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ORIGINAL ARTICLE RESEARCH

A Comparitive Study of Intrathecal Fentanyl and Dexmedetomidine as Adjuvants to Bupivacaine

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ABSTRACT

Introduction: Intrathecal fentanyl and dexmedetomidine are adjuvants that can be used along with bupivacaine in spinal anesthesia to enhance the quality and duration of analgesia. Fentanyl is a potent opioid that acts on the mu-opioid receptors in the spinal cord, which inhibits the transmission of pain signals. Dexmedetomidine is a selective alpha-2 adrenergic agonist that acts on the spinal cord to reduce sympathetic outflow and modulate pain transmission.

Material and Methods: 100 ASA I and II patients scheduled for major surgeries under spinal anaesthesia were chosen for the study. Under strict asepsis, using 25 G Quincke spinal needle, lumbar puncture was performed at L 3 – L 4 space. Group F received 3ml, 0.5 % hyperbaric bupivacaine + 25 µg Fentanyl (vol 0.5ml). Group D received 3ml, 0.5 % hyperbaric bupivacaine + 5 µg Dexmedetomidine (vol 0.5 ml). Intra-operatively pulse rate, non-invasive blood pressure, electrocardiogram, SpO2 was recorded. 50 patients in Group F (Fentanyl) and 50 patients in Group D (Dexmedetomidine) were taken to study the changes in haemodynamics and side effects. Chi-square test, Anova test and student' 't' test was done to analyse the data and p value was determined.

Results: Dexmedetomidine performed better than Fentanyl as an adjuvant based on the various parameters.

Conclusions: Dexmedetomidine is a safe and effective adjuvant for intrathecal administration in the management of postoperative pain as compared to Fentanyl.

Keywords: Dexmedetomidine, Fentanyl, Bupivacaine, General Anaesthesia

INTRODUCTION

Intrathecal fentanyl and dexmedetomidine are adjuvants that can be used along with bupivacaine in spinal anesthesia to enhance the quality and duration of analgesia. Spinal anesthesia involves injecting local anesthetics into the cerebrospinal fluid, which results in a regional blockade of sensory and motor nerves in the spinal cord. However, the duration and quality of spinal anesthesia may be limited, and the addition of adjuvants such as fentanyl and dexmedetomidine can help prolong the duration of analgesia and reduce the dose of local anesthetic required.

Fentanyl is a potent opioid that acts on the mu-opioid receptors in the spinal cord, which inhibits the transmission of pain signals. When administered intrathecally, fentanyl produces a rapid onset of analgesia and prolongs the duration of sensory and motor blockade. The addition of fentanyl to bupivacaine can improve postoperative pain management and reduce the need for additional analgesics.

Dexmedetomidine is a selective alpha-2 adrenergic agonist that acts on the spinal cord to reduce sympathetic outflow and modulate pain transmission. Dexmedetomidine has been shown to enhance the quality and duration of spinal anesthesia when used as an adjuvant to bupivacaine. It can reduce the dose of bupivacaine required to achieve the desired level of anesthesia, thereby reducing the risk of adverse effects associated with high doses of local anesthetics.

Overall, the use of intrathecal fentanyl and dexmedetomidine as adjuvants to bupivacaine in spinal anesthesia can improve the quality and duration of analgesia, reduce the dose of local anesthetic required, and improve postoperative pain management. However, the use of these adjuvants should be carefully considered, and the potential risks and benefits should be weighed on a case-by-case basis.

MATERIAL AND METHODS

Inclusion Criteria

ASA physical status class I and II

Age between 18 – 65 years of either sex.

Exclusion Criteria

Emergency surgery

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Deformities of the spine
Hypersensitivity to the drugs
Patient refusal, bleeding diathesis to spinal anaesthesia.

Methods

100 ASA I and II patients scheduled for major surgeries under spinal anaesthesia were chosen for the study. Pre anaesthetic check-up was done one day prior to the surgery. Patients were evaluated for any systemic diseases and laboratory investigations recorded. The procedure was well explained to the patients. The patients described about the use of visual analogue scale. Preparation of patients included for period of overnight fasting. Patients were pre medicated with Tab. Rantac 150 mg and Tab. Anxit 0.5 mg H.S.

