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A Comparative study of Esmolol and Nitroglycerine for Controlled Hypotension in patients undergoing Tympanoplasty

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Abstract

Introduction: *Middle ear surgeries like tympanoplasty involve utilization of microscope in a small area. Slightest bleeding at surgical area would look larger due to magnifying effect of microscope. Controlled hypotension is a method by which the arterial blood pressure is decreased in a way to limit intra-operative blood loss and to provide the best possible surgical field for operating. In the present study, an attempt was made to compare the efficacies of Nitroglycerine and Esmolol and the quality of surgical field during controlled hypotensive anaesthesia induced by either of the two drugs intravenously when performing elective Tympanoplasty under General Anaesthesia.*

Methods: *60 patients having ASA I or ASA II undergoing tympanoplasty under general anaesthesia was randomly allocated to two groups of 30 patients each using computer generated sequence. Sequence concealment was done using opaque sealed envelope technique. Group E(n=30) received Esmolol 500 mcg/kg bolus over 30 seconds followed by continuous administration at a dose of 25-300mcg/kg/minute to maintain mean arterial pressure at 60-65 mmHg 10 minutes before surgery. Group N(n=30) received Nitroglycerine at a dose of 0.5-2mcg/kg/min to maintain mean arterial pressure at 60-65 mmHg 10 minutes before surgery. Parameters to be measured are heart rate, SBP, DBP and MAP every 5 minutes.*

Results: *There was increase in the Heart Rate in the Group N as compared to Group E. SBP, DBP and MAP decreased in Group N as compared to Group E. The surgical blood loss and duration of surgery was lower in the Group E. Both Nitroglycerine and Esmolol are useful for controlled hypotensive anaesthesia but Esmolol given in the dose of 25-300 mcg/kg/min (after a bolus of 500 mcg/kg) effectively reduced the surgical blood loss and duration. It also enhanced the operative visibility better. There was no clinically significant bradycardia or any other side effects or complications noted with Esmolol.*

Conclusion: *Esmolol is a safe and superior agent to Nitroglycerine for controlled hypotension in tympanoplasty as it minimizes surgical blood loss, enhances the operative field visibility and reduces overall duration of surgery at higher MAP compared to Nitroglycerine.*

Introduction

Middle ear surgeries like tympanoplasty involve utilisation of microscope in a small area. Slightest bleeding at surgical area would look larger due to magnifying effect of microscope[1]. Haemostasis for the middle ear poses special problems because even minimal bleeding impairs the surgeon's vision and lengthens the time of surgery[2]. Overall, reduced visibility of the surgical field is related to an increased risk of dangerous vascular and intracranial complications, prolonged duration, and reduced quality of intervention in the above surgeries[3].

Controlled hypotension is a method by which the arterial blood pressure is decreased in a deliberate but predictable manner to limit intraoperative blood loss and to provide the best possible surgical field for operating.[3] Methods to achieve controlled hypotension can broadly be classified as pharmacological and non-pharmacological. Non-pharmacological method includes tourniquets, patient positioning, positive airway pressure etc. while the pharmacological methods include local infiltrations, non-depolarising muscle relaxants, inhalational agents, alpha/beta blockers and direct vasodilators.[4]

Nitroglycerine mainly used to treat angina, has also been used for controlled hypotension. It is a directly acting vasodilator that primarily dilates capacitance vessels, thus reducing venous return with concomitant reductions in stroke volume and cardiac outputthereby causing hypotension.[5]

Esmolol is a short-acting cardio-selective $beta_1$ adrenergic antagonist. It has a rapid onset of action. It causes a decrease in heart rate, cardiac output and blood pressure. Other than its use as a drug of choice for perioperative hypertension, it is also commonly used for controlled hypotension.[5]

In the present study, an attempt was made to compare the efficacies of Nitroglycerine and Esmolol and the quality of surgical field during controlled hypotensive anaesthesia induced by either of the two drugs intravenously when performing elective Tympanoplasty under General Anaesthesia.

Aim and Objective

To compare the effectiveness of esmolol and nitroglycerine for controlled hypotension, access the quality of dryness at operative field and to access the side effect associated with controlled hypotension in patients undergoing tympanoplasty.

