ORIGINAL RESEARCH ARTICLE

Comparison of the Efficacy of Intravenous (IV) Infusion of Dexmedetomidine and Intravenous (IV) Infusion of Nitroglycerine for Controlled Hypotensive Anaesthesia in Elective Spine Surgeries

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ABSTRACT

BACKGROUND

Induced hypotension limits intra-operative blood loss to provide better visibility of the surgical field and diminishes the incidence of major complications during spine surgeries. Nitroglycerine (NTG) is a well-established vasodilator that acts by reducing increasing the venous capacitance and reducing preload and cardiac output, thereby reducing the arterial blood pressure and dexmedetomidine, a selective α2 agonist has sympatholytic action and thus induce hypotension, so these 2 drugs have been used in this study to induce hypotensive anaesthesia.

AIM

We aimed at comparing nitroglycerine, and dexmedetomidine for inducing controlled hypotension in patients undergoing spine surgeries under general anaesthesia.

MATERIALS AND METHODS

50 patients of ASA class I and II posted for elective spine surgeries under general anaesthesia were taken for this study. Patients were randomly allocated into 2 groups. Group D and group N containing 25 patients each. Group D – received injection dexmedetomidine 0.5 mcg/kg in 10 ml 0.9% NS over 10 mins as loading dose before induction, followed by maintenance dose of 0.2-0.7 mcg/kg/hr infusion. Group N – received 10 ml plain 0.9% NS over 10 mins loading dose before induction, followed by maintenance dose of 0.5-10 mcg/kg/min infusion.

RESULTS

In patients who received dexmedetomidine observed to have lower mean heart rate, mean SBP, mean DBP and mean MAP. Also, group D had better surgical field grading as per Fromme Boezaart grading.

CONCLUSION

Dexmedetomidine is an effective drug to induce hypotensive anaesthesia in surgeries requiring lower blood pressures for better surgical field to operate. Controlled hypotension using dexmedetomidine as bolus dose 0.5 microgram per kg intravenous over 10 minutes prior to induction followed by continuous intravenous infusion at 0.2 - 0.7 microgram per kg per hour, provided more stable hemodynamic and better surgical field quality compared to nitroglycerine intraoperative infusion at 0.5 to 10 microgram/kg/min.

KEYWORDS: Hypotensive Anaesthesia, Dexmeditomidine, Nitroglycerin, Spine Surgery.

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INTRODUCTION

Hypotensive anaesthesia has been used since many years as a means of reducing intraoperative blood loss and facilitating good surgical exposure. Reduced intraoperative blood pressure leads to less blood loss from surgical site blood vessels. Decreased bleeding improves surgical visualisation of the wound, resulting in faster surgeries and also reducing the requirement for blood transfusions. Many previous studies have described the efficacy of deliberate hypotension, alone or in combination with other techniques, at reducing the blood loss and transfusion requirement of major spine surgeries.[1]

Complexity of the Spinal Vessels

Extramedullary artery: there are three longitudinal arteries along the spinal cord, providing transverse branches to the white matter and gray matter. These arteries supply a network of circular arteries located on the surface of the spinal cord, called the “dural plexus.” The first longitudinal artery is the anterior spinal artery (ASA). The other two longitudinal arteries are the paired posterior spinal arteries (PSA). The ASA provides blood flow to the first 2/3 of the spinal cord, while the PSA provides blood to the back 1/3 of the spinal cord. The branches of these arteries that reach the spinal cord are called radiculomedullary arteries. The largest one is the “great anterior radiculomedullary artery”. This artery is particularly important because it anastomoses with the ASA and supplies the major part of the arterial flow to the lumbar enlargement.[2,3]

Arterial anastomotic systems: When considering the spinal cord in the axial plane, four anastomotic circles have been described: intramedullar, intradural, extradural, and extravertebral. They each bear the confluence and shunt of blood. The ASA and the PSA reach the conus medullaris, where they anastomose through the anastomotic loop of the conus medullaris. It represents the largest anastomotic system between the ASA and PSA. Many of the most invasive resections of spinal surgeries endanger the extramedullary artery and intradural anastomotic network.[4]

The need for spinal surgeries has progressively increased in recent years. The most common indication for spine surgeries is disc herniation, spondylosis, spondylolisthesis, degenerative disc disease, scoliosis and pathological or traumatic fractures involving the vertebra.

