Original Article

Psychomotor recovery of dexmedetomidine compared with propofol after sedation during spinal anesthesia: A randomized control trial

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Abstract

Background and Aims: Early psychomotor recovery is an essential part of day care surgery which depends on brain integration of motor and sensory co-ordination. Even though dexmedetomidine is commonly used for day care procedures, the recovery profile was not studied. Hence, this study was designed to evaluate the psychomotor recovery of sedation with dexmedetomidine during spinal anesthesia.

Material and Methods: Sixty-six patients were included. Group D received dexmedetomidine 0.5 μg/kg (loading dose) followed by 0.2–1 μg/kg/hour. Group P received propofol infusion of 25–100 μg/kg/minute. Psychomotor recovery was assessed by finger-tapping, manual dexterity, visual spatial memory capacity, and pen and paper tests. Psychomotor tasks were given to the patients postoperatively at every 30 minutes for 2 hours followed by every hour up to 4 hours after surgery. Distribution of patients, age, weight, duration of surgery, and the level of sensory blockade was compared using independent *t*-test. Student's *t*-test has been used to find the significance of parameters such as heart rate, mean arterial pressure, oxygen saturation (SpO_2), psychomotor recovery between two groups. $P < 0.05$ was considered as significant.

Results: The motor recovery using finger tapping test was faster in Group D than Group P (73.94 ± 42.13 vs 101.21 ± 37.98 minutes, *P*–value = 0.007). Motor recovery using peg board test was faster in Group P than Group D (82.12 ± 40.37 vs 99.39 ± 43.08 minutes, *P*–value = 0.098). Visual spatial capacity memory test and pen and paper test were unaffected.

Conclusions: We conclude that patients who received dexmedetomidine showed earlier recovery with finger tapping test. Hence, we suggest to use dexmedetomidine for complete psychomotor recovery and fast-track discharging of the patient after spinal anesthesia.

Keywords: Dexmedetomidine, finger tapping test, peg board test, pen and paper test, propofol, psychomotor recovery, visual spatial capacity test

Introduction

Dexmedetomidine has a unique property of sedation that it does not cause respiratory depression even with higher doses. Day care surgeries have been increasing significantly in the recent time and psychomotor function is of utmost importance for earlier discharge. Psychomotor recovery depends on various processes in the brain requiring integration of motor and sensory co-ordination. It further determines the patient's capabilities of co-ordination, occupational, and driving skills. We put forward the hypothesis that psychomotor recovery of dexmedetomidine will be comparable to propofol using neurocognitive tests.[1] Propofol is known to cause impaired cognitive, coordination, and reactive skills on which dexmedetomidine has a little effect. Dexmedetomidine has a unique property of sedation that it does not cause respiratory depression even with higher doses.

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However, higher doses of dexmedetomidine can cause reduced attention and mental slowness and little is known about the effects of dexmedetomidine on psychomotor function. Hence, we planned to investigate the time and quality of psychomotor recovery of dexmedetomidine in comparison with propofol for intraoperative sedation for surgeries requiring spinal anesthesia.

Material and Methods

This study was a randomized control trial undertaken in the Department of Anesthesiology and Critical Care, between the years June 2014 and August 2015. The Sample size was calculated considering a difference of 6 minutes in postoperative recovery event from the previous study by Arain *et al*. This time difference may not be significant but was used only for calculating sample size,[2] 33 in each group dexemedetomidine and propofol, with power of 80% and confidence interval of 95%. After the review and approval from the Institute Ethics Committee, patients were enrolled.

Patients were randomized by a computer-generated randomization list; a sequentially numbered and opaque sealed envelope technique was used for allocation concealment [Figure 1]. An envelope was opened just before taking the patient to the operation table. Written consent was taken from all 66 patients scheduled for surgeries under spinal anesthesia. We included patients aged between 18 and 60 years of either sex with physical status of 1 and 2 according to American Society of Anesthesiologists (ASA), who were scheduled for elective lower abdominal, urological, gynecological, and orthopedic surgeries under spinal anesthesia.