Materials and Methods

The study was carried out at Katihar Medical College, Katihar from December 2019 to November 2020 after obtaining the institutional ethical committee clearance and taking informed consent from patients.60 patients having ASA I or ASA II undergoing tympanoplasty under general anaesthesia were randomly allocated to two groups of 30 patients each using computer generated sequence. Sequence concealment was done using opaque sealed envelope technique. Group E(n=30) received esmolol 500 mcg/kg bolus over 30 seconds followed by continuous administration at a dose of 25-300mcg/kg/minute to maintain mean arterial pressure at 60-65 mmHg 10 minutes before surgery. Group N(n=30) received Nitroglycerine at a dose of 0.5 - 2mcg/kg/min to maintain mean arterial pressure at 60-65 mmHg 10 minutes before surgery. The following parameters were recorded in all patients were Heart rate, SBP, DBP and MAP and Fromme scale for visual surgical field rating (surgeon's assessment). Basal readings of heart rate, SBP, DBP and MAP were noted followed by readings every 5 minutes.

Quality of the surgical field- The quality of the surgical field in terms of blood loss and dryness, was rated every 10 min by the same attending surgeon who is unaware of the pharmacological treatments, using a six-point Fromme scale. This assessment tool was proposed and popularized by Fromme et al[43]. The from me scale is as follows:

5 – Massive uncontrollable bleeding. Surgery impossible. Constant suctioning required.

4 – Heavy but controllable bleeding that interferes with dissection. Prompt suctioning required.

3 –Moderate bleeding that moderately compromises surgical dissection. Frequent suctioning required.

2 – Moderate bleeding but without interference with accurate dissection. Surgical field not threatened. Occasional suctioning required.

1 – Bleeding, so mild it is not even a surgical nuisance. No suctioning.

0 – No bleeding, virtually bloodless field.

Results

Change in Mean heart rate (HR) between study groups

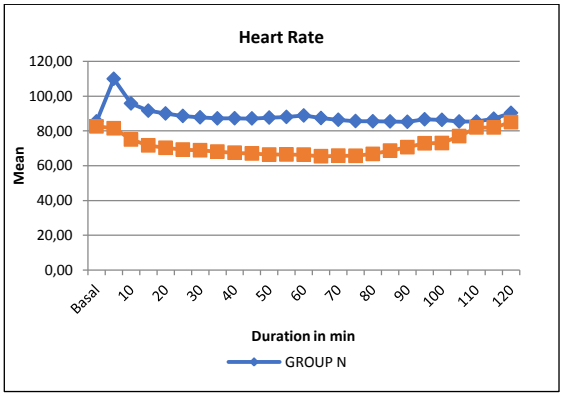

Fig 1: Graph showing mean Heart Rate among both groups. Mean basal heart rate in group N was 85.47 ± 10.75 and in group E was82.60 ± 10.44. Mean heart rate in group E decreased from base line upto 120minutes with significant value of <0.05.

Change in Mean Systolic blood pressure (SBP) between study groups

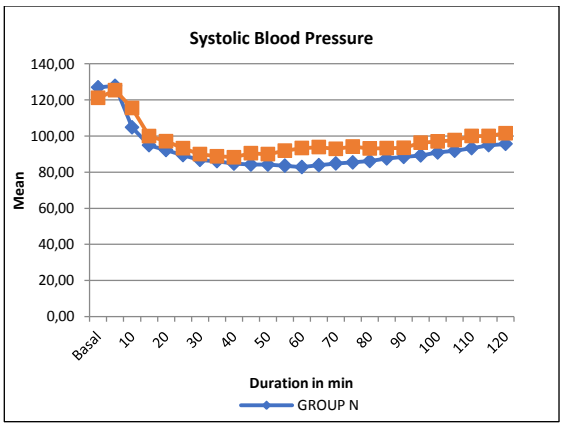

Fig 2: Graph showing mean Systolic blood pressure among both groups.

The mean basal values of SBP of the Group N were 126.97 ± 6.14 while that of Group E were 121.13 ± 7.07. Group N achieved a fall in SBP much earlier than in the Group E (at 10th min, NTG = 104.8 ± 3.54 and ESM = 115.50 ± 5.78).