While the technical advances for surgical exposure and spinal pathology correction continue to advance, the prevention of intraoperative complication of bleeding continue to be evaluated. Anaesthetic approaches towards prevention of intraoperative bleeding includes judicial selection of patients with thorough clinical history and examination, to include history of coagulation disorders, intake of antiplatelets or anticoagulant medications, multiple comorbid conditions are essential in preventing bleeding manifestations during and after surgery.[5]

Intraoperative methods to reduce or prevent intraoperative blood loss include controlled hypotension, meticulous surgical technique, pharmacological and non-pharmacological techniques.

Non pharmacological methods include Intermittent Positive Pressure Ventilation(IPPV) and patient positional variation to reduce bleeding.

Pharmacological agents include beta blockers, alpha blockers, combined α+β blockers, selective alpha-2 agonists, calcium channel blockers, venodilating agents, neuromuscular relaxants, volatile anaesthetic agents etc.

Nitrogycerin (NTG) is a well-established vasodilator that acts by increasing the venous capacitance and reducing preload and eventually decreasing cardiac output, leading to hypotension. It has rapid onset, ultra short duration of action and it is easy to titrate. Adverse

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effects of NTG include significant reflex tachycardia, venous congestion due to vasodilatation that may increase local bleeding and tachyphylaxis.[6]

Dexmedetomidine is a selective alpha-2 agonist with alpha 2: alpha 1 activity in the range of 1620:1 and significant central sympatholytic action leading to hypotension. Other advantages of dexmedetomidine are sedation, anxiolysis and analgesic effect that enhance the ease of anaesthesia during surgery.[7,8]

Based on the properties of both the drugs and few previous studies we decided to inspect and explore the beneficial properties of both dexmedetomidine and nitroglycerine in providing hypotensive anaesthesia and reducing the intraoperative blood loss during spine surgeries.

MATERIALS AND METHODS

After obtaining permission from institutional ethics committee, the study was conducted in 50 ASA I and II patients undergoing elective spine surgeries under general anaesthesia.

Before including the patients for the study, all patients were explained about the procedure, study drug and a written informed consent were obtained.

Inclusion Criteria

- American Society of Anaesthesiologist class I and II
- Patients of either gender aged between 18 to 60 years, scheduled for elective spine surgery under general anaesthesia.

Exclusion Criteria

- American society of Anaesthesiologist class III and IV
- Known allergy to either of the study drug
- Patient not willing for the study
- Prior treatment with calcium channel blockers, opioids, anticoagulants and
- patients receiving magnesium supplementation or drugs known to have a
- significant interaction with NMDAs.

Preoperative preparation:

During preanesthetic visit, the patients were explained about the study purpose, advantages, risks of procedure and informed written consent was obtained in regional language. The patients were allocated randomly into 2 study groups using a simple sealed envelope method: Group D containing 25 patients, receiving Inj Dexmedetomidine in the dose of 0.5 mcg/kg body weight in 10 ml normal saline over 10 minutes as a loading dose before induction, followed by titrating the maintenance dose at an infusion rate of 0.2-0.7 microgram/kg/hr using an infusion pump. Group N containing 25 patients, receiving a loading dose of 10 ml plain normal saline over 10 minutes before induction followed by titrating the maintenance dose of Inj Nitroglycerine at an infusion rate of 0.5-10 microgram/kg/min using an infusion pump. A premedication of IV 0.2 mg Inj Glycopyrrolate, 0.02mg/kg body weight of Inj Midazolam was administered, 20 minutes before induction of general Anaesthesia. General anaesthesia was induced with Inj Fentanyl 1.5 microgram/kg body weight IV and IV Propofol 2mg/kg body weight. Tracheal intubation was facilitated by administering IV Inj.Atracurium0.5mg/kg body weight and maintained by IV Inj. Atracurium 0.1 mg/kg body weight and by inhalational agent Isoflurane at 1-2% MAC. General anaesthesia commonly results in mild hypotension due to the effects of intravenous induction agents and inhalational agents in reducing cardiac output and systemic vascular resistance. In the elderly induction agents need to be given slowly and at reduced doses to avoid severe hypotension. Spinal and epidural anaesthesia cause vasodilatation due to sympathetic block, and if the block is above T4 may also result in

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decreased myocardial contractility and bradycardia. Patients undergoing combined regional and general anaesthesia are particularly susceptible to hypotension.

