Original Article

A Comparative Study between Propofol-fentanyl versus Propofol-suxamethonium for Ease of Endotracheal Intubation in Children

Abstract

Background: Following propofol induction, suxamethonium tremendously improves intubating conditions in children and has been the gold standard agent for this purpose. However, suxamethonium could be absolutely contraindicated in some patients. Fentanyl, a short acting opioid, has been investigated as a suitable alternative with varying results. **Aim and Objectives:** This study compares the ease of tracheal intubation between propofol-suxamethonium (1.5 mg/kg) and propofol-fentanyl (3 mcg/kg) during general anaesthesia among children. **Patients and Methods:** In this double-blind randomised controlled study, 84 ASA I or II patients booked for elective surgery under general anaesthesia requiring tracheal intubation were randomised into two groups (F and S). Induction was with propofol 3 mg/kg over 30 s followed by either fentanyl 3 mcg/kg or suxamethonium 1.5 mg/kg. Two minutes later, there was an attempt at intubation and intubating conditions were assessed using Steyn's modification of Helbo-Hansen's score (ease of laryngoscopy, jaw relaxation, coughing, vocal cord position, and limb movement). **Results:** All patients in both groups had successful intubation at the first attempt. Patients in group S (suxamethonium) had significantly better overall intubating conditions compared to those in group F (fentanyl) (p=0.0001), 85.7% in group S compared to 21.4% in group F had excellent intubation condition. None of the patients in the two groups demonstrated fair or poor intubation condition. **Conclusion:** A combination of propofol-fentanyl can be used as an alternative to propofol-suxamethonium to ease intubation in paediatric patients.

Keywords: *Endotracheal intubation, fentanyl, intubating conditions, propofol, suxamethonium*

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Introduction

Endotracheal intubation is one of the ways of providing an unobstructed airway during administration of general anaesthesia. Children are often intubated for various kinds of procedures for surgical purposes or in the intensive care unit. It is one of the critical steps during administration of general anaesthesia. A major responsibility of the anaesthetist is the provision of adequate airway for the patient especially in children who have peculiar anatomical, physiological, and pharmacological characteristics.[1]

Endotracheal intubation is usually preceded by induction of anaesthesia with an intravenous or an inhalational agent. Propofol, an isopropyl phenol induction agent, has been used solely to facilitate intubation without muscle relaxant due to its better jaw relaxation and laryngeal reflex attenuation.[2] However, in other studies, propofol alone was found not to produce optimal intubating conditions in 44%–80% of patients.[3,4] Larger doses of propofol will cause further laryngeal reflex attenuation, thereby improving ease of tracheal intubation,[5] but due to haemodynamic depression at larger doses, such technique is not recommended.

Muscle relaxants are often administered during general anaesthesia to facilitate laryngoscopy and endotracheal intubation[6] after induction of anaesthesia. Muscle relaxant technique for endotracheal intubation started in 1942 in the USA, and within few years of introduction, this technique quickly gained widespread acceptance in the country.[7,8]

Suxamethonium, a short acting depolarising muscle relaxant, with rapid onset and offset of action, is the frequently used muscle relaxant for endotracheal intubation.

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Suxamethonium has a profound muscle relaxant effect which allows tracheal intubation in few seconds in almost every attempt, with a 100% success rate having been reported.[1,2] The use of suxamethonium has however generated some controversies because of its associated side effects such as bradycardia, prolonged paralysis, masseter spasm, postoperative myalgia, and malignant hyperthermia.[1] Opioids have also been used for the facilitation of endotracheal intubation. Studies have shown that a combination of opioids with propofol can be used to facilitate tracheal intubation in children.[9,10] Most of these studies demonstrated improvement in intubating conditions with increasing doses of either opioids or propofol. Fentanyl is a short acting opioid and found to obtund pressor response to laryngoscopy and improve intubating conditions optimally after 5–7 min of administration.[9]

Although fentanyl is available in our environment, it is hardly used to facilitate endotracheal intubation. Literature search revealed no previous study that has evaluated the intubating conditions with propofol-fentanyl combination in children in Nigeria. This study therefore aimed to investigate whether the combination of propofol-fentanyl would provide acceptable conditions for endotracheal intubation in children comparable with propofol-suxamethonium combination.

