

## A comparison of Esmolol and Labetalol for Attenuation of Sympathomimetic Responses to Laryngoscopy and Intubation



### Medical Science

**KEYWORDS :** labetalol, esmolol, sympathomimetic response

**Dr Mimiksha Giri**

Resident, Dept of Anaesthesiology, BJMC Ahmedabad

**Dr Dhaval Patel**

Resident, Dept of Anaesthesiology, BJMC Ahmedabad

**Dr Shakuntala Goswami**

Associate Professor, Dept of Anaesthesiology, BJMC Ahmedabad

### ABSTRACT

*Objective: The study was designed to Compare esmolol and labetalol for attenuation of sympathomimetic responses to laryngoscopy and intubation.*

*Materials & Methods: 80 patients were randomly divided into two groups by prospective randomized single blind study, 40 patients received labetalol 0.5mg/kg and other patients received esmolol 0.25mg/kg. The baseline heart rate, BP, Spo2 were recorded & Compared.*

*Conclusion: both Labetalol ( 0.25mg/kg ) and Esmolol (0.5 mg/kg ) in low doses are not effective in attenuation of sympathomimetic response to laryngoscopy and endotracheal intubation.*

### Introduction

Success of all surgical procedures depend on balanced anesthetic techniques, with minimal haemodynamic disturbance to the patients.

Laryngoscopy and tracheal intubation are noxious stimuli that provoke transient but marked sympathetic response manifesting as hypertension, tachycardia, arrhythmia, myocardial ischemia, increased catecholamine concentration in susceptible individuals (Kovac et al 1996).

In 1951, King et al first described the reflex circulatory responses to direct laryngoscopy and tracheal intubation of sympathetic stimulation<sup>[1]</sup>.

Typically blood pressure begins to increase after 15 seconds of laryngoscopy and become maximum after 30 seconds of direct laryngoscopy. These circulatory responses are exaggerated in hypertensive patients<sup>[2]</sup> (Prys – Roberts 1971).

Many methods to attenuate these responses e.g. premedicating the patient with drugs that tend to block the response to laryngoscopy and intubation with antihypertensive drugs, increasing concentration of volatile anaesthetic agents during mask ventilation before intubation.

Numbers of drugs have been used in an attempt to attenuate these undesirable hemodynamic responses. These include- Lidocaine spray / i.v. lignocaine , Opioids , Droperidol , $\beta$ -blockers , Nitroglycerine ointment or spray ,Isosorbide dinitrate ,Calcium channel blocker , Magnesium sulphate.

The present study was designed to study the effectiveness of Labetalol and Esmolol in attenuating the hemodynamic response to laryngoscopy and endotracheal intubation in patients undergoing surgical procedures under general anaesthesia.

### AIMS AND OBJECTIVES

- To study the effectiveness of I.V. Labetalol and I.V. Esmolol in attenuating the sympathomimetic response to laryngoscopy and endotracheal intubation in patients undergoing surgical procedures under general anaesthesia.
- To study perioperative hemodynamic stability.
- To note effect and side effects of both drugs during intra-operative and post-operative period.

### METHOD

This prospective randomized single blinded study was carried after approval of institutional ethical committee approval & written & informed consent out on 80 ASA grade I & II patients aged 18 to 60 years scheduled for elective surgical procedures under general anesthesia, divided randomly into 2 groups of 40 each.

Group	Drug	Dose
A	Labetalol	0.25 mg/kg
B	Esmolol	0.5 mg/kg

All patients undergone PAC before surgery and explained about the anesthetic technique and perioperative course. Informed consent was taken from each patient. The patients were randomized into two groups of 40 each, using random number table. Treatment was randomly allocated to the patients.

On arrival in the operation theatre, Baseline parameters [Spo<sub>2</sub>, Heart rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP)] were recorded. Two IV lines with 18/20 G cannula were secured. DNS was started through one IV cannula. All the patients were premedicated by giving Inj. Glycopyrolate (0.005 mg/kg) and injection fentanyl (1 $\mu$ g/kg) intravenously. The patients belonging to Group A received 0.25 mg/kg Inj. Labetalol while the patients belonging to Group B received 0.5mg/kg Inj. Esmolol. The patients were preoxygenated with 100% O<sub>2</sub> at 8 lit/min for 3 min during this period.

