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Original Article

Effects of Post-Operative Cognitive Dysfunction after Spinal Anesthesia between Geriatric and Middle-Aged Patients

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ABSTRACT

Objective: To compare the effects of Post-Operative Cognitive Dysfunction after spinal anesthesia between geriatric and middle-aged patients presenting for elective surgery.
Study Design: Quasi-experimental study.
Place and Duration of Study: Anesthesia Department of Combined Military Hospital, Peshawar Pakistan, from Jan to Jun 2022.
Methodology: A total of 90 patients were included in the study divided into the geriatric group (Group-A, n=45) and the middle age group (Group-B, n=45) according to ages defined. Primary variables measured were Mini-Mental State Examination pre-operatively and 12 and 24 hours after surgery for cognitive impairment.
Results: Mean age of patients was 64.56±3.85 years in the geriatric versus 38.11±3.62 years in the middle age group. The mean total MMSE score out of 30 was 24.36±1.5 in the geriatric versus 25.58±1.3 in the middle age group at the 12-hour interval (p<0.001). The score improved at the 24-hour interval but was still hampered in the geriatric Group more than the middle age group, 26.76±1.00 versus 27.36±0.74 (p<0.001).
Conclusion: We conclude that neuraxial anesthesia is associated with deterioration in logical and analytical memory both in the middle age and geriatric age group with return to full neurological function early in the middle age group.

Key Words: Cognitive dysfunction, Geriatric, Middle aged, Spinal anesthesia.

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INTRODUCTION

Post-Operative Cognitive Dysfunction (POCD) is defined as a new cognitive impairment arising after surgical anesthesia resulting in memory and psychomotor impairment.[1] The term was first coined as "adverse cerebral effects of anesthesia on old people", in 1955 and has since been established as a clinical phenomenon commonly seen after general anesthesia especially in the elderly.[2-4]

A lot of theories have been proposed for the possible mechanism of this clinical entity with inflammatory and immune responses of surgery being implicated, along with hypoxemia, extremes of age, prolonged hypoxia, educational and type of anesthesia or surgery.[5,6] It has been found to usually be more prevalent in the older age group after general anesthesia and tends to arise early and may persist up to 3-6 months in certain cases.[3] The diagnosis is usually made with pre and post assessment of mental status in these patients and standardized tests are repeated after consecutive intervals post-surgery to see a trend in aggravation or improvement of the condition.[7]

The modality of spinal anesthesia is also associated with hypotension, hypoxemia with the same immune responses such as increase in cyclooxygenase-II in the brain during hypotension and cerebral ischemia causing memory disturbances as well as increase in Interleukin-6 levels acting as a pro-inflammatory cytokine in cognitive impairment.[8,9] Since a major portion of lower limb procedures are done under spinal anesthesia nowadays, studies comparing the effects of spinal anesthesia have been done in recent years, but they have been curtailed to the geriatric population in majority of the cases.

Since there are very few similar studies regarding the same in our region, our study aims to compare the effects of post-operative cognitive dysfunction (POCD) after spinal anesthesia between geriatric and middle-aged patients presenting for elective surgery in our department.

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METHODOLOGY

The quasi-experimental study was carried out at the Department of Anesthesiology, Combined Military Hospital, Peshawar Pakistan, from Jan to Jun 2022 after approval form the Institutional Ethical Review Board. The sample size was calculated using WHO calculator, keeping the with the population prevalence of POCD after spinal anesthesia being 4.25%.[10]

Inclusion Criteria: Patients of either gender presenting to the hospital for elective lower abdominal and limb surgeries requiring spinal anesthesia, in the age brackets of 30-49 and 50-69 years, with an educational level of matriculation or higher and the ability to understand and follow the MMSE questionnaire, were included.

Exclusion Criteria: Patients with major cardiac or respiratory disease, low ejection fraction, allergy to bupivacaine, coagulation disorders, infection at spinal anesthesia site, pregnancy, ongoing hypothermia or hypoxia/hypoxemia, vital parameters exceeding 20% of baseline according to age, those who required general anesthesia or redo spinal post-spinal failure, patients with known cognitive defects, dementia, Alzheimer's were excluded.

