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A PROSPECTIVE RANDOMIZED STUDY TO COMPARE SEVOFLURANE WITH PROPOFOL FOR LARYNGEAL MASK AIRWAY INSERTION IN PAEDIATRIC PATIENTS

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ABSTRACT

Objective: The present study was done in paediatric patients to compare sevoflurane with propofol inductions for quality and ease of insertion of Laryngeal mask airway (LMA). **Methods:** The present prospective randomized study was carried out in a tertiary care teaching hospital. Sixty premedicated patients of 3-12 years of age were randomly assigned to two equal groups. In propofol group, injection propofol 3mg/kg intravenous, and in sevoflurane group 6-7% sevoflurane inhalation in 4 lit/min O_2 were given. Parameters of comparison were time of induction, time of successful insertion, insertion conditions, number of attempts, ease of insertion, hemodynamic parameter, and postoperative complications. All data were analyzed using paired t-test and chi-square test. P values calculated and $P<0.05$ was considered significant. **Results:** The mean time for induction was 45.93 ± 5.58 seconds for sevoflurane group and 45.2 ± 6.07 seconds for propofol group. Insertion time for sevoflurane group (106.7 ± 17.64 sec.) was higher than the propofol group (77.23 ± 22.73 sec.) with P value <0.001, which was statistically significant. It was slight easier to insert LMA in sevoflurane group compared to propofol group. In sevoflurane group overall insertion condition was excellent in 76.66%, satisfactory in 20% and poor in 3.33% as compared to propofol group which was 66.66%, 26.66%, 6.66% respectively. The result was statistically not significant. Both groups exhibited stable hemodynamic profile. Post operative complications in both groups were not significant. **Conclusion:** Sevoflurane is an equally good alternative to propofol for insertion of LMA in paediatric patients.

Key words: Laryngeal mask airway (LMA), Sevoflurane, Propofol, Induction

INTRODUCTION

The most important role of an anaesthesiologist is to control the airway particularly in paediatric age group who is more vulnerable to life threatening hypoxia. Laryngeal mask airway (LMA) offers some of the advantages of tracheal intubation while avoiding the fundamental disadvantages by eliminating the necessity of visualizing the larynx and penetrating the laryngeal opening.[1, 2] It is safe and preferred in many procedures that are unique to children and require multiple administration of anaesthesia in short interval. Thus LMA serves as effective bridge between facemask and endotracheal tube.[3, 4] Insertion of LMA requires sufficient depth of anaesthesia for suppression of airway reflexes.[5] Among the intravenous induction agents, propofol offers a smooth and rapid induction, potent in depressing the airway reflexes, and emergence is devoid of delirium.[6] Propofol has been proved superior to other intravenous agents in insertion of LMA and has been recommended as induction agent of choice in LMA insertion when used with midazolam and fentanyl.[7, 8] Among inhalation agents, sevoflurane a halogenated volatile agent, has pleasant odour, non-pungency and low blood gas solubility which allows rapid and smooth induction with good recovery characteristics and excellent hemodynamic stability.[5, 9] Its pleasant odour and lack of discomfort coupled with fast induction makes it a highly popular induction agent in paediatric anaesthesia. A high inspired concentration for induction provides good conditions for insertion of LMA.[10-13] LMA have become widely used device in practice of anaesthesia; so it becomes imperative to search an ideal induction agent in LMA insertion. Propofol has been used as induction agent of choice since long time. Growing studies now available comparing sevoflurane 'halogenated volatile agent' with propofol. Very few studies were done in paediatric patients in India and no study was done in our institute. So, the present study was done in paediatric patients to compare sevoflurane inhalation induction with propofol intravenous induction for insertion of LMA in a tertiary care teaching hospital.

MATERIALS AND METHODS

The present study was carried out in a tertiary care teaching hospital. Hospital ethics committee approval was obtained before commencing the study. Informed and written consent was obtained from parents. Sixty patients of 3-12 years of age with ASA grade I or II posted for minor and short duration (anticipated time <60min) procedures which can be conducted under LMA anaesthesia were included in study. Patients having clinically significant cardiovascular, pulmonary, renal or hepatic disease, patients with oropharyngeal pathology, patients with limited mouth opening, laproscopic procedures, hypersensitivity to halogenated anesthetic agents were exclude from the study. It was a prospective randomized study. Patients were randomly assigned to one of two treatment groups:

Group S (n1=30) received inhalational induction with sevoflurane.

Group P (n2=30) received injection propofol intravenously.

A proper pre-anesthetic check up was performed one day before and on the morning of surgery. Clinical history was obtained and physical examination done including weight, mouth opening etc for selection of patients. Basic routine investigations like haemogram, renal function test, serum electrolytes, random blood sugar, chest x-ray etc were advised and recorded. In operation theatre after taking informed consent and confirming adequate preoperative fasting, monitors like ECG, SpO_2, and NIBP were applied and base line vital parameters were recorded. Intravenous line was taken and infusion of crystalloids started. Intravenous premedication in the form of Inj. Glycopyrrolate 4µg/kg, Inj. Ondansetron 0.1mg/kg, Inj. Fentanyl 2µg/kg and Inj. Midazolam 0.02mg/kg were given. Adequate preoxygenation with 100% oxygen for 3 minutes was done. In Propofol group, anaesthesia was induced with Inj. Propofol 3mg/kg (incremental dose of 0.5mg/kg given if required). In Sevoflurane group, circuit was primed with 6-7% Sevoflurane in 4 lit/min O_2 and patients induced with gas oxygen and sevoflurane. The induction time was noted in all patients from the time of start of drug administration (either sevoflurane or propofol) to the onset of loss of consciousness (loss of eye reflex). After achieving proper relaxation of jaw, insertion of appropriate size of LMA was attempted. Ease of insertion, coughing and gagging, laryngospasm or any airway obstruction and patient movement were evaluated in all patients and score was given accordingly. Scores attributed for condition of insertion of LMA was following; jaw opening (full 3/ partial 2/ nil 1), ease of LMA insertion (easy 3/ difficult 2/