Change in Mean Diastolic blood pressure (DBP) between study groups

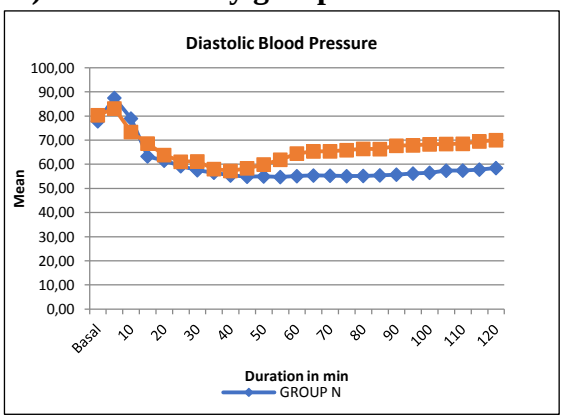

Fig 3: Graph showing mean Diastolic blood pressure among both groups.

The observed mean basal DBP values of Group N and E were 77.83 ±6.14 and 80.33 ± 4.75 respectively. After 45 min in hypotensive period, the difference in DBP between the two groups was highly significant.

Change in Mean arterial pressure (MAP) between study groups

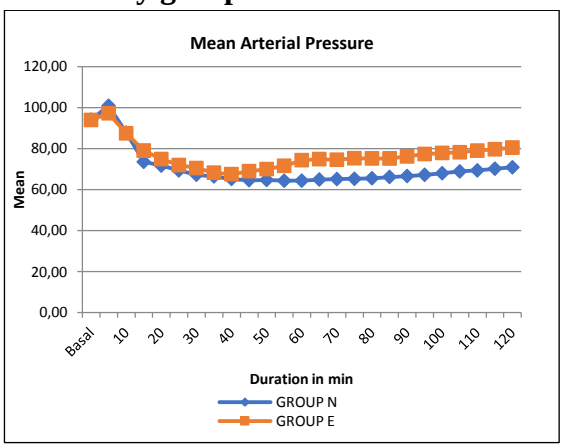

Fig 4: Graph showing mean arterial blood pressure among both groups.

The basal MAP values of Group N and E were 94.08 ± 4.86 and 93.93 ± 4.28 respectively. On an average, the mean MAP of ESM group at the end of hypotensive period was 80.5 ± 2.59 while for Nitroglycerine, it was 70.8 ± 1.12.

Change in Mean FROMME SCORE between study groups

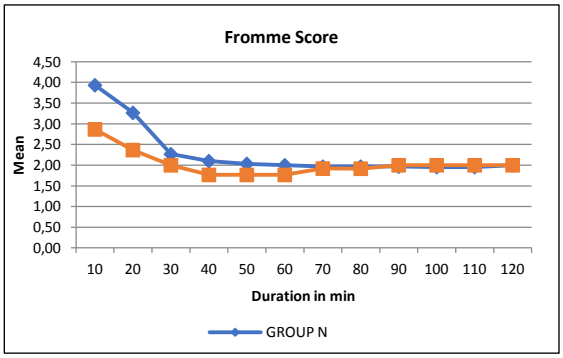

Fig 5: Graph showing mean Fromme scale between both groups.

Group E had lower Fromme score compared to group N from 10 minutes of start of infusion up to 70 minutes with statistically significant p value of **< 0.001.**

Mean Surgical Duration between study groups

Parameter	Group N		Group E		P Value
	Mean	SD	Mean	SD	
Surgical Duration	111.50	10.27	96.67	9.41	<0.0001

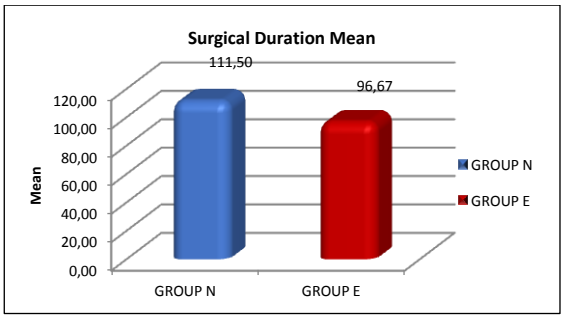

Fig 6: Graph showing the Surgical Duration Mean between both groups.

