ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 6, Issue – 4, August – 2021 , Page No. : 01 - 11

Comparison of Intravenous Dexmedetomidine with Intrathecal Dexmedetomidine on Characteristics of Spinal Anaesthesia

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Citation this Article: Nivedita J. Vadodaria, Harsha T. Patel, "Comparison of Intravenous Dexmedetomidine with Intrathecal Dexmedetomidine on Characteristics of Spinal Anaesthesia", IJMSIR- August - 2021, Vol – 6, Issue - 4, P. No. 01 – 11.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Present study was aimed to compare the effect of intrathecal and intravenous dexmedetomidine on characteristics of bupivacaine spinal anaesthesia in adults scheduled for lower limb surgeries.

Aim: To compare characteristics of spinal anaesthesia with intrathecal or intraventous dexmedetomidine.

Materials and Methods: An observational study was conducted with 60 patients,30 in each group. Group IV received intravenous Dexmedetomidine (1µg/kg) diluted in 10ml of normal saline and infused over 10minutes as a loading dose,prior to subarachnoid block and Group IT received injection dexmedetomidine(5 µg) intrathecally as an adjuvant to (0.5%)15mg bupivacaine.The onset time, maximum block level, time to maximum sensory and Bromage 3 motor block, duration of sensory and motor anesthesia, time to first analgesic request were recorded. Hemodynamics, side effects, and sedation scores were assessed.

Results: In both categories, demographic data including age, ASA class, baseline pulse rate, blood pressure and duration of surgery were comparable. Onset of sensory and motor blockade were not significant between two groups. Mean duration of sensory block as well as motor block were comparable between both groups. Median of maximum sensory level achieved was T10 in both IV & IT Group. Intrathecal Group showed significant prolongation of duration of post-operative analgesia ($p<0.001$).Hemodynamic parameters were not significantly different between two groups throughout the surgery.

Conclusion: It is concluded that dexmedetomidine, whether added intravenously(1µg/kg) or intrathecally(5µg) to Bupivacaine(0.5%) 15mg in spinal anaesthesia showed equal effects on characteristics of spinal anaesthesia with hemodynamic stability, conscious sedation and minimal side effects.

Keywords: spinal anesthesia, dexmedetomidine, bupivacaine, intrathecal, intravenous

Introduction

For certain procedures, in particular those on the limbs and lower belly, regional anaesthesia is ideal. Regional analgesia will supplement general anaesthesia with several other procedures and offer lasting and productive post-operative pain relief. Although regional anaesthesia has side effects and risks, many patients with significant respiratory and cardiovascular co-morbidities still find it an excellent choice [1-2].

Sub arachnoid block is the most frequently practised regional anaesthesia, since it is simple to administer, needs fewer supplies, is reasonably effective and has a very high rate of effectiveness. It also gives both analgesia and relaxing of the muscles. It has drawbacks, though, such as a shorter time of operation and a loss of long-lasting postoperative analgesia [2-3]. Different adjuncts coupled with spinal anaesthesia are used to resolve this weakness with development. For spinal block facilitation, medications such as clonidine, fentanyl, dexmedetomidine, tramadol, and midazolam are commonly added [4].

Different experiments have been carried out to extend the length of spinal anaesthesia. It has been shown that the addition of intrathecal alpha2 agonists (clonidine, dexmedetomidine) greatly prolongs the length of spinal anaesthesia [5-8]. Similarly, experiments to assess the effectiveness of intravenous dexmedetomidine in prolonging the block length have been performed [6,9]. Dexmedetomidine is a strongly selective alpha2 agonist that operates on both pre and post synaptic nerve terminals and the central nervous system, reducing the sympathetic outflow and release of norepinephrine, resulting in hemodynamic stability sedation, anxiolysis and analgesia [10].

In previous researches, [9,11,12] it has been found that dexmedetomidine intravenously provides sedation, analgesia and hemodynamic stabilisation. There is scarcely any evidence available on the impact of sensory and motor blockade on its usage as intravenous premedication in spinal anaesthesia. Present study was aimed to compare the effect of intrathecal and intravenous dexmedetomidine on characteristics of bupivacaine spinal anaesthesia in adults scheduled for lower limb surgeries.

