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A Comparative Study on the Airway Responses, Hemodynamic Parameters and Recovery using Sevoflurane and Desflurane via Laryngeal Mask Airway in Day Care Peadiatric Surgeries

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Abstract: ***This is a prospective randomised study conducted at Govt. General Hospital, Kurnool, to compare the airway responses, haemodynamic parameters and recovery characteristics using desflurane and sevoflurane administered via LMA for maintenance in paediatric day care surgeries. A 60 paediatric patients were divided into two groups. Sevoflurane group (group S) received sevoflurane 2% to 3% and patients in desflurane group (group D) received desflurane 6% to 8% for maintenance of anaesthesia. Descriptive statistics was done for all data and suitable statistical tests of comparison were done. These included the mean and Standard Deviation (SD) for quantitative variables analysed by Student's t unpaired test. P value ≤0.05 was considered statistically significant. Desflurane provides stable hemodynamics and respiratory variable on par with sevoflurane for maintenance of anaesthesia. Recovery is significantly faster in comparison to sevoflurane. Fast tracking is early with Desflurane complications are a bit more when compared with sevoflurane but there is no statistically significant difference between the two drugs.***

Keywords: Desflurane, Sevoflurane, Lma, Paediatric Day Care

1. Introduction

The general observation that children achieve better convalescence in the home environment supports the need for adoption of day care surgeries in them.1 Advantages of paediatric outpatient anaesthesia include-minimises parental separation, uninterrupted feeding schedule/sleeping patterns, less risk of nosocomial infections, reduced cost of hospitalization, convenience and improved patient satisfaction.

The Laryngeal Mask Airway (LMA) is most commonly used airway device in day care surgery and has numerous advantages for day care anaesthesia in children.2 In experienced hands, tracheal intubation can be avoided for nearly all of the usual day care procedures by the use of LMA, thereby avoiding the use of neuromuscular blocking drugs and problems such as extubation stridor. The ideal day care anaesthetic agent should provide smooth and rapid induction, optimal operating conditions and facilitate a fast-track recovery.3 Propofol effectively obtunds upper airway reflexes and has a favourable recovery profile, therefore, appears to be the optimal intravenous induction agent for LMA insertion. The use of low-solubility inhalation agents can be of benefit to day care anaesthesia as they allow more rapid emergence and recovery. Sevoflurane (blood-gas partition coefficient 0.69) and desflurane (blood-gas partition coefficient 0.42) are relatively new inhalational agents that are widely used in both paediatric and adult anaesthesia by virtue of their superior recovery profiles. Though desflurane possesses lower blood-gas solubility than sevoflurane, desflurane can be irritant to airways.4 Therefore, sevoflurane is generally considered to be the agent of choice for day care anaesthesia with spontaneous respiration for short cases, despite possibly faster recovery with desflurane. Thus, whether the effect of desflurane in paediatric anaesthesia is superior to sevoflurane remains controversial. So, we compared the efficacy of sevoflurane and desflurane for short day care procedures in paediatric surgery.

2. Literature Survey

Inhaled anaesthesia has a long history. Both nitrous oxide and ether were introduced more than 150 years ago, and the introduction of halogenated inhaled anaesthetics during the mid-1950s was a significant step in the development of safe and efficacious anaesthesia. Halothane was the first in this series of potent inhaled anaesthetics; this halogenated hydrocarbon was first synthesised by C. W. Suckling of Imperial Chemical Industries in 1951 and was first used clinically by M. Johnstone in Manchester in 1956. Halothane became popular as a non-flammable, potent, general anaesthetic and replaced other flammable volatile anaesthetics such as diethyl ether and cyclopropane.

The second generation of inhaled halogenated anaesthetics (i.e. methoxyflurane, enflurane, and isoflurane) was introduced during the following decades, though methoxyflurane was withdrawn from use in many countries because of case reports of renal impairment caused by free fluoride produced from its in vivo breakdown. The third generation of inhaled halogenated anaesthetics (i. e. desflurane and sevoflurane) was introduced in the 1990s, resulting now in more than a decade of experience with both of these anaesthetics

The 'ideal inhaled anaesthetic'

The ideal inhaled anaesthetic agent should have ample potency and a low solubility in blood and tissues, thus promoting a rapid equilibration and subsequent rapid elimination and recovery after cessation of administration. In addition, it should provide safe and effective anaesthesia while administered. It should have minimal effects on respiration and circulation; it should not cause airway irritation or produce negative effects on organ functions. The molecule should not have any deleterious effects or possess the potential to cause any injury to body tissues. The ideal inhaled anaesthetic'should resist physical and metabolic degradation, both in vitro and in vivo, and it should not react in carbon dioxide (CO2) absorbers or with filters, tubing, or connections.

The clinical features of the halogenated hydrocarbon gases have led to their widespread use for general anaesthesia since their initial introduction. Most of the desired effects are provided by all of the available agents – isoflurane, sevoflurane, and desflurane. As a class, they provide rapid onset of action, safe and efficacious anaesthesia during administration, and rather minimal effects on circulation and cardiac performance. Through appropriate titration, they may all be used to rapidly increase or decrease the depth of anaesthesia. Following cessation of administration, elimination is governed by wash-out by exhalation and does not require any metabolism. However, subtle differences that have an impact on anaesthesia practice and patient management do exist among the agents

3. Materials and Methods

This is a prospective randomised study conducted at Govt. General Hospital, Kurnool, to compare the airway responses, haemodynamic parameters and recovery characteristics using desflurane and sevoflurane administered via LMA for maintenance in paediatric day care surgeries. After obtaining Institutional Ethical Committee clearance and written informed consent from the parents, randomisation was done based on computer-generated tables.

A 60 paediatric patients were divided into two groups. Sevoflurane group (group S) received sevoflurane 2% to 3% and patients in desflurane group (group D) received desflurane 6% to 8% for maintenance of anaesthesia.

Patients of both gender belonging to age group of 6-14 years with ASA grade I and II undergoing elective surgery under general anaesthesia lasting for 30 to 90 mins. Duration were included in the study.

Children with active airway disease, known allergy to sevoflurane or desflurane were excluded from the study.

All patients underwent a thorough pre-anaesthetic evaluation and kept nil by mouth as per the American Society of Anaesthesiologists (ASA) fasting guidelines. A peripheral Intravenous (IV) access was established and antibiotics administered.

