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Comparative assessment of the propofol-butorphanol with propofol-fentanyl combination for different insertion conditions of laryngeal mask airway in orthopedic surgery

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Abstract:

INTRODUCTION: Shoulder arthroscopy can be performed under regional blocks or general anesthesia. General anesthesia using laryngeal mask airway (LMA) can be an alternative to regional techniques. Insertion of LMA within the hypopharynx mandates a depth of anesthesia apt enough to relax the jaw and obtund the laryngeal reflexes. Various adjuncts are combined with the induction agent propofol to facilitate improved insertion conditions of LMA and improved pain scores in shoulder surgeries.

AIM: The aim of this study was to a comparison of insertion conditions of LMA and postoperative pain scores in shoulder arthroscopies using either intravenous (IV) butorphanol or IV fentanyl in combination with IV propofol.

METHODS: A total of 100 patients scheduled for various elective surgical procedures were randomly selected and divided into two groups of 50 each, that is, Group F (propofol and fentanyl) and Group B (propofol and butorphanol). Coinduction was done in Group B with IV butorphanol (30 μg/kg) and in Group F with IV fentanyl (1.5 μg/kg). One minute after coinduction, the induction was achieved with IV propofol 2.5 mg/kg, jaw relaxation was assessed, and LMA was inserted. The postoperative pain scoring was done with visual analog scale (VAS).

RESULTS: With the observations made and analyzed, we found that the LMA insertion conditions were significantly better with butorphanol (jaw relaxation [90% vs. 34%; $P < 0.0001$] and ease of insertion [96% vs. 66%; $P = 0.0001$]) than fentanyl. Comparison of average VAS score of patients postoperatively during the study showed low VAS score in both groups at 1 h, but Group B showed significantly lower score as compared to Group F. Group F showed a higher mean score of VAS at 2 h and 4 h and signified first analgesic need in the majority.

CONCLUSION: The use of propofol-butorphanol combination produces excellent LMA insertion conditions as compared to propofol-fentanyl combination. Lower VAS scores due to analgesic effects of fentanyl and butorphanol contribute to painless shifting of patients undergoing shoulder arthroscopy.

Keywords:

Fentanyl, insertion conditions, laryngeal mask airway, propofol, shoulder arthroscopy

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Introduction

To decide on the best anesthetic technique for patients posted for shoulder arthroscopy, pros and cons of regional versus general anesthesia have to be taken into account. For regional blocks, interscalene approach is particularly challenging to the anesthesiologist because of lesser acceptance, postoperative neurologic symptoms, and phrenic nerve palsy. Considering these,

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general anesthesia can be an alternative, but failure to secure airway can cause catastrophic results.[1] To secure airway, general anesthesia involves laryngoscopy and endotracheal tube insertion as a common practice; the noxious stimuli of which leads to reflex rise in sympathoadrenal activity.[2] As an alternative to this invasive procedure, many noninvasive supraglottic devices are used, of which laryngeal mask airway (LMA) is the preferred one.[3] It is a supraglottic airway device that has established its role in the management of anesthesia and airway procedures.[4] The use of muscle relaxants[5] and jaw thrust is not mandatory for its insertion,[6] and it allows both spontaneous as well as positive pressure ventilation.[7] Lung function tests and recovery are better with LMA as compared to endotracheal tube.[8]

Of the various induction agents that have been used to achieve optimal condition for LMA insertion, propofol provides rapid induction, and easy insertion of LMA as gagging, coughing, and laryngospasm are minimal with propofol.[9] Propofol, if used alone, causes excessive patient movement, pain at injection site,[10] and often the dose exceeds 2.5 mg/kg leading to prolonged apnea, prolonged sedation, and hypotension.[11]

To overcome this, drugs such as opioids, midazolam, ketamine, inhalation anesthetics, or muscle relaxants are combined with propofol.[7]

In this study, the combination of propofol and butorphanol was compared to the combination of propofol and fentanyl to assess insertion conditions of LMA and analgesic effects of both the opioids in shoulder arthroscopies.