impossible 1), coughing and gagging (nil 3/ moderate 2/ vigorous 1), laryngospasm / airway obstruction (nil 3/ partial 2/ full 1), and patient movements (nil 3/ moderate 2/ vigorous 1). All the scores with regard to insertion condition were summed up and were classified as **Excellent** if score = 15, **Satisfactory** if 13-14 or **Poor** if score <13. In all patients positioning of LMA was checked. In patients whom position of LMA was found unsatisfactory; it was removed and intubated with proper size endotracheal tube. Such incidences were regarded as failure. The time taken for insertion was defined as time taken from start of induction to successful placement of LMA. In both group, anaesthesia was maintained with sevoflurane in 50% O_2 and 50% N_2O with or without nondepolarizing muscle relaxant. Heart rate, blood pressure and SpO_2 were monitored throughout surgical procedure. These vitals were recorded at following stages: Base line, premedication, induction, insertion of LMA, 1, 2, 3, 5, 10, 30 minutes then at every 15min. At the end of procedure, all anaesthetic agents were discontinued, and 100% oxygen was given. Residual neuromuscular blockade was reversed with glycopyrrolate (8 µg/kg i.v.) and neostigmine (50 µg/kg i.v.). As patient became fully conscious and able to open mouth, LMA was deflated and removed gently and surface checked for any presence of blood. Patients were observed for any post-operative complications like sore throat, nausea, vomiting, agitation etc. Parameters of comparison for both groups were time of induction, time of successful insertion, insertion conditions, number of attempts, ease of insertion, hemodynamic parameter, and postoperative complications.

All data expressed as mean values ± SD and analyzed using paired t-test and chi-square test. P values calculated and $P<0.05$ was considered significant.

OBSERVATION AND RESULTS

In this study 60 patients of ASA I-II were allocated randomly in to group S [n1=30] and group P [n2=30]. Demographic details of the patients were comparable with no significant difference in both the groups. There was no significant difference in induction time among both groups. Insertion time for sevoflurane group was higher than the propofol group with P value <0.001 which was statistically significant. (Table 1) It was slight easier to insert LMA in sevoflurane compared to propofol having score of 2.86 in group S vs 2.73 in group P. Jaw opening was slightly better in group P which is 2.93 as compared to 2.9 in group S. Incidence of coughing/gagging and laryngospasm were very low in both the groups. Incidence of patient movement was more in group P for which incremental dose of propofol was given in four patients. Score for patient movements was 2.96 in group S vs 2.86 in group P. Average score in sevoflurane group was slightly higher i.e.14.61 as compared to propofol group which was 14.41 out of 15. (Figure 1) In group S overall insertion condition was excellent in 76.66%, satisfactory in 20% and poor in 3.33% as compared to group P which was 66.66%, 26.66%, 6.66% respectively. The result was statistically not significant. (Table 2) Twenty seven patients in group S was successfully inserted in 1st attempt while in group P, it was 25 patients. There was difficulty in placement of LMA in one patient of group S and two patients in group P, these patients were intubated. The overall success rate was 96.66% in group S as compared to 93.33% in group P which was not statistically significant. (Figure 2) Both group exhibited stable hemodynamic profile. There was no significant change found in SBP in both the groups except the statistically significant difference was observed at only 2’ post LMA interval between two groups where fall in SBP (systolic blood pressure) was more in propofol group (P value <0.05). There were no statistically significant difference at any point of observation for DBP (diastolic blood pressure) in both groups (P value >0.05). Heart rate at different time periods in both the groups was almost similar. There was no significant difference at any given point of observation for heart rate in both groups (P value >0.05). The arterial oxygen saturation showed parallel changes in both the groups and statistically insignificant. (Table 3) Post operative complications like nausea-vomiting, agitation, sore throat and blood on LMA were found in some patients in both groups but not significant. (Table 4)

Table-1: Demographic characteristics of patients in both groups (n1=n2=30)

	Group S (Mean ± SD)	Group P (Mean ± SD)
Mean age (yrs)	6.3 ± 3.06	6.33 ± 3.02
Mean weight (kgs)	18.03 ± 6.77	18.53 ± 7.26
No. of Male patients	22	21
No. of female patients	8	9
Operating time (min)	33.33 ± 13.58	32.86 ± 14.68
Induction time (sec)	45.93 ± 5.58	45.2 ± 6.07
Insertion time (sec)	106.7 ± 17.64	77.23 ± 22.73

Table-2: Overall insertion condition with score in both the groups

Group	Excellent (score=15)	Satisfactory (score=13-14)	Poor (score<13)	Average score
S (n1=30)	23 (76.66%)	6 (20%)	1 (3.33%)	14.61
P (n2=30)	20 (66.66%)	8 (26.66%)	2 (6.66%)	14.41
P Value	>0.05			