Standard monitoring including Non-invasive Blood Pressure, Continuous ECG, Pulse oximetry, Estimation of Blood loss, Fluid Input/Output charting and Capnography was done.

Aim was to maintain MEAN ARTERIAL PRESSURE (MAP) between 60-65mm of Hg by titrating with the drugs used in the study.

5 minutes before turning the patient to supine position, infusion of study drugs was stopped.

Parameters recorded:

1. Demographic parameters like age, weight, height and BMI (body mass index).
2. Hemodynamic parameters like baseline heart rate, baseline mean arterial pressure (MAP).
3. Duration of surgery
4. Assessment of surgical field using Fromme – Boezaart grading done by the surgeon.

The anaesthesiologist preparing the infusions was not involved in the data collection. Once the acceptable level of MAP was achieved and maintained for approximately ten minutes, the surgeon assessed the quality of the surgical field. A predefined category scale, adapted from Fromme GA et al., and Boezaart AP et al., was used: [9,10] Grade 0: No bleeding. Grade 1: Slight bleeding. No suctioning of blood needed. Grade 2: Slight bleeding. Occasional suctioning of blood required. Surgical field not threatened. Grade 3: Slight bleeding. Frequent suctioning required. Bleeding threatens surgical field a few seconds after suction is removed. Grade 4: Moderate bleeding. Frequent suctioning required. Bleeding threatens surgical field directly after suction is removed. Grade 5: Severe bleeding. Constant suctioning required. Bleeding appears faster than can be removed by suction. Surgical field severely threatened, and surgery not possible. The HR and MAP were recorded at regular intervals before and after extubation, and the quality of the surgical field was graded by the surgeon every 30 minutes during the procedure. If the HR and MAP increased beyond 20% of the baseline values, fentanyl 1 mcg/kg was administered. The depth of anaesthesia was increased by escalating the concentration of sevoflurane up to a MAC of 2. In case of no response and tachycardia (>100 beats/min), esmolol was administered in 10 mg bolus increments. Nitroglycerin boluses were used if the desired blood pressure level was still not achieved. If the MAP dropped below 60 mmHg, fluid boluses were given, followed by injection mephenteramine 6 mg if needed. The infusion was discontinued if hypotension persisted. Bradycardia (<50 beats/min) was treated with atropine 0.6 mg, and if it was not resolved, the drug infusion was discontinued. Paracetamol 1 gm i.v. was administered half an hour before the estimated end of surgery. Ondansetron 0.1 mg/kg was given to treat postoperative nausea or vomiting. The study drug infusions were stopped 10 minutes before the anticipated end of the procedure, and sevoflurane was discontinued when suturing was started. The residual neuromuscular blockade was antagonised with glycopyrrolate 0.008 mg/kg and neostigmine 0.05 mg/kg. Extubation was performed once the patient was fully awake, breathing spontaneously, and able to respond to verbal commands.

OBSERVATION AND STATISTICAL ANALYSIS

All 50 patients in two groups completed the study without any exclusion. The collected data were analysed by chi square test and results obtained in the form of range, mean and standard deviation.

The probability value ‘p’ of less than 0.05 considered statistically significant. Patient demographic data that includes hemodynamic variables like heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were recorded between two groups were comparable.

RESULTS

Features	Group N	Group D	p-value
Age (in years)	45.63 ± 9.915	42.77 ± 10.903	0.291
Weight (in kgs)	67.53 ± 4.431	66.03 ± 3.653	0.158
Height (in meters)	1.667 ± 0.099	1.694 ± 0.092	0.279
BMI (in kg/m2)	24.417 ± 2.244	23.127 ± 2.103	0.025
Baseline heart rate (in bpm)	78.13 ± 8.827	79.07 ± 9.706	0.698
Baseline MAP	95.03 ± 2.512	91.50 ± 6.730	0.009
Duration of surgery (in mins)	149.00 ± 17.191	144.67 ± 20.083	0.373

Table 1: Demographic Distribution and Baseline Hemodynamic Parameters of Patients

There was no significant difference between the two study groups with regard to age, mean height, mean weight, BMI, gender of the patients, Baseline HR, MAP, mean duration of surgery (Table 1).

