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Research Article

PSYCHOMOTOR RECOVERY AFTER INTRAVENOUS DEXMEDETOMIDINE INFUSION AS A PART OF BALANCED ANAESTHESIA – AN OBSERVATIONAL STUDY

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ABSTRACT

Objective: The aim of the study was to determine the recovery of psychomotor function from balanced anesthesia with and without intravenous (IV) dexmedetomidine infusion as an adjunct.

Methods: A prospective and observational study was conducted in a tertiary care teaching hospital for 12 months. A total of 170 patients (American Society of Anaesthesiologists 1 and 2) in the age group of 18–50 years scheduled for elective surgery under general anesthesia with an anticipated duration of <3 h received either dexmedetomidine infusion (Group D) or not (Group S). Recovery of psychomotor function postoperatively was assessed with trieger dot test (TDT), digit symbol substitution test (DSST), and intraoperative fentanyl requirement in both groups. Data collected were analyzed using SPSS version 16.

Results: Both groups were comparable with respect to demographic variables. Psychomotor recovery assessed by TDT showed statistically significant early recovery in Group D compared with Group S. This was seen in the number of dots missed, maximum distance of dots missed as well as in the average distance of dots missed at post-operative time intervals of 30 min, 60 min, 90 min, and 120 min. Similarly, DSST revealed early recovery at these time points. There was a significant decrease in the intraoperative fentanyl requirement in Group D compared with Group S.

Conclusion: The addition of dexmedetomidine to the balanced anesthetic technique significantly hastened the psychomotor recovery.

Keywords: Balanced anesthesia, Dexmedetomidine, Psychomotor recovery, Trieger dot, Digit symbol substitution.

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INTRODUCTION

Post-operative psychomotor dysfunction is one of the deciding factors for discharge after daycare surgeries. Post-procedural cognitive dysfunction, post-procedural pain, nausea, and vomiting were the causes of delayed discharge or readmission and may cause anxiety to patients and increase the financial burden. Out of these, post-operative psychomotor recovery depends only on the pharmacodynamic property of the sedative agent used. Hence, an ideal sedative agent which provides smooth and early psychomotor recovery should be used for daycare surgeries.

The main function of dexmedetomidine is to activate alpha-2-adrenergic receptors with high selectivity so that these can have their effect on the locus coeruleus of the central nervous system, the spinal cord and central and peripheral neurotransmitters to result in sedation and hypnosis, analgesia, and antagonism of sympathetic activity, respectively. Dexmedetomidine also displays a cerebroprotective effect. During cerebral ischemia-reperfusion, dexmedetomidine reduces levels of nitric oxide and tumor necrosis factor and increases the superoxide dismutase activity so that nerve injuries can be avoided. Moreover, dexmedetomidine can minimize vasospasm by inhibiting the release of catecholamines in cerebral tissues, which can prevent brain injuries from subarachnoid hemorrhages. Furthermore, dexmedetomidine can avoid damage to the hippocampus, thalamus, and cortex caused by inhaling isoflurane independently as well as influence the long-term impact of isoflurane on neurocognitive functions. Various studies have shown that psychomotor function has been preserved with dexmedetomidine when it is used for sedation. We hypothesized that post-operative psychomotor recovery from anesthesia would be better if dexmedetomidine was used as an adjunct to the balanced anesthetic technique. Hence, this study was designed to assess the recovery of psychomotor function from the balanced anesthesia with IV dexmedetomidine infusion as an adjunct in patients undergoing elective surgery under general anesthesia with an anticipated duration of <3 h.

METHODS

This was a prospective and observational study done over a period of 1 year in a tertiary care teaching hospital. One hundred and seventy patients (American Society of Anaesthesiologists, ASA I and II) of either sex, aged 18–50 years scheduled for elective surgery under general anesthesia with an anticipated duration of <3 h were allocated to two groups – one which receives dexmedetomidine infusion (Group D) and the other without dexmedetomidine infusion (Group S) using simple randomization. The study was started after getting ethical clearance from the Institutional Review Board of our institute. Informed written consent was taken from all patients included in the study.

Inclusion criteria

Patients of either sex belonging to ASA Physical Status (ASA PS) I and II, age 18–50 years, elective surgical procedures under general anesthesia with anticipated duration <3 h.

Exclusion criteria

Patients with a known history of psychiatric illness, known history of chronic drug or alcohol abuse, known history of hypersensitivity to drugs, family history of malignant hyperthermia, pregnant and breastfeeding women, hypertensive patients not on any treatment or those treated with alpha or beta blockers, patients on concurrent sedative medications, and patients who refused to give consent were excluded from the study.