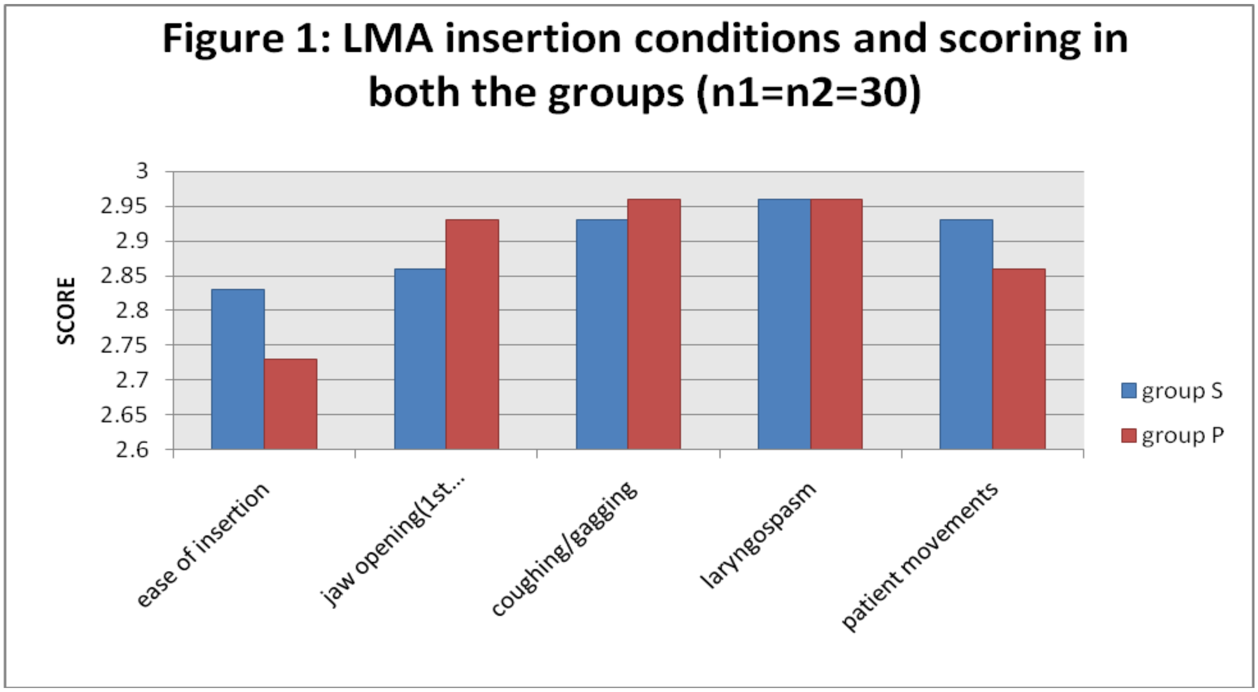
Table 3: Hemodynamic data of both the groups (n1=n2=30)

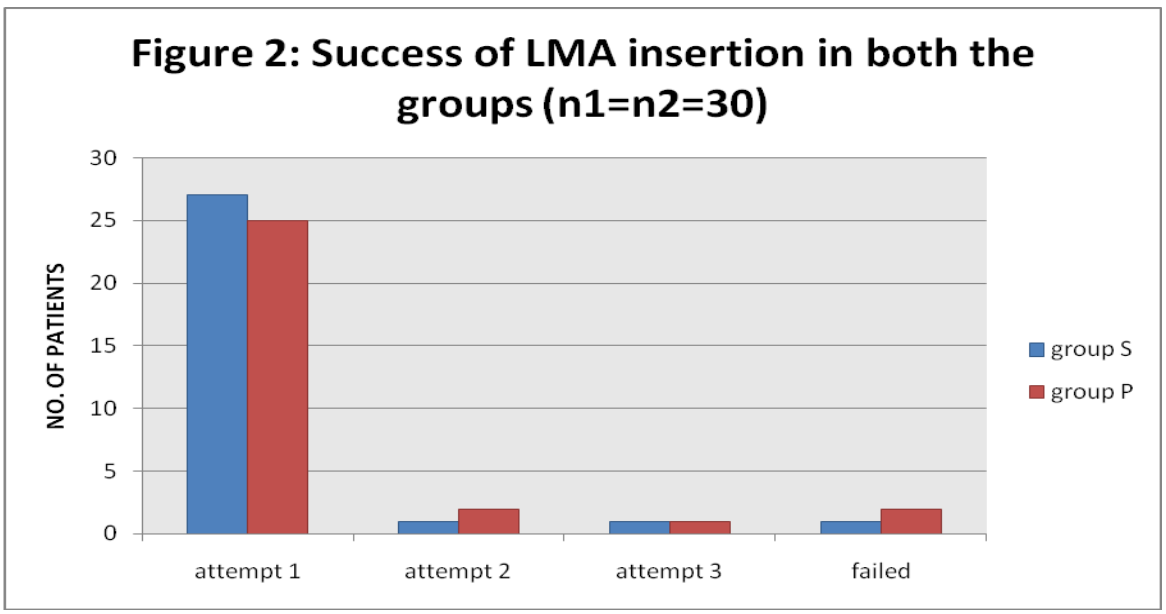
Parameters	Time of observation											
	Baseline		Induction		Insertion of LMA		2' Post LMA		5' Post LMA		10' Post LMA	
BP(mmHg)	**SBP**	**DBP**	**SBP**	**DBP**	**SBP**	**DBP**	**SBP***	**DBP**	**SBP**	**DBP**	**SBP**	**DBP**
Group S	96.80	61.26	100	62.46	88.73	56.13	91.06	56.06	92.20	57.20	93.66	58.33
Group P	96.43	62.13	103.13	64.20	87.46	55.60	85.55	54.93	89.26	56.93	91.13	58.33
HR(bpm)												
Group S	109.7		115		117.6		109		105		102	
Group P	111.7		114.5		117.5		104.2		101.4		101	
SpO2(%)												
Group S	99.30		98.9		98.13		99.23		99.63		99.63	
Group P	99.57		98.7		98.27		99.10		99.50		99.70	

