INDuced Hypotension for MAJOR Spine Surgeries, A Comparison BETWEEN HaloTHANE AND NItrOGLYCerin

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How to Cite this Article:

Abstract: Background: Induced Hypotension as an adjunct to general anesthesia provides a relatively bloodless surgical field, facilitates surgical dissection, decreases operative time and diminishes the need for blood transfusion. Aim: We conducted a prospective randomized study to compare two commonly used drugs, inhalation agent Halothane and vasodilator Nitroglycerine for hypotensive anesthesia in patients undergoing major spine surgery. Material and Methods: 40 adult patients were scheduled for double level lumbar or thoracic intervertebral fusion of spine in two groups of 20 each, either receiving nitroglycerine or halothane to maintain a mean arterial pressure of 50-60 mmHg. The effectiveness was compared with respect to the systolic pressure, diastolic pressure, and mean arterial pressure, bloodless surgical field as graded by the surgeon, blood loss and recovery. Results: The results were analyzed statistically using the students’ t test and the ’p’ value for the corresponding ‘t’ values were derived. The operative field was clear and ideal with nitroglycerin and blood loss statistically significantly lower with lesser requirement for blood transfusion. Conclusion: Hypotension in the Nitroglycerine group was more effective, gradual and sustained in comparison to halothane group. Keywords: Induced hypotension, Halothane, Nitroglycerin, Double level spinal fusion, Blood loss.

Introduction: Deliberate hypotension, as an adjunct to general anesthesia, provides a relatively bloodless surgical field, facilitates surgical dissection and decreases operative time.¹-³ It decreases the intra operative blood loss and also diminishes the need for and the risks of blood transfusions.

Spinal surgeries are elective or emergency, involving both adult and pediatric age group with procedures ranging from minimally invasive micro discectomy to prolonged operations involving multiple spinal levels and significant blood loss.⁴ Extensive procedures like posterior or anterior inter-vertebral fusion are associated with considerable hemorrhage during surgery.

Controlled hypotension is defined as a reduction in systolic blood pressure to 80-90 mmHg or mean arterial pressure to 50-65 mmHg. The main purpose is to decrease blood loss, improve operating conditions and to decrease the need for blood transfusions.⁵,⁶ Nitroglycerin has been used to control blood pressure postoperatively after coronary artery surgery⁷ and to reduce blood loss in major orthopedic surgery.⁸

The use of halothane for controlled hypotension has been studied by Prys-Roberts et al⁹ and it is an accepted method to decrease blood loss during major surgery.¹⁰ Halothane and nitroglycerine are both commonly used drugs and safe to be used for long hours of surgery. In the present study we have compared the effects of halothane and intravenous nitroglycerin on blood pressure, blood loss, and duration of surgery, recovery and requirement of blood transfusion during spine surgery.
MATERIALS AND METHODS:

STUDY DESIGN: This is a prospective randomized controlled study involving 40 patients of ASA grades I and II of either sex undergoing double level spinal fusion surgery. The following patients were excluded from the study:

1. Patients with cerebrovascular disease
2. Cardiovascular disease
3. Inadequately treated hypertensive.
4. Peripheral vascular disease
5. Patient with liver or renal dysfunction.
6. Anemia.

After obtaining institutional ethical committee approval and written informed consent from the patient, they were randomly allocated into two groups

Group 1: Patients received intravenous nitroglycerin infusion of 0.01% solution. The solution was prepared by adding 50mg of nitroglycerin to 500ml of 5% dextrose or 0.9% normal saline. Infusion was started at a rate of 1μg/kg/min and increased in 0.5μg/kg/min increments and adjusted to decrease and maintain the systolic arterial blood pressure at about 80-90mmHg.

Group 2: Patients received inhalational agent Halothane for controlled hypotension. Halothane vapor was administered through Fluotec mark III vaporizer at a concentration of 0.5 – 2.5% which was titrated to maintain a systolic blood pressure of 80 – 90 mmHg.

Preoperative Preparation: Patients were kept nil per oral 8 hours before the start of surgery. Allen’s test was done to assess patency of ulnar arch, as radial artery was cannulated for intra-arterial blood pressure monitoring. Premedication with Inj.Pethidine 1mg/kg and Inj.Promethazine hydrochloride 0.5mg/kg were given intramuscularly one hour before induction of anesthesia. Before induction the basal vital signs were recorded and two peripheral intravenous lines were cannulated with 14 or 16 gauge cannula for fluid and drug administration. A 20 gauge Teflon catheter was cannulated into the radial artery for continuous direct intra-arterial blood pressure monitoring.