Haemodynamic Parameters

Heart rate	Group N (mean ± SD)	Group D (mean ± SD)	p-value
Baseline heart rate	78.13 +/- 8.827	79.07 +/- 9.706	0.698
2 mins from the start of bolus infusion	85.17+/-5.937	91.43+/-4.116	0.000
5min from start of bolus infusion	86.20+/-5.927	89.87+/-4.041	0.007
8 min from start of bolus infusion	86.03+/-6.371	88.27+/-3.532	0.098
5 min from intubation	91.53+/-3.560	86.80+/-2.858	0.000
15 min after start of Bolus infusion	89.67+/-5.339	82.13+/-5.367	0.000
30 min from the start of bolus infusion	84.83+/-4.757	76.13+/-5.544	0.000
45 min from the start of bolus infusion	86.00+/-5.045	72.03+/-5.684	0.000
1hr 15min from the start of bolus infusion	80.90+/-5.492	65.27+/-3.279	0.000
1hr 30min from the start of bolus infusion	80.17+/-6.455	64.80+/-3.210	0.000
30 sec post extubation	101.47+/-5.716	67.73+/-3.921	0.000
5min post extubation	107.13+/-5.399	73.00+/-4.017	0.000
15min post extubation	103.37+/-5.314	70.60+/-4.090	0.000

Table 2: Comparison of Heart Rate in Both Groups

In table no 2 the basal heart rates are comparable between the two groups and the difference is not statistically significant. There is a statistically significant difference after starting the loading dose infusion and induction between the two groups, with a significant fall in heart rate in Dexmedetomidine group. The heart rates increased in both groups post laryngoscopy and intubation, more in Group N when compared to Group D. Intraoperatively the mean heart rate was lower in Group D in comparison to Group N. After stopping the infusions heart rate remained lower in Group D compared to group N, despite an increase in heart rate after repositioning and extubation.

SBP	Group N (mean ± SD)	Group D (mean ± SD)	p-value
Baseline SBP	131.13+/-5.056	122.80+/-8.348	0.000
2 mins from the start of bolus infusion	128.33+/-4.205	127.53+/-4.747	0.492
5min from start of bolus infusion	126.07+/-4.623	121.47+/-5.303	0.001
8 min from start of bolus infusion	125.80+/-4.4678	119.53+/-5.526	0.000

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5 min from intubation	133.40+/-3.936	116.80+/4.597	0.000
15 min after start of Bolus infusion	125.47+/-4.265	117.40+/-4.583	0.000
30 min from the start of bolus infusion	118.60+/-5.411	114.13+/-6.663	0.006
45 min from the start of bolus infusion	114.33+/-5.333	111.33+/-7.581	0.082
1hr 15min from the start of bolus infusion	111.8+/-3.458	112.80+/-6.446	0.457
1hr 30min from the start of bolus infusion	114.53+/-6.599	112.93+/-5.699	0.317
30 sec post extubation	118.53+/-5.507	113.80+/-5.391	0.001
5min post extubation	131.20+/-5.294	117.47+/-5.251	0.000
15min post extubation	128.07+/-4.051	119.33+/-5.339	0.000

Table 3: Comparison of Systolic Blood Pressure in Both Groups

In the table no 3, Mean systolic blood pressure was significantly lower in Group D when compared to Group N. 10 minutes within bolus infusion of the drugs the systolic blood pressure decreased in both the groups but more in group D. The Systolic Blood Pressure decreased 30 minutes from start of bolus infusion in both the groups but more in group D.