Patients and Methods

This was a prospective, double-blind, randomised study carried out at Aminu Kano Teaching Hospital, a tertiary institution in northwest Nigeria. With Institutional Ethical Committee approval obtained, 84 children aged 3–12 years belonging to the American Society of Anesthesiologists' (ASA) physical status classification I or II and whose parent/guardian had given written consent were recruited into the study. These patients were scheduled for elective surgical procedures under general anaesthesia with endotracheal intubation. Patients excluded from this study included those with anticipated difficult airway, those undergoing ophthalmic or neurosurgical procedure, those with full stomach, history of reactive airway such as asthma, or recent upper respiratory tract infection, those with history of upper gastrointestinal tract reflux and ambulatory anaesthesia.

All prospective patients were reviewed at least a day before the surgery by the researcher. Available and relevant investigation results were reviewed and recorded. Patient's age, sex, weight, height, and body mass index (BMI) were recorded. Patient was instructed to abstain from clear fluids and solid meals for 2 hr and 6 hr respectively prior to induction of anaesthesia according to ASA fasting guidelines. On the day of surgery, the patients were randomly allotted to either group F (propofol-fentanyl) or group S (propofol-suxamethonium) after either the patient or parent/guardian was asked to pick uniformly sized sheets of paper representing either of the groups from a large box. The patient's file number was written on a sheet of paper bearing the group which the patient belonged to and kept in a sealed separate envelope that was opened after evaluation was completed. Both the investigator and the patient were blinded to the group allocation.

An intravenous access was secured with an appropriately sized cannula, anaesthetic machine and oxygen source were checked, and appropriate sizes of endotracheal tube (ETT), oropharyngeal airways, and laryngoscope blades were made available. The patient was placed on the operating bed and the baseline vital signs including noninvasive blood pressure (NIBP), pulse rate (PR), mean arterial pressure (MAP), respiratory rate (RR), peripheral oxygen saturation ($Sp0_2$) and electrocardiography (ECG) were taken with a multiparameter patient monitor All the patients had 4.3% dextrose in 0.18% saline for fluid maintenance based on calculated fluid requirement. The patients were premedicated using intravenous (IV) midazolam 0.05 mg/kg and IV atropine 0.02 mg/kg prior to induction of anaesthesia. The patients were preoxygenated with 100% oxygen using face mask via Ayre's T-piece for patients less than 25 kg and Bain's circuit for patients above 25 kg for 3–5 min.

All patients were induced with IV bolus propofol 3 mg/kg (0.2 mg/kg plain lidocaine was added to prevent injection pain) by the research assistant over 30 s. Group F then received fentanyl 3 mcg/kg while group S received 1.5 mg/kg of suxamethonium both made up to 5 ml. Two minutes later, laryngoscopy and intubation were attempted using appropriate-sized Macintosh laryngoscope blade and appropriate-sized ETT only by the researcher who had been behind the screen and unaware of the administered drugs. The ETT was then connected to the breathing circuit. Intubating conditions were assessed by the researcher using the Steyn's modification of Helbo-Hansen scoring system.[11] Intubating conditions and ease of tracheal intubation were assessed on a 1–4 scoring scale using five criteria namely: *Ease of laryngoscopy* which was classified as either easy, fair, difficult, or impossible; *Vocal cord* as open, moving, closing, or closed; *Jaw relaxation* as complete, slight, stiff, rigid; *Coughing* and *Limb movement* were both classified as none, slight, moderate, or severe. The total sums of scores accruing from the five individual criteria were recorded. A total score of 5 was judged to be excellent, 6–10 good, 11–15 poor, and a score of 16–20 as bad intubating conditions. Scores obtained were further divided into either clinically acceptable or unacceptable (total score ≤ 10 acceptable and unacceptable if total score > 10). If the score was >10, this was considered as an unfavourable intubating condition. IV suxamethonium 1 mg/kg was then given to facilitate intubation. Intubation was judged successful or failed after an attempt. Failed intubation was defined as inability to achieve tracheal intubation after an attempt and was managed by a second attempt using IV suxamethonium 1 mg/kg.

Maintenance of anaesthesia was with 1%–2% volume of isoflurane in 100% oxygen. Intraoperative monitoring included capnography, electrocardiography, SpO_2, PR and systolic blood pressure, diastolic blood pressure, and MAP. Intraoperative fluid management continued with 4.3% dextrose in 0.18% saline. Analgesia was provided by administering top-up doses of fentanyl (1–2 mcg/kg). At the end of the surgery, the patient was extubated awake and transferred to the recovery room. Data on demographic characteristics, assessment of intubating conditions, outcome of laryngoscopy, and tracheal intubation using total intubation score were recorded using a data collection.