We recruited 90 patients using non-probability consecutive sampling and divided them into Group-A (n=45), aged 35-49 years, and Group-B (n=45), aged 50-65 years (Figure-1). Informed written consent was taken prior to commencement of data collection.

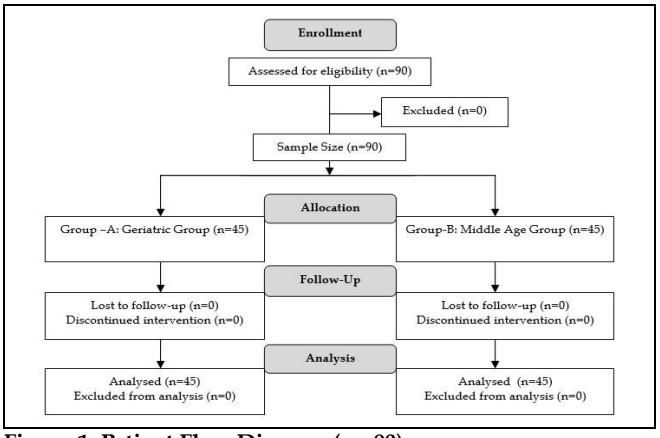
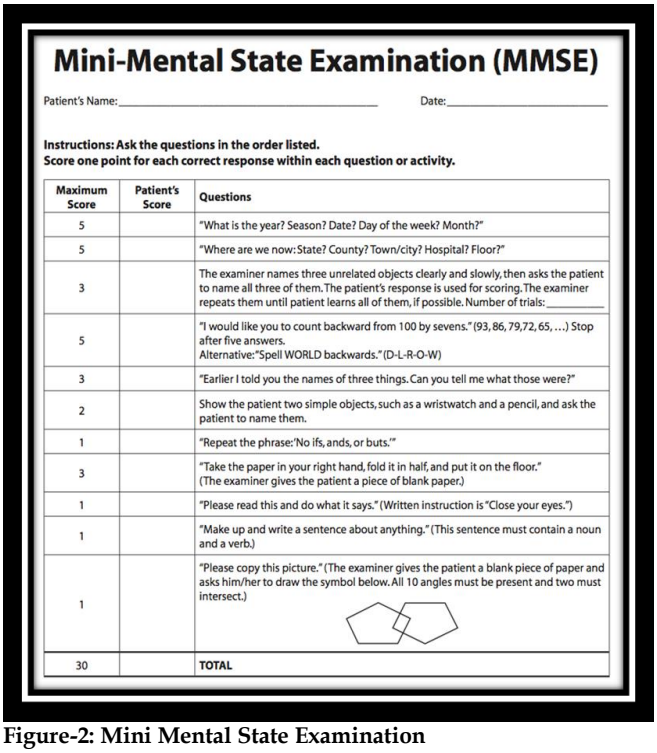


Figure-1: Patient Flow Diagram (n= 90)

Standard questionnaire of Mini Mental State Examination (MMSE) was used pre-operatively by a resident anesthetist unaware of the study protocol and reason for assessment and total score was noted. Standard monitoring including non-invasive blood pressure, heart rate, capnography and ECG were attached to participants in both groups. Random blood sugar was checked before the operation and maintained between 110-160 mg/dl before the start of procedure.

Spinal anesthesia was given using 0.5% hyper-baric bupivacaine at a dose of 2.5 ml using a 25 G standard B Braun spinal needle in the Lumbar 2 vertebral space after pre-loading patients with 500 ml of normal saline over 20 minutes. Vitals were recorded every 15 minutes till the end of surgery and any event of hypotension and bradycardia was noted. In both groups, bradycardia was defined as a heart rate of <60 beats per minute[11] and hypotension as Mean Arterial Pressure <50 mm Hg[12] and was treated with 5 mg ephedrine and 600 mcg of glycopyrrolate where needed.

Post-operatively, patients were kept in the post-operative surgical ward and MMSE score (Figure-2) was assessed after 12 and 24 hours by an independent anesthesia resident on duty.



Mini-Mental State Examination (MMSE)

Patient's Name:_____ Date:_____

Instructions: Ask the questions in the order listed.
Score one point for each correct response within each question or activity.