A battery of four tests was used to assess psychomotor recovery and base line scores of each test were recorded the day before the surgery after giving practice sessions to accustom themselves. Final attempt after four practice sessions was taken as baseline value.

Manual dexterity test was used to assess coordination, that is, the ability to make skillful, arm-hand manipulations of smaller and larger objects mainly involving gross motor activity and hand dexterity. This manual dexterity was assessed using Purdue peg board test. This test, which involved assembling of pins in holes on a board in a 30-second period with two hands separately and placing pins, washer, and collar all together, called as an assembly on a board in 1 minute that was calculated as the mean score.[3] This test took about 5 minutes [Figure 2].

Finger tapping test was done with a special tapper and counter, where the patient was required to tap, using the index finger of the hand for a 10-second period. Five trials of 30 seconds for each hand were conducted, and mean score was taken from the five tapping times. It was mainly used to assess fine motor function associated with skills of hand.[4-6] It took a total duration of 10 minutes for assessment [Figure 3].

Visual spatial capacity memory test: Visual spatial capacity memory test was used to assess memory of recall. In this test, patients were given a sample of coloured squares. For each time, patients were asked to see a display of coloured squares on a computer screen and needed to remember them. Patients were expected to notice the change after the colored squares disappeared and reappeared after some time with color changes and give an answer Yes/No. We presented test arrays to the patients with different sets of papers with the change of coloured diagrams instead of automated array presentations to suit the Indian rural population as they were unaccustomed to computer tasks.[7] This task took about 2–5 minutes.

Pen and paper test (for Indian rural population) Figure 4: This pen and paper test was simplified into a six-point questionnaire testing orientation of a person to time, place, and season. Attention and concentration by serial subtraction of 7 starting from 100; registering three objects, and naming them after 1 minute; execution of a function such as folding a paper into half, construction of a diagram such as a pentagon, and recall of the abovementioned objects at the end. It took about 5 minutes and was an important test for cognition.[8] The time duration for all tests was 20 minutes.

Spinal anesthesia was performed after preloading with intravenous crystalloids 10 mL/kg and bupivacaine of 2.8 cc volume was used as a standard in all patients, and after the fixation of spinal anesthesia Group D patients received intravenous (IV). Dexmedetomidine 0.5 μg/kg loading dose for 15 minute followed by a maintenance dose of 0.2–1 μg/kg/hour[9,10] via a three-way cannula attached till the end of the surgery. Sedation was assessed using Ramsay sedation scale (RSS) at the time of incision and then every 30 minutes until the end of the surgery. The dexmedetomidine infusion was adjusted with incremental doses of 0.2 μg/kg until the target RSS score of 3–4 was achieved and the patient could respond to commands or to light glabellar tap and also titrated to maintain stable hemodynamic parameters throughout the surgery.

Group P patients received propofol 25–100 μg/kg/minute and the infusion rate was also adjusted with incremental doses of 10 μg/kg/minute to maintain the level of sedation to RSS values 3–4. Oxygen was administered with a face mask at 5 L/minute only when the pulse oximetry reading was falling below 95%. Hypotension defined as a decrease in systolic blood pressure