Data obtained was analysed using Statistical Package for Social Sciences (SPSS) version 21.0. Quantitative variables such as age and weight were summarised using mean (± standard deviation) and compared using independent *t*-test. Qualitative variables such as intubating conditions in the two groups were summarised using percentages and compared using Chi-squared test or Fisher's exact test where applicable. Level of statistical significance was set at *p*-value of <0.05.

Results

All patients completed the study and none of them was excluded from the final analysis. There was no statistically significant difference in the demographic parameters between the two groups with respect to age, BMI, and sex distribution as shown in Table 1.

As seen in Table 2, all the patients in the two groups had complete (full) jaw relaxation ($p = 1.000$). The ease of ETT insertion grading was significantly better in group S than in group F ($p = 0.0001$). Insertion of the ETT was easy in 41 (97.6%) and 27 (64.3%) patients in groups S and F respectively, whereas the insertion was fair in 1 (2.4%) and 15 (35.7%) patients in groups S and F respectively. No patient in both groups had difficult or impossible insertion.

In group S, vocal cords were open in all patients 42 (100%) compared with 40 (95.2%) patients in group F. There was no patient in both groups with closing or closed vocal cords. The difference in vocal cord behaviour in the two groups was however not significant ($p = 0.152$).

Table 1: Patients' demographic data and clinical characteristics

	Group S (*n* = 42)	Group F (*n* = 42)	*P*-value
Age (years)	6.52 ± 2.75	7.00 ± 3.32	0.476
Gender (Male:Female)	23:19	24:18	0.826
Body mass index (kg/m^2)	21.98 ± 3.87	21.88 ± 4.51	0.918

Table 2: Comparison of intubation conditions in the two groups

Insertion conditions	Group S (*n* = 42)	Group F (*n* = 42)	*P*-value
Jaw relaxation			
Complete	42 (100%)	42 (100%)	1.000
Slight	0 (0%)	0 (0%)	
Stiff	0 (0%)	0 (0%)	
Rigid	0 (0%)	0 (0%)	
Vocal cords			
Open	42 (100%)	40 (95.2%)	0.152
Moving	0 (0%)	2 (4.8%)	
Closing	0 (0%)	0 (0%)	
Closed	0 (0%)	0 (0%)	
Coughing			
None	39 (92.9%)	22 (52.4%)	0.0001
Slight	3 (7.1%)	19 (45.2)	
Moderate	0 (0%)	0 (0%)	
Severe	0 (0%)	0 (0%)	
Laryngoscopy			
Easy	41 (97.6%)	27 (64.3%)	0.0001
Fair	1 (2.4%)	15 (35.7%)	
Difficult	0 (0%)	0 (0%)	
Impossible	0 (0%)	0 (0%)	
Limb movement			
None	36 (85.7%)	10 (23.8%)	0.0001
Slight	6 (14.3%)	31 (73.8%)	
Moderate	0 (0%)	1 (2.4%)	
Severe	0 (0%)	0 (0%)	

Table 3: Comparison of overall intubation condition in both groups

	Group S (n = 42)	Group F (n = 42)	P-value
Excellent (5)	36 (85.7%)	9 (21.4%)	0.0001
Good (6–10)	6 (14.3%)	33 (78.6%)	
Fair (11–15)	0 (0%)	0 (0%)	
Bad (16–20)	0 (0%)	0 (0%)	
Clinical condition of intubation			
Acceptable (Excellent or Good)	42 (100%)	42 (100%)	1.000
Unacceptable (Fair or Bad)	0 (0%)	0 (0%)	

Significantly higher proportion of patients in group S, 39 (92.9%) compared with that in group F 22 (52.4%), had no cough after ETT insertion (p = 0.0001). Slight cough occurred after ETT insertion in 3 (7.1%) patients in group S and 19 (45.2%) patients in group F. None of the patients in the two groups had moderate or severe cough after ETT insertion.

Slight limb movements occurred in 6 (14.3%) patients in group S. In group F, 32 (76.2%) patients moved post-ETT insertion and it was slight in 31 (73.8%) patients and moderate in 1 (2.4%) patient. None of the patients in both groups had severe (jerky) movement after intubation. The difference in the incidence of limb movements between the two groups was statistically significant (p = 0.0001).