Maximum Score	Patient's Score	Questions
5		"What is the year? Season? Date? Day of the week? Month?"
5		"Where are we now: State? County? Town/city? Hospital? Floor?"
3		The examiner names three unrelated objects clearly and slowly, then asks the patient to name all three of them. The patient's response is used for scoring. The examiner repeats them until patient learns all of them, if possible. Number of trials:_____
5		"I would like you to count backward from 100 by sevens." (93, 86, 79,72, 65, …) Stop after five answers. Alternative: "Spell WORLD backwards." (D-L-R-O-W)
3		"Earlier I told you the names of three things. Can you tell me what those were?"
2		Show the patient two simple objects, such as a wristwatch and a pencil, and ask the patient to name them.
1		"Repeat the phrase: 'No ifs, ands, or buts.'"
3		"Take the paper in your right hand, fold it in half, and put it on the floor." (The examiner gives the patient a piece of blank paper.)
1		"Please read this and do what it says." (Written instruction is "Close your eyes.")
1		"Make up and write a sentence about anything." (This sentence must contain a noun and a verb.)
1		"Please copy this picture." (The examiner gives the patient a blank piece of paper and asks him/her to draw the symbol below. All 10 angles must be present and two must intersect.)
30		TOTAL

Figure-2: Mini Mental State Examination

Primary variables measured were MMSE pre-operatively, and 12 and 24 hours after surgery. Data was analyzed using Statistical Package for Social Sciences (SPSS) version 26. Demographics were described in terms of mean and SD, frequencies, and percentages when appropriate. Independet sample t-

test was used to compare means between the groups. The *p*-value of ≤0.05 was considered statistically significant.

RESULTS

A total of 90 patients were included in the study divided into the geriatric group (Group-A, n=45) and the middle age group (Group-B, n=45) according to ages previously defined. Mean age of patients was 64.56±3.85 years in the geriatric versus 38.11±3.62 years in the middle age group. Mean weight in both groups was 68.42±3.87 kg in the geriatric versus 68.62±3.92 kg in the middle age group. Mean duration of lower abdominal surgeries done was 130.0±7.35 minutes in the geriatric versus 129.16±6.70 minutes in the middle age group (Table-I).

Table-I: Descriptive Statistics of Both Groups (n=90)

Variables	GROUP-A (n=45)	GROUP-B (n=45)	*p*-value
Mean age (years)	64.56±3.8	38.11±3.6	0.001
Mean weight (kg)	68.42±3.8	68.62±3.9	0.395
Mean duration of surgery (minutes)	130.0±7.3	129.16±6.7	0.449

Mini Mental State Examination was done at 12 hours between both groups showed a mean orientation score of 9.44±0.75 versus 9.51±0.75 in the middle age group (*p*=0.083). A significant difference was seen for registration with mean value of 2.69±0.46 in the geriatric versus 2.87±0.34 in the middle-aged group (*p*=0.004). Attention and calculation between group showed a mean value of 2.56±0.81 in the geriatric versus 2.87±0.69 in the middle-aged group (*p*=0.012). Recall assessment showed a mean value of 2.49±0.62 in the geriatric versus 2.96±0.20 in the middle-aged group (*p*=0.001). Language and copying showed mean values of 6.24±0.57 versus 6.38±0.53 (*p*=0.013) and 0.93±0.25 versus 1.00±00 (*p*=0.083).

When the same assessment was done at 24-hours, mean orientation and registration scores between both groups were statistically similar with 9.84±0.47 versus 9.89±0.43 (*p*=0.16) and 2.96±0.20 versus 3.00±00 (*p*=0.16). Attention and calculation were still different statistically between both groups with values 3.18±0.61 versus 3.49±0.50 (*p*=0.001) and recall mean values being 2.89±0.31 versus 3.00±00 (*p*=0.020). Language and copying assessment done showed mean values of 6.91±0.28 versus 6.98±0.14 (*p*=0.083) for language and 0.98±0.14 vs 1.00±00 for copying (*p*=0.32) (Table-II).