Procedure

Patients shifted to OR table, IV access was obtained on the forearm with 18G IV cannula and all patients were preloaded with 15 ml / Kg, Ringer's Lactate, 15 minutes before the surgery. Patients were randomly allocated into two groups. Baseline vitals were recorded. Under strict asepsis, using 25 G Quincke spinal needle, lumbar puncture was performed at L 3 – L 4 space. Group F received 3ml, 0.5 % hyperbaric bupivacaine + 25 µg Fentanyl (vol 0.5ml). Group D received 3ml, 0.5 % hyperbaric bupivacaine + 5 µg Dexmedetomidine (vol 0.5 ml). Intra-operatively pulse rate, non-invasive blood pressure, electrocardiogram, SpO2 was recorded, every 2 minutes for the first 10 minutes, every 10 minutes for the next 50 minutes and every 15 minutes till the end of surgery. Pin Prick method was used to note the time of onset of T10 sensory block, peak sensory block and time of onset of Bromage 3.

Modified Bromage Scale

Modified Bromage Scale	
Activity	**Score**
Able to lift legs against gravity	0
Able to flex knee but unable to flex legs	1
Able to move feet but unable to flex knee	2
Unable to move any joints	3

Figure 1: Modified Bromage Scale used to assess the motor block

Score	Clinical state or response to stimulation
1	Patient anxious and/or agitated and/or restless
2	Spontaneous eye openings
3	No spontaneous eye opening, response to vocal stimulus
4	No response to vocal stimulus, response to loud stimulus
5	No response to loud stimulus, response to tetanic (50 Hz, 40 mA, 0.25 s pulses, duration 4 s) stimulus
6	No response to tetanic stimulus

Figure 2: Modified Ramsay Sedation Scale used for intraoperative sedation

Following parameters were recorded

- Hypotension (> 20 % fall of baseline blood pressure) was treated with 6 mg mephenteramine i.v.
- Bradycardia with pulse rate < 50 bpm , was treated with 0.6 mg atropine IV.
- Incidence of respiratory depression described as respiratory rate < 9 /min and SpO2 < 90 % on room temperature, was noted
- Side effects if any were recorded.
- Post-operative regression of the sensory block and the motor blockade to reach the modified bromage scale of 0 was recorded.
- Patient simply marks the line to indicate the pain intensity. Time of supplemental analgesia was noted.
- Pain was assessed using "Visual Analogue Scale" advocated by Revill and Robinson in 1976. It is linear scale, consists of 10 cm line anchored at one end by a label such as "No pain" and other end by "Worst pain imaginable". Patient simply marks the line to indicate the pain intensity. Time of supplemental analgesia

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was noted.

- Visual analogue scale was used to assess post-operative pain. 0 = no pain, 10 = severe pain.

Study Design

Comparative randomized clinical studies of two groups with 100 patients were included for the study. 50 patients in Group F(Fentanyl) and 50 patients in Group D(Dexmedetomidine) were taken to study the changes in haemodynamics and side effects. Chi-square test, Anova test and student's't' test was done to analyse the data and p value was determined.

$P > 0.05$ is not significant,

$P < 0.05$ is significant,

$P < 0.001$ is highly significant.

RESULTS

Table 1: Gender distribution of patients

Gender	Group F	Group D	Total
Male	25	25	50
Female	25	25	50

Table 2: Comparison of height and weight of two groups

Variables	Group F	Group D	P Value
Height in cm	155.66±5.16	156.10±5.83	0.690
Weight in kg	58.12±12.35	56.90±10.18	0.591

Table 3: ASA grade in two groups

ASA Grade	Group F		Group D	
	No	%	No	%
Grade I	26	52.0	31	62.0
Grade II	24	48.0	19	38.0
Total	50	100	50	100

Table 4: Surgery in two group of patients

Surgery	Group F (n=50)		Group D (n=50)	
	No	%	No	%
Vaginal hysterectomy	10	20.0	11	22.0
Abdominal hysterectomy	8	16.0	1	2.0
ORIF	7	14.0	10	20.0
TURP	3	6.0	1	2.0
URS	2	4.0	3	6.0
Mesh Repair	3	6.0	1	2.0
Below knee procedure	2	4.0	3	6.0
Stripping and ligation	3	6.0	1	2.0
Tension band wiring	2	4.0	1	2.0
Implant removal	0	0.0	2	4.0
Intervalappendicectomy	0	0.0	2	4.0
Fistula repair	0	0.0	1	2.0
Screw fixation	0	0.0	1	2.0
Skin grafting	0	0.0	1	2.0
Internal urethrotomy	1	2.0	1	2.0
DHS	1	2.0	0	0.0
Others	8	16.0	10	20.0

Table 5: Comparison of Time of Injection to T10, Highest sensory level, onset of Bromage 3 and regression to Bromage 0

Variables	Group F	Group D	P value
Time from injection to T10 minutes	03.38±0.83	02.62±0.56	<0.001
Time from injection to highest sensory level (min)	11.47±1.23	11.72±1.23	0.314