The average surgical duration in the group N was 111.5 ± 10.27 min while it was 96.67 ± 9.41 min in the group E andstatistically significant p value of **< 0.001.**

Discussion

Nitroglycerine dilates the capacitance vessels and reduce the venous return with concomitant reductions in stroke volume and cardiac output thereby causing hypotension.

Esmolol produces hypotension by reducing the heart rate, cardiac output and blood pressure. Other than its use as an anti-arrhythmic agent, it has also been found useful by several authors for the induction of controlled hypotension[7,8,9,10]. Our clinical study compared the hypotensive effects of the nitrovasodilator nitroglycerine and the ultra short acting β-adrenergic blocker esmolol in elective tympanoplasty under general anaesthesia.

The study population involved 60 consenting normotensive adults who were randomly divided into two groups with 30 patients each. The Group N received an i.v. infusion of nitroglycerine 0.5-2 mcg/kg/min 10 minutes before surgery and Group E received an initial bolus of intravenous Esmolol at 500 mcg/kg over 30 seconds followed by an infusion at 25-300 mcg/kg/min 10 minutes before surgery.

In the group N, the basal heart rate was in the range of 85.47 ±10.75and in the group E, it was 82.60 ±10.44. This difference was comparable but was statistically insignificant. At the 10th minute of infusion however, the heart rates in Group E were much lower (75.07 ±5.36) compared to the Group N (95.8 ± 8.32). This difference was highly significant (p<0.0001). This fall in heart rates in the Group E is attributed to the beta-adrenergic blocking effects of Esmolol. Throughout the surgery, the mean heart rates in the Group E were much lower than in the Group N.

The mean basal values of SBP of the Group N were 126.97 ± 6.14 while that of Group E were 121.13 ± 7.07. It is noteworthy that on an average, the Group N achieved a fall in SBP much earlier than in the Group E (at 10th min, NTG = 104.8 ± 3.54 and ESM = 115.50 ± 5.78). This difference was highly significant (p<0.0001). This is purely attributed to the mechanism of hypotension caused by each drug. Nitroglycerine has a venodilatory action while esmolol reduces the cardiac output by negative chronotropism. The latter mechanism takes some time. Even though the SBP fall is higher in the Group N, the surgical dryness was superior in the Group E.

The mean basal DBP values of Group N and E were 77.83 ±6.14 and 80.33 ± 4.75 respectively. From 45 min onwards in hypotensive period, the

difference in DBP between the two groups was highly significant.

The basal MAP values of Group N and E were 94.08 ± 4.86 and 93.93 ± 4.28respectively. This difference was comparable but clinically insignificant.

On an average, the mean MAPs of ESM group at the end of hypotensive period was 80.5 ± 2.59 while for Nitroglycerine, it was 70.8 ± 1.12.

The mean fromme score for group N at 10th min was 3.93 ±0.52 while in the Esmolol group was 2.87 ± 0.63. At 30 min, patients of the Esmolol group had a mean score of 2 compared to Nitroglycerine group that had mean score of 2.27 ±0.45. It is also worthwhile to note that at 30 min, the MAPs in the Esmolol group was 70.50 ± 4.61 versus a 67.23 ± 3.24 in the Nitroglycerine group.

The average surgical duration in the Nitroglycerine group was 111.5 ± 10.27 min while it was 96.67 ± 9.41 min in the Esmolol group. This difference is significant. The shorter duration in the Esmolol group is probably owing to the superior operative field.

On an average, we found that similar operative visibility was obtained in the Esmolol group with much higher MAPs than in the Nitroglycerine group.

Conclusion

From our study, we conclude that-

1) Both Esmolol and Nitroglycerine produced hypotension required for tympanoplasty.
2) Optimum operative conditions with better surgical field visibility were achieved at higher MAPs with Esmolol whereas similar operative conditions were achieved only with more reduction in MAP with Nitroglycerine.
3) Better surgical field dryness with reduced intraoperative bleeding was seen in the Esmolol group compared to Nitroglycerine group with a statistically significant difference between both groups.
4) The average duration of surgery was lower in the Esmolol group.
5) No complications were noted with either drug.

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