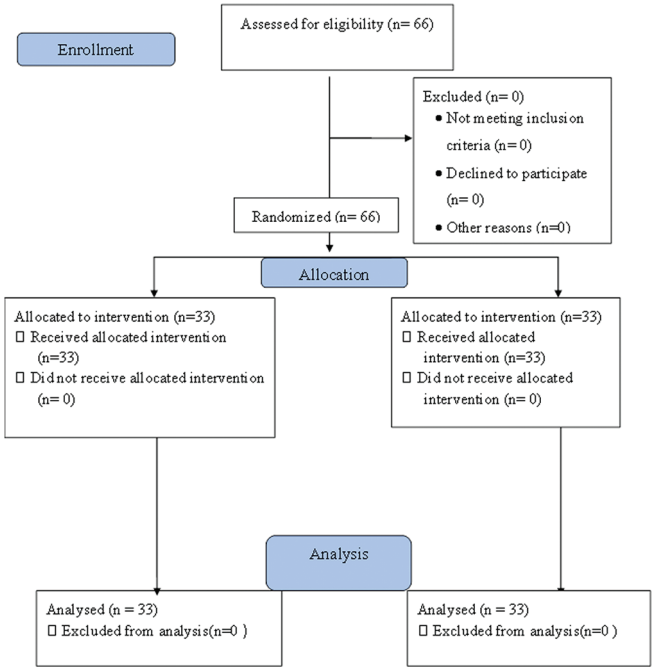


Figure 1: Consort flow diagram

Figure 3: Finger tapping test

by >20% from baseline or <90 mm Hg was treated with IV doses of mephentermine 3 mg and further boluses of IV fluid as required. Bradycardia defined as heart rate (HR) <50 bpm and was treated with IV atropine 0.6 mg. Loading dose of dexmedetomidine was not started if systolic blood pressure was <90 mm Hg, whereas maintenance infusion was continued with lower doses during the episodes of hypotension and bradycardia in both the groups as they were treated promptly and sedation was stopped only at the time of skin closure.

Psychomotor tasks were given to the patients by the same person in postanesthesia care unit at half an hour intervals between the two sets up to 2 hours after surgery and every hour up to 4 hours after surgery.

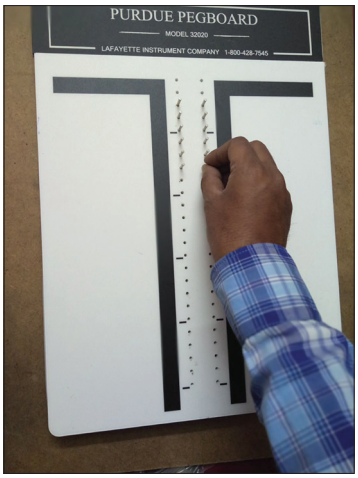


Figure 2: Manual dexterity test using peg board

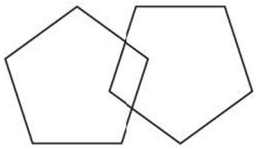
Test	Question	Answer	Points
Orientation time/place	Place/time/season		2
Registration	Name 3 objects		2
Attention concentration	Serial subtraction of 7		1
Execution	Folding paper		1
Recall of words	Recall of above 3 objects		1
Construction Of A Diagram			1

Figure 4: Pen and paper test

Statistical analysis used

Statistical analysis was done using statistical software SPSS version 20. Descriptive and inferential statistical analyses have been carried out in the present study. Results of continuous measurements, such as HR, mean arterial pressure, SpO_2, psychomotor recovery, duration of surgery, are presented as mean ± standard deviation (SD) and results of categorical measurements, such as maximum sensory level of spinal anesthesia, Bromage scale, atropine, and mephenteramine boluses used are expressed as proportions (%). *P* value <0.05 was considered as significant. All parameters have been tested for normal distribution using Shapiro–Wilk and Kolmogorov–Smirnov tests.

Distribution of patients, age, weight, duration of surgery, and the level of sensory blockade were compared using independent *t*-test. Student's *t*-test (two-tailed, independent) has been used to find the significance of study parameters such as HR, mean arterial pressure, SpO_2, maximum sensory level after spinal anesthesia, Bromage scale, and psychomotor recovery between two groups (intergroup analysis). All parameters of

psychomotor recovery tests were recorded as mean ± SD. $P < 0.05$ was considered as significant.

Results

All sixty-six patients completed the study and none excluded. Differences between the two groups in demographic characteristics were not statistically significant. Demographic characteristics of the groups are presented in Table 1. The average (±SE) age, weight, and height of Group D were 45.91 ± 10.21, 54.97 ± 11.98, 157.76 ± 6.16 and of Group P 44.91 ± 11.09, 59.27 ± 9.50, 160.36 ± 6.78, respectively.