Diastolic blood pressure	Group N (mean ± SD)	Group D (mean ± SD)	p-value
Baseline DBP	76.93+/-3.352	75.87+/-6.887	0.449
2 mins from the start of bolus infusion	77.93+/-3.695	72.13+/-7.026	0.000
5min from start of bolus infusion	76.40+/-4.280	69.27+/-5.496	0.000
8 min from start of bolus infusion	75.60+/-4.116	69.00+/-5.350	0.000
5 min from intubation	81.60+/-5.184	66.87+/-4.718	0.000
15 min after start of Bolus infusion	76.47+/-5.056	66.27+/-5.401	0.000
30 min from the start of bolus infusion	71.20+/-3.699	66.00+/-4.457	0.000
45 min from the start of bolus infusion	67.93+/-4.085	64.93+/-4.510	0.009
1hr 15min from the start of bolus infusion	64.80+/-3.916	63.73+/-4.448	0.328
1hr 30min from the start of bolus infusion	65.53+/-4.384	63.40+/-3.158	0.035
30 sec post extubation	64.40+/-2.848	67.20+/-4.444	0.005
5min post extubation	79.47+/-5.303	65.60+/-4.116	0.000
15min post extubation	74.80+/-5.135	66.87+/-4.091	0.000

Table 4: Comparison of Diastolic Blood Pressure in Both Groups

The Mean diastolic blood pressure was significantly lower in Group D when compared to Group N. 2 minutes within bolus infusion of the drugs the systolic blood pressure decreased in both the groups but more in group D.

MAP	GROUP N (mean ± SD)	GROUP D (mean ± SD)	p-value
Baseline MAP	95.03+/-2.512	91.50+/-6.730	0.009
2 mins from the start of bolus infusion	94.77+/-3.461	90.50+/-5.303	0.000
5min from start of bolus infusion	92.97+/-3.801	86.67+/-4.436	0.000
8 min from start of bolus infusion	92.23+/-3.266	85.90+/-4.483	0.000
5 min from intubation	99.00+/-3.797	83.53+/-3.319	0.000
15 min after start of Bolus infusion	92.83+/-4.211	83.33+/-4.278	0.000
30 min from the start of bolus infusion	86.93+/-3.483	82.13+/-4.584	0.000
45 min from the start of bolus infusion	83.43+/-4.083	80.50+/-3.637	0.005
1hr 15min from the start of bolus infusion	80.37+/-3.222	79.70+/-3.743	0.463
1hr 30min from the start of bolus infusion	81.70+/-4.316	79.70+/-3.019	0.042
30 sec post extubation	84.23+/-4.174	80.90+/-3.010	0.001

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5min post extubation	96.77+/-5.049	82.97+/-3.232	0.000
15min post extubation	92.60+/-3.081	84.40+/-3.081	0.000

Table 5: Comparison of Mean Arterial Pressure in Both Groups

Table no 5 shows the time intervals that were clinically significant are p value <0.005.

Assessment of the surgical field:

Fromme – Boezaart surgical field grading	Group D (mean value)	Group N (mean value)	p-value
30 mins from start of bolus infusion	1	1.7	0.000
45 mins from start of bolus infusion	1.32	2	0.000
60 mins from start of bolus infusion	1.2	1.66	0.003
90 mins from start of bolus infusion	1.12	1.44	0.024
120 mins from start of bolus infusion	1.16	1.3	0.035
150 mins from start of bolus infusion	1	1.12	0.463

Table 6: Fromme – Boezaart Surgical Field Grading at Regular Time Intervals

Fromme – Boezaart surgical field grading at regular time intervals (table no 6) was comparable in both groups. At 30 min, 45 mins and 60 mins there are significant difference between 2 groups with group D having average surgical field grade of 1.33 which is less compared to that of group N,1.53.

DISCUSSION

In this study, we evaluated the efficacy of 2 drugs dexmedetomidine and nitroglycerine to maintain hypotensive anaesthesia for patients undergoing elective spine surgeries under general anaesthesia.

In this study, patient demographic factors like age, height, weight and BMI were standardized and there was no significant difference within the groups.

In table no 2, comparison of heart rate between the 2 groups, it was found that patients in group D had lower mean heart rate when compared to group N, so it implies that dexmedetomidine was more effective in controlling hemodynamic parameters and maintaining stable haemodynamic during and post-surgery. The time intervals that were clinically significant in table no 2 were (2mins, 5 mins, 15 mins, 30 mins,45 mins, 1hr and 15 mins and 1 hr 30 mins) from start of infusion and (30 secs, 5 mins and 15 mins) post extubation.