* Statistically significant difference was observed at only 2' post LMA interval between two groups (P value <0.05)

Table-4: Incidence of post-operative complications after LMA insertion

Group	Blood on LMA	Sore throat	Nausea-vomiting	Agitation
S (n1=30)	2 (6.66%)	2 (6.66%)	2 (6.66%)	5 (16.66%)
P (n2=30)	2 (6.66%)	3 (10%)	1 (3.33%)	3 (10%)
P Value	>0.05			





DISCUSSION

LMA provides a safe and effective form of airway management for infant and children both for controlled and spontaneous ventilation. LMA fills a niche between face mask and endotracheal tube in terms of both anatomical position and degree of invasiveness. LMA produces lower hemodynamic instability during placement as they avoid stimulating the infraglottic structures.[2] When compared to endotracheal tube, LMA is easy to place, does not require any muscle relaxant as well as laryngoscopy there by prevents complications associated with laryngoscopy and endotracheal intubation.[14] LMA is tolerated at lower anaesthetic concentrations than the tracheal tube which allows earlier emergence from anaesthesia.[15] Amongst the commonly used IV agents, propofol offers a smooth and rapid induction. Propofol is known to be potent in depressing the airway reflexes, its antiemetic properties and low incidence of euphoria on emergence, thus facilitating LMA insertion.[6, 14, 16] Amongst the inhalation agents, sevoflurane has pleasant, non pungent odor and minimal respiratory irritant features which makes it suitable for insertion of LMA.[17] It has low blood gas partition coefficient (0.66) which provides rapid and smooth induction and recovery from anaesthesia.[6, 11, 17] It has excellent hemodynamic stability which is suitable for paediatric patients.[11] This profile makes sevoflurane the agent of choice for inhalation induction in paediatric anaesthesia. The present study was conducted to compare Sevoflurane inhalation induction with Propofol intravenous induction for placement of LMA in paediatric patients of ASA I-II posted for elective surgeries of shorter duration. All patients in our study were demographically similar in both the groups. There were no statistically significant intergroup variations regarding age, body weight, and gender distribution.

Induction time

In our study induction was equally fast in both sevoflurane group (45.93 ± 5.58 seconds) and for propofol group (45.2 ± 6.07 seconds), which was not statistically significant. Our study was in agreement to that of Kah L et al study which also observed fast induction in both groups.[10] Two studies reported faster induction with propofol compared to sevoflurane.[18, 19] This could be because of using tidal volume ventilation technique. In contrast to our finding two studies reported faster induction with sevoflurane compared to propofol.[12, 20] A high inspired concentration provides good conditions for the insertion of the LMA.[12] Induction with sevoflurane 8% rather than 3% significantly reduced the second stage of anaesthesia without adversely affecting hemodynamic stability in paediatric patients.

Time for insertion

In our study the time of insertion was higher in sevoflurane group (106.7 ± 17.64 sec.) compared to propofol group (77.23 ± 22.73 sec.), which was statistically significant. This can be attributed to the initial difficult jaw opening with sevoflurane. The result of our study was comparable to other studies which also observed significantly longer time of LMA insertion in sevoflurane group than in propofol group. [10, 12, 19, 21, 22] While Koppula RK et al study reported similar time in both the groups.[20] In contrast to our study Gil ML et al study observed shorter insertion time with sevoflurane.[11]

Insertion condition

The ease of insertion was higher with sevoflurane as compared to propofol, while jaw opening was slightly better in propofol group. Similar results were found in other studies which also failed to elicit a significant difference.[5, 21] Most of other studies showed longer time for jaw relaxation with sevoflurane when compared to propofol.[19, 22] The likely explanation for the poor mouth opening in our patients is the lag time during which the alveolar concentration of sevoflurane equilibrates with the brain, which results in inadequate anaesthesia for early insertion. This is supported by the fact that the LMA was eventually inserted in most of the patients and conditions were equally good in both the groups. Furthermore, relaxation of the jaw muscles sufficient for a jaw thrust may be a reflection of adequate depth of anaesthesia. However this is unlikely to be important with sevoflurane because of its low blood gas partition coefficient. Another possible explanation for the difference could be that equipotent doses of both drugs could not be determined. A third possibility is related to the anaesthetics themselves. Propofol is known to have a relaxant effect on jaw muscles, whereas inhaled anaesthetics may cause increased muscle tone and spasticity. The incidence of coughing/gagging was low in both the groups. Incidences of Laryngospasm were very low and essentially similar in the both groups. The patient movements were more with propofol as compared to that with sevoflurane. Similar results were reported by another study.[19] Two other studies found slightly higher incidence of limb movement in sevoflurane in contrast to propofol.[12, 22] In our study sevoflurane induction was not associated with significant excitatory activity because of higher concentration used in our study. Koppula RK et al study reported almost similar insertion condition in both groups.[20] Unlike, Priya V et al study found excellent condition in propofol group with statistically significant difference.[13] In contrast to our study some studies reported a significantly higher number of adverse events during LMA insertion in both groups.[5, 12, 18, 21] This can be attributed to the fact that they did not use any premedication. One study observed a higher adverse events during insertion using propofol but not of statistical significance.[10] Successful attenuation of the laryngeal reflexes is essential to reduce the incidence of respiratory complications during LMA insertions. Propofol is known to depress laryngeal reflexes and facilitate LMA insertion. However, sevoflurane preserves laryngeal reflexes at values up to 1.8 MAC.[23] Sevoflurane may depress laryngeal reflexes at the higher MAC values achieved in our patients.