Methodology

On the day before surgery, the psychomotor function of the patient was assessed with the trieger dot test (TDT) and digit symbol substitution test (DSST). Both the tests were done thrice to familiarize the patient,

and the fourth test was taken as the baseline psychomotor evaluation for that patient. TDT consists of joining dots with a line to form a figure within a time limit of 60 s. It was analyzed by the number of dots missed (NDM), maximum distance of dots missed (MDDM), and an average distance of dots missed (ADDM). DSST consists of matching digits with their corresponding symbol within a time limit. The digits along with the corresponding symbols will be located in a legend given at the top of the page. Nine such digits were assigned symbols in the legend. It was analyzed by the number of digits correctly matched with the corresponding symbols within 90 s. After shifting the patient to the operation theater, baseline and continuous recording of an electrocardiogram, hemodynamic parameters (heart rate and non-invasive blood pressure [BP]), and oxygen saturation were performed using a multi parameter monitor. An 18 Gauge intravenous (IV) cannula was put on the non-dominant hand of the patient and IV fluids were started based on the Holiday Segar equation. All patients were pre-medicated with Inj. Midazolam 0.02 mg/kg, Inj. Ondansetron 0.1 mg/kg and Inj. Glycopyrrolate 0.01 mg/kg, Inj. Fentanyl 2 mcg/kg followed by pre-oxygenation with 100% oxygen with an appropriate face mask. Then, the patient was induced with Inj. Propofol 2 mg/kg i.v. After ensuring the adequacy of mask ventilation, vecuronium (0.1 mg/kg) was administered and the trachea was intubated after 3 min. Dexmedetomidine was diluted to 2 μg/mL in a total volume of 50 mL. After intubation, Group D participants received an infusion dosage of 0.5 μg/kg/h. The infusion was continued up to the initiation of skin closure. Group S participants do not receive dexmedetomidine infusion. Anesthesia was maintained in both groups with oxygen, nitrous oxide, sevoflurane, and adequate muscle relaxants. Supplemental fentanyl was given as clinically indicated (After ensuring adequate depth of anesthesia, 1 μg/kg of fentanyl was administered for a 20% increase in heart rate or systolic blood pressure [SBP] from baseline.) Ventilation was adjusted to maintain end-tidal carbon dioxide within a normal range of 35–40 mmHg. Fentanyl was not administered within 30 min of the end of surgery. Inhalational agents and infusions were stopped at the time of skin closure. Hypotension, defined as SBP <90 mmHg, was treated with mephentermine 6 mg IV and a fluid bolus of 5 mL/kg. Symptomatic bradycardia, defined as a heart rate <50/min associated with SBP <90 mmHg, was treated with 0.5 mg of atropine. For hypertension and tachycardia, defined by heart rate or BP increase of more than 20% over baseline, fentanyl 1 μg/kg was given and the depth of anesthesia was reviewed. At the end of the surgery, the patient was ventilated with 100% oxygen at a flow rate of 6 L/min. Once the patient developed spontaneous breathing efforts, neuromuscular blockade was antagonized with 50 μg/kg of neostigmine and 10 μg/kg of glycopyrrolate extubation was performed when adequate spontaneous ventilation and response to verbal commands were established. TDT and DSST were conducted at intervals of 30, 60, 90, and 120 min after the extubation. The primary outcome measures assessed were the NDM and the distance (average and maximum) by which these dots were missed on the TDT, and the scores of the DSST. The secondary outcome measure assessed was the total dosage of fentanyl used intraoperatively between the two groups, which were calculated at the end of the surgical procedure.

Statistical analysis

Data collected for the study were compiled and entered into MS excel software and analyzed using SPSS. Pearson's Chi-square test was used to compare the categorical variables and independent-sample t-test for comparison between two groups in terms of age. For all observations analyzed, we chose a level of significance also called the alpha value as 0.05 and accepted it as significant and *p<0.05 was considered as statistically significant.

RESULTS

The two groups were comparable in terms of age distribution (Table 1) since there was no statistically significant difference present. *p=0.191 (>0.05).

The two groups were comparable in terms of ASA PS Grading (Table 2). There was no significant difference between the two groups with *p=0.339 (>0.05).