The mean total MMSE score out of 30 was 24.36±1.5 in the geriatric versus 25.58±1.3 in the middle age group at the 12-hour interval (*p*<0.001). The score improved at the 24-hour interval but was still hampered in the geriatric Group-Bore than the middle age group, 26.76±1.00 versus 27.36±0.74 (*p*<0.001) (Table-II).

Table-II: Comparison of Mini Mental State Examination (MMSE) Parameters Between Both Groups (n=90)

Variables	Group-a (Mean±SD) (n=45)	Group-b (Mean±SD) (n=45)	*p*-value
MMSE Pre-Operatively (Mean Score)			
Total Score (out of 30)	30±0.00	30±0.00	0.07
MMSE 12 Hours After Surgery (mean score)			
Orientation (out of 10)	9.44±0.75	9.51±0.75	0.083
Registration (out of 3)	2.69±0.46	2.87±0.34	0.004
Attention and calculation (out of 5)	2.56±0.81	2.87±0.69	0.012
Recall (out of 3)	2.49±0.62	2.96±0.20	0.0001
Language (out of 8)	6.24±0.57	6.38±0.53	0.013
Copying (out of 1)	0.93±0.25	1.00±00	0.083
Total Score (Out of 30)	24.36±1.5	25.58±1.3	0.001
MMSE 24 Hours After Surgery (Mean Score)			
Orientation (out of 10)	9.84±0.47	9.89±0.43	0.16
Registration (out of 3)	2.96±0.20	3.00±0.00	0.16
Attention and calculation (out of 5)	3.18±0.61	3.49±0.50	0.001
Recall (out of 3)	2.89±0.31	3.00±0.00	0.024
Language (out of 8)	6.91±0.28	6.98±0.14	0.083
Copying (out of 1)	0.98±0.14	1.00±0.00	0.32
Total score (out of 30)	26.76±1.00	27.36±0.74	0.001

DISCUSSION

When considering the overall results of the study, cognitive impairment was present more in the geriatric age group versus the middle age group. This was also confirmed in a study carried out by Lin *et al*.[5] and Kotekar *et al*.[13] The proposed mechanisms implicated are peripheral pro inflammatory signals acting as activators of changes in the brain[14] as well as immune response resulting in peripheral release of factors reaching the brain and causing cognitive impairment.[15]

When discussing the parameters of MMSE, it was seen that logic and analytical memory was hampered more post-operatively in both groups, but the deterioration was more in the geriatric age group. The mean scores of Attention, Calculation and Recall were more affected than those of Orientation and Registration. This was also seen in studies carried out by Smith *et al*.[16] and Schenning *et al*.[17] The mechanism bringing about this disparate change in neurological parameters is thought to be the involvement of multiple centers required for logical and analytical

thinking.[18] More studies are needed to find areas of cognitive impairment in the brain bringing about these elective changes.

CONCLUSION

We conclude that neuraxial anesthesia is associated with deterioration in logical and analytical memory both in the middle age and geriatric age group with return to full neurological function early in the middle age group.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SH & AHB: Conception, study design, drafting the manuscript, approval of the final version to be published.

SHF & NTB: Data analysis, data interpretation, critical review, approval of the final version to be published.

KAK & NIC: Data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Czyż-Szypenbejl K, Mędrzycka-Dąbrowska W, Kwiecień-Jaguś K, Lewandowska K. The occurrence of postoperative cognitive dysfunction (POCD)-systematic review. Psychiatr Pol 2019; 53(1): 145-160. https://doi.org/10.12740/PP/90648
2. Zhao Q, Wan H, Pan H, Xu Y. Postoperative cognitive dysfunction-current research progress. Front Behav Neurosci 2024 ; 18: 1328790. https://doi.org/10.3389/fnbeh.2024.1328790
3. Daiello LA, Racine AM, Yun Gou R, Marcantonio ER, Xie Z, Kunze LJ, et al. Postoperative delirium and postoperative cognitive dysfunction: overlap and divergence. Anesthesiology 2019; 131(3): 477-491.

   https://doi.org/10.1097/ALN.0000000000002729
4. Berger M, Nadler JW, Browndyke J, Terrando N, Ponnusamy V, Cohen HJ, et al. Postoperative cognitive dysfunction: minding the gaps in our knowledge of a common postoperative complication in the elderly. Anesthesiol Clin 2015; 33(3): 517-550.

