot have their MRI without general anaesthesia.

Giving general anaesthesia for MRI depends upon personal preferences and resources. Armed Forces Institute of Radiology (AFIRI) is one of the few medical institutes in Pakistan that provide the luxury of general anaesthesia for MRI. The patient population consists mostly of paediatric patients, many of whom

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are mentally compromised. Even in the adult age group, there are many indications of general anaesthesia and commoner are claustrophobic individuals, patients who cannot or will not hold still, one is who feel extreme pain laying on their back un-cooperative adults with various psychiatric diseases.[8] Being a part of the MRI team as an anaesthetist in AFIRI is challenging. Along with patient care, there are environmental and procedure-related limitations that anaesthetist has to cater for, including MRI-compatible equipment, limited patient access, high-intensity acoustic noise, low ambient temperature, static magnetic field,[4] and the large number of patients that require swift turnover.

General anaesthesia is routinely given and preferred over deep sedation for MRI.[8] It provides absolute motionless patient during the procedure compared to sedation with minimal motion artefact 0.7% compared to sedation 12%,[8] but at the cost of exposing children to all inherent risks of general anaesthesia.[9] Since the greater portion of our patient population is paediatric, this study was carried out in this age group. Although there is an array of intravenous and inhalational induction agents, we studied Sevoflurane as its rapid and safe.[10] It provided a comfortable environment for intravenous cannulation and further placement of SAD. We can avoid other induction agents that can prolong sedation by using Sevoflurane as the sole anaesthetic agent for induction and maintenance. Children present at MRI suite for multiple reasons like imaging of the central nervous system, musculoskeletal system, cardiovascular system, liver and pelvis.

METHODOLOGY

This prospective longitudinal study was conducted at the Department of Anaesthesiology, Pak Emirates Military Hospital, Rawalpindi, from January to June 2019. Ethical approval from the Hospital Research Ethical Committee was taken (IERB approval certificate number A/28/EC141/19). The sample size was calculated using the WHO calculator, keeping the confidence level 95%, the margin of error to be 5%.[11] The sample size obtained was 152 patients.

Inclusion Criteria: Patients of either gender, from birth to 12 years, having ASA status I or II were included in the study.

Exclusion Criteria: All those patients who had ASA status III and IV and were already intubated or ventilator-dependent were excluded from the study. Patients were either booked by the primary physician on the out-patient basis or already admitted to the inpatient facility. Written informed consent was obtained from parents or guardians after explaining the purpose of the study and carefully recorded. Non-probability purposive sampling was done to collect samples among the patients whom primary care practitioners booked to undergo general anaesthesia, and an indication of anaesthesia was also recorded. All the patients were subjected to a thorough pre-anaesthesia assessment in the pre-anaesthesia clinic before arriving in the MRI suite.

Anaesthesia was induced by a consultant anaesthetist assisted by a trained anaesthesia assistant. Inhalational anaesthetic Sevoflurane was used, and rapid induction of anaesthesia was achieved by overpressure technique,[11] which increases the inspired concentration of Sevoflurane to values that are several folds greater than the MAC for the paediatric age group. After induction, intravenous cannulation was done with a 22 or 24G iv catheter. A Supraglottic airway device (I gel) of adequate size was inserted after the adequate depth of anaesthesia was measured by the Jaw thrust test.[12] Anaesthesia was maintained with one MAC of Sevoflurane in 50% percent oxygen and 50% air. Patients' spontaneous ventilation was preserved in all cases. After the MRI, Sevoflurane was flushed away with 100 percent oxygen, and SAD was removed when the patient was fully awake and shifted to PACU. Monitoring was done according to ASA standards and continued in post anaesthesia care unit (PACU) for 45 minutes post-MRI.

Complications developed any time during anaesthesia were recorded and managed promptly and effectively. Premeditated, generally accepted well, known complications were hypoxemia (desaturation), cough, apnoea, respiratory arrest, pulmonary aspiration, bradycardia, hypotension, arrhythmia and cardiac arrest.[13] Statistical Package for Social Sciences (SPSS) version 23.0 was used for the data analysis. Procedure onset time, duration of MRI, recovery time and motion artefact were analysed as mean and standard deviation. Complications were analysed using descriptive statistics.

RESULTS

A total of 152 patients aged 4.07±2.312 years received GA during the study period, out of which 90 (59.2%) were males, and 60 (40.7%) were females. 101 (66%) patients were classified as ASA-I, and 51 (44%) patients were classified as ASA-II. 34 (14%) patients developed complications managed adequately, and an

MRI study was completed successfully in 151 (99.3%) patients.

Table-I showed the time of onset of induction, duration of induction, duration of MRI and total stay in the MRI suite.