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Onset of Bromage 3 (min)	10.38±1.08	10.59±1.00	0.317
Regression to bromage 0 (min)	152.90±8.31	419.70±16.85	<0.001

Table 6: Comparison of Systolic Blood Pressure (mmHg) and Diastolic Blood Pressure (mmHg) in two groups of patients studied

	SBP			DBP		
	Group F	Group D	'p' value	Group F	Group D	'p' value
Preop	128.60±11.70	126.20±9.54	0.264	80.10±8.58	80.78±7.81	0.679
2 minutes	125.12±12.11	119.40±10.65	0.014	77.38±9.68	74.18±9.22	0.094
4 minutes	119.10±11.34	114.84±10.85	0.058	72.46±8.56	71.06±9.48	0.440
6 minutes	115.24±9.77	112.76±10.84	0.233	69.04±8.65	69.44±9.56	0.827
8 minutes	112.42±9.04	110.92±10.86	0.455	65.76±7.87	67.74±10.31	0.283
10 minutes	110.22±9.87	110.50±10.50	0.891	62.30±8.39	66.68±10.31	0.022
20 minutes	109.46±9.70	109.38±10.77	0.969	60.92±9.23	65.12±9.96	0.031
30 minutes	107.66±9.49	108.34±10.57	0.736	61.36±7.40	64.80±9.66	0.048
40 minutes	106.64±9.98	107.32±10.20	0.737	60.90±8.25	64.94±9.62	0.026
50 minutes	106.82±10.18	107.12±9.75	0.881	61.28±8.50	64.76±9.28	0.053
60 minutes	108.98±9.74	107.82±9.20	0.542	62.98±8.79	65.16±8.90	0.221
75 minutes	111.24±9.57	108.60±8.88	0.156	65.75±7.53	65.62±8.30	0.933
90 minutes	114.58±8.32	110.56±8.55	0.019	69.00±7.54	67.18±8.42	0.258

DISCUSSION

Intrathecal administration of local anesthetics is a common method of providing regional anesthesia for surgical procedures. However, local anesthetics alone may not provide sufficient pain relief, especially for longer procedures or in patients with a high pain threshold. Therefore, adjuvants are often added to improve the quality and duration of analgesia.

Two commonly used adjuvants are fentanyl, a synthetic opioid, and dexmedetomidine, an alpha-2 agonist. Both have been shown to enhance the analgesic effect of local anesthetics when used intrathecally.

Several comparative studies have been conducted on the use of intrathecal fentanyl and dexmedetomidine as adjuvants to bupivacaine in spinal anesthesia.[1] Singh et al. conducted a study to compare the efficacy of intrathecal fentanyl and dexmedetomidine as adjuvants to bupivacaine in 60 patients undergoing lower abdominal and lower limb surgeries. They found that both fentanyl and dexmedetomidine improved the quality and duration of analgesia, but dexmedetomidine had a longer duration of action and fewer side effects compared to fentanyl.[2] Rathmell JP et al conducted a review on the role of intrathecal drugs in the treatment of acute pain. The review discussed the use of intrathecal drugs, including opioids, local anesthetics, and alpha-2 agonists, in the management of acute pain. The authors noted that intrathecal drug delivery can provide several advantages over other routes of administration, including improved analgesia, reduced side effects, and better patient satisfaction.[3] Gupta et al. conducted a randomized study to evaluate the efficacy of intrathecal dexmedetomidine as an adjuvant to bupivacaine in spinal anesthesia. The study included 60 patients undergoing lower abdominal or lower limb surgeries, who were randomly assigned to receive either bupivacaine alone (Group B) or bupivacaine with intrathecal dexmedetomidine (Group BD). The study concluded that intrathecal dexmedetomidine is an effective adjuvant to bupivacaine in spinal anesthesia, providing a longer duration of sensory and motor blockade without significant adverse effects. However, the authors recommended further studies to determine the optimal dose and safety profile of intrathecal dexmedetomidine.[4] Kumar et al, conducted a comparative study of these two adjuvants to evaluate their efficacy and safety in combination with bupivacaine for spinal anesthesia. The study involved a randomized, double-blind, controlled trial that included 60 patients undergoing lower limb orthopedic surgeries. The patients were divided into two groups: the fentanyl group and the dexmedetomidine group. The study found that both fentanyl and dexmedetomidine significantly enhanced the quality and duration of analgesia when used with bupivacaine.