**Induction-** done with inj. Thiopentone sodium at a dose sufficient to abolish eyelash reflex, followed by inj. Succinylcholine 2 mg/kg after recording hemodynamic measurements. Patient was ventilated with 100% oxygen for 3 mins. Hemodynamic measurements were recorded just before intubation. **Intubation-** Was done with cuffed portex endotracheal tube of appropriate size after direct laryngoscopy . Hemodynamic measurements were recorded 30 sec after intubation then 1 min, 2min, 3min, 4min, 5 min, 10min and 30 min after intubation.

**Maintenance-** Was done with 50% O<sub>2</sub>+ 50% N<sub>2</sub>O+ Isoflurane . Muscle relaxation was provided by vecuronium (0.1 mg/kg b.w).

**Reversal-** Was done with inj. neostigmine (0.05 mg/kg b.w) and inj.glycopyrrolate (0.01mg/kg b.w). Reversal was done

after onset of spontaneous respiration

Any prevalence of laryngospasm, bronchospasm or desaturation were recorded and managed according to standard protocols. Any intraoperative complication were recorded and managed accordingly .

Patients were shifted to recovery room and any immediate post operative complication e.g. nausea, vomiting, shivering, respiratory depression, sedation, restlessness, hypotension, bradycardia etc were recorded and managed.

**Data management: Proposed statistical method:**

Data were entered in excel sheet and analysed by Epi Info software. Qualitative data were expressed by number and percentage. Quantitative data were presented by mean +/-SD. Difference between the means were analysed by repeated student – t test. Confidence interval were calculated and P value <0.05 was considered as significant level.

**OBSERVATION & RESULTS**

The present study was conducted in 80 patients belonging to ASA physical status class I and II scheduled for elective surgeries at B.J.Medical College & Civil hospital , Ahmedabad.

The patients were randomly divided into two groups of 40 patients each.

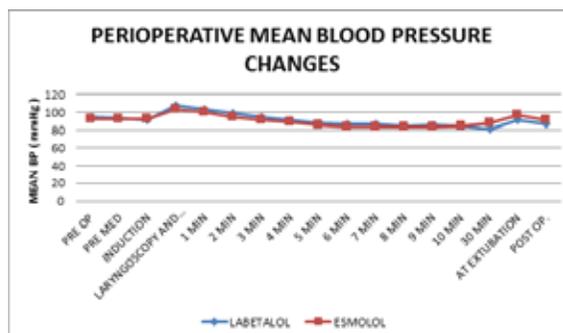
GROUP	DRUG	DOSE
A	Labetalol	0.25mg/kg
B	Esmolol	0.5mg/kg

**Table 1: Comparison of Mean ± S.D. of MBP (Mean Blood Pressure) at various intervals in patients in TWO Groups**

MEAN BP	LABETALOL		ESMOLOL		P Value
	MEAN	±SD	MEAN	±SD	
PRE OP	94.42	14.70	92.52	10.53	0.5084
PRE MED	93.65	12.92	92.50	11.46	0.6748
INDUCTION	91.17	11.22	91.67	10.74	0.8292
LARYNGOS-COPY AND INTUBATION	107.67	17.09	102.72	12.50	0.1435
1 MIN	103.30	16.50	99.57	12.56	0.2596
2 MIN	99.02	15.47	94.22	11.09	0.1150
3 MIN	94.2	14.74	91.00	12.59	0.3000
4 MIN	91.37	14.57	88.4	12.36	0.3615
5 MIN	87.65	14.59	85.72	12.23	0.5245
6 MIN	86.95	14.05	83.62	12.33	0.2643
7 MIN	86.25	13.20	83.57	11.75	0.3415
8 MIN	84.75	14.98	83.45	11.84	0.6737
9 MIN	85.57	12.98	82.95	12.19	0.3541
10 MIN	84.7	12.28	84.52	11.27	0.9472
30 MIN	80.65	10.70	87.10	11.62	0.0141
AT EXTUBA-TION	90.97	9.39	96.05	9.37	0.0170
POST OP.	86.82	7.99	90.80	10.21	0.0560

The preinduction values of MBP were comparable between two groups with no significant difference. MBP increased in both labetalol and esmolol groups after laryngoscopy and intubation without any statistically significant difference ( p >0.05 ). MBP decreased over period of 3 min to baseline value after laryngoscopy without significant difference between two groups. MBP were significantly less in patients receiving labetalol compared to those who received esmolol ( p<0.05) at 30 min after intubation and at the time of extubation .Post operative MBP values were comparable in both groups without any significant difference .