In the OT, pre-induction monitoring including ECG, Non-Invasive Blood Pressure (NIBP) and pulse oximetry were used. Baseline Heart Rate (HR) and Mean Arterial Pressure (MAP) were recorded.

All patients were preoxygenated with 100% O2 at 6 litres/minute. Prior to induction of anaesthesia, premedicated with IV glycopyrrolate 0.01 mg/kg, IV midazolam 0.05 mg/kg, IV fentanyl 2-3 μg/kg and IV ondansetron 0.1 mg/kg. General anaesthesia was induced with IV propofol 2 mg/kg. After loss of consciousness (confirmed by loss of eyelash reflex) and after assessing jaw relaxation, LMA placement was attempted.

Following LMA placement, patients were randomised to receive either sevoflurane 2%-3% or desflurane 6%-8% in a 50% N2O/O2 mixture for maintenance of anaesthesia. Patients were maintained on spontaneous ventilation.

Ringers lactate as maintenance fluid at a rate of 4 mL/kg/hr. during the intervention. MAP and HR were recorded before induction, before LMA insertion, immediately after insertion, then every minute for 5 minutes, at 10 minutes after insertion and thereafter every 10 minutes until removal of LMA.

Inhalational agent was discontinued at the end of the procedure and after thorough suctioning of throat; LMA was removed under deeper planes and assisted with mask ventilation with 100% O2 till complete recovery.

Time to eye opening and response to verbal commands were noted. Recovery characteristics were rated by the modified Aldrete score at 5 and 10 minutes and time to reach discharge criteria, which is defined as an Aldrete score ≥9 was observed. Incidence of adverse events including bronchospasm, desaturation, coughing, laryngospasm, nausea, vomiting and shivering were noted. Demographic data like age, sex, weight and height were recorded in both the groups.

The intraoperative variables heart rate, mean arterial pressure, O2 saturation, duration of procedure and duration of anaesthesia were recorded.

Descriptive statistics was done for all data and suitable statistical tests of comparison were done. These included the mean and Standard Deviation (SD) for quantitative variables analysed by Student's t unpaired test. P value ≤0.05 was considered statistically significant.

4. Results and Discussion

Table 1: Age wise distribution of the study groups

Group	Mean	Standard deviation	p-value
Group D	10.6	2.04	0.720
Group S	10.4	2.25	

Mean age of the participants in group D (children who received Desflurane) was 10.6±2.04 years and age ranges from 7 to 14 years. Mean age of the participants in group S (children who received Sevoflurane) was 10.4±2.25 years and age ranges from 6 to 14 years. Two groups were not showing significant difference with respect to mean age.

(t=0.361; p>0.05)

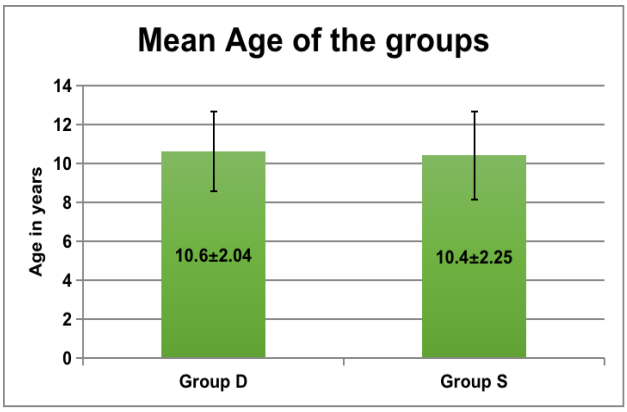

Figure 1: Bar diagram showing the age wise distribution of the study groups

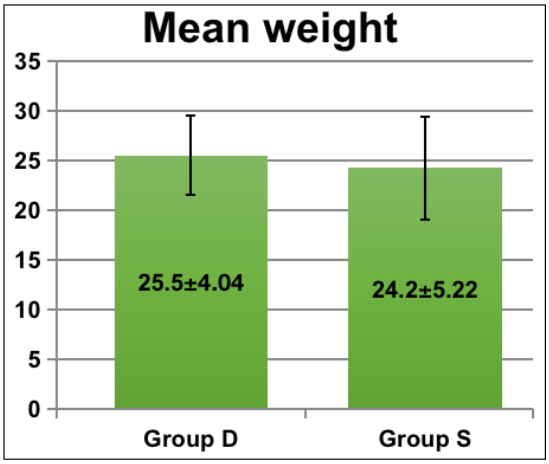

Figure 2: Bar diagram showing the weight wise distribution of study groups

Table 2: Weight wise distribution of the study groups

Group	Mean	Standard deviation	p-value
Group D	25.5	4.04	0.285
Group S	24.2	5.22	

Mean weight of the participants in group D was 25.5±4.04 kgs and mean weight of the participants in group S was 24.2±5.22 kgs. Two groups were not showing significant difference with respect to mean weight. (t=1.079; p>0.05)

Table 3: Distribution of the groups by mean heart rate

Time	Group D	Group S	p-value
Before induction	99.2±6.18	98.8±5.61	0.794; NS
Before LMA	97.2±6.18	96.7±5.09	0.734; NS
Immediately after LMA	101.4±5.16	100.7±6.07	0.632; NS
2 min	100.3±5.57	99.1±6.08	0.429; NS
3 min	99.3±5.26	98.3±5.50	0.475; NS
4 min	93.2±5.59	92.5±5.73	0.634; NS
5 min	85.2±6.18	84.9±5.71	0.846; NS
10 min	81.2±6.32	80.7±6.08	0.756; NS
20 min	80.5±5.76	80.2±5.36	0.835; NS
30 min	82.8±4.88	81.9±5.57	0.508; NS
40 min	81.3±6.42	80.9±5.99	0.804; NS
50 min	82.6±3.74	81.8±5.28	0.501; NS
60 min	83.4±4.20	82.3±5.22	0.372; NS
70 min	84.4±5.37	83.1±6.19	0.389; NS
80 min	87.2±6.18	86±5.55	0.432; NS
90 min	89.2±6.18	88.7±5.75	0.747; NS

In both the groups mean heart rate changes equally with time. At any point of time the difference between the groups were not significant statistically. (p>0.05)