The primary objective was to assess psychomotor recovery in which impairment was seen in both groups up to 1 hour. The motor recovery using finger tapping test was faster in Group D than Group P (73.94 ± 42.13 **vs** 101.21 ± 37.98 min, *P*–value = 0.007**)**. Motor recovery using peg board test was faster in Group P than Group D **(**82.12 ± 40.37 vs 99.39 ± 43.08 minutes, *P*–value = 0.098**)**. Visual spatial capacity memory test and pen and paper tests were unaffected (*P*–value = 1.00) and patients of both groups reached the baseline values in 30 minutes [Table 2]. Lower blood pressures and HR were seen with propofol group patients than dexmedetomidine group patients. The hemodynamic profile of patients among the groups was comparable and the incidence of side effects such as bradycardia and hypotension was not significant between the two groups. The onset of sedation was gradual and the target level on RSS (3–4) was achieved within 15–30 minutes after the start of continuous infusion and was comparable between the groups. Maximum sensory level of anesthesia was also comparable Table 3.

Discussion

In our study, we have observed that patients in dexmedetomidine group had significantly earlier psychomotor recovery compared with propofol. Dexmedetomidine group performed significantly better in the psychomotor tests such as finger tapping 60 minutes following anesthesia in comparison with propofol group. Though there was delayed recovery in hand dexterity with Purdue peg board in dexmedetomidine group, it was not statistically significant [Figure 5].

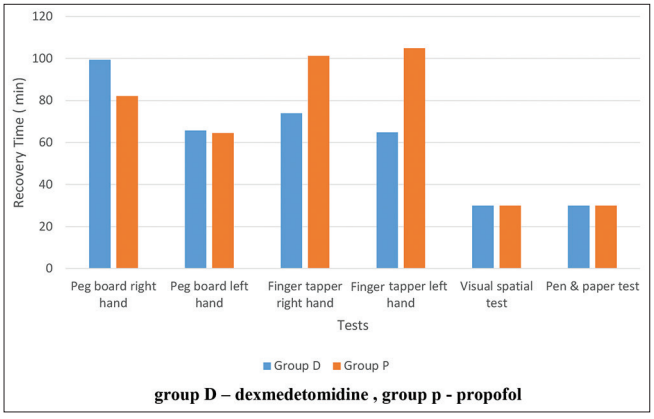


Figure 5: Recovery of psychomotor function (time to reach baseline value in all four tests)

In our study, free recall was unimpaired, with complete preservation of recognition recall with visual spatial memory task for all patients irrespective of the anesthetic agent used. Recovery was noted within 30 minutes for visuospatial capacity memory test and pen and paper test.

Dexmedetomidine is a selective α-2 receptor agonist with a sedative, anxiolytic, and analgesic effect, which does not cause respiratory depression.[11,12] Dexmedetomidine causes the "natural sleep" through inhibition of neuronal firing in the locus coeruleus in the brainstem, which means the patient is easily arousable on verbal stimulation without impaired cognitive abilities and psychomotor functions.[13] Although dexmedetomidine is in use for intraoperative sedation, there is limited information about its psychomotor recovery after surgery.[14-18]

Propofol's actions are generated by enhanced γ-aminobutyric acid suppression at cortical and thalamic interneurons and it

Table 1: Demographic data of the groups

	Group D (*n*=33)	Group P (*n*=33)	*P*
Age (yrs)	45.91±10.21	44.91±11.09	0.704
Weight (kg)	54.97±11.98	59.27±9.50	0.111
Height (cm)	157.76±6.16	160.36±6.78	0.107
BMI	21.9±1.8	23.1±1.41	0.105

group D - dexmedetomidine , group P - propofol

Table 2: Recovery of Psychomotor function (Mean time to reach baseline value)