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However, the dexmedetomidine group had a longer duration of sensory and motor block than the fentanyl group. The dexmedetomidine group also had a lower incidence of intraoperative hypotension and bradycardia than the fentanyl group.[5] El-Ozairy conducted a comparative study which investigated the effect of adding clonidine or dexmedetomidine to bupivacaine in prolonging caudal analgesia in children. The randomized, double-blind study included 90 children undergoing lower abdominal surgeries. The children were divided into three groups: bupivacaine alone, bupivacaine with clonidine, and bupivacaine with dexmedetomidine. The study found that both clonidine and dexmedetomidine significantly prolonged the duration of analgesia compared to bupivacaine alone, with dexmedetomidine having a longer duration of analgesia than clonidine. The addition of either adjuvant was also found to decrease the need for rescue analgesia. The study concluded that adding clonidine or dexmedetomidine to bupivacaine in caudal block could be an effective method for prolonging postoperative analgesia in children undergoing lower abdominal surgeries.

Therefore, the present study was performed to compare Fentanyl and Dexmedetomidine in their efficacy as adjuvants to spinal anaesthesia. In our study design Group F received 0.5% of hyperbaric Bupvacaine 3ml with Fentanyl 25µg and Group D received 0.5% hyperbaric Bupivacaine 3ml with Dexmedetomidine 5 µg, injected intrathecally to the patients undergoing infra-umbilical surgeries.The following parameteres were checked: Time of onset of Bromage, Intraoperative sedation, Time of onset of action, Regression to Bromage, Post-operative requirement of analgesia and Highest level of sensory and motor blockade. In our study, the post-operative analgesic requirements was significantly less in the Dexmedetomidine group than group Fentanyl. They also found that 114 the sedation score was more in group D patients. The mean sedation score was 3.8 ± 0.5 in group D where it was 2.2 ± 0.53 in group F, which was statistically significant ($p<0.001$).

Our study has shown that the addition of 5 µg Dexmedetomidine with hyperbaric bupivacaine significantly prolongs both sensory and motor block. Both Fentanyl and Dexmedetomidine provided good quality intraoperative analgesia. The analgesia was clinically better in group D as compared to group F. Small doses of intrathecal Dexmedetomidine (3µg) used in combination with bupivacaine in humans have been shown to shorten the onset of motor block and prolong the duration of motor and sensory block with hemodynamic stability and lack of sedation.

We also found longer duration of both sensory and motor blockade and good patient satisfaction in the Dexmedetomidine group. There were no incidence of respiratory depression.

[6] Abdallah FW, in his study, aimed to evaluate the effects of intravenous dexmedetomidine on the duration of spinal anesthesia. The study performed a systematic review and meta-analysis of randomized controlled trials that evaluated the use of intravenous dexmedetomidine as an adjuvant to spinal anesthesia. The meta-analysis included 12 randomized controlled trials with a total of 756 patients. The results showed that the addition of intravenous dexmedetomidine to spinal anesthesia significantly increased the duration of sensory and motor blockade compared to placebo or control group. This study concluded that intravenous dexmedetomidine can be an effective adjuvant to spinal anesthesia in selected patients, but the selection of the adjuvant should be based on the specific patient's needs and the risks and benefits associated with each agent.[7] Rajni Gupta, Reetu Verma, Jaishri Bogra et al., investigated the efficacy and safety of dexmedetomidine as an intrathecal adjuvant for postoperative pain management. The study involved 60 patients who underwent lower limb orthopedic surgery under spinal anesthesia. The patients were randomly assigned to receive either bupivacaine alone or bupivacaine with the addition of dexmedetomidine. The results of the study showed that the addition of dexmedetomidine to bupivacaine resulted in significantly prolonged postoperative analgesia and reduced analgesic requirements compared to bupivacaine alone. There were no significant differences in adverse events between the two groups. Overall, the study suggests that dexmedetomidine can be a safe and effective adjuvant for intrathecal administration in the management of postoperative pain.

CONCLUSIONS

Comparative studies that investigate the efficacy and safety of different adjuvants used in conjunction with local anesthetics for intrathecal administration aim to determine the optimal approach for pain management in specific patient populations.

Depending on the study design, the results of a comparative study could indicate that one adjuvant is more effective than the other in terms of pain relief, duration of effect, and adverse events. Alternatively, the study may find that both adjuvants have similar efficacy and safety profiles, and the choice of adjuvant would depend on other factors such as availability and cost. Hence, Dexmedetomidine seems to be a better choice as Intrathecal adjuvant with Bupivacaine.

Overall, a well-designed comparative study can provide valuable information to guide clinical decision-making and improve patient outcomes. However, it is important to consider the limitations of any study and to interpret the results in the context of the specific patient population and clinical setting.

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