Number of attempts of LMA insertion and Success rate

The average number of attempts for insertion in our study was 1.10 for sevoflurane group and 1.14 for propofol group which was not statistically significant. The result of our study was comparable to other study which also reported similar average number of attempts.[18] This was in contrast to other studies which reported less number of attempts with propofol compared to sevoflurane.[10, 19] In our study the 1st time success rate was higher in sevoflurane (90%) compared to 83.33% in propofol which was comparable to that of Joo HS et al study which also reported higher mean 1st time success rate with LMA.[24] With regard to the first time insertion success rate, this study found a significantly higher success rate in the propofol group in contrast to that other studies.[10, 19] Overall success rate for LMA insertion was good in both the groups which was not statistically significant. The results of other studies were comparable to our study.[13, 18, 19] When compared to these studies slight lower success rate in our study may be multifactorial.

Hemodynamic parameters

The heart rate was slightly higher in sevoflurane group at all time intervals without any statistically significant difference. Gil ML et al study also observed a higher heart rate with sevoflurane in paediatric patients.[11] Propofol group had a greater magnitude of fall in systolic and diastolic BP after induction but well tolerated by patients. The difference was statistically significant at only 2'post LMA insertion in systolic BP. Kah L et al study could observe a statistically significant difference only in the 4th and 5th minute post induction.[10] One other study also found a significant difference only in the 3rd minute after induction.[13] Some other studies did not find any significant difference.[11, 19, 21] The arterial oxygen saturation changes were comparable in both the groups and this was in agreement to other studies.[10, 13, 19]

Post operative complications

Most of the patients of both groups reported a pleasant experience. The incidence of post operative complications like sore throat, nausea vomiting, blood on LMA and agitation were also low and did not reach any statistical significance. The similar incidence of nausea and vomiting in the study groups was in contrast to the perception, that propofol is associated with less vomiting than inhalation agents. Possibly the improved incidence of postoperative nausea and vomiting with propofol as compared to sevoflurane is lost when opoid are added. It is also possible that sevoflurane has less emetic potential. Some studies reported lesser incidence of nausea and vomiting with propofol.[19, 22, 24] Kah L et al study could not find a significant difference between both groups.[10] The agitation in present study was slightly more in sevoflurane group without any statistical significance. Two other studies also observed that agitation during emergence was more common in sevoflurane group.[11, 22] It is possible that the incidence of agitation may be reduced by progressive weaning rather than abrupt cessation at the end of surgery.

CONCLUSION

In this randomized prospective study we observed that speed of induction was almost similar in both groups. Sevoflurane took significantly longer time for insertion of LMA but numbers of attempts were slightly lower as compared to that with propofol. Insertion conditions were similar in both the groups. Hemodynamic stability was maintained in both group but slightly better in sevoflurane. There were very low incidences of post operative complications in either group. Thus sevoflurane is an equally good alternative to propofol for insertion of LMA in paediatric age group.

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DESIGN OF DUAL BAND ELECTRICALLY SMALL MICRO-STRIP ANTENNA WITH WAVE TYPE SLOT AS COMPLEMENTARY OF FOLDED DIPOLE ANTENNA FOR WI-MAX, WLAN AND TERRESTRIAL COMMUNICATION AND NETWORKING

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ABSTRACT

This paper presents a new electrically small rectangular probe-fed micro-strip patch antenna loaded with material Rogers rt/duriod5880(tm). The present dissertation deals with electrically small antenna which are electrically small compared to wave length. the performance of electrically small antenna are closely related to their electrical size, so the gain can be increased to maintain radiating efficiency. The micro-strip patch antennas have been widely used in satellite and telecommunications for their good characteristics such as light weight, inexpensive, low cost and so on. here in this design slots are placed to form folded dipole, which increases the band width of the antenna. Different parameters like returnloss, gain (2d&3d), radiation pattern in θ, Ø directions, current distribution, E&H fields and VSWR are simulated in HFSS 13.0.This type of proposed patch can be used for various applications in C & X-Bands.

Keywords: Electrically small antennas, probe-fed, Dipole antenna.

INTRODUCTION

Electrically small antenna is small compared to the extremely long waves lengths used at the lowest radio frequencies. There are various rules for considering an antenna to be electrically small. The large dimension of the antenna is no more the One-Tenth of a wave length. The most common structure in electrically small antenna is short dipole. The 3 basis for understanding electrically small antenna is

- Efficiency
- Impedance matching
- Radiation patterns.