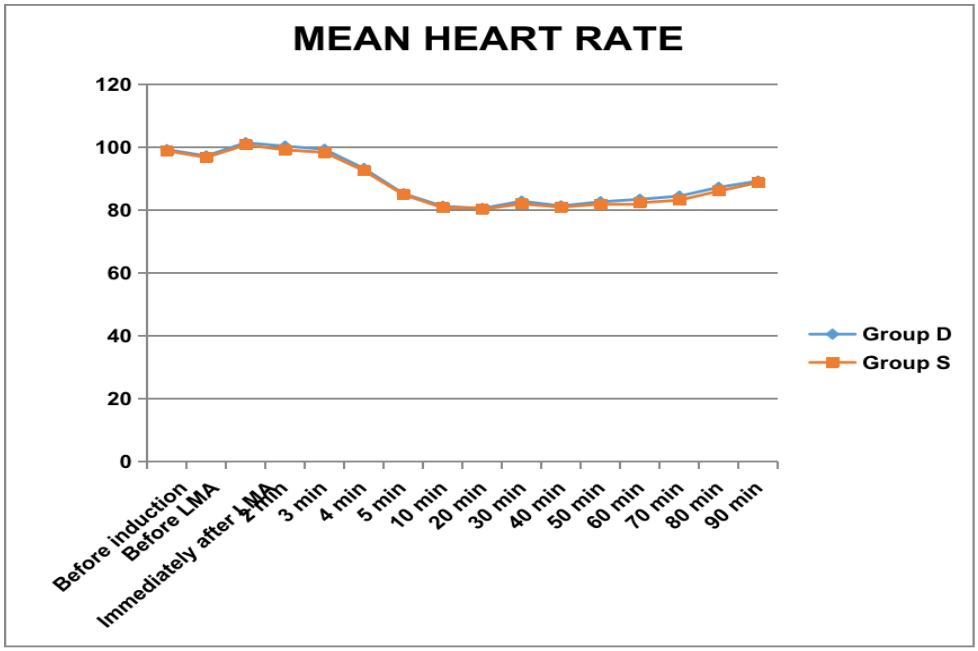

Figure 3: Line diagram showing the distribution of groups by mean heart rate

Table 4: Distribution of the groups by mean arterial pressure (MAP)

Time	Group D	Group S	p-value
Before induction	73.1±3.28	72.6±2.53	0.559; NS
Before LMA	63.1±2.70	64±2.66	0.162; NS
Immediately after LMA	67±1.95	66.3±1.82	0.617; NS
2 min	69.7±1.87	70.4±1.99	0.179; NS
3 min	72.4±3.01	72±2.31	0.545; NS
4 min	69.8±2.62	70.4±2.47	0.366; NS
5 min	72.5±2.83	72.7±2.70	0.804; NS
10 min	69.7±2.59	70.5±2.48	0.227; NS
20 min	72.6±2.61	72.7±2.73	0.911; NS
30 min	71.8±2.65	72.8±2.33	0.117; NS
40 min	72±2.57	72.4±2.21	0.520; NS
50 min	71.9±2.58	72.4±2.43	0.433; NS
60 min	72±2.56	72.3±2.36	0.602; NS
70 min	71.9±2.56	72.2±2.36	0.626; NS
80 min	71.8±2.62	72.1±2.43	0.588; NS
90 min	71.6±2.70	71.9±2.57	0.685; NS

In both the groups mean arterial pressure changes equally with time. At any point of time the difference between the groups were not significant statistically. (p>0.05)

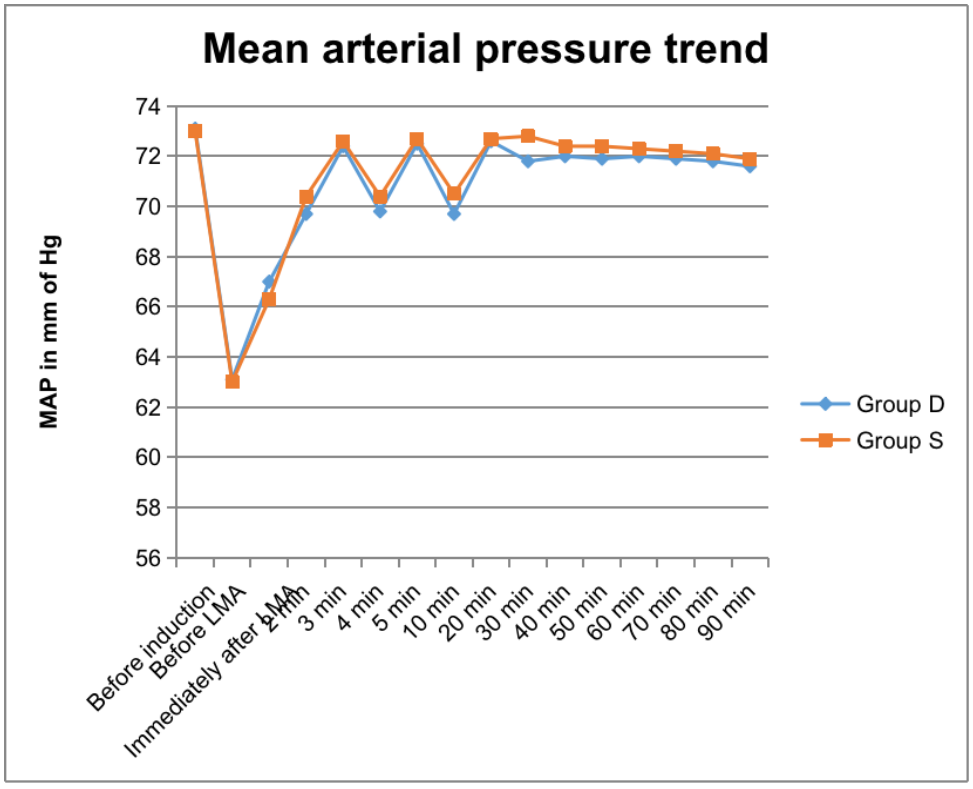

Figure 4: Line diagram showing the changes in mean arterial pressure (MAP)

Table 5: Distribution of the groups by mean oxygen saturation (SpO2)