Table-I: Duration (in minutes) of onset, induction, MRI and total stay in MRI suite (n=152)

Parameters	Time (minutes) Mean ± SD
Time taken for onset of induction	15.00± 6.70
Duration of induction	25.00 ±11.30
Duration of MRI	45.00± 24.89
Total stay in MRI suite	113.00± 72.64

The quality of all MRI studies was assessed, and motion artefact was found to be 0.6% (Table-II).

Table-II: Presence or Absence of Motion Artefact To Assess Quality of MRI (n=152)

	Frequency (%)
No motion artefact (successful)	151 (99.3)
Motion artefact (unsuccessful)	1 (0.7)

One child developed hypoxemia (1.3%), and another child developed laryngospasm (1.3%), twelve children developed apnoea (8%) at induction and eight patients (5%) developed cough after removal of SAD. There was no pulmonary aspiration, respiratory arrest, arrhythmia, bradycardia, hypotension or cardiac arrest (Table-III).

Table-III: Respiratory and Cardiovascular Complications of MRI Under General Anaesthesia

Complications	Frequency (%)
Hypoxemia	1 (1.3)
Laryngospasm	1 (1.3)
Apnoea	12 (8.0)
Cough	8 (5.0)
Respiratory Arrest	0 (0)
Bradycardia	0 (0)
Arrhythmia	0 (0)
Cardiac Arrest	0 (0)

DISCUSSION

Hybrid environments are on the rise like MRI suites, catheterization labs of interventional radiology, endoscopy units and electrophysiology operating rooms. However, secure and efficacious delivery of anaesthesia in an unfamiliar environment is challenging for anaesthesiologists, especially if the patient is in the paediatric age group.[12,13]

The paediatric population is at greater risk of developing anaesthetic complications due to the unique physiology as children are not simply small adults. The most prevalent complication of GA is drug-induced cardiorespiratory depression, which includes upper-airway obstruction, hypoventilation, hypoxia and hypotension.[14] In contrast, other adverse effects of GA in practice include postoperative nausea, vomiting, disorientation, sleep disturbance and nightmares, although their incidence is much lower. The overall incidence of anaesthesia-related aspiration in paediatric patients is 0.10%, twice as reported in adults.[15] Although sedation can also be used, and Ketamine-induced sedation may be a safe and effective alternative to general anesthesia,[16] it is not particularly helpful in MRI and proved high priced in terms of quality of the scan, increased workforce, time wastage, a higher risk of sedation-related adverse outcomes and discrepancy in the onset of action.[10]

Sevoflurane has gained popularity as an anaesthetic for children because it is less pungent and has lower solubility and greater hemodynamic stability than the other potent inhaled anaesthetics. Sevoflurane was used as the sole anaesthetic agent in our study because using three or more sedative drugs significantly increases the rate of adverse outcomes.[15,16] Rapid induction of anaesthesia was achieved by overpressure technique,[11] that is, to increase the inspired concentration to values that are several folds greater than the MAC for the paediatric age group. Uezono *et al.* suggested in their study that the use of Sevoflurane for maintenance of anaesthesia for minor non-invasive surgery in preschool-aged and non-premedicated children was associated with a greater incidence of emergence agitation (38%), they reduced it with Nalbuphine administration towards the end of MRI.[17] However, it was not a great concern for us in our study as none of our patients developed clinically significant emergence reactions. We focused on respiratory and cardiovascular complications, including hypoxemia, apnea, laryngospasm, respiratory arrest, pulmonary aspiration, bradycardia, arrhythmia, and cardiac arrest. In a recent study, Malviya *et al.* pre-selected general anaesthesia for MRI due to previously failed sedation (28%), the potential for failed sedation (32%), perceived medical risk (14%), excessive motion (12%) and adverse events (20.1%).[8] Motas *et al.* in a prospective study of children undergoing sedation by non-anaesthesiologists for various procedures, reported failure to achieve sedation (12-28%) using bispectral index.[18] Thakkar *et al.* in cross-sectional retrospective research, reported a complication rate of 1.2% associated with procedures performed under GA as compared to a 3.7% incidence associated with IV sedation. After adjusting with all other variables, they reported IV sedation to be independently associated with a cardiopulmonary complication rate 5.3% times higher when compared to GA.[19]

In our study, an anaesthesiologist gave GA to all patients. GA was induced in all patients with Sevoflurane, and Sevoflurane was used as the sole agent for maintenance as imaging evaluation is not a noxious procedure.

CONCLUSION

The overall complications in our study were 12%. Motion artefact was considerably low (0.6%) which emphasized that general anaesthesia mitigates motion artefact effectively. Therefore, it is safe to conclude that Sevoflurane anaesthesia alone is a reliable and safe choice for children undergoing MRI using a supraglottic airway device. It mitigates motion artefacts without significant hemodynamic compromise.

Conflict of Interest: None.

Author's Contribution

ART:, SM: Conception, AR:, KM Design analysis, AG:, AA: Interpretation of data.

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