The overall intubation condition grades were significantly better in group S compared with group F (p = 0.0001) as shown in Table 3. Thirty-six (85.7%) patients in group S and 9 (21.4%) patients in group F had an excellent intubation condition. Good intubation condition was observed in 6 (14.3%) patients in group S and in 33 (78.6%) patients in group F. None of the patients in the two groups demonstrated fair or poor intubation condition.

Discussion

The results from this study showed that in children, successful tracheal intubation is achievable with propofol-fentanyl combination similar to propofol-suxamethonium combination. This reaffirms the possibility of endotracheal intubation without muscle relaxants. Tracheal intubation without neuromuscular blockade is performed more frequently especially with the increasing popularity of daycase surgery.[12] Although the laryngeal mask airway offers an alternative to intubation in daycase anaesthesia, tracheal intubation for surgery in the prone position, laparoscopic, or ear, nose, and throat (ENT) surgery is essential.[12] Intubation without muscle relaxants avoids allergic reaction to the muscle relaxants and postoperative complications such as myalgia.[13]

The propofol-suxamethonium combination in this study was associated with a significantly greater rate of excellent intubation conditions (85.7%) when compared with the propofol-fentanyl combination (21.4%) (p = 0.0001). Intubation was attempted 2 min after administration of the study drugs. Fentanyl is known to exhibit its peak effect at up to 5 min after administration.[14] This might have accounted for the excellent intubation conditions in the results obtained. In a study by Rizvanovic and colleagues,[6] they investigated a similar group of children with those in this study with similar doses of drugs given, but had laryngoscopy delayed until time of peak effect. They recorded higher excellent intubation conditions with propofol-fentanyl, 85%, compared with ours of 21.4%. They also reported 97.5% excellent intubation conditions with propofol-suxamethonium combination. This underscores the fact that the timing of administration of an adjuvant is as important as the dose used. The finding by Shaikh and Bellagali[15] in a similar study as ours also revealed that propofol-suxamethonium combination produced excellent intubation conditions in a significantly higher proportion of patients, 90%, compared with propofol-fentanyl at 35% ($p < 0.01$).

Our patients were premedicated with midazolam before induction of anaesthesia. Midazolam is synergistic with propofol and may reduce its required dose. Oral midazolam is also known to be an effective premedicant in children. Contrary to the finding in this present study, Blair and colleagues[16] demonstrated a lower incidence of excellent intubation conditions (70%) with propofol-suxamethonium combination. The patients in their study, however, were not premedicated and the dose of suxamethonium used,1 mg/kg, was also lower than that in this present study.

The minimum dose of propofol required for paediatric induction of anaesthesia is 3 mg/kg and may be as high as 5 mg/kg in unpremedicated children.[17] There is an increased requirement for propofol in children which may be explained by a larger central volume of distribution of the drug with a greater cardiac output per kilogram body weight, which could result in a lower peak concentration of propofol in the blood perfusing the brain after bolus injection. Eldemrdash and Fahmy[2] combined varying doses of propofol (2.5 mg/kg, 3.0 mg/kg, and 3.5 mg/kg) with a fixed dose of 2 mcg/kg of fentanyl for intubation in unpremedicated patients and their findings in the 3.0 and 3.5 mg/kg propofol conformed with that in this present study. In their study, jaw relaxation was complete, laryngoscopy was easy to fair, in all patients (100%) who had propofol at the dose of 3.0 mg/kg or 3.5 mg/kg, similar to the finding in this study. There was a high

incidence of poor insertion conditions in the propofol 2.5 mg/kg group in their study which suggests that propofol at that dose might not be enough to achieve anaesthesia induction in unpremedicated children despite supplementation with adjuvants. In their study, vocal cords were seen moving or closing at laryngoscopy in 10% and 2.5% respectively of patients that received propofol 3 mg/kg but not in any patients that had propofol 3.5 mg/kg. We found only 4.8% of our patients with moving cords at laryngoscopy. The propofol 3 mg/kg group in their study had 2.5% of patients with moderate limb movements and this compared well with the 2.4% in our study. Although the dose of fentanyl used in this present study (3 mcg/kg) is slightly higher than in theirs (2 mcg/kg), the similarity in our results may be attributable to the delay in intubation and allowing fentanyl to achieve its peak effect (>7 min) in their study. We administered fentanyl after propofol induction, and tracheal intubation attempted 2 min thereafter in order to standardise the sequence with the suxamethonium group thus reducing bias. Furthermore, they also used lidocaine 1.5 mg/kg which is sufficient enough to obtund airway reflexes; they, however, did not give a reason why large dose lidocaine was administered.