**Chart 1**



**Table 2 : Comparison of Mean ± S.D. of MBP Oxygen Saturation at various intervals in patients in TWO Groups**

OXYGEN SATURATION	LABETALOL		ESMOLOL		P Value
	MEAN	±SD	MEAN	±SD	
PRE OP	98.72	0.96	98.47	1.01	0.20
PRE MED	98.55	1.15	98.7	1.04	0.54
INDUCTION	99.27	0.81	99.3	0.82	0.86
LARYNGOS-COPY AND INTUBATION	98.92	0.72	99.1	0.67	0.25
1 MIN	98.95	0.63	99	0.59	0.85
2 MIN	99.05	0.67	92.97	0.57	0.56
3 MIN	99	0.67	98.85	0.57	0.43
4 MIN	99.2	0.56	98.97	0.47	0.26
5 MIN	99.2	0.72	99.07	0.65	0.39
6 MIN	99.1	0.63	99.05	0.59	0.71
7 MIN	99.17	0.59	99.17	0.50	0.99
8 MIN	99.30	0.64	99.25	0.58	0.71
9 MIN	99.77	0.83	98.9	0.49	0.24
10 MIN	99.92	0.61	98.9	0.63	0.16
30 MIN	99.15	0.53	99.22	0.42	0.89
AT EXTUBA-TION	99.15	0.48	99.07	0.26	0.86
POST OP.	99.12	0.56	98.75	0.49	0.34

**DISCUSSION**

The hemodynamic responses to laryngoscopy and tracheal intu-

bation from reflex sympathetic discharge result from epipharyngeal stimulation. (King BD et al 1951)<sup>[1]</sup>. It is logical to select an agent which would prevent or minimize the laryngopharyngeal stimulation

The present study aimed to study the effectiveness of Labetalol and Esmolol in attenuating the hemodynamic response to endotracheal intubation and to note any significant side effect caused by the drug.

Labetalol is an antihypertensive drug that decreases the pressure response of intubation by  $\alpha_1$  and  $\beta$ -adrenergic receptor blockade. Esmolol hydrochloride is an ultra-short acting,  $\beta_1$  selective adrenergic receptor blocker with a distribution half-life of 2 min and an elimination half-life of 9 min.

Labetalol has been used by many researchers like Singh *et al.*,<sup>[22]</sup> Ramanathan *et al.*,<sup>[15]</sup> and Maharaj *et al.*<sup>[14]</sup> for the attenuation of hemodynamic response to tracheal intubation as well as extubation in various doses, along with various anesthetic regimens. They have been quite successful in their efforts and have found labetalol effective in attenuating the pressure responses to laryngoscopy and intubation but their findings need to be further substantiated and the effectiveness of labetalol in blunting the pressure response and its comparison to esmolol needs to be evaluated in our scenario.

#### Mean Baseline Variables

The mean baseline Heart rate, systolic blood pressure, diastolic blood pressure and mean blood pressure were similar in both the groups. The mean baseline Heart rate in group A was  $83.35 \pm 12.35$  and in group B was  $88.62 \pm 11.99$ . The difference in mean systolic blood pressure was not significant as shown by P value of 0.505. Baseline mean blood pressure was also statistically similar in both the groups ( $p=0.5084$ ).

#### Heart Rate

There was significant rise in Heart rate in both groups which returns to baseline value after 7 mins of laryngoscopy. There was no significant difference between both groups up to 10 mins after post intubation ( $p>0.05$ ). When the effect of stimulus wears off, as occurs at 10 min postintubation effect Labetalol takes over and Heart rate go below baseline value as observed at 30 min post intubation.

Over study correlates with Benstein *et al.*<sup>[7]</sup> who concluded Labetalol (0.25 mg/kg) significantly blunt but does not completely block, autonomic responses to rapid sequence induction and intubation.

Roelofse *et al.*<sup>[3]</sup> found that labetalol of dosage 1 mg/kg given as an IV bolus 1 min before laryngoscopy was not effective in the attenuation of HR.

Leslie *et al.*<sup>[8]</sup> used labetalol in doses of 0.25, 0.5, 0.75 and 1.0 mg/kg and found there was dose dependent attenuation of increase in heart rate following intubation.

Our study also validates findings of Ebert DO *et al.*<sup>[6]</sup>, Singh *et al.*<sup>[22]</sup>, Saubhagyalaxmi *et al.*<sup>[24]</sup> who failed to attenuate heart rate with Esmolol.