Recovery time (min)		Group D (*n*=33)	Group P (*n*=33)	*p*
Peg board test	Right hand	99.39±43.08	82.12±40.37	0.098
	Left hand	65.76±41.08	64.55±47.90	0.912
Finger Tapping test	Right hand	73.94±42.13	101.21±37.98	0.007
	Left hand	64.85±49.95	104.85±44.94	0.001
Visual spatial test		30.00±0.00	30.00±0.00	1.00
Pen & Paper test		30.00±0.00	30.00±0.00	1.00

Table 3: Maximum sensory level of Spinal anesthesia

Max Sensory level	Group D Number (%)	Group P Number (%)	*P*
T 4-6	9 (27.3%)	14 (42.4%)	0.085
T 7-10	23 (69.7%)	19 (57.6%)	0.081
T >10	1 (3%)	0 (0%)	0.080
Total	33	33	

can decrease basal ganglia activity causing diminished finger movements and automatic finger movement sequencing.[19,20] These rhythmic finger movements were diminished in the propofol group of our study. Propofol also impedes the blood flow regionally to the thalamocortical, basal ganglia circuits even at low doses, which are essential for the rhythmic motor activity.[20,21] All the above can be the reasons for subjects of propofol group performing poorly when tested with finger tapping test compared with Dexmedetomidine which involves locus coeruleus and acts through endogenous NREM sleep circuits and has no effect on basal ganglia.[22]

Finger tapping test evaluates the fine motor skills and it indicates the subject's fine motor speed ability. The test was originally used by Halstead 1947 and is performed with the index finger. Impaired rhythmic finger movements were seen with propofol sedation as a result of its effect on thalamocortical and basal ganglia circuits.

Purdue peg board test is one of the best methods to evaluate fine dexterity and coordination of hand. Functioning of substantia nigra helps in the performance on the Purdue Pegboard test.[23,24] Sedation with an infusion of propofol was found to be associated with early psychomotor recovery regarding coordinated movements tested by dexterity test but was not statistically significant. Propofol and dexmedetomidine do not involve any of the neural pathways of substantia nigra that explains the better performance of peg board test in both groups of our study.

Pen and paper test was used for assessing diminished cognition, memory attention, concentration, and central integration. This test was successfully performed in all sixty-six subjects of the study indicating an absence of any cognition impairment for both the groups.

Some studies have been done in the past to evaluate the recovery profile of dexmedetomidine and propofol using various psychomotor tests.[25] Hall *et al.*[26] have demonstrated impairment of memory and psychomotor performance with dexmedetomidine infusion and also estimated the safety and efficiency of two dexmedetomidine infusions. Recovery profile was assessed by using a digit symbol substitution test (DSST) and a memory recall test (MEM) and a comprehensive memory test (CMEM) and results were unimpaired in comparison to cognitive dysfunction.

Arain *et al.* evaluated the cardiac and respiratory effects of equisedative doses of dexmedetomidine 0.4-0.7 μg/kg/hour and propofol 12.5–75 μg/kg/minute for intraoperative sedation in surgeries requiring regional anesthesia. Psychomotor recovery was assessed by using (digital symbol substitution test). There were no differences between the groups in psychomotor recovery.

Pawar and Malde[1] evaluated psychomotor, cognitive, and ambulatory recovery using Propofol and thiopentone as induction agents for general anesthesia. Psychomotor recovery was tested using, namely, memory, attention, concentration, speed, auditory and visual perception, manual dexterity, visuomotor and auditory-motor coordination, and simple reaction time tests. Postoperative recovery, early and late psychomotor function was comparable.

The dearth of data involving postoperative psychomotor recovery up to 4 hours and cognition assessment in Indian rural population, which was there in the previous validating studies, was fulfilled by our study without any limitations.

Conclusions

We conclude that dexmedetomidineis superior to propofol in terms of psychomotor recovery as seen on finger tapping test, which is a better predictor of various daily activities, even though other tests were comparable between both the groups. Thus, dexmedetomidine may prove to be a better sedative agent than propofol for spinal anesthesia in providing a complete psychomotor recovery and helps in fast track discharge of the patient.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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