Table 1 : Comparison of two groups according to mean age

Category	Group	n	Mean	SD	t	p
Age	S	85	36.5059	6.50572	1.05	0.191
	D	85	35.4	7.10667		

SD: Standard deviation

Table 2 : Comparison of cases in both groups according to American society of anaesthesiologists physical status grading

Group	ASA PS, count (%)		Total	χ^2	p
	ASA I	ASA II			
S	51 (60.0)	34 (40.0)	85 (100.0)	0.915	0.339
D	57 (67.1)	28 (32.9)	85 (100.0)		
Total	108 (63.5)	62 (36.5)	170 (100.0)		

ASA PS: American Society of Anaesthesiologists Physical Status

Table 3: Comparison of two groups according to sex

Group	Sex, count (%)		Total	χ^2	p
	Male	Female			
S	35 (41.2)	50 (58.8)	85 (100.0)	0.383	0.536
D	39 (45.9)	46 (54.1)	85 (100.0)		
Total	74 (43.5)	96 (56.5)	170 (100.0)		

Table 4: Comparison of number of dots missed at 30 min, 60 min, 90 min, and 120 min

Category	Group	n	Mean	SD	t	p
NDM/baseline	S	85	0.13	0.34	0.386	0.700
	D	85	0.15	0.45		
NDM/30	S	85	15.42	1.58	36.775	0.000
	D	85	7.47	1.22		
NDM/60	S	85	7.44	1.40	21.642	0.000
	D	85	3.36	1.02		
NDM/90	S	85	4.18	1.19	19.211	0.000
	D	85	1.11	0.87		
NDM/120	S	85	1.79	0.89	17.356	0.000
	D	85	0.06	0.24		

NDM: Number of dots missed, SD: Standard deviation

Table 5: Comparison of maximum distance of dots missed at 30 min, 60 min, 90 min, and 120 min

Category	Group	n	Mean	SD	t	p
MDDM/baseline	S	85	0.21	0.58	0.127	0.899
	D	85	0.22	0.62		
MDDM/30	S	85	4.61	0.64	19.685	0.000
	D	85	3.07	0.34		
MDDM/60	S	85	3.12	0.32	10.734	0.000
	D	85	2.35	0.57		
MDDM/90	S	85	2.78	0.42	13.202	0.000
	D	85	1.32	0.93		
MDDM/120	S	85	1.82	0.71	20.252	0.000
	D	85	0.08	0.35		

MDDM: Maximum distance of dots missed, SD: Standard deviation

The two groups were comparable in terms of sex (Table 3). There was no significant difference between the two groups with *p=0.536 (>0.05).

The NDM in TDT was assessed at 30 min, 60 min, 90 min, and 120 min post-operative period (Table 4) in both groups and were compared. Baseline values of NDM showed that there was a significant difference between these groups with p=0.70. It was found that at 30, 60, 90, and 120 min, postoperatively, there was a significant reduction in NDM in

Table 6: Comparison of average distance of dots missed at 30 min, 60 min, 90 min, and 120 min

Category	Group	n	Mean	SD	t	p
ADDM/baseline	S	85	0.21	0.58	0.127	0.899
	D	85	0.22	0.62		
ADDM/30	S	85	3.19	0.27	24.569	0.000
	D	85	2.35	0.15		
ADDM/60	S	85	2.50	0.17	11.834	0.000
	D	85	2.07	0.29		
ADDM/90	S	85	2.25	0.16	9.658	0.000
	D	85	1.28	0.91		
ADDM/120	S	85	1.76	0.67	19.727	0.000
	D	85	0.09	0.40		

ADDM: Average distance of dots missed, SD: Standard deviation

Table 7: Comparison of digit symbol substitution test at 30 min, 60 min, 90 min, and 120 min

Category	Group	n	Mean	SD	t	p
DSST/baseline	S	85	36.58	5.14	0.074	0.941
	D	85	36.52	5.17		
DSST/30	S	S85	6.61	0.96	19.354	0.000
	D	85	10.42	1.54		
DSST/60	S	85	10.22	1.58	18.072	0.000
	D	85	15.00	1.86		
DSST/90	S	85	13.26	1.35	22.844	0.000
	D	85	19.15	1.96		
DSST/120	S	85	16.11	1.40	36.955	0.000
	D	85	24.87	1.68		

DSST: Digit symbol substitution test, SD: Standard deviation

Table 8: Comparison of amount of fentanyl consumption

Category	Group	n	Mean	SD	t	p
Amount of fentanyl required (mcg)	S	85	182.82	20.56	17.819	0.000
	D	85	132.00	16.39		

SD: Standard deviation

Group D compared to Group S. The *p-value obtained was 0.00 and hence statistically significant.

MDDM assessed at 30 min, 60 min, 90 min, and 120 min postoperatively (Table 5) showed a significant reduction in MDDM in Group D compared to Group S. The p-value obtained was 0.00 (<0.05) and hence statistically significant.

ADDM assessed at 30 min, 60 min, 90 min, and 120 min postoperatively (Table 6) showed a significant reduction of ADDM in Group D compared to Group S in all time intervals. The *p-value obtained was 0.00 (<0.05) in all 4-time intervals and hence statistically significant.