   https://doi.org/10.1016/j.anclin.2015.05.008
5. Lin X, Chen Y, Zhang P, Chen G, Zhou Y, Yu X. et al. The potential mechanism of postoperative cognitive dysfunction in older people. Exp Gerontol 2020; 130: 110791.

   https://doi.org/10.1016/j.exger.2019.110791
6. Langer T, Santini A, Zadek F, Chiodi M, Pugni P, Cordolcini V, et al. Intraoperative hypotension is not associated with postoperative cognitive dysfunction in elderly patients undergoing general anesthesia for surgery: results of a randomized controlled pilot trial. J Clin Anesth 2019; 52: 111-1118.

   https://doi.org/10.1016/j.jclinane.2018.09.021
7. Lu W, Zhang K, Chang X, Yu X, Bian J. The Association Between Systemic Immune-Inflammation Index and Postoperative Cognitive Decline in Elderly Patients. Clin Interv Aging 2022; 17: 699. https://doi.org/10.2147/CIA.S357319
8. Safavynia SA, Goldstein PA. The role of neuroinflammation in postoperative cognitive dysfunction: moving from hypothesis to treatment. Front psychiatry 2019; 9: 752.

   https://doi.org/10.3389/fpsyt.2018.00752
9. Zhang N, Liang M, Zhang D-d, Xiao Y-r, Li Y-z, Gao Y-g, et al. Effect of goal-directed fluid therapy on early cognitive function in elderly patients with spinal stenosis: a case-control study. Int J Surg 2018; 54: 201-205.

   https://doi.org/10.1016/j.ijsu.2018.04.007
10. Ehsani R, Motlagh SD, Zaman B, Kashani SS, Ghodraty MR. Effect of general versus spinal anesthesia on postoperative delirium and early cognitive dysfunction in elderly patients. Anesth Pain Med 2020; 10(4).

    https://doi.org/10.5812%2Faapm.101815
11. Sidhu S, Marine JE. Evaluating and managing bradycardia. Trends Cardiovasc Med 2020; 30(5): 265-272.

    https://doi.org/10.1016/j.tcm.2019.07.001
12. Yu Q, Qi J, Wang Y. Intraoperative hypotension and neurological outcomes. Curr. Opin. Anesthesiology 2020; 33(5): 646-650.

    https://doi.org/10.1097/ACO.0000000000000904
13. Kotekar N, Shenkar A, Nagaraj R. Postoperative cognitive dysfunction–current preventive strategies. Clin Interv Aging 2018; 13: 2267.

    http://doi.org/10.2147/CIA.S133896
14. Zhao S, Chen F, Wang D, Han W, Zhang Y, Yin Q. et al. NLRP3 inflammasomes are involved in the progression of postoperative cognitive dysfunction: from mechanism to treatment. Neurosurg Rev 2021; 44(4): 1815-1831.

    https://doi.org/10.1007/s10143-020-01387-z
15. Bhuiyan P, Chuwdhury G, Sun Z, Chen Y, Dong H, Ahmed FF, et al. Network Biology Approaches to Uncover Therapeutic Targets Associated with Molecular Signaling Pathways from circRNA in Postoperative Cognitive Dysfunction Pathogenesis. J Mol Neurosc 2022: 1-27.

    https://doi.org/10.1007/s12031-022-02042-6
16. Smith P, Blumenthal J, Hoffman B, Davis RD, Palmer S. Postoperative cognitive dysfunction and mortality following lung transplantation. Am J Transplant 2018; 18(3): 696-703.

    https://doi.org/10.1111/ajt.14570
17. Schenning KJ, Murchison CF, Mattek NC, Kaye JA, Quinn JF. Sex and genetic differences in postoperative cognitive dysfunction: a longitudinal cohort analysis. Biol Sex Differ 2019; 10(1): 1-9.

    https://doi.org/10.1186/s13293-019-0228-8
18. Klimesch W. The frequency architecture of brain and brain body oscillations: an analysis. Eur J Neurosci 2018; 48(7): 2431-2453.

    https://doi.org/10.1111/ejn.14192