Materials and Methods

Study setting, study type and study period: An observational study was conducted at tertiary care centre, after approval from institutional scientific research committee and ethical committee.

Study participants: Purposively 60 patients of ASA class I, II and III, aged between 18 to 60 years scheduled for elective lower limb surgeries were included into the study.

Exclusion criteria: Participants with of systemic illness or neuropsychiatric disorders, History of substance abuse or dependence, History of serious adverse effects related to anaesthetics (e.g. allergic reactions), or a family history of reactions to the study drugs, Pregnancy, Patients who were needed supplementary general anaesthesia, Contraindications of spinal anaesthesia and those who were not agree to participate were excluded from the study

Study groups: Patients were assigned to two groups. Group IV who had received intravenous dexmedetomidine 1µg/kg diluted in 10ml of normal saline and infused over 10minutes as a loading dose, prior to sub arachnoid block and Group IT who had received injection dexmedetomidine 5 µg intrathecally as an adjuvant to 0.5% 15mg (3ml) bupivacaine in sub arachnoid block.

Pre-anaesthetic management: A detailed preanaesthetic checkup was done a day before surgery. The procedure to be performed was explained to patient and patient's relatives. Informed consent of patient and patient's relative were taken. A full assessment of history, clinical examination, and revision of investigations was conducted preoperatively for all patients. All patients were kept nil per oral overnight. In the preanaesthetic room, after establishing an intravenous line, patients were preloaded with ringer lactate solution (15ml/kg) after IV insertion of 18G cannula. All patients were pre medicated with inj. Glycopyrrolate 4 µg/kg intravenously before shifting to operation theatre. After taking patient on operation table, non-invasive blood pressure cuff and pulse oxymeter and ECG leads were applied. Baseline vital signs such as blood pressure, heart rate (HR), oxygen saturation by pulse oximetry (SpO2), and respiratory rate were recorded. Oxygen (2–4 l/min) was supplied by a nasal cannula.

Anesthetic drug administration: Under a sterile technique, spinal anesthesia was performed with the patient in sitting position with 25G Quincke needle in L3–L4 intervertebral space using midline approach. The time of spinal injection was considered time zero (T0). The IV drug regimen was started according to the group to which patients were assigned.

Intraoperative observations and management: Intraoperatively pulse rate, systolic, diastolic and mean arterial Blood pressure, ECG and SPO2 were monitored continuously and along with this, level of sensory blockade and degree of motor blockade, were recorded at every 2 minutes up to 10 minutes, then every 5 minutes up to 30 minutes and after that every 15 minutes by pin-prick method and Modified Bromage scale till the end of surgery. The onset time (the time to achieve loss of sensation at the level of T10 dermatome from the time of giving intrathecal injection), time to achieve highest sensory level and highest sensory level achieved, was noted. Time to 2 segment regression of the sensory level from highest level of sensory block and time to complete regression was also noted. Time to complete sensory regression was considered when all the sensations return back. Pain was assessed postoperatively using Verbal Rating Scale. Intravenous tramadol 75 mg was given when patient requested for pain relief or achieved VRS of at least 3. The sedation level was recorded intraoperatively and postoperatively using Ramsay Sedation Score. All the patients were watched for side effects like Hypotension (systolic blood pressure <20% of baseline or systolic blood pressure <80mm Hg), Bradycardia (when pulse rate is <50/minutes), Shivering. Nausea and vomiting, Respiratory depression (when RR<8/minute), High spinal (when >T2 level), SPO2 <90%. If patient developed hypotension, it was treated with inj. ephedrine 6mg i.v. bolus and i.v. crystalloids. Bradycardia was treated with inj. atropine 0.6mg i.v. Other side effects were treated symptomatically

Statistical Analysis

Data were entered and analysed through EPI info 7. Categorical variables were expressed in percentages while continuous variables were expressed in mean and standard deviation. Chi square test were used to know the association between categorical variables while t-test used to know relation between continuous variables. A p-value less than 0.05 were considered as statistically significant.