In Tele communication Micro-strip patch antennas are widely used in portable electronic devices due to their compact size, low profile and low cost which can be mounted on a flat surface. The patch is generally made of conducting material such as copper or gold and can take any possible shape. Micro strip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation. In order to design a compact Micros trip patch antenna, higher dielectric constants must be used which are less efficient and result in narrower bandwidth.

The main purpose of this work is to investigate the miniaturization of a rectangular probe-fed micro-strip folded dipole patch antenna by inserting a number of slots one-by-one to the radiating edges. so that the slot length is a half wavelength at the desired frequency and the width is a small fraction of a wave length. The antenna is frequently compared to a conventional half wave dipole consisting of two flat metal strips. Here the design of folded dipole is presented. Generally dipole is the complementary of the slot antenna. Slot antennas are often used at UHF & Microwave frequencies

In this paper, a compact size micro-strip folded dipole slot antenna is proposed with dielectric substrate as Rogers RT/duroid 5880(tm) with εr=4.4 and dimensions are base on resonant frequency. Various attempts are made to adjust the dimensions of the patch to improve the parameters like bandwidth, return loss, gain along **θ, Ø** directions, radiation pattern in 2-D and 3-D, E and H Field Distributions, Current Distributions using HFSS 13.0

DESIGN MODEL

The basic structure of the proposed antenna is shown in figure 1. The antenna is designed based on the substrate material as Rogers RT/Duroid 5880 with a dielectric constant εr of 4.4.The size of the antenna is 3cm.fundamental patch is a rectangular one with probe-feed, rectangular slots were inserted one with a length of 0.6cm and a width of 0.1cm.The substrate thickness is 0.16cm.So we designed the slots with individual manner and part of the patch was removed in the shape of wave . The patch can be fed with a probe through ground plane. Placing the slots in complementary of folded dipole increases antenna's electrical length, without modifying the patch's global dimensions.The slot antenna consists of a radiator formed by cutting a narrow slot in a large metal surface. Such an antenna is shown in figure. The slot length is a half wavelength at the desired frequency and the width is a small fraction of a wavelength. The antenna is frequently compared to a conventional half-wave dipole consisting of two flat metal strips. The physical dimensions of the metal strips are such that they would just fit into the slot cut out of the large metal sheet.

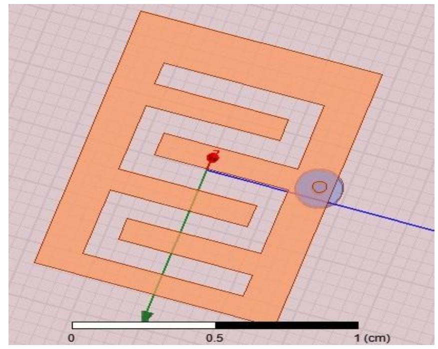

Figure 1: geometry of rectangular probe-fed with folded dipole.

Here both probe fed & edge fed electrically small micro-strip folded dipole antennas are measured in order to validate the results of the simulations. From the results obtained, the simulated return loss & gain values of electrically small micro strip probe fed folded dipole antenna are better than the values obtained using edge fed. Micro-strip probe fed folded dipole antenna was simulated and the numerical return loss and radiation patterns were shown. The purpose of this paper is to discuss the micro strip probe-fed folded dipole patch antenna and to present the experimental results. In particular, the dimensions of the patch are given along with the feed network. Discussion of the dimensions and how they were obtained are presented. The experimental return loss and the experimental E and H-plane radiation patterns are compared with the Ansoft HFSS 13.0 results.

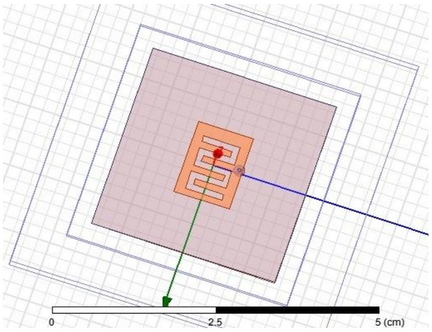

Figure 2: Ansoft HFSS generated model.

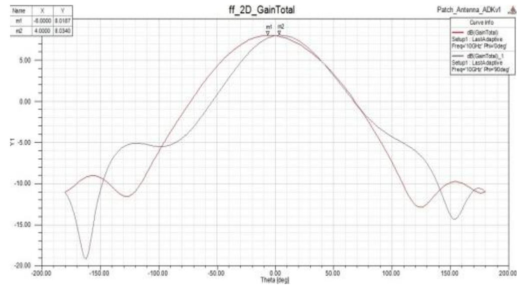

Figure 4: 2D gain total

SIMULATION RESULTS

A.Return loss:

It is defined as the signal attenuation caused by impedance variations in the structure of a cable or associated connection parts.

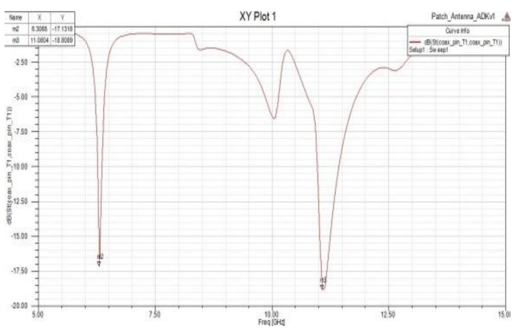

Figure 3: Return Loss

From the figure 3, the return losses of the proposed antenna at 6.3065GHz and 11.0804GHz are -17.1318dB and -18.8089dB.