Parnass SM *et al.*<sup>[10]</sup> and Yuan L *et al.*<sup>[13]</sup> showed effectiveness of single preinduction dose of intravenous bolus of 100mg and 200 mg in blunting hemodynamic response to laryngoscopy and intubation. In our study we failed to attenuate heart rate with esmolol (0.5mg/kg). This difference might be because of lower dose of Esmolol in our study.

#### Systolic Blood pressure

There was no significant difference between values of Es-

molol and Labetalol during laryngoscopy and up to ten minutes after that ( $p>0.05$ ). Our findings correlates with findings of Inda *et al.*<sup>[9]</sup> (labetalol 10 mg), Benstein *et al.*<sup>[7]</sup> (Labetalol 0.25mg/kg), Chung KS *et al.*<sup>[12]</sup> (0.4 mg/kg) and Maharaj *et al.*<sup>[4]</sup> (Labetalol 0.25 and 0.5 mg/kg) who failed to attenuate the rise in systolic blood pressure. Esmolol even in doses exceeding  $> 1$  mg/kg have been found to be ineffective in controlling systolic pressure rise which correlate with studies of Ebert DO *et al.*<sup>[6]</sup>, Parnass SM *et al.*<sup>[10]</sup>, Yuan L *et al.*<sup>[13]</sup>, Oda Y *et al.*<sup>[19]</sup>, Sarvesh P Sing *et al.*<sup>[22]</sup>, Sowbhagya Laxmi *et al.*<sup>[24]</sup>

Values of rise in systolic blood pressure returns to baseline 3 mins after laryngoscopy and intubation in both groups.

This failure to attenuate rise in systolic blood pressure in our study may be due to lower dose of both Esmolol and Labetalol we used in our study, as Sowbhagya Laxmi *et al.*<sup>[24]</sup> (labetalol 0.5mg/kg), Leslie *et al.*<sup>[8]</sup> (labetalol 0.5, 0.75, 1 mg/kg), Louizos AA *et al.*<sup>[20]</sup> (2mg/kg), effectively controlled rise in systolic blood pressure.

Thus we can conclude that labetalol provide better control of blood pressure 10 mins after intubation and at the time of extubation which correlates to its longer duration of action.

#### Diastolic Blood pressure

There was no significant difference between values of Esmolol and Labetalol during laryngoscopy and up to ten minutes after that ( $p>0.05$ ). Our findings correlates with findings of Inda *et al.*<sup>[9]</sup> (labetalol 10 mg), Benstein *et al.*<sup>[7]</sup> (Labetalol 0.25mg/kg), Chung KS *et al.*<sup>[12]</sup> (0.4 mg/kg) and Maharaj *et al.*<sup>[4]</sup> (Labetalol 0.25 and 0.5 mg/kg) who failed to attenuate the rise in diastolic blood pressure. Esmolol even in doses exceeding  $> 1$  mg/kg have been found to be ineffective in controlling diastolic pressure rise which correlate with studies of Ebert DO *et al.*<sup>[6]</sup>, Parnass SM *et al.*<sup>[10]</sup>, Yuan L *et al.*<sup>[13]</sup>, Oda Y *et al.*<sup>[19]</sup>, Sarvesh P Sing *et al.*<sup>[22]</sup>, Sowbhagya Laxmi *et al.*<sup>[24]</sup>

Values of rise in diastolic blood pressure returns to baseline 3 mins after laryngoscopy and intubation in both groups.

This failure to attenuate rise in diastolic blood pressure in our study may be due to lower dose of both Esmolol and Labetalol we used in our study, as Sowbhagya Laxmi *et al.*<sup>[24]</sup> (labetalol 0.5mg/kg), Leslie *et al.*<sup>[8]</sup> (labetalol 0.5, 0.75, 1 mg/kg), Louizos AA *et al.*<sup>[20]</sup> (2mg/kg), effectively controlled rise in diastolic blood pressure.

Thus we can conclude that labetalol provide better control of diastolic blood pressure 10 mins after intubation and at the time of extubation which correlates to its longer duration of action.