We observed that coughing and limb movement were the most frequent response after intubation in both study groups. Morgan and colleagues[18] also reported that coughing and limb movement were responsible for the few poor intubation scores in their study with propofol-suxamethonium combination for intubation.

Conclusion

We conclude that a combination of propofol-fentanyl can be used as an alternative to propofol-suxamethonium to ease intubation in paediatric patients.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Salawu MM, Ogboli-Nwasor EO, Jamgbadi SS, Akpa FN. A study of intubating conditions: Sevoflurane versus propofol-suxamethonium in children. Niger Postgrad Med J 2017;24:155-61.
2. Eldemrdash A, Fahmy H. Assessment of intubating conditions with different doses of propofol without muscle relaxant in children. J Anesth Clin Res 2017;8:1-7.
3. Asuncao Braga FA, Silva Braga FS, Poterio GM, Filier PR, Cremonesie E. The effect of different doses of propofol on tracheal intubating conditions without muscle relaxant in children. Eur J Anaesth 2001;18:384-8.
4. Mulholland D, Carlisle RJ. Intubation with propofol augmented with intravenous lignocaine. Anaesthesia 1991;46:312-3.
5. Noh C, Ko YK, Kim YH, Lim CS, Chung WS, *et al*. Effect of dexmedetomidine on endotracheal intubating conditions during endotracheal intubation without neuromuscular blocker following propofol-remifentanil. Anaesth Pain Med 2017;12:56-61.
6. Rizvanović N, Čaušević S, Šabanović A. Conditions of endotracheal intubation with and without muscle relaxant in children. Med Glas (Zenica) 2017;14:41-8.
7. Griffith H, Johnson G. The use of curare in general anesthesia. Anesthesiology 1942;3:418-20.
8. Ezri T, Evron S, Hadad H, Roth Y. [Tracheostomy and endotracheal intubation: A short history]. Harefuah 2005;144:891-3, 908.
9. Srivastava U, Kumar A, Ghandi NK, Saxena S, Agarwal S. Comparison of propofol and fentanyl with thiopentone and suxamethonium for tracheal intubation in children. Indian J Anaesth 2001;45:263-6.
10. Inomata S, Maeda T, Shimizu T, Satsumae T, Tanaka M. Effects of fentanyl infusion on tracheal intubation and emergence agitation in preschool children anaesthetized with sevoflurane. Br J Anaesth 2010;105:361-7.
11. Steyn MP, Quinn AM, Gillespie JA, Miller DC, Best CJ, Morton NS. Tracheal intubation without neuromuscular block in children. Br J Anaesth 1994;72:403-6.
12. Ozbilgin S, Kuvaki B, Şimşek HK, Saatli B. Comparison of airway management without neuromuscular blockers in laparoscopic gynecological surgery. Medicine (Baltimore) 2021;100:e24676.
13. Beleña JM, Ochoa EJ, Núñez M, Gilsanz C, Vidal A. Role of laryngeal mask airway in laparoscopic cholecystectomy. World J Gastrointest Surg 2015;7:319-25.
14. Vahedi HSM, Hajebi H, Vahidi E, Nejati A, Saeedi M. Comparison between intravenous morphine versus fentanyl in acute pain relief in drug abusers with acute limb traumatic injury. World J Emerg Med 2019;10:27-32.
15. Shaikh SI, Bellagali VP. Tracheal intubation without neuromuscular block in children. Indian J Anaesth 2010;54:29-34.
16. Blair JM, Hill DA, Bali IM, Fee JP. Tracheal intubating conditions after induction with sevoflurane 8% in children: A comparison with two intravenous techniques. Anaesthesia 2000;55:774-8.
17. Yentis SM, Hirsch NP, Smith GB, Ip JK. Anaesthesia and Intensive Care A-Z. 5th ed. Edinburgh, London: Elsevier; 2013. p. 483-84.
18. Morgan JM, Barker I, Peacock JE, Eissa A. A comparison of intubating conditions in children following induction of anaesthesia with propofol and suxamethonium or propofol and remifentanil. Anaesthesia 2007;62:135-9.