SpO_2	Group D	Group S	p-value
Before induction	97.5±0.97	97.7±1.06	0.614 (NS)
Before LMA	97.8±0.97	97.7±0.92	0.785 (NS)
Immediately after LMA	97.6±0.93	97.5±1.01	0.791 (NS)
2 min	97.7±0.92	97.9±0.97	0.417 (NS)
3 min	97.7±0.94	97.7±1.03	0.795 (NS)
4 min	97.6±0.96	97.6±0.93	0.892 (NS)
5 min	97.5±1.01	97.7±0.92	0.595 (NS)
10 min	97.7±0.92	97.7±0.94	0.890 (NS)
20 min	97.6±0.93	97.5±1.01	0.791 (NS)
30 min	97.7±0.94	97.7±1.03	0.795 (NS)
40 min	97.6±0.96	97.6±0.93	0.892 (NS)

50 min	97.5±1.01	97.7±0.92	0.595 (NS)
60 min	97.5±1.01	97.5±0.97	0.997 (NS)
70 min	97.9±0.97	97.8±0.97	0.692 (NS)
80 min	97.7±1.03	97.6±0.96	0.897 (NS)
90 min	97.7±1.06	97.5±1.01	0.620 (NS)

In both the groups mean oxygen saturation changes equally with time. At any point of time the difference between the groups were not significant statistically. (p>0.05)

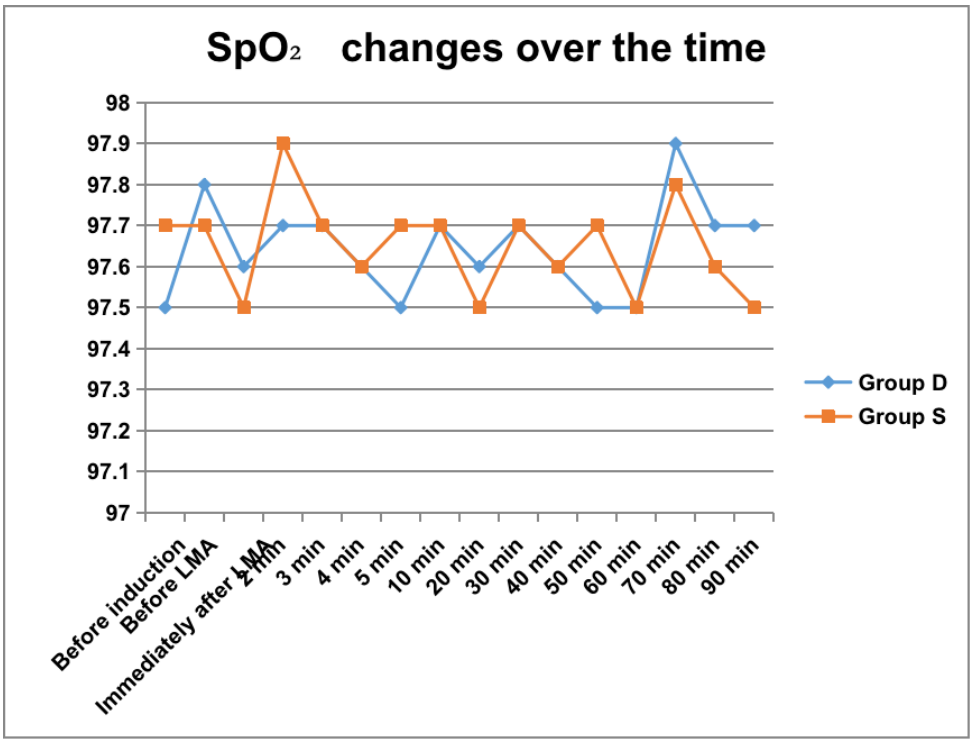

Figure 5: Line diagram showing the SpO2 changes of the groups

Table 6: Distribution of the groups by mean Aldrete score

mean Aldrete score	Group D	Group S	p-value
5 mins of LMA removal	8.1±0.76	7.43±0.82	0.002; S
10 mins of LMA removal	9.23±0.73	8.67±0.71	0.003; S

The Aldrete score was calculated in all patients at 5 minutes and 10 minutes following LMA removal. The mean Aldrete score at 5 minutes following LMA removal was 8.1±0.76 in desflurane group and 7.43±0.82 in the sevoflurane group.

The mean Aldrete score at 10 minutes following LMA removal was 9.23±0.73 in desflurane group and 8.67±0.71 in the sevoflurane group. The difference in the Aldrete score in the two groups at 5 minutes and at 10 minutes following LMA removal was statistically significant (p value <0.05).

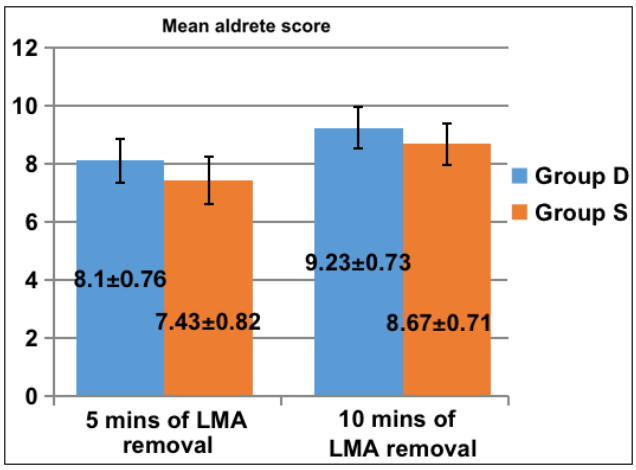

Figure 6: Bar diagram showing the Distribution by mean Aldrete score

Table 7: Distribution of the groups by time to reach aldrete score of 9

Time of reaching aldrete score 9			
Group	Mean	Standard deviation	p-value
Group D	9.87	1.38	0.005; S
Group S	11.73	3.22	

Mean time to reach aldrete score of 9 in group D was 9.87±1.38 minutes and in group S was 11.73±3.22 minutes. The difference in mean time to reach aldrete score of 9 in two groups is significant statistically. (t=2.001; p<0.05)