Bajwa SJ et al[11] conducted a study and found that, the mean heart rate was significantly lower in group D compared to groups E and N at all times of measurement ($P < 0.05$). The MAP was found to be significantly lower in group D compared to groups E and N after infusion of study drugs, after induction, just after intubation and 5 min after intubation. Dexmedetomidine and esmolol provided better hemodynamic stability and operative field visibility compared to nitroglycerin during FESS.

In table no 3, comparison of systolic blood pressure between the 2 groups, it was found that patients in group D had lower mean SBP when compared to group N, thus dexmedetomidine was more potent in inducing hypotensive anaesthesia when compared to nitroglycerine infusion during surgery and post extubation. The time intervals that were clinically significant in table no 3 were baseline SBP, (5 mins, 8 mins, 15 mins) from start of infusion, 5 mins from intubation and (30 secs, 5 mins and 15 mins) post extubation.

Shah et al[12] conducted a study and found that, dexmedetomidine provided better haemodynamic stability and an additional benefit of reduced requirement of intraoperative supplemental analgesia.

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In table no 4, comparison of diastolic blood pressure between the 2 groups, it was found that patients in group D had lower mean DBP when compared to group N, thus dexmedetomidine was more potent in inducing hypotensive anaesthesia when compared to nitroglycerine infusion during surgery and post extubation. The time intervals that were clinically significant in table no 4 were (2mins, 5 mins, 8 mins, 15 mins, 30 mins) from start of infusion, 5 mins post intubation and 15 mins and 30 mins post extubation.

Meena paul et al[13] conducted a study where, controlled hypotension using dexmedetomidine as bolus dose 1 microgram per kg intravenous over 10 minutes prior to induction followed by continuous intravenous infusion at 0.2 - 0.7 microgram per kg per hour, provided more stable hemodynamic and better surgical field quality compared to nitroglycerine intraoperative infusion at 0.5 to 10 microgram/kg/min.

In table no 5, comparison of mean arterial pressure between the 2 groups, it was found that patients in group D had lower mean MAP when compared to group N, thus dexmedetomidine was more potent in inducing hypotensive anaesthesia when compared to nitroglycerine infusion during surgery and post extubation. The time intervals that were clinically significant in table no 5 were (2mins, 5 mins, 8 mins, 15 mins, 30 mins) from start of infusion, 5 mins post intubation and (30 sec, 5 mins and 15 mins) post extubation.

Nasr et al[14] conducted a study and concluded that dexmedetomidine provided better hemodynamic stability and comparable operative field visibility to nitroglycerine during FESS. Dexmedetomidine provides an additional benefit of reducing the analgesic requirements and providing postoperative sedation. Mean HR and mean MAP was significantly lower in dexmedetomidine group than NTG group.

Fromme – Boezaart surgical field grading at regular time intervals was comparable in both groups. At 30 min, 45 mins and 60 mins there are significant difference between 2 groups with group D having average surgical field grade of 1.33 which is less compared to that of group N 1.53.

So, this shows that patients in group D had better surgical field with less blood loss.

SUMMARY AND CONCLUSION

The present study "**Comparison of the Efficacy of Intravenous (IV) Infusion of Dexmedetomidine and Intravenous (IV) Infusion of Nitroglycerine for Controlled Hypotensive Anaesthesia in Elective Spine Surgeries**" was carried out to study and compare the efficacy of dexmedetomidine and nitroglycerine in inducing and maintaining hypotensive anaesthesia, which inturn will lead to decreased blood loss and better surgical field. This study was conducted on 50 ASA I and II patients in the age group 18 to 60 years belonging to both sexes. After comparing various parameters, we concluded that:

1) Group D was more successful in maintaining haemodynamic stability as seen in tables 1, 2 and 3, were there was significant low heart rates, SBP, DBP and MAP at various time intervals.
2) Duration of surgery was also less in group D when compared to group N (144 ± 20 vs 149 ± 17 mins) respectively.
3) According to Fromme – Boezaart surgical field grading. At 30 min, 45 mins and 60 mins there are significant difference between 2 groups with group D having average surgical field grade of 1.33 which is less compared to that of group N 1.53.

Therefore, it is concluded that, dexmedetomidine infusion intraoperatively was more effective in maintaining hypotensive anaesthesia and providing better surgical field when compared to nitroglycerine infusion.

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