#### Mean Blood pressure

There was no significant difference between values of Esmolol and Labetalol during laryngoscopy and up to ten minutes after that ( $p>0.05$ ). Our findings correlates with findings of Inda *et al.*<sup>[9]</sup> (labetalol 10 mg), Benstein *et al.*<sup>[7]</sup> (Labetalol 0.25mg/kg), Chung KS *et al.*<sup>[12]</sup> (0.4 mg/kg) and Maharaj *et al.*<sup>[4]</sup> (Labetalol 0.25 and 0.5 mg/kg) who failed to attenuate the rise in mean blood pressure. Esmolol even in doses exceeding  $> 1$  mg/kg have been found to be ineffective in controlling mean pressure rise which correlate with studies of Ebert DO *et al.*<sup>[6]</sup>, Parnass SM *et al.*<sup>[10]</sup>, Yuan L *et al.*<sup>[13]</sup>, Oda Y *et al.*<sup>[19]</sup>, Sarvesh P Sing *et al.*<sup>[22]</sup>, Sowbhagya Laxmi *et al.*<sup>[24]</sup>

Values of rise in mean blood pressure returns to baseline 3 mins after laryngoscopy and intubation in both groups.

This failure to attenuate rise in mean blood pressure in our study may be due to lower dose of both Esmolol and Labetalol we used in our study, as Sowbhagya Laxmi et al.<sup>[24]</sup> (labetalol 0.5mg/kg), Leslie et al.<sup>[8]</sup> (labetalol 0.5, 0.75, 1 mg/kg), Louizos AA et al.<sup>[20]</sup> (2mg/kg), effectively controlled rise in mean blood pressure.

Thus we can conclude that labetalol provide better control of mean blood pressure 10 mins after intubation and at the time of extubation which correlates to its longer duration of action.

So both Labetalol and Esmolol are ineffective in lower doses in attenuating sympathomimetic response to laryngoscopy and intubation. The results in our study are inconsistent and insignificant, therefore further study with higher doses of the drugs is required.

### Oxygen Saturation

The mean oxygen saturation remained above 98% in both groups throughout peri operative period.

### Side effects and Complications

There were no incidence of hypotension, bradycardia, nausea, vomiting and bronchospasm in our study.

### SUMMARY AND CONCLUSION

After giving premedication and at the time of induction Pulse rate decreased significantly in group A compared to group B whereas systolic blood pressure, diastolic blood pressure and mean blood pressure were comparable.

There was a significant increase in the heart rate, systolic blood pressure, diastolic blood pressure and mean blood pressure during laryngoscopy and post endotracheal intubation in both the groups. So in lower doses both Labetalol and Esmolol does not attenuate sympathomimetic stress response to laryngoscopy and intubation.

Labetalol is better agent than Esmolol in control of both heart rate and blood pressure intraoperative and at the time of extubation due to longer duration of action.

The results in our study are inconsistent and insignificant, therefore further study with higher doses of the drugs is required.

Therefore, from the present study it is concluded that **the both Labetalol (0.25mg/kg) and Esmolol (0.5 mg/kg) in low doses are not effective in attenuation of sympathomimetic response to laryngoscopy and endotracheal intubation.**