Measurement of arterial pressure was continuous with the transducer placed at the mid axillary line using “Spacelabs”model 9060 3A intra-arterial pressure monitor. Monitoring was done with pulse oximetry, non-invasive and invasive blood pressure, electrocardiogram, temperature monitor, end-tidal carbon-di-oxide monitor and serial arterial blood gas estimations. Catheterization of the urinary bladder was done for all patients to measure urine output. Patients were positioned prone, lateral, or supine depending on the nature of surgery and surgical approach.

Intraoperative Management: All patients were induced with Inj. Thiopentone sodium 5-7mg/kg and intubated with Succinyl choline 1.5mg/kg with appropriate size endotracheal tube. A standard technique of general anesthesia was employed consisting of nitrous oxide and oxygen, Vecuronium bromide as muscle relaxant, (Midazolam as amnesic agent) and Pethidine as analgesic with controlled intermittent positive pressure ventilation with a closed circuit with carbon-di-oxide absorber. Inj Nitroglycerin or Halothane was used to achieve systolic blood pressure at 80 – 90 mmHg before skin incision and maintain throughout the surgery. The heart rate, systolic, diastolic
and mean arterial pressure was noted at 15, 30, 60, 90 and 120 minutes for both the groups. The surgeon was asked to grade the dryness of surgical field on a scale of (0, 1, 2)

- 0 - No bleeding.
- 1 - Minor bleeding (not troublesome).
- 2 - Excessive bleeding (troublesome).

Intravenous fluid of Ringer’s lactate and 5% Dextrose with normal saline were used to maintain hourly urine output of 1ml/kg/hr or more.

Blood loss was assessed by measuring the volume of blood in the suction bottle and by an estimate of soaked sponges. Towards the end of surgery, the hypotensive agent was withdrawn and the systolic blood pressure was maintained at pre-hypotensive level and hemostasis was obtained. Injection Neostigmine 0.05mg/kg and Inj. Glycopyrrolate 0.01mg/kg was used to reverse the patient from residual neuromuscular block. Inj. Glycopyrrolate was given intravenously if heart rate was less then 50 beats/min and Inj. Esmolol 10mg/dose up to 50mg was given for reflex tachycardia of more than 100/min persisting for more than 10 minutes in the face of a urine output of more than 1ml/kg/hr.

At the end of surgery, recovery was assessed on the following scale:

- 0 - Awake, eyes open.
- 1 - Awake, reacting to normal speech.
- 2 - Asleep reacting to loud speech or touch.
- 3 - Unconscious.

Duration of surgery was noted from start of skin incision to end of skin closure.

RESULT: The results were analyzed statistically using the students’t’ test for the following data: Heart rate, Systolic blood pressure, Diastolic blood pressure, Mean arterial pressure, Blood loss, Duration of surgery, Recovery score.

The probability (P value) for the corresponding ‘t’ values for the degree of freedom was derived. There was no statistically significant difference with regard to age and weight of the patient.

Changes in Heart Rate: In the present study the mean basal heart rate is 77.85/minute and after 15 minutes of NTG infusion it is 84.90/minute, at 30 minutes it increases to 85.95/minute, at 60 minutes it stabilizes at 85.15/minute and at 90 minutes it is 83.50/minute and at 120 minutes it is 84.40/minute.

In the halothane group the basal heart rate is 79.65/minute and after 15 minutes of halothane inhalation it is 72.50/minute at 30 minutes it decreases to 68.80/minute at 60 minutes it is 69.50/minute, at 90 minutes it stabilizes at 66.50/minute and at 120 minutes it is 65/minute.

The ‘p’ value for the mean basal heart rate is 0.654, so the basal heart rates are comparable between the two groups. After the induction of hypotension, the heart rate in NTG group was significantly higher than the halothane group. The heart changes were significantly higher at 15, 30, 60, 90 and 120 minutes in the NTG group when compared to the halothane group.

Changes in Systolic Blood Pressure: In this study it was observed that the mean basal systolic blood pressure in NTG group was 132. 4 mmHg, at 15 minute it had decreased to 102.3 mmHg at 30 minute it was 91.3 mmHg it was 88.2 mmHg and at 120 minute it was 92.2 mmHg It was observed that the mean basal systolic blood pressure in halothane group was 128.6 mmHg, at 15 min it was
108.3 mmHg, at 30 min it was 97.7 mmHg, at 60 min it was 105.1 mmHg at 90 min it was 104.4 mmHg and at 120 minutes it was 111.1 mmHg.