Results

As per Table 1, in both categories, demographic data including mean age, ASA class, baseline pulse rate, blood pressure were comparable. The mean age of patients in group IV was 36.9± 13.9 years and in group

IT, it was 36.5 ± 11.5 years. It was comparable in both the groups (P>0.05). According to table 2, it was observed that mean time of onset of sensory blockade (Time to achieve T10 sensory block) was 8.31 ± 3.69 minutes in Group IV and 8.96 ± 4.31minutes in Group IT. But, the difference was statistically not significant. (p>0.05) The mean time to two segment sensory regression was 75.66 +/-46.55 minutes in Group IV and 73.53 ± 34.64 minutes in Group IT. The difference was statistically not significant (p>0.05). Mean duration of sensory block was 271.30 ± 90.42minutes in Group IV as compared to 288.76 ± 94.11minutes in Group IT, but the difference was statistically not significant (p>0.05). T4 level of sensory block was achieved in 1 patient of Group IV and no patients of Group IT. T6 level of sensory block was achieved by 1 patient in either group IV or IT. T8 level of sensory block was achieved in 12 patients of Group IV and 13 patients of Group IT achieved T10 level of sensory blockade was achieved in 15 patients of IV Group and in 16 patients of IT group. Median of maximum sensory level achieved was T10 in Group IV and Group IT. Thus, with regards to characteristics of sensory blockade, no statistical difference was observed between the groups. As per Table 3, the mean duration of surgery in group IV was 84.34±38.9 minutes whereas in group IT, it was 109.66±62.93 minutes which was comparable in both the groups (>0.05) From Table 3, it can be seen that there was no statistical significance in intraoperative haemodynamic parameters like pulse, systolic blood pressure and diastolic blood pressure (p >0.05). As per Table 3, Duration of postoperative analgesia was significantly higher in Group IT(368.50 ± 111.36min) than in Group IV which is 161.00 ± 142.00 minutes.(p<0.001) It was observed that all patients in Group IT and most patients in Group IV had Ramsay Sedation Score of 2 and only few patients had Ramsay sedation score 3 throughout the surgery. Thus, most of the patients in both the groups were cooperative, oriented or tranquil during the intraoperative period. [Figure 1-4]

Discussion

The aim of the current research was to compare the impact of low-dose intravenous and intrathecal dexmedetomidine on the spinal block of bupivacaine. In the present study total volume of drug used for spinal anaesthesia was 3ml 0.5% (15mg) bupivacaine plus dexmedetomidine 5µg intrathecally or 3ml 0.5%(15mg) bupivacaine plus dexmedetomidine 1µg/kg intravenously.

Intrathecal dexmedetomidine has been a cause for discussion for years as an adjuvant to local anaesthetic. In spinal anaesthesia, the usage of intrathecal adjuvants with local anaesthetics has been a common technique for superior postoperative analgesia and improved block efficiency. Opioids such as adjuvants are related to multiple adverse effects including breathing depression, pruritus, nausea, vomiting and hemodynamic instability [4,13].

In present study, difference in mean time to achieve T10 sensory block between groups IV Group IT was statistically not significant. (p>0.05). In a study done by Hamed AM et al [14]. Difference between time of onset of sensory block at T10 dermatome not significant between two groups. Routray S. et al compared intrathecal bupivacaine with either dexmedetomidine and saline, fentanyl and saline and saline alone and observed that onset of sensory block at T10 was comparable and not significant between two groups. While study done by Harsoor et al [8]. Onset of sensory block was significantly faster in patients with iv dexmedetomidine (66±44.14 s) compared to control

group (129.6±102.4 s) with P<0.001. Faster onset of the sensory block may be due to alpha-2 receptor activation induced inhibition of nociceptive impulse transmission

It our study, T4 level of sensory block was achieved in one patient of Group IV and none of the patients of Group IT. Median of maximum sensory level achieved was T10 in both groups.