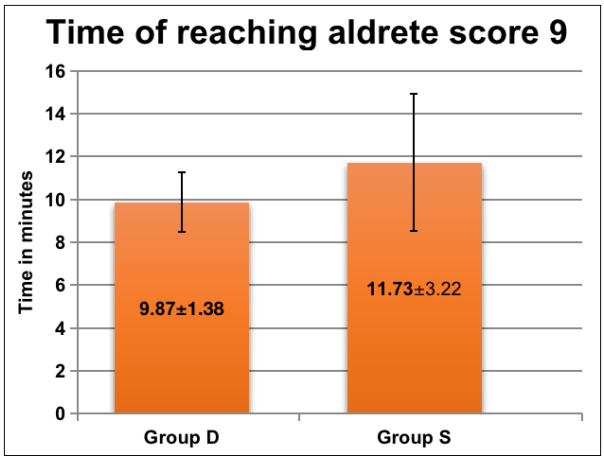

Figure 7: Bar diagram showing the mean time to reach aldrete score of 9

Table 8: Distribution by time taken to open eyes following discontinuation of Volatile anaesthesia

Time taken to open eyes following discontinuation of Volatile anaesthesia (minutes)			
Group	Mean	Standard deviation	p-value
Group D	5.1	0.99	<0.001; S
Group S	8.63	1.33	

Mean time taken to open eyes following discontinuation of volatile anaesthesia in group D was 5.1±0.99 minutes and in group S was 8.63±1.33 minutes. The difference in mean time taken to open eyes following discontinuation of volatile anaesthesia in two groups is significant statistically. (t=2.011; p<0.05)

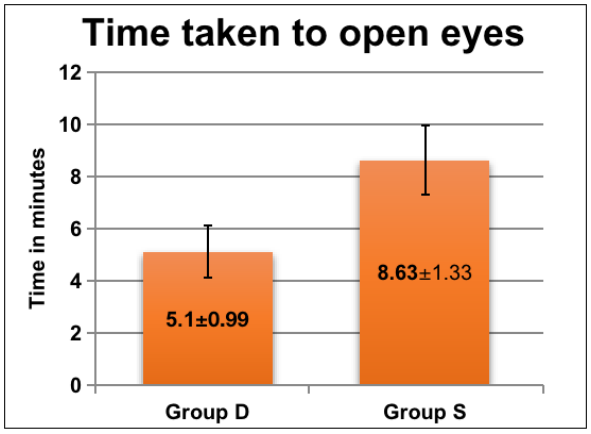

Figure 8: Bar diagram showing the time taken to open eyes following discontinuation of Volatile anaesthesia

Table 9: Distribution of the groups by duration of surgery

Duration of surgery (in minutes)			
Group	Mean	Standard deviation	p-value
Group D	45.4	3.85	0.099; NS
Group S	47.1	4.00	

Mean duration of surgery in group D was 45.4±3.85 minutes and in group S was 47.1±4.00 minutes. The difference in mean duration of surgery in two groups is not significant statistically. (t=1.677; p>0.05)

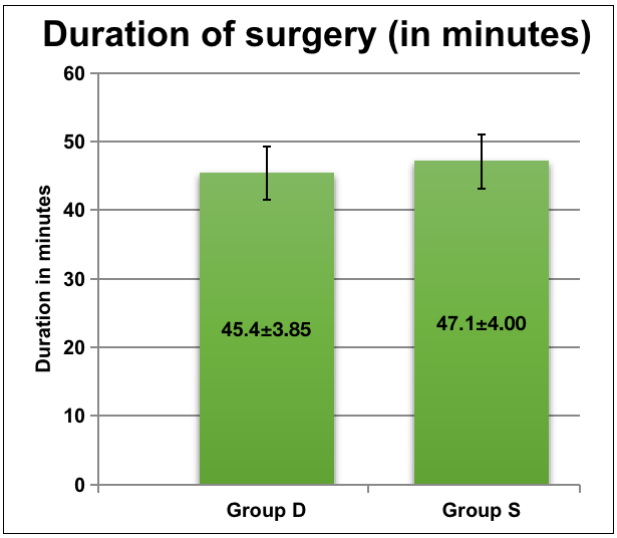

Figure 9: Bar diagram showing the distribution by duration of surgery

Table 10: Distribution of the groups by duration of Anaesthesia

Duration of Anaesthesia (in minutes)			
Group	Mean	Standard deviation	p-value
Group D	50.9	3.36	0.215; NS
Group S	52.1	4.02	

Mean duration of anaesthesia in group D was 50.9±3.36 minutes and in group S was 52.1±4.02 minutes. The difference in mean duration of anaesthesia in two groups is not significant statistically. (t=1.255; p>0.05)

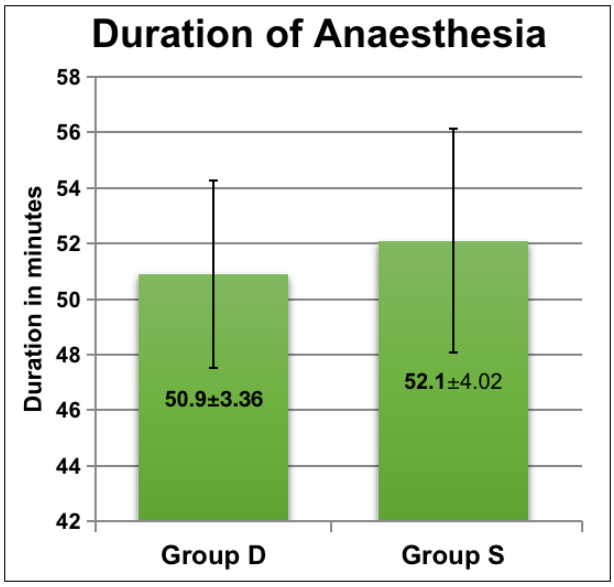

Figure 10: Bar diagram showing the distribution by duration of anaesthesia

Table 11: Distribution of the groups by FTC score

FTC score at	Group D	Group S	p-value
5 min	12.07±1.39	11.03±1.40	0.006; S
10 min	12.27±1.23	11.23±1.19	0.001; S
15 min	12.63±1.13	11.6±0.93	<0.001; S
20 min	13.13±1.11	12.03±0.85	<0.001; S
25 min	13.6±1.04	12.67±0.96	<0.001; S
30 min	13.7±0.70	13.1±0.89	0.005; S

In both the groups FTC scores changes equally with time. At any point of time these two groups shows significant difference statistically. (p>0.05)