Methods

The present study was conducted after approval from the Institutional Ethical Committee. A total of 100 patients between 18 and 60 years of age, the American Society of Anesthesiologists physical status I and II, Mallampati I and II, scheduled for elective shoulder arthroscopies were randomly selected and divided into two groups of 50 each, that is, Group F (propofol and fentanyl) and Group B (propofol and butorphanol).

The detailed clinical examination was performed. All patients were kept nil by mouth overnight before surgery. The patients in both groups were explained about the surgery, anesthesia procedure, and the present study.

After the establishment of the standard monitoring and securing, intravenous (IV) cannula patients were preoxygenated with 100% O_2 for 3 min. Group B patients were coinduced with IV butorphanol 30 μg/kg and Group F patients were coinduced with IV fentanyl 1.5 μg/kg. One minute after coinduction, the induction was achieved with IV propofol 2.5 mg/kg over 60 s, and the depth of anesthesia was assessed with the loss of eyelash reflex. Jaw relaxation was assessed on 3-point scale, and disposable unique LMA of size 3 or 4 was inserted with standard technique according to the weight of the patients (30–50 or 50–70 kg, respectively). If LMA placement was not successful in the first attempt within 15–20 s, then the second attempt was made. If it would fail, then the patient was intubated and the LMA placement scored as unsuccessful and excluded from the study. Insertion conditions were assessed. There are six variables on 3-point scale from 0 to 2. The six variables assessed were jaw relaxation, ease of insertion, swallowing, coughing/gagging, head and limb movements, and laryngospasm.

Postoperatively, the intensity of pain was assessed using a 10-point visual analog scale (VAS). All patients were explained about VAS preoperatively. If the score was more than 4, a rescue analgesic was given IM. The time taken for the need to administer rescue analgesic was noted as the first analgesic need (FAN) in hours. Pain score assessment was stopped once rescue analgesic was given.

All results were compared; compiled and statistical analysis was carried out to reach the conclusion. Student's *t*-test applied for age and weight; Mann–Whitney U-test was applied for ordinal data, that is, insertion condition. $P < 0.05$ was considered statistically significant. Statistical analysis was done by computer software package SPSS version 14.0 (IBM corp,Chicago,USA) and GraphPad Prism 4. Chi-square test was used for comparing the frequencies. Observation table was made and conclusions were drawn.

Results

No significant difference ($\chi^2 = 2.43$; $P = 0.11$) was observed for gender distribution between the groups. Patients in both groups (Group F and Group B) were comparable with respect to age and weight ($P = 0.42$ and 0.07, respectively) [Table 1].

Table 1: Distribution of patients according to demographic characteristics

Variables	Group F (*n*=50)	Group B (*n*=50)	*Z*	*P*
Age (years)	33.48±11.15	31.84±11.49	0.72	0.42 (NS), >0.05
Weight (kg)	47.66±7.51	50.42±7.65	1.81	0.07 (NS), >0.05
Gender (male/female)	6/44	12/38	χ^2=2.43	0.11 (NS), >0.05

NS=Not significant

Insertion conditions for LMA showed statistically significant higher incidence of jaw relaxation ($\chi^2 = 33.28$; $P < 0.0001$) and ease of insertion ($\chi^2 = 16.42$; $P = 0.0001$) in Group B as compared to Group F. Gross relaxation of the jaw (Score 0) was achieved in 90% of cases in Group B as compared to 34% of cases in Group F. Majority of cases (66%) in Group F showed moderate relaxation (Score 1). The insertion could easily be attempted in 96% of cases in Group B, and only 4% of cases showed difficulty at the time of insertion of LMA. On the other hand, difficulty during insertion of LMA was noticed in 34% in Group F. The incidence of coughing/gagging was significantly less in Group B ($\chi^2 = 4.89$; $P = 0.02$) as compared to Group F. No significant difference was found in the incidence of swallowing ($\chi^2 = 2.04$; $P = 0.15$), head and limb movements ($\chi^2 = 2.62$; $P = 0.26$), and laryngospasm ($\chi^2 = 1.01$; $P = 0.31$) between the groups [Table 2].