According to Hamed AM et al [14]. There was no statistical disparity between the mean time to hit the T10 sensory block and the maximal sensory level between the classes. There were no major variations between groups in the median and scale of the highest sensory level attained. Harsoor S et al [8]. observed that peak level of sensory blockade was observed in group who received intravenous dexmedetomidine prior to and following SAB, while that of control group receiving plain Bupivacaine was T8 (T6-T10).

In present study, there was no significant difference in the meantime of duration of sensory blockade between two groups. According to Hamed AM et al [14]. The regression periods of the two dermatomes (TDSR) varied substantially between groups IV and IT, and the disparity between the groups was significant. The DSA regression periods for S1 were substantially different between groups IV and IT, and the disparity between the groups was highly significant. In a study done by Harsoor S et al [8]. Two segment regression time was prolonged in group who received intravenous dexmedetomidine as compared to control group. Similar results were observed by Dinesh C. et al [5].

In present study, the mean time to achieve grade 3 motor block was not significantly differ between both groups also mean Duration of motor block was longer in Group IT compared to Group IV. However, the difference was not significant statistically. Hamed AM et al [14]. compared dexmedetomidine intravenously and intrathecally with bupivacaine. He observed that in both IT and IV classes, the period to hit the Bromage 3 motor block was slightly shorter relative to the bupivacaine community, but with no statistically meaningful difference between each other. Hamed AM et al [14] also showed that dexmedetomidine increased the length of the motor block of bupivacaine intravenously or intrathecally and was slightly longer in the IT community relative to the IV group. Harsoor S et al [8]. Observed that onset motor block in group who received intravenous dexmedetomidine was faster than control group. However the difference was not statistically significant.

It was seen that mean duration analgesia was significantly longer in IT group as compared to IV group (368.5 minutes as compared to 161 minutes). In a study done by Hamed AM et al [14]. it was observed that duration of post-operative analgesia was significantly prolonged in Group IT (5.40 ± 1.25 hr.) as compared to Group IV (3.29 ± 0.85 hr.)

The process by which the motor and sensory block of bupivacaine is prolonged by intrathecal or intravenous dexmedetomidine is the additive or synergistic influence of the two. By attaching to presynaptic C fibres and hyperpolarization of postsynaptic dorsal horn neurons, intrathecal dexmedetomidine works by depressing the release of C-fibers transmitters. As for the intravenous path, by anaesthetic and analgesic operation, it offers supraspinal influence. By selectively blocking myelinated A alpha-fibers involved in sensory conduction over unmyelinated C fibres involved in motor conduction, it creates a differential blockade. Such selectivity can be beneficial when it is advantageous to provide sustained analgesia but not generally motor block. Alpha2-adrenoceptor agonists

administered intrathecally have a dose-dependent sedation effect [9,15,16].

In present study, it was observed that all patients in Group IT and most patients in Group IV had Intraoperative sedation score (Ramsay Sedation Score) of 2 and only few patients had Ramsay sedation score 3 throughout the surgery. Thus, most of the patients in both the groups were cooperative, oriented or tranquil during the intraoperative period. Other studies [5,8]. observed that intraoperatively Ramsay sedation score was more in group who received intravenous dexmedetomidine as compared control group. Fatma N. et al [6]. who compared and evaluated effects of intravenous dexmedetomidine and midazolam for prolongation of Bupivacaine spinal anesthesia. Ram Say sedation score was significantly higher in dexmedetomidine 2(2-5) and midazolam group 3(2-5) than in saline group 1(1-2). Sedative and hypnotic effect of dexmedetomidine are thought to be mediated through activation of central pre and post synaptic α2 receptors in the locus ceruleus and dexmedetomidine acts to influence endogenous sleep promoting pathways.

Pulse rate, blood pressure were comparable between both the groups at baseline and even after anaesthesia at various time periods (no significant difference). Dexmedetomidine operates on presynaptic receptors and decreases norepinephrine release and has a sympatholytic effect on the central nervous system, resulting in a drop in heart rate. Reduction of sympathetic sound, induced by reduction of norepinephrine release at the neuroeffector junction, and suppression of neurotransmission in sympathetic nerves, is the primary activity of alpha2adrenergonist receptor agonist activation at low doses. With a small reduction of blood pressure and a moderate decrease in heart rate, the overall result is a decrease in circulating catecholamines [4,17].