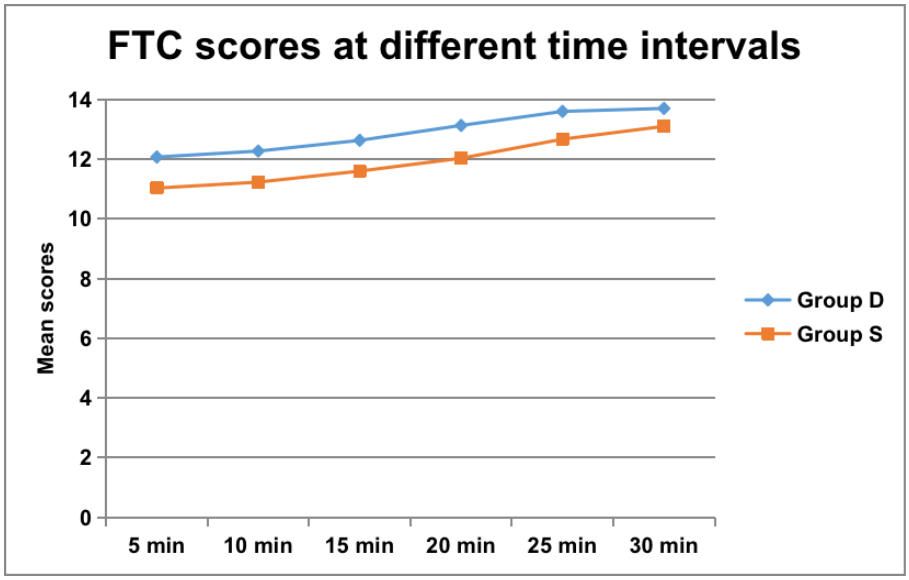

Figure 11: Line diagram showing the distribution by FTC score

5. Discussion

In recent years, the emphasis in providing surgical services has undergone remarkable change Multi-dimensional benefits to the patient, hospital and national economy are the driving forces behind the changing scenario on the horizon of day-care surgery and it has facilitated the rapid rise in ambulatory surgery worldwide with the availability of rapid, short acting anesthetics, analgesics as well as improved monitoring devices, it has been possible to minimize the adverse effects of anesthesia on the recovery process.

The low solubility of inhalational agents can be of benefit to day care anesthesia as they allow more rapid emergence and recovery. Sevoflurane (blood gas partition coefficient 0.69) and desflurane (blood-gas partition coefficient 0.42) are relatively new inhalational agents that are widely used in both paediatric and adults population by virtue of their superior recovery profile.

The laryngeal mask airway is the most commonly used airway device in day care surgery and has numerous advantages for day care anaesthesia in children[2]. The incidence of desaturation, laryngospasm cough and breath holding during recovery from anaesthesia can be minimized by using LMA[13].

While PF et al., conducted a study on desflurane versus sevoflurane for maintenance of outpatient anaesthesia. The effect on early versus late recovery and preoperative coughing and they concluded that the use of desflurane for maintenance of anaesthesia was associated with a faster emergence and higher incidence of coughing. Despite the faster initial recovery with sevoflurane, no significant differences were found between the two volatile anaesthetics in the late recovery period.

Ravi Jindal et al., conducted a study on comparison of maintenance and emergence characteristics after desflurane or sevoflurane in outpatient anesthesia and they concluded that the emergence and early recovery time were shorter after maintenance of anaesthesia with desflurane compared with that of sevoflurane. The intra operative hemodynamic were comparable with both sevoflurane and desflurane

EH Kim et al compared. The recovery characterization and complications like respiratory events in 200 children undergoing strabismus surgery with LMA insitu and sevoflurane and desflurane for maintenance of anesthesia. They concluded that desflurane shows a similar rate of overall respiratory events when compared with sevoflurane.

Desflurane due to its low blood gas solubility allows for rapid recovery and has widely been used for maintenance of general anaesthesia for ambulatory surgery in adults[2]. However desflurane has not been widely used in paediatric population because of its two main concerns its pungent smell and irritant nature makes it unsuitable for its use for

inhalation induction. The possibility of airway complications such as cough, laryngospasm and breath holding, especially when the airway is unprotected [1, 2, 3]. This concern is of real importance considering the fact that more and more paediatric ambulatory surgeries all now being carried out in general anaesthesia without muscle relaxants using supra glottic airway devices. Unlike adults there is a dearth of literature comparing various inhalational agents for maintenance of anaesthesia using SGA in children.

Sevoflurane is generally considered to be the agent of choice for day care anaesthesia with spontaneous respiration, despite possible faster recovery with desflurane. Thus whether the effect of desflurane in pediatric anesthesia is superior to sevoflurane remains controversial. Desflurane cannot be used for induction of anaesthesia. Most authors have used halothane[9] or sevoflurane [12, 14, 15, 16] for induction of anesthesia and then randomized patients to receive sevoflurane or desflurane for maintenance of anaesthesia. In that case one may not get true picture about emergence characteristics and incidence of agitation etc. Hence we used propofol as an induction agent to avoid such bias we therefore planned this study the maintenance and emergence characteristics of sevoflurane and desflurane in children who receive SGA based general anaesthesia without using muscle relaxants. Only after SGA was inserted, sevoflurane or desflurane was started for maintenance of anaesthesia in the respective group. We wanted to ensure good plane of anaesthesia at the time of starting the study drugs, hence number of attempts taken for LMA insertion was also recorded. Too many attempts for successful LMA placement can result in light planes of anaesthesia and can increase the requirement of study drugs which can result in bias. Hence number of attempts were recorded. In our study no patients required more than one attempt. Modified aldrette score is regarded as the gold standard for discharge criteria to postoperative units. In our study apart from recording modified Aldrette Score at 5 & 10 min we have also used another popular and new criteria for fast-tracking i. e., fast track criteria score (FTC Score) to authenticate our findings FTC Score at various intervals have been recorded after LMA removal.

Regarding demographic data, the mean age of participants in Group-D (Children who received Desflurane) was 10.6 ± 2.04 years and age ranges from 7 to 14 years. Mean age of participants in Grop S was 10.4 ± 2.25 and age ranges between 6 to 14 years. There was no statitstical significant difference with regard to age ($p>0.05$). We purposefully avoided children below 6 years and it is reported that the adverse airway reactions of desflurane are more in children below 6 years based on report by Lerman et al. Another reason for choosing this particular age group is that, in children below 6 years the interpretation of Fast Track criteria Score (FTC) would become difficult.