B. Gain:

It is defined as the ratio of the radiation intensity in the peak intensity direction to the intensity that would be obtained if the power accepted by the antenna were radiated isotropically.

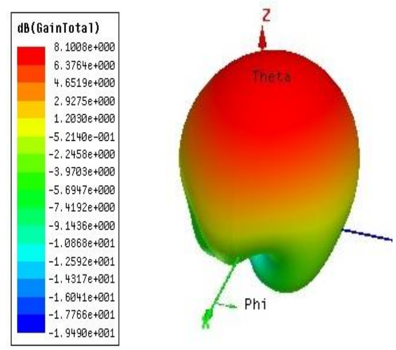

Figure 5: 3D gain total

Figure 4 & 5 shows the gain of the antenna in 2D & 3D patterns. The gain of the proposed antenna is 8.1008 dB.

C. Radiation patterns:

The radiation pattern of an antenna is a plot of the far-field radiation properties of antenna as a function of the spatial co-ordinates which are specified by the elevation angle **θ and** Ø and the azimuth angle. It is a plot of the power radiated from an antenna per unit solid angle which is nothing but the radiation intensity.

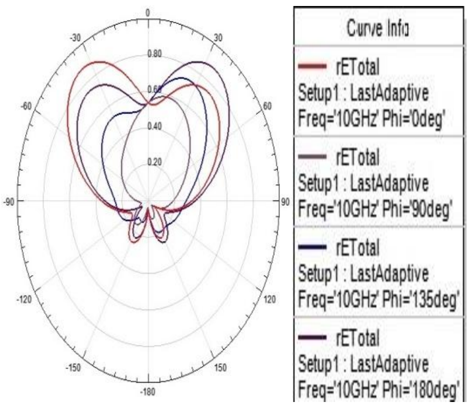

Figure 6: Radiation Pattern total

Figure 6 shows the radiation pattern total (E-total) plotted at 10GHz.

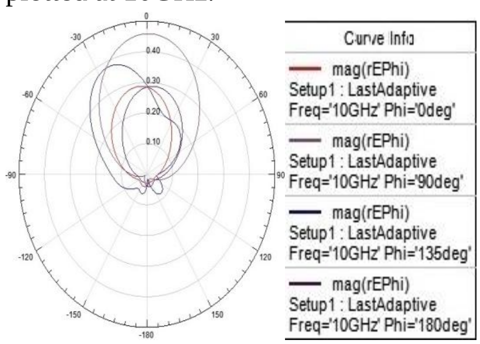

Figure 7:Radiation pattern phi

Figure 7 shows the radiation pattern phi (E -Phi) plotted at 10Ghz.

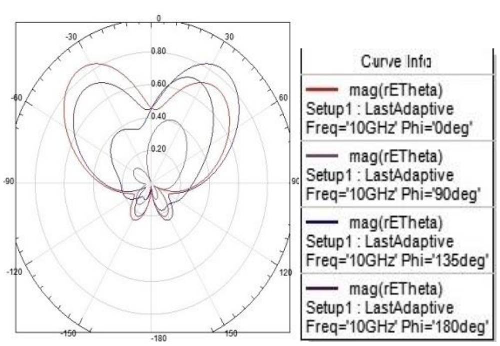

Figure 8: Radiation pattern theta

Figure 8 shows the radiation pattern theta (E-Theta) plotted at 10GHz.

D. E-Feild distribution

The effect produced by an electric charge that exerts a force on charged objects is the E-field and its distribution in the patch is as shown in figs 9 & 10

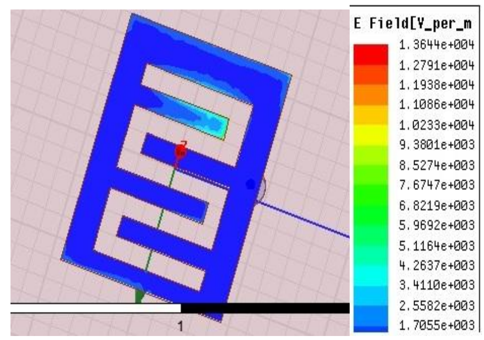

Figure 9 : Electric field at mag_E

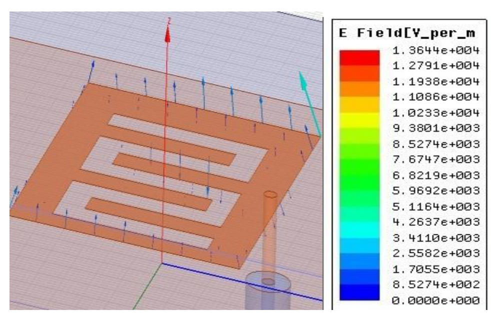

Figure 10: electric field at vector_E

The value obtained from the figures 9 & 10 is 1.3644e+004 at 10GHz frequency.