**Changes in Diastolic Blood Pressure:** In this study it was observed that the mean basal diastolic blood Pressure in NTG group was 81.4 mmHg, at 15 minutes it was 71.5 mmHg at 30 minutes it was 65.9 mmHg, at 60 minutes it was 60.7 mmHg, at 90 minutes and at 120 minutes it was 57.4 mmHg. Whereas the mean basal diastolic blood Pressure in Halothane group was 77.4 mmHg, at 15 minutes it was 73.7 mmHg at 30 minutes it was 70.8 mmHg at 60 minutes it was 71.1 mmHg, at 90 minutes it was 70.3 mmHg and 120 minutes it was 71.5 mmHg.

**Duration of Surgery:** In this study the mean duration of surgery in NTG group was 231 minutes and in Halothane group it was observed to be 279.25 minutes.

**Blood Loss:** In the present study it was observed that the blood loss in NTG group was 847.5 ml and in the halothane group it was 1281 ml.

**Surgical Field:** It was observed that 25% of the patients in NTG group had an operative field score of ‘0’ or no bleeding, 60% had a score of ‘1’ or minimal bleeding (not troublesome) and 15% i.e. 3 patients had a score of ‘2’ or excessive bleeding (troublesome). In the halothane group only 5% had a score of ‘0’ or no bleeding, 50% had a score of ‘1’ or minimal bleeding and 45% had a score of ‘2’ or excessive bleeding which was troublesome.

**Recovery Score:** In the present study the mean recovery score for NTG group at 5 minutes was 7.65, at 15 min it was 8.5, at 30 minutes it was 9.55 at 60 min was 10. Whereas the mean recovery score for halothane at 5 min was 6.2, at 15 min it was 7, at 30 min it was 7.85 and at 60 min it was 9.

**Amount of Drug Consumed:** An average of 12 to 15 mg of NTG was consumed for the total duration of surgery in the group-1. Halothane was consumed in an average of 100 to 120 ml for the total duration of surgery with a fresh gas flow of 6 liter per minute.

**Complications:** Two patients in the NTG group had reflex tachycardia requiring injection esmolol 10 mg bolus up to a maximum of 30 mg.

**DISCUSSION:** The major advancement with normovolemic hypotension was achieved in 1950 when Enderby introduced ganglionic blockade using pentamethonium combined with foot down tilt. Enderby described the new method as “Controlled hypotension with hypotensive drugs and posture to reduce bleeding in surgery”, (11)

**Heart Rate:** It was noted that the heart rate in the NTG group was statistically significantly higher than the halothane group. This higher heart rate can be attributed to reflex sympathetic nervous system response mediated by catecholamines and renin-angiotensin system. The halothane group having a lower heart rate despite a decrease in blood pressure is attributed to halothane related depression of carotid sinus as well as halothane induced decreases in rate of sinus node.
depolarization. Although the heart rate was higher in the NTG group the mean increase from baseline was only 6 to 8 beats and only two patients had reflex tachycardia and required treatment with 10 mg dose bolus of injection esmolol up to 30 mg intravenously.

The lowest heart rate in halothane group was 50 beats/minute. In a study by Nabil. R. Fahmy, there was a significant increase in heart rate following 15 minutes of NTG infusion and subsequent changes were not significant.12 In the study by Kadam. P.P etal comparing halothane and NTG, they did not find any significant effect on heart rate in either group.8

**Hypotension:** Comparing the hypotension achieved, both the drugs were equally effective in lowering the blood pressure in the first 15 minutes. The fall in systolic, diastolic and mean arterial pressure in the first 15 minutes were similar in both the groups and there was no statistically significant difference with the ‘p’ value being > 0.05. However the subsequent values at 30, 60, 90 and 120 minutes have shown that the NTG group had a statistically significant lower blood pressure. In the NTG group the decrease in diastolic and thereby mean arterial pressure was very highly significant with the ‘p’ value < 0.01. Kadam. P. P etal also noted that hypotension achieved by NTG was more sustained than that by halothane and with the latter had a tendency for gradual rise in systolic blood pressure.