The comparison of average VAS score of patients postoperatively during the study showed low VAS score in both groups at 1 h, but Group B showed significantly lower score as compared to Group F. Group F showed higher mean score of VAS at 2 h and 4 h and signified need of FAN in majority, which can be explained by shorter duration of fentanyl. Group B also showed a rise in VAS score at 2 h and 4 h, but the need of FAN was seen in limited patients only. At 6 h, rescue analgesia was given in all patients of Group F [Table 3].

Table 2: Comparison of various insertion conditions in Group F and Group B

Variables	Score	Group F (%)	Group B (%)	χ^2	P
Jaw relaxation	0	17 (34)	45 (90)	33.28	<0.0001 (S)
	1	33 (66)	5 (10)		
	2	0	0		
Ease of insertion	0	33 (66)	48 (96)	16.42	0.0001 (S), <0.05
	1	17 (34)	2 (4)		
	2	0	0		
Swallowing	0	48 (96)	50 (100)	2.04	0.15 (NS), >0.05
	1	2 (4)	0		
	2	0	0		
Coughing/gagging	0	43 (86)	49 (98)	4.89	0.02 (S), <0.05
	1	7 (14)	1 (2)		
	2	0	0		
Hand and limb movement	0	41 (82)	46 (92)	2.62	0.26 (NS), >0.05
	1	8 (16)	4 (8)		
	2	1 (2)	0		
Laryngospasm	0	49 (98)	50 (100)	1.01	0.31 (NS), >0.05

NS=Not significant, S=Significant

Table 3: Comparison of visual analog score for assessment of postoperative pain in both the groups

VAS	Group F	Group B	Z	P
0 min	0.00±0.00	0.00±0.00		NA
10 min	0.00±0.00	0.00±0.00		NA
30 min	0.00±0.00	0.00±0.00		NA
1 h	0.50±1.11	0.16±0.37	2.05	0.044 (S) P<0.05
2 h	5.18±1.00	0.58±0.67	26.91	0.000 (S) P<0.05
4 h	5.33±0.51	3.02±1.57	7.55	0.000 (S) P<0.05
6 h	-	5.34±0.48	68.49	0.000 (S) P<0.05
8 h		-		

NA=Not available, VAS=Visual analog scale, S=Significant

Discussion

Shoulder arthroscopic surgeries are being performed under general anesthesia as well as interscalene block. Interscalene block for shoulder surgeries is not very popular among anesthesiologist prompting them to search for alternatives in the form of general anesthesia with LMA. LMA has a very useful impact on the practice of anesthesia.[12] As laryngoscopy and laryngeal invasion is not needed, it is less noxious and decreases the incidence of hemodynamic changes.[13] LMA reduces airway-related laryngoscopic response and muscle relaxants-related risks such as anaphylaxis, awareness, and prolong neuromuscular blockade.[14] Successful insertion of LMA requires an adequate depth of anesthesia to suppress pharyngeal and laryngeal reflexes by either inhalation or IV agents.[15] IV induction agents are the preferred choice for insertion of LMA.[16]

The insertion of LMA following IV induction with thiopentone results in a greater incidence of gagging as compared with propofol.[17] Currently, propofol is the most widely used induction agent for LMA insertion as it provides rapid induction and excellent jaw relaxation, suppression of laryngeal and pharyngeal reflexes, and rapid induction and recovery.[10,18-21]

Propofol, when used alone, often exceeds 2.5 mg/kg which causes cardiorespiratory depression. To reduce this adverse cardiorespiratory depressant effects, a number of conduction drugs[9,22-25] were introduced among which we compared butorphanol and fentanyl. Opioids are used during induction of anesthesia as they depress upper airway reflexes and potentiate the effect of propofol. Four different doses of fentanyl (0.5, 1.0, 1.5, and 2.0 µg/kg) co-administered with propofol 2.5 mg/kg were compared by Wong *et al.*,[26] and they observed that a standard dose of that 1.0 µg/kg fentanyl provided optimal conditions in 65% of the cases. We selected the doses of fentanyl and butorphanol on the basis of a study which states that 20-40 micro gm/kg of butorphanol is comparable to 1-2 micro gm /kg of fentanyl.[27,28]