DSST done at 30 min, 60 min, 90 min, and 120 min time interval postoperatively (Table 7) showed significant improvement in DSST in Group D compared to Group S in all time intervals. The *p-value obtained was 0.00 (0.05) and hence statistically significant.

It was found that amount of fentanyl required intraoperatively was less in Group D compared to Group S with a mean of 182.82 in Group D and a mean of 132 in Group S (Table 8). The *p-value obtained was 0.00 (<0.05) and hence was statistically significant.

DISCUSSION

In anesthesia practice, post-operative psychomotor recovery is a complex and significant factor because there is an increasing trend toward daycare and ambulatory surgeries. Post-operative readiness for discharge is consistent with the recovery of psychomotor function after undergoing surgery under general anesthesia [1]. Dexmedetomidine has analgesic and sedative properties that do not cause respiratory depression [2]. Hypoxic and hypercapnic ventilator drives are also preserved with this drug. The addition of dexmedetomidine as an adjuvant to a balanced anesthetic technique decreases perioperative opioid consumption and has also been shown to minimize the requirement of inhalational agent [3-6]. Our study aimed to assess whether the addition of dexmedetomidine improves psychomotor recovery when used as a component of general anesthesia. It was demonstrated that the addition of dexmedetomidine as a component of balanced anesthesia significantly improved psychomotor recovery.

In our study, we chose 170 patients of ASA 1 and 2 in the age group of 18–50 years scheduled for elective surgery under general anesthesia with an anticipated duration of <3 h. The sample size was calculated based on the study conducted by Mishra *et al*. [1], they were divided into two groups with 85 each. One group received dexmedetomidine and the other group did not. Psychomotor recovery was assessed with TDT and DSST. TDT is a modification of the motor gestalt test [7]. Takayama *et al*. [8] compared the recovery of psychomotor function after total IV anesthesia with propofol-remifentanil and propofol-fentanyl. They assessed the recovery profile with TDT and TDT was recorded using the same variables as used by us. They also noted TDT to be more sensitive compared with other tests for assessing the intermediate and late recovery of psychomotor function after general anesthesia. TDT is a pure psychomotor test, whereas DSST involves memory processing and cognitive function apart from assessing psychomotor function.

The baseline characteristics of the population in terms of age, gender, weight, and ASA PS grades were analyzed and no significant differences were seen. Hence, both groups were comparable. In this study NDM, MDDM and ADDM were significantly lesser in the dexmedetomidine group when compared with the control group at 30, 60, 90, and 120 min postoperatively. Psychomotor recovery was assessed with DSST also. DSST has been used in various studies for assessing psychomotor function. DSST also showed significant difference between the groups 40 at 30, 60, 90, and 120 min. DSST score was significantly better in dexmedetomidine group when compared to control group at all time intervals.

Mishra *et al*. [1] studied psychomotor recovery after IV dexmedetomidine infusion during general anesthesia, by the same variables as used by us – that is, TDT, DSST, and intraoperative fentanyl requirement. In that study, TDT showed statistically significant early recovery in Group D compared with Group S. DSST revealed early recovery at 30 min post-operative interval but not at other time intervals.

In this study, the cumulative dose of fentanyl requirement in Group D was decreased compared with Group S. The decrease in fentanyl dose requirement was probably because of analgesic property of dexmedetomidine [9,10,11]. This is consistent with the studies done by Arain *et al*. and Bajwa *et al*. Arain *et al*. [2,12] studied the effect of dexmedetomidine on early post-operative morphine requirement and the time for first analgesic dose in patients undergoing elective inpatient surgery and showed that there was a 66% decrease in the early post-operative morphine requirement as well as a significant delay in the demand for the first analgesic dose. Bajwa *et al*. [13] showed that there was a more than 50% decrease in the fentanyl and is of lurane requirement in the dexmedetomidine group.

There are a few limitations to this study. Psychomotor recovery was assessed based on TDT and DSST. These are paper and pencil tests. The disadvantage with these tests is that they have a practice effect, that is, improvement in score from baseline with repeated testing. The tests for psychomotor analysis were done from 30 to 120 min postoperatively. We should have included 15 and 150 min also as it would have shown a complete recovery of psychomotor function. Most of the patients in both groups did not reach their baseline value at 120 min intervals. We should have assessed the time to recover to baseline which would have given us a complete recovery profile.

CONCLUSION

The results of this study suggest that the addition of dexmedetomidine to a balanced anesthetic technique significantly hastened the psychomotor recovery and also there was a reduction in the perioperative fentanyl consumption in the dexmedetomidine group.

AUTHORS' CONTRIBUTIONS

All the authors contributed to the preparation of the final manuscript.

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