In present study, all patients were observed for side effects of spinal anaesthesia as well as for dexmedetomidine like hypotension, shivering, bradycardia, decreased respiratory rate, high spinal and fall in SPO2 throughout the study period. Shivering was observed in 2 patients, each in either group. It was treated by using air warmer and blankets. Bradycardia Nausea/vomiting, Respiratory depression high spinal (sensory block>T2 and fall in SPO2 were not observed in any patients of either groups. Harsoor S. et al [8]. Was observed that dexmedetomidine provides intraoperatively arousable sedation without incidence of bradycardia and depression. Hemodynamic effects of dexmedetomidine include transient hypertension, bradycardia and hypotension. It results from peripheral vasoconstrictive and sympatholytic effects [10].

Strength of the study

In both instances, an experienced anaesthesiologist administered spinal anaesthesia. Thus, there were less risks of technological failure. The single observatory took all the readings to reduce the inter-observer bias

Limitation(s)

As this study was observational, rather than a randomised controlled experiment. To access pain, VRS (Verbal Rating Scale) has been used, but pain itself is rather subjective, so VRS cannot serve as an objective instrument for measuring pain. It was an empirical analysis and our study had no control group. The consultant anaesthesiologist determined that dexmedetomidine could be provided intravenously (1μg/kg) or intrathecally (5μg) in the spinal block of bupivacaine. So, there was a possibility of selection bias.

Conclusion

It is concluded that dexmedetomidine, whether added intravenously (1µg/kg) or intrathecally (5µg) to Bupivacaine(0.5%) 15mg in spinal anaesthesia showed equal effects on characteristics of spinal anaesthesia with hemodynamic stability, conscious sedation and minimal side effects. However, intrathecal dexmedetomidine provides longer duration of post-operative analgesia as compared to intravenous dexmedetomidine. Spinal anaesthesia with dexmedetomidine, as intravenous or intrathecal adjuvant proves to be the best technique in lower limb surgeries, as it provides conscious sedation, hemodynamic stability, without affecting airway reflexes during intraoperative period with prolonged duration of postoperative analgesia.

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Legend Tables and Figures

Table 1: Socio-Demographic and baseline parameters of study participants

Demographic characters of patients	Group IV (intravenous) (n=30)	Group IT (intrathecal) (n=30)	P value
Age in years (Mean ± SD)	36.90 ±13.90	36.5 ± 11.5	>0.05
Sex Male Female	 21 09	 07 23	<0.05
ASA Class Grade I Grade II Grade III	 00 21 09	 01 20 09	>0.05
Pulse rate (BPM)	83.14 ±12.93	88.90 ± 9.80	>0.05
Systolic Blood pressure (mmHg)	122.50 ± 14.35	123.80 ± 16.59	>0.05
Diastolic blood pressure (mmHg)	77.10 ± 7.19	79.36 ± 7.20	>0.05
Mean arterial blood pressure (mmHg)	91.30 ±- 8.93	94.10 ± 8.73	>0.05

Table-2: Comparison of anaesthetic parameters between two groups

	Group IV (intravenous) (n=30)	Group IT (intrathecal) (n=30)	P value
Sensory Blockade			
Time to achieve sensory block T10 (minutes)	8.31 ± 3.69	8.96 ± 4.31	NS
Time to two segment sensory regression (minutes)	75.66 ± 46.55	73.53 ± 34.64	NS
Time to complete sensory regression (minutes)	271.30 ± 90.42	288.76 ± 94.11	NS
Motor Blockade			
Degree of max. motor block	3	3	
Time to achieve maximum motor block (minutes)	4.31 ± 3.03	5.46 ± 3.49	NS

Duration of motor blockage (minutes)	253.00 ± 88.04	277.96 ± 93.72	NS
Post-operative analgesia			
Duration (minutes)	161.00 ± 142.00	368.50 ± 111.36	<0.001