Hypotension achieved in NTG group was more effective, gradual and sustained where as in halothane group increasing concentrations were required to maintain the same level of hypotension. This is supported by Bryth AS et al study where in they compared enflurane and halothane for hypotensive eye surgery and found that halothane was effective in producing hypotension but higher concentrations were required.13

NTG mainly induces hypotension primarily by direct effect on vascular smooth muscle, mainly the venous capacitance vessels where as in halothane, the hypotensive effect is proportional to the inspired concentration and the hypotension is almost exclusively the result of direct myocardial depression with only a slight effect on total systemic vascular resistance.14 There was no evidence of severe hypotension in either group nor was there any rebound hypertension.

**Operative Field:** The operative field was clear dry and ideal in the NTG group when compared to the halothane group. Only 3 patients out of 20 in the NTG group had a poor score of 2 or excessive and troublesome bleeding whereas 9 patients in the halothane group had the similar score as assessed by the surgeon. This finding is similar to the study done by Kadam.P.P et al using NTG and halothane where he observed that NTG had a better operative field than halothane.

**Blood Loss:** The blood loss was statistically significantly higher in halothane group (mean=1202±530.43) as compared to NTG group (mean=860±328.31). Although the duration of surgery was not statistically significant between the two groups 231±42.04 minutes in NTG group as compared to 249±44.63 minutes in halothane group, the blood loss was significantly higher in the halothane group. Since most of the bleeding during spine surgery is of venous origin it may well be that the lower venous pressure associated with NTG was partially responsible for the decreased blood loss as well as better surgical operative field.
**Transfusion requirement:** The blood transfusion rate was higher in the halothane group with 9 patients requiring blood transfusion in the range of 2 to 3 units as compared to only 4 patients who required transfusion in the NTG group. This study is supported by a similar study done by Kadam. P. P. et al.

**Recovery Score:** Recovery from anesthesia was very highly significantly delayed in the halothane group when compared to the NTG group, ‘p’ value <0.01. Around 15% of patients in halothane group had a score of 3 or unconscious at the end of surgery and required 30 minutes to awaken. Using halothane alone to induce hypotension often fails to produce adequate hypotension unless a undesirably high concentration is administered, so this could be the reason why patients with halothane induced hypotension had a poor recovery score post operatively. This is also supported by Kadam. P. P et al study.

**CONCLUSION:** We conclude that both NTG and halothane are effective and safe in producing controlled hypotension for spine surgery. However NTG is preferable as the hypotension achieved was gradual, more effective and sustained, providing a better operating field, decreased blood loss and thereby less blood transfusion requirements and faster recovery from anesthesia.

**REFERENCES:**


<table>
<thead>
<tr>
<th>TIME</th>
<th>GROUP I NTG (N=20)*</th>
<th>GROUP II HALOTHANE (N=20)*</th>
<th>‘t’</th>
<th>‘p’</th>
</tr>
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<tbody>
<tr>
<td>BASAL</td>
<td>77.85±12.29</td>
<td>79.65±12.93</td>
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<td>0.654</td>
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<tr>
<td>15 MIN</td>
<td>84.90±10.95</td>
<td>72.50±11.02</td>
<td>3.569</td>
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<tr>
<td>30 MIN</td>
<td>85.95±9.43</td>
<td>68.80±10.71</td>
<td>5.375</td>
<td>0.000</td>
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<tr>
<td>60 MIN</td>
<td>85.15±7.09</td>
<td>69.50±8.71</td>
<td>6.233</td>
<td>0.000</td>
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<tr>
<td>90 MIN</td>
<td>83.50±9.93</td>
<td>66.50±6.04</td>
<td>6.542</td>
<td>0.000</td>
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<tr>
<td>120MIN</td>
<td>84.40±5.44</td>
<td>65±5.12</td>
<td>11.600</td>
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**TABLE 1: CHANGES IN HEART RATE**