There was no statistical difference among two groups with regard to gender ($p>0.05$). Both study groups were comparable with regard to height and weight. Hence there was no statistical significance among the two groups with regards to demographic variable.

The mean duration of surgery was 45.4±3.85 minutes in group D and in 47.1±4.00 minutes Group S both groups were comparable in this regard. The mean duration of anaesthesia in Group D was 50.9±3.36 minutes and in Group S was 52.1±4.02 minutes.

There is no statistical significance among two groups. In few studies, the mean duration of surgery was very short and the effect of drugs used for induction like propofol, thiopentone sodium on recovery profile can interfere drugs. But in our study the mean duration of anaesthesia was 50 to 55 minutes and hence this bias can be ruled out.

In our study the mean heart rate at any point of time starting before induction to the end of the procedure showed no statistical significant difference between the two groups. The cardiovascular effect of desflurane can be of two types: the direct effect of the anaesthetic and a transient response involving sympathetic nervous system activation[20]. Heart rate changes in our study are in conjunction with studies done by White PF et al[6], Nathanson et al[7] and Bed for NM et al[8], Thomas Ebert et al[11] observed tachycardia after increasing the concentration of desflurane from 1 MAC to 1.5 MAC and have ascertained this to biphasic response of desflurane due to sympathetic nervous system stimulation. But no patient in either groups in our study developed tachycardia. Induction with propofol and administration of midazolam and fentanyl in our study might have obtained this response.

In our study the mean arterial blood pressure at any point of time starting before induction to the end of the procedure showed no statistical significant difference between the two groups. The concentration of study drugs were adjusted accordingly when there was >15% of fall of mean arterial blood pressure from the base-line. These findings are similar to studied by Jindal et al, White PF et al and Nathanson et al[7] maintenance of good plane of anaesthesia, use of LMA instead of endotracheal tube, administration of drugs like propofol, xylocard, midazolam and fentanyl and removal of LMA in deep planes could have resulted in better hemodynamic stability in both the groups. In both groups the mean oxygen saturation changes equally with time. Though there was mild desaturation in desflurane group when compared with sevoflurane group it was not statistically significant.

6. Recovery Parameters

In our study recovery parameters noted are the mean time taken to open the eyes following discontinuation of volatile anaesthetic and the mean time taken to obey verbal commands following discontinuation of volatile anaesthetics.

Mean time taken to open eyes following discontinuation of Volatile anaesthetic in Group D was 5.1 ± 0.99 minutes and

in group S was 8.63 ± 1.33 minutes. The difference in mean time taken to open eyes following discontinuation of volatile anaesthetics in two groups is statistically significant (t: 2.011: p<0.05). White PF, Jun Tang et al also observed the mean time taken to open eyes was 5 ± 3.1 min in desflurane group and 8 ± 1.01 min in sevoflurane groups which correlate well with the results observed in our study. Our results are also in conjunction with the results are also in conjunction with the results observed in Satyanarayana et al., Kim JM et al., Cohen et al., Mean time taken to obey commands following discontinuation of volatile anesthetic in Group D was 6.2 ± 0.92 minutes and in group S was 9.87 ± 1.11 minutes. The difference in mean time taken to obey commands following discontinuation of volatile agent in two groups is statistically significant. Jadhav SV et al observed the mean time of response to verbal commands e. g squeezing the hand in Group D was 8.98 ± 1.31 min which was statistically significantly shorter than in group S which was 12.30 ± 1.34 min (p<0.05) Satyanarayana et al observed the mean time of response to verbal commands was 6.23 ± 0.935 in Desflurane group and 9.73 ± 1.112 in sevoflurane group which was statistically significant. Similar findings were seen in study of strum et al., so all these observation are similar to our results. In a study by Jindal et al the time for response to verbal commands in desflurane group was 3.48 minutes and in sevoflurane was 5.04 min which was statistically significant (p<0.05) similar to present study. But the mean duration was shorter than present study. They have not used midazolam as a premedication and this can be attributed to shorter times for response to commands Priyanka Gupta, et al compared emergence and recovery characteristics of children undergoing surgery for spinal dysraphism with sevoflurane and desflurane time to open eyes was 2.5 min (0.83-8) vs 8 min (2.5-14) in sevoflurane and extubation time 3 (0.8-10) vs 5.5 (1.2-14) in sevoflurane and desflurane groups respectively. The short times with statistical significance has been attributed to decrease in the depth of anaesthesia at the time of skin closure in their study.

Aldrette Score: The aldrette Score was calculated in all patients at 5 minutes and 10 minutes following LMA removal. The mean Aldrette Score at 5 minutes following LMA removal was 8.1 ± 0.76 in desflurane group and 7.43 ± 0.82 in sevoflurane group. The mean aldrette score at 10 minutes following LMA removal was 9.23 ± 0.73 in desflurane group and 88.67 ± 0.71 in the sevoflurane group. The diference in the aldrette Score in the two groups at 5 minutes and at 10 minutes following LMA removal was mean time taken to obey commands following discontinuation of volatile anaesthetic in Group D was 6.2 ± 0.92 minutes and in group S was 9.87 ± 1.11 minutes. The difference in mean time taken to obey commands following discontinuation of volatile agent in two groups as statistically significant.

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Our results are also in conjunction with results in study by Akkineni Lokesh et al.

The mean aldrette score at 5 min 8.80 ± 1.152 (D) Vs 7.15 ± 1.268 (S) and at 10 min 9.60 ± 0.598 (D) vs 9.05 ± 1.005 and there was statistically significant difference among two groups at 5 min and 10 min.

Similar results were observed in studies done by Satyanarayana et al the mean aldrette score at 5 min was 8.35 ± 0.615 (D) Vs 7.63 ± 0.55 (S) and meal aldrette score at 10 min was 9.30 ± 0.651 (D) Vs 8.77 ± 0.679 (S) and this was statistically significant at both 5 and 10 minutes.

Mean time to reach Aldrette Score of 9 in Group D was 9.87 ± 1.38 minutes and in group S was 11.73 ± 3.22 minutes. The difference in mean time to reach aldrette score of 9 in two groups is statistically significant.