Dutt *et al.* observed that with 2 µg/kg fentanyl, mouth opening was full in 80% of patients, whereas in our study, full mouth opening was observed only in 34% of the patients. Insertions were easier in 90% of patients in their study compared to 66% in our study. This variation in mouth opening and ease of insertions might have been due to the difference in the assessment of depth of anesthesia in both the studies. They used jaw thrust as an indicator of the adequate depth of anesthesia, while we used loss of eyelash reflex as the adequate depth.[29]

Gupta *et al*. also got similar results where the incidence of absolute jaw relaxation was better in propofol-butorphanol group 28 (93.33%), intermediate in propofol-fentanyl group 16 (53.33%), and lowest in propofol-ketamine group 11 patients (36.66%).[30]

Our results are also consistent with the study conducted by Chari and Ghai, in which they compared jaw relaxation on 3-point scale for LMA insertion. Their results showed that butorphanol-thiopentone group (92.30%) had significantly higher incidence of full jaw relaxation as compared to fentanyl-thiopentone group (67.30%) ($P = 0.001$).[9]

Findings of our study were also comparable with that of study done by Doshi *et al*. who found that the incidence of absolute jaw relaxation was highest in butorphanol group (93.33%) than in fentanyl group (73.33%).[4]

Pillai and Jagadamma compared jaw relaxation between group fentanyl and butorphanol and observed that Grade I jaw relaxation was seen in 40% of patients in Group F and 85% of the patients in Group B. About 98% of patients in Group B and 86% of the patients in Group F had no cough or gagging.[31]

Decreased gagging in butorphanol group is probably due to the antitussive action and limited skeletal muscle action of butorphanol.

This finding is supported by another study conducted by Gupta *et al*. in 2011. Cough was present in 43.33% of patients in fentanyl group versus 13.33% in butorphanol group.[30] In another study conducted by Wong *et al*., higher doses of fentanyl were associated with increased incidence of coughing.[26] Increased incidence of gagging in Group F can be due to the administration of bolus dose of IV fentanyl. El Baissari *et al*. in 2014, suggested that the reason of cough during bolus administration of fentanyl may be due to several reasons including inhibition of central sympathetic system leading to vagal predominance, reflex bronchoconstriction after stimulating tracheobronchial tree, or histamine release.[32]

Better insertion conditions, as well as less number of attempts in the butorphanol group, are due to better jaw relaxation and ease of insertion as well as lesser incidence of coughing and gagging.

No significant difference was found in the incidence of swallowing ($\chi^2 = 2.04$; $P = 0.15$), head and limb movements ($\chi^2 = 2.62$; $P = 0.26$), and laryngospasm ($\chi^2 = 1.01$; $P = 0.31$) between the groups in our study which were comparable to the study done by Chari and Ghai.[9]

Our findings were consistent with the study done by Gupta *et al*. In their study, mild laryngospasm was observed in one, and mild movement was seen in 40% of patients in propofol-fentanyl group, whereas no patient suffered laryngospasm and mild movement was seen in 10% of patient in propofol-butorphanol group which was statistically nonsignificant.[30]

Comparison of average VAS score of patients postoperatively during the study showed low VAS score in both groups at 1 h, but Group B showed significantly lower score as compared to Group F. This is in accordance with the longer plasma half-life of butorphanol as compared to fentanyl. Atkinson *et al*. also reported better VAS scores with IV butorphanol as compared to IV fentanyl during labor in a double-blind study.[33]

Group F showed a higher mean score of VAS at 2 h and 4 h and signified FAN in majority. Higher VAS scores are reported in Group B also at 2 and 4 h, but it does not signify the need of FAN in majority. At 6 h, rescue analgesia was needed in all patients of Group F whereas mean VAS was 5.34 in Group B, that is, maximum patients had received rescue analgesics.

Conclusion

The present study observed excellent insertion conditions with propofol-butorphanol combination with less incidence of coughing/gagging as compared to propofol-fentanyl combination. Analgesic effects of fentanyl and butorphanol in the postoperative period helped painless shifting of patients who underwent shoulder arthroscopy.

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Conflicts of interest
There are no conflicts of interest.

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