E. H-Field distribution:

The measured intensity of a magnetic field in the patch is shown in figure 11 & 12

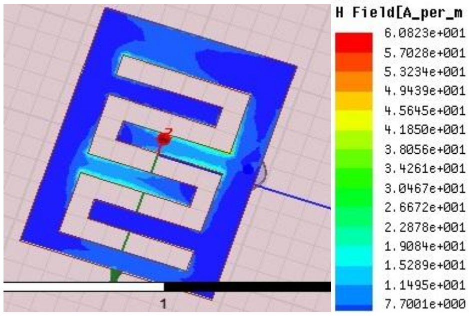

Figure 11: Magnetic field at mag_H

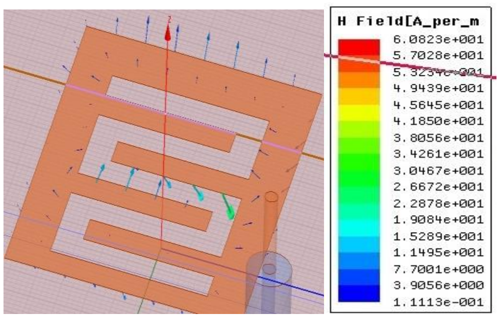

Figure 12: Magnetic field at vector_H

The value obtained from the figures 11 & 12 is 6.0823e+001 at 10GHz.

F. Current distribution:

The distribution which establishes itself when the influence of over potential is negligilble.

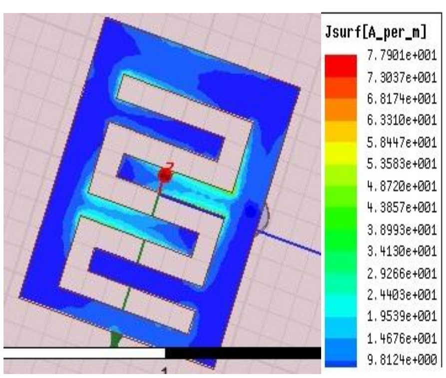

Figure 13: Current distribution at mag_Jsurf

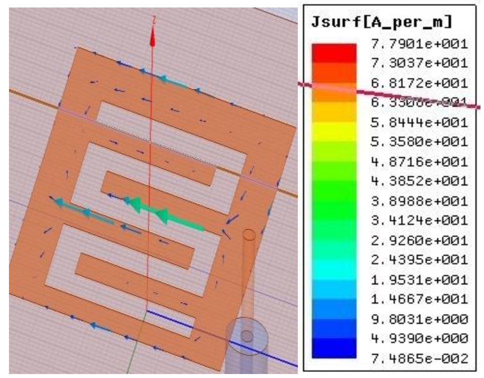

Figure 14: Current distribution at vector_Jsurf

The measured value obtained from the figure 13 & 14 is 7.7901e+001 at 10GHz.

G.Mesh plot

It can be said by the rectangles which defines the current distribution.current distribution on the patch and from the figure it is clear that current distribution is more on the patch when compared to the substrate.

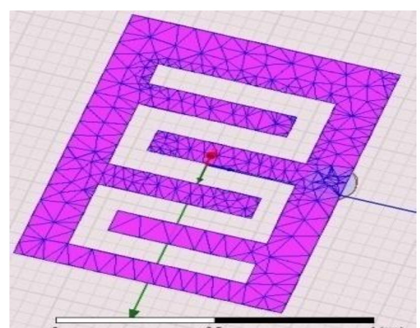

Figure 15: Mesh Plot

H. VSWR

It is a function of reflection coefficient, which describes the power reflected from the antenna.

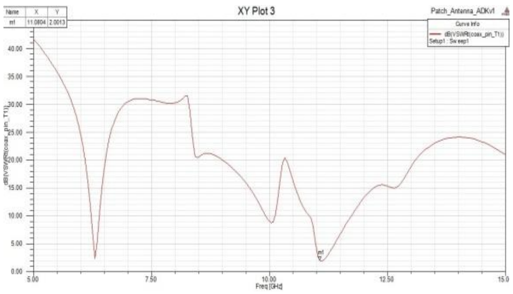

Figure 16: Terminal VSWR

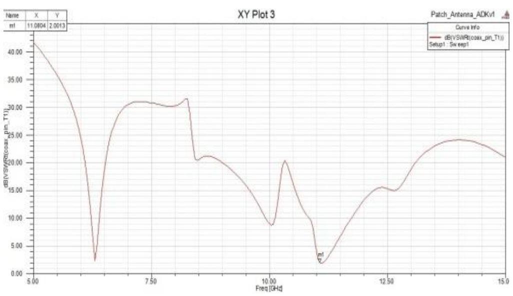

Figure 17: Active VSWR

Figure 16 & 17 shows Terminal and Active VSWR plotted at 10GHz.The VSWR obtains 2.0013 at 11.0804GHz frequency.

Tabular form:

Typical dimensions for the antenna designed for 10GHz.

S.NO	Parameter	Magnitude	Units
1.	Gain	1.0000	dB
2.	Directivity	0.9975	No units
3.	Realized Gain	0.9849	dB
4.	Polarization Ratio	1.0000	dB
5.	Axial Ratio	1.0000	dB

CONCLUSION

A basic rectangular probe-fed micro-strip patch antenna can be miniature by inserting a number of slots placing one-by-one to the radiating edges with short range tracking, satellite, weather radar systems and wi-fi applications. The resultant antennas with slots can be characterized as small antennas. In this design the proposed antenna can operate at 10GHz with return loss <-10dB.Good return loss and radiation pattern characteristics are obtained in the frequency band of interest. The antenna is successfully designed and optimized. The performance properties are analyzed for the optimized dimensions and the proposed antenna works well at C & X-band. Finally, the measurements of rectangular micro-strip probe-fed patch antenna on Rogers RT/duroid 5880(tm) substrate for satellite, military, short range tracking, missile guidance and marine radar applications have been investigated.

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