Table 3: Intra-operative and Post-operative parameters between two groups:

Intraoperative &Post-operative parameters	Group IV (intravenous) (n=30)	Group IT (intrathecal) (n=30)	P value
Duration of surgery (minutes)	84.34 ± 38.90	109.66 ± 62.93	>0.05
Post-operative analgesia Duration (minutes)	161.00 ± 142.00	368.50 ± 111.36	<0.001
Pulse rate (BPM)	74.07 ± 15.5	83.56 ± 13.44	<0.05
Systolic Blood pressure (mmHg)	110 ± 16.48	112.40 ± 13.04	>0.05
Diastolic blood pressure (mmHg)	68.60 ± 11.60	68.90 ± 8.40	>0.05
Mean arterial blood pressure (mmHg)	82.6 ± 12.60	82.80 ± 9.44	>0.05

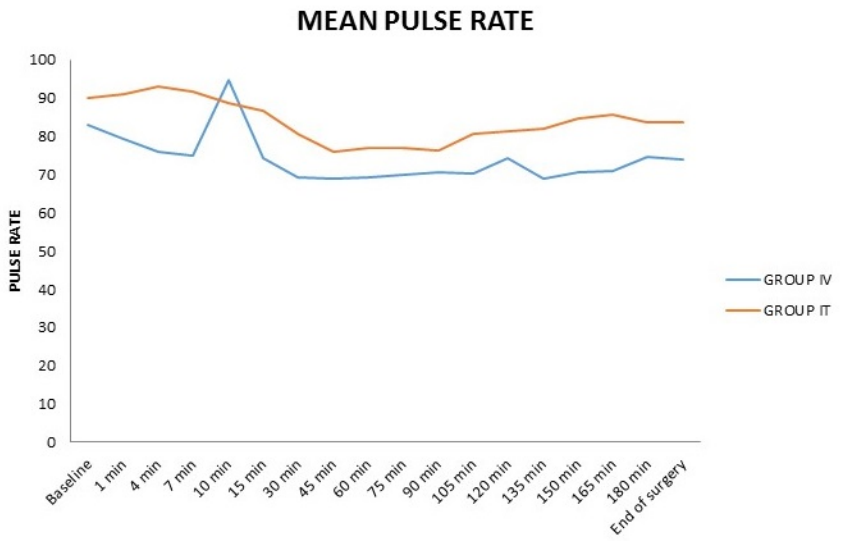

Figure 1: Pulse rate from baseline to end of surgery of both groups

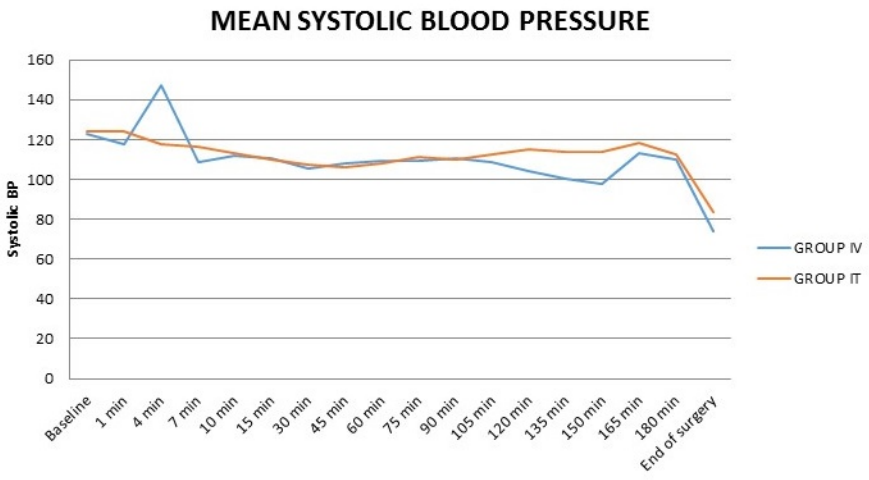

Figure 2: Systolic blood pressure from baseline to end of surgery of both groups

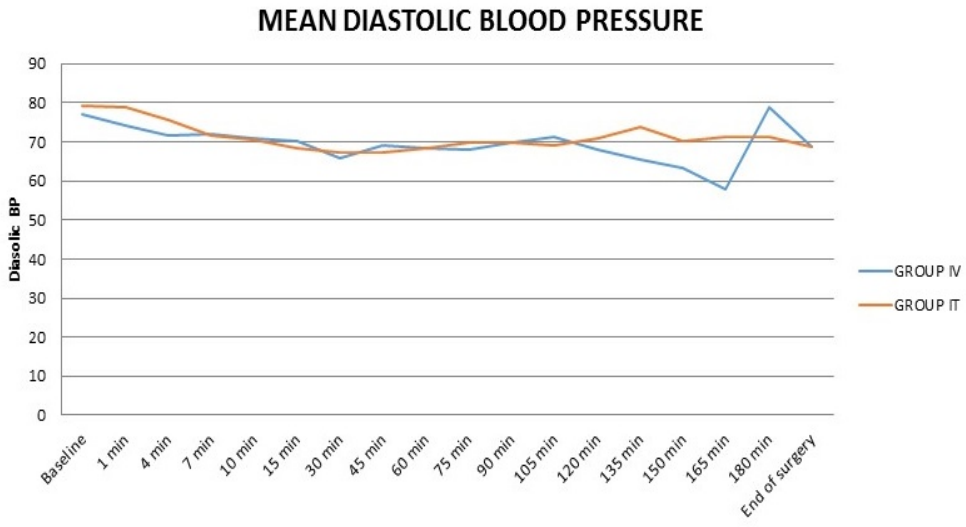

Figure 3: Diastolic blood pressure from baseline to end of surgery of both groups

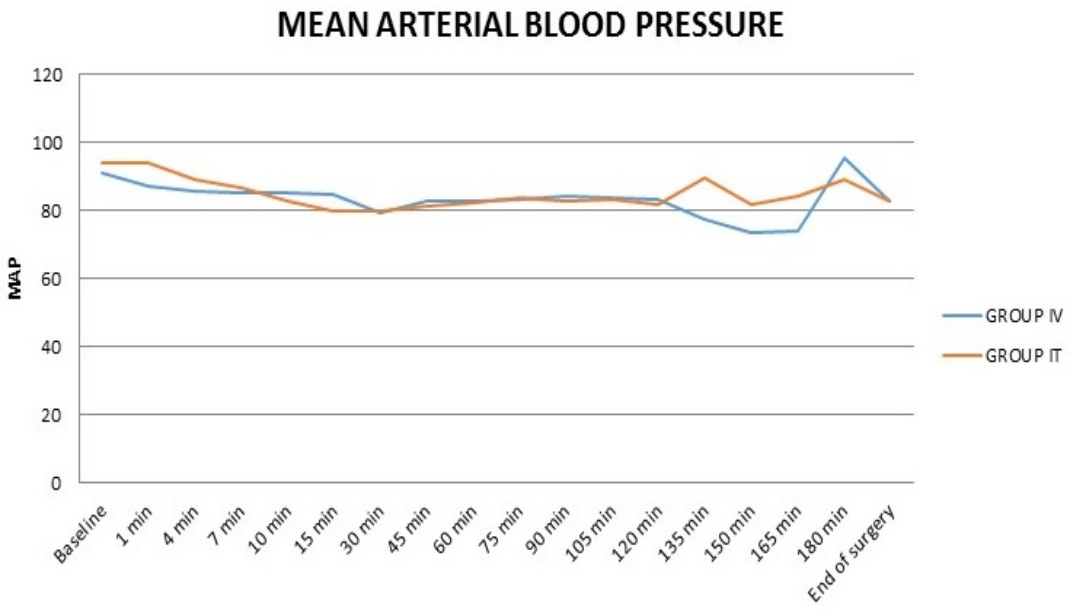

Figure 4: Mean arterial blood pressure from baseline to end of surgery of both groups