<table>
<thead>
<tr>
<th>TIME</th>
<th>NTG (N=20)* mmHg</th>
<th>HALOTHANE (N=20)* mmHg</th>
<th>‘t’</th>
<th>‘p’</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASAL</td>
<td>132.4±11.06</td>
<td>128.6±14.28</td>
<td>0.941</td>
<td>0.353</td>
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<tr>
<td>15 MIN</td>
<td>102.3±8.71</td>
<td>108.3±9.43</td>
<td>-2.090</td>
<td>0.043</td>
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<tr>
<td>30 MIN</td>
<td>91.3±5.36</td>
<td>97.7±8.27</td>
<td>-2.905</td>
<td>0.006</td>
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<tr>
<td>60 MIN</td>
<td>90.5±5.69</td>
<td>105.1±9.48</td>
<td>-5.905</td>
<td>0.000</td>
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<tr>
<td>90 MIN</td>
<td>88.2±4.94</td>
<td>108.4±7.86</td>
<td>-9.735</td>
<td>0.000</td>
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<tr>
<td>120 MIN</td>
<td>92.2±6.01</td>
<td>111.1±7.21</td>
<td>-9.002</td>
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**TABLE 2: CHANGES IN SYSTOLIC BLOOD PRESSURE**

**FIGURE 1: CHANGES IN HEART RATE**
TABLE 3: CHANGES IN DIASTOLIC BLOOD PRESSURE *Mean ± Standard deviation

<table>
<thead>
<tr>
<th>TIME</th>
<th>NTG (N=20)* mmHg</th>
<th>HALOTHANE (N=20)* mmHg</th>
<th>‘t’</th>
<th>‘p’</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASAL</td>
<td>81.4±6.16</td>
<td>77.4±6.56</td>
<td>1.981</td>
<td>0.054</td>
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<tr>
<td>15 MIN</td>
<td>71.5±6.65</td>
<td>73.7±5.55</td>
<td>-1.36</td>
<td>0.263</td>
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<td>30 MIN</td>
<td>65.9±5.37</td>
<td>70.8±4.65</td>
<td>-3.04</td>
<td>0.004</td>
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<tr>
<td>60 MIN</td>
<td>60.7±4.69</td>
<td>71.1±4.7</td>
<td>-7.03</td>
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<tr>
<td>90 MIN</td>
<td>57.4±5.28</td>
<td>70.3±4.65</td>
<td>-8.21</td>
<td>0.000</td>
</tr>
<tr>
<td>120 MIN</td>
<td>57.4±5.07</td>
<td>71.5±3.49</td>
<td>-10.25</td>
<td>0.000</td>
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</table>

TABLE 4: DURATION OF SURGERY*Mean ± Standard deviation

<table>
<thead>
<tr>
<th>DURATION OF SURGERY</th>
<th>NTG (N=20)* minutes</th>
<th>HALOTHANE (N=20)* minutes</th>
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</tr>
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<td>DURATION OF SURGERY</td>
<td>231±42.04</td>
<td>279.25±37.29</td>
<td>-3.84</td>
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FIGURE 2: CHANGES IN SYSTOLIC PRESSURE

FIGURE 3: CHANGES IN DIASTOLIC BLOOD PRESSURE
### TABLE 5: TOTAL BLOOD LOSS *Mean ± Standard deviation

<table>
<thead>
<tr>
<th>Time</th>
<th>NTG (N=20)* ml</th>
<th>HALOTHANE (N=20)* ml</th>
<th>'t'</th>
<th>'p'</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL BLOOD LOSS</td>
<td>847.5±321.71</td>
<td>1281±466.24</td>
<td>-3.422</td>
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### TABLE 6: OPERATIVE FIELD

<table>
<thead>
<tr>
<th>OPERATIVE FIELD SCORE</th>
<th>GROUP I NTG (N=20)</th>
<th>GROUP II HALOTHANE (N=20)</th>
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<tbody>
<tr>
<td></td>
<td>NO OF CASES</td>
<td>%</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
<td>60</td>
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<tr>
<td>2</td>
<td>3</td>
<td>15</td>
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### TABLE 7: RECOVERY SCORE *Mean ± Standard deviation

<table>
<thead>
<tr>
<th>TIME</th>
<th>NTG (N=20)*</th>
<th>HALOTHANE (N=20)*</th>
<th>'t'</th>
<th>'p'</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 MIN</td>
<td>7.65±0.49</td>
<td>6.20±0.41</td>
<td>10.153</td>
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<tr>
<td>15 MIN</td>
<td>8.50±0.69</td>
<td>7±0.79</td>
<td>6.381</td>
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<tr>
<td>30 MIN</td>
<td>9.55±0.60</td>
<td>7.85±0.37</td>
<td>10.752</td>
<td>0.000</td>
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<tr>
<td>60 MIN</td>
<td>10±0.00</td>
<td>9±0.56</td>
<td>7.958</td>
<td>0.000</td>
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