### REFERENCES:

- King BD, Harris LC, Greifenstein FE, Elder JD and Dripps RD: Reflex circulatory responses to direct laryngoscopy and tracheal intubation performed during general anesthesia. *Anesthesiology* 1951; 12:556-66.
- Pyrs-Roberts, Foex P, Biro GP and Roberts JG: Studies of anaesthesia in relation to hypertension V: Adrenergic Beta receptor blockade. *Br. J. Anaesth.* 1973; 45: 671.
- Elkayam, Uri and Wilbert S Aronow: Glyceryl trinitrate (Nitroglycerine) ointment and isosorbide dinitrate: review of their pharmacological properties and therapeutic use. *Drugs* 1982; 23: 165.
- Maharaj RJ, Thompson M, Brock-Utne JG, Williamson R, Downing JW. Treatment of hypertension following endotracheal intubation. A study comparing the efficacy of labetalol, practolol and placebo. *S Afr Med J.* 1983 Apr 30;63(18):691-4
- Ramanathan J, Sibai BM, Mabie WC, Chauhan D, Ruiz AG. The use of labetalol for attenuation of the hypertensive response to endotracheal intubation in preeclampsia. *Am J Obstet Gynecol.* 1988 Sep;159(3):650-4.
- Ebert DO, John P, Pearson JD, Gelman S, Harris C and Bradley EL: Circulatory responses to laryngoscopy: The comparative effects of placebo, Fentanyl and esmolol. *Can. J. Anaesth.* 1989; 36: 301-6.
- Bernstein JS, Ebert TJ, Stowe DF, Schmeling WT, Nelson MA, Woods MP. Partial attenuation of hemodynamic responses to rapid sequence induction and intubation with labetalol. *J Clin Anesth.* 1989;1(6):444-51.
- Leslie JB, Kalayjian RW, McLoughlin TM, Plachetka JR. Attenuation of the hemodynamic responses to endotracheal intubation with preinduction intravenous labetalol. *J Clin Anesth.* 1989;1(3):194-200
- Ebert TJ, Bernstein JS, Stowe DF, Roerig D, Kampine JP. Attenuation of hemodynamic responses to rapid sequence induction and intubation in healthy patients with a single bolus of esmolol. *J Clin Anesth.* 1990 Jul-Aug;2(4):243-52.
- Parnass SM, Rothenberg DM, Kerchberger JP, Ivankovich AD. A single bolus dose of esmolol in the prevention of intubation-induced tachycardia and hypertension in an ambulatory surgery unit. *J Clin Anesth.* 1990 Jul-Aug;2(4):232.
- Bruder N, Ortega D and Granthil C: Consequences and preventive methods of hemodynamic changes during laryngoscopy and intratracheal intubation. *Ann Fr Anesth Reanim* 1992;11:57-71.
- Chung KS, Sinatra RS, Chung JH. The effect of an intermediate dose of labetalol on heart rate and blood pressure responses to laryngoscopy and intubation. *J Clin Anesth.* 1992 Jan-Feb;4(1):11-5.
- Yuan L, Chia YY, Jan KT, Chen CS, Wang CH, Haung LH, Kang L. The effect of single bolus dose of esmolol for controlling the tachycardia and hypertension during laryngoscopy and tracheal intubation. *Acta Anaesthesiol Sin.* 1994 Sep;32(3):147-52.
- Singh H, Vichitvejpaisal P, Gaines GY, White PF. Comparative effects of lidocaine, esmolol, and nitroglycerin in modifying the hemodynamic response to laryngoscopy and intubation. *J Clin Anesth.* 1995 Feb;7(1):5-8.
- Feng CK, Chan KH, Liu KN, Or CH, Lee TY: A comparison of lidocaine, fentanyl, and esmolol for attenuation of cardiovascular response to laryngoscopy and tracheal intubation. *Acta Anaesthesiol Sin* 1996 Sep;34(3):172.
- Mikawa K, Nishina K, Maekawa N, Obara H. Comparison of nicardipine, diltiazem and verapamil for controlling the cardiovascular responses to tracheal intubation. *Br J Anaesth.* 1996 Feb;76(2):221-6.
- Sharma S, Mitra S, Grover VK, Kalra R. Esmolol blunts the hemodynamic responses to tracheal intubation in treated hypertensive patients. *Can J Anaesth.* 1996 Aug;43(8):778-82.
- Bensky KP, Donahue-Spencer L, Hertz GE, Anderson MT, James R. The dose-related effects of bolus esmolol on heart rate and blood pressure following laryngoscopy and intubation. *AANA J.* 2000 Oct;68(5):437-42.
- Oda Y, Nishikawa K, Hase I, Asada A. The short-acting beta1-adrenoceptor antagonists esmolol and landiolol suppress the bispectral index response to tracheal intubation during sevoflurane anesthesia. *Anesth Analg.* 2005 Mar;100(3):733-7.
- Louizos AA, Hadzilia SJ, Davilis DI, Samanta EG, Georgiou LG. Administration of esmolol in microlaryngeal surgery for blunting the hemodynamic response during laryngoscopy and tracheal intubation in cigarette smokers. *Ann Otol Rhinol Laryngol.* 2007 Feb;116(2):107-11.
- Paul G, Barash, Bruce F, Cullen, Robert K, Stoelting, Michael K, Cahalan, M. Christine stock: *Clinical Anesthesia.* Edition 6, 2010:444-527.
- 
- 
- Sarvesh P Singh, Abdul Quadir, Poonam Malhotra. Comparison of esmolol and labetalol, in low doses, for attenuation of sympathomimetic response to laryngoscopy and intubation. *Saudi J Anaesth.* 2010 Sep-Dec; 4(3): 163-168.
- Shobhana Gupta, Purvi Tank. A comparative study of efficacy of esmolol and fentanyl for pressure attenuation during laryngoscopy and endotracheal intubation. *Saudi J Anaesth.* 2011 Jan-Mar; 5(1): 2-8.
- Saubhagya Lakshmi, M Santhi Sree. To evaluate effect of iv esmolol (1mg/kg) to iv labetalol(0.5mg/kg) in attenuating pressor response during laryngoscopy & intubation in general anesthesia. *Jemsd.*2014; 3(35) : 9371-9378.