Similar results were observed in study by Valley et al, Jindal et al., in study by Jindal et al the mean time to achieve aldrette score of 9 was 10.80 (3.774) in Desflurane group and 16.20 (3.870) in sevoflurane group and is statistically significant.

Our results are in contradiction to results in study by Coloma et al who found no statistical significant difference between sevoflurane and desflurane with regard to mean time to reach aldrette score of 9. They observed the mean time to reach aldrette score of 10 was 12 ± 6 min in Desflurane and 13 ± 5 min in sevoflurane group with no statistically significant differences. These finding can be due to use of long acting muscle relevant Rapacuronium and prolonged surgery time in their study

FTC (a): The new Fast-track scoring system takes into consideration pain and emetic symptoms as well as Aldrettes assessment of consciousness, physical activity, hemodynamic and respiratory stability. Using the new Fast

track criteria significantly fewer out patients would require IV medication for management of pain and emesis in the step down unit. Although the modified aldrette scoring system provided a useful starting point in assessing the fast-tracking eligibility of patients in the ambulatory Setting[2], FTC Score should help to limit the number of additional nursing interventions in the step down unit. Although FTC Score should be useful for determining which outpatient can safely by pass the PACU, these criteria were not designed for determining home readiness after ambulatory surgeries[8].

FTC (b): FTC score was significantly higher in group D as compared to Group S at all times ($p<0.05$) for 30 minutes. Discharge criteria from PACU in all patients was achieved at 20th min in Group D while in Group S it was achieved at 30th min. The difference was statistically significant ($p=0.00$). Our findings corroborate with the studies of White et al. in their study all patients met fast-track recovery criteria (FTC Score ≥ 12) upon leaving the OR. Sevoflurane group had medic FTC Score of 13, while desflurane group had median FTC Score of 14. In our study median FTC Score on leaving OR was 13 in Group D while 11 in Group S

Complications

Cough: 5 patients (16.67%) in group D, 4 patients (13.33%) in group S had cough after removal of LMA. There was no statistically significant difference between the two groups (p value 0.718) similar results were observed in studies by Mahamood et al, Satya Narayana et al, Kotwani et al., in study by Mohmood et al 5 out of 30 patients in Desflurane group, 3 out of 30 patients in sevoflurane group developed cough. There was no statistically significant difference among both groups. In study by Satyanarayana et al the incidence of coughing was 23.3% in desflurane in comparison with 16.7% in sevoflurane. There was no statistically significant difference among the two groups (p: 0.748). Paul F white, Jun Tang[16] et al reported a very high incidence of cough in comparison to our study values. The overall perioperative cough was seen in 10 out of 65 patients in sevoflurane group and 21 out of 65 patients in desflurane group with a statistically significant difference among the two groups ($p<0.05$).

This high incidence of cough has been attributed to avoidance of opioid in their study out results are also in conjunction with results observed in study by Manish Kotwari et al where cough was present in 13% patients in Desflurane group and none in 13% patients in desflurane group and none in sevoflurane group. Although this is not statistically significant ($p=0.0112$) it may not be acceptable after certain procedures like ophthalmic surgeries where it can affect the surgical outcome.

Emergence agitation: 2 patients in Group D and none is group S developed emergence agitation there was no significant difference among two groups. These findings are in conjunction to results observed in studies by Priyanka Gupta et al, Cohen IT et al[1], Demir bileks, Togal T et al[22]. Eun Hee Kim et al emergence agitation is a well-documented clinical phenomenon in children characterized by confusion, irritability disorientation and inconsolable cry. It is hypothesized to be due to rapid emergence following the use of newer, less soluble anaesthetic agents. The rapid emergence may create a dissociative state and the children awaken with altered cognition. In contrast to our study, Locatelli et al observed a comparable incidence of emergence agitation in children receiving either sevoflurane or desflurane, however the duration of emergence delirium was significantly shorter with desflurane. The discrepancy in the occurrence of emergence agitation may possibly due to different scores utilized for the assessment and different premedication drugs given to patients who were evaluated[24].

Excessive secretions, laryngospasm, Bronchospasm:

Excessive secretions were observed in 2 patients in Group D (6.67%) and 2 patients in groups 5 (6.67) with no statistically significant difference no patient developed laryngospasm or bronchospasm in either groups. Our results are similar to results observed in studies by Eshima RW et al[23], MC Kay RE et al[18], Jindal et al. Our study found no difference in incidence of respiratory complications between the two groups. Due to its pungency and airway irritant properties, desflurane is expected to produce more complications than halothane & sevoflurane but it is not observed in our study due to various confounding variables like using LMA instead of endotracheal tube, administration of opioids like Fentanyl which suppresses airway reflexes, administration of drugs like midazolam and propofol, removal of LMA in deep planes could have nullified the effects of desflurane.

Nausea and Vomiting 3 patients in Group D (10%) and 2 patients in Groups (6.67%) developed Nausea and vomiting. There was no statistically significant difference among the two study groups.

Our findings are similar to results observed in studies by Satya Narayana et al, Priyanka Guptha, supriya V. Jadhav et al. one factor that has been implicated in the etiology of PONU is gastric distension after mask ventilation especially by in experienced hands.

In contrast to our study Karlsen[10] found that the post-operative nausea rate was higher in desflurane group (67%) than is sevoflurane group (36%). The low incidence rates in our study can be attributed to effective antiemetic prophylaxis and administration of propofol as intravenous inducing agent.

7. Conclusions

Desflurane provides stable hemodynamics and respiratory variable on par with sevoflurane for maintenance of anaesthesia.

Recovery is significantly faster in comparison to sevoflurane.

Fast tracking is early with Desflurane complications are a bit more when compared with sevoflurane but there is no statistically significant difference between the two drugs.

8. Future Scope

Limitations of our study:

1) Small sample size
2) Double blinding was not possible as the anesthetist who was adjusting the dial settings on the vaporizers was also looking at the variables of study.
3) Total amount of volatile agent delivered could not be calculated and hence the cost-effectiveness of the procedure is not known.
4) Bispectral index was not used to assess the depth of anaesthesia
5) Post-operative sedation levels were not studied.
6) Though neuromuscular blockade was avoided the effects of additional drugs like midazolam fentanyl, propofol and nitrous oxide on study variables and recovery profile cannot be ruled out.

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