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Original Research Article

Impact of Anaesthesia on Postoperative Cognitive Dysfunction in the Elderly Population: A Myth or Reality

Vaishali C. Shelgaonkar[1], Medha A. Sangawar[2] and Himani Baxy[3]

[1]Professor, [2]Assistant Professor, [3]Intern,
Department of Anaesthesiology, Indira Gandhi Government Medical College and Hospital, Nagpur, Maharashtra, India- 440018

Abstract

Background: With the increasing number of surgeries being performed on elderly people worldwide each year, it has become important to study and manage the complications related to them. Post-operative cognitive dysfunction (POCD) is an age-related complication, very frequent in the older people. Hence, the present study was undertaken to detect the incidence of POCD and compare it between those undergoing surgery under regional anaesthesia and general anaesthesia.
Methods: This prospective observational study was conducted in 81 patients of age above 60 years, ASA physical status I, II, III, undergoing major surgeries during the period of one year. Pre and post-operative cognitive assessment was done using the Mini Mental State Examination (MMSE)/ Short Portable Mental State Questionnaire (SPMSQ), and Memory Impairment Screen (MIS).
Results: About 40% of the study population showed POCD. There was no significant difference between General and Regional anaesthesia techniques regarding POCD incidence. Increasing age and extensive surgery correlated with higher POCD occurrence. No significant association was found between addiction, co-morbidities and type of surgery.
Conclusion: Increasing age makes the elderly more prone to POCD and can have significant effect on their quality of life. So, such cases must be looked for in this population and managed accordingly.
Keywords: Anaesthesia, Cognitive dysfunction, Incidence, Older people, Co-morbidities.

***Correspondence Info:**
Dr. Vaishali C. Shelgaonkar
Professor,
Department of Anaesthesiology,
Indira Gandhi Government Medical College and Hospital, Nagpur, Maharashtra, India- 440018

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1. Introduction

The advanced medical technology and anaesthetic care has led to an increase in surgeries performed in the elderly population. During the aging process, the ability to withstand stress of surgery and anaesthesia is influenced by the deteriorating structural and functional changes in the body. In elderly, due to increased vulnerability, neurological sequelae are very common after surgery and one of the most important conditions is post-operative cognitive dysfunction (POCD) which is associated with significant morbidity and mortality [1,2].

POCD is defined as a more than expected post-operative deterioration in cognitive domains, including short-term and long-term memory, mood, consciousness, and circadian rhythm [3]. It has also been defined in a consensus statement as a 'spectrum of postoperative central nervous system (CNS) dysfunction both acute and persistent, including brain death, stroke, subtle neurologic signs and neuropsychological impairment [4]. Although pathophysiology remains unclear, various risk factors such as increasing age, genetic predisposition and pre-existing cognitive impairment have been identified. Possible etiological factors include neurotoxic drugs, low cerebral oxygenation and neuro-inflammation [5, 6].

POCD is evident in both general anaesthesia and regional anaesthesia [7]. The present study was focus on comparing the cognitive function decline in geriatric patients receiving general anaesthesia (GA) and regional anaesthesia (RA).

2. Material and Methods

After obtaining Institutional Ethics Committee approval and written inform consent from all the patients, this prospective observational study was conducted at a Tertiary Care Medical College and Hospital under Department of Anaesthesiology, in pre-operative wards from Jan. 2017 to Dec. 2017. The study enrolled total 81 patients of age > 60 years, ASA physical status I-III, scheduled for an elective surgical procedure under General Anaesthesia or Regional Anaesthesia and those able to understand various scores used during assessment. Patients with MMSE score <23, pre-existing cognitive dysfunction, severe auditory or visual disability or language, prior cardiac or neurosurgery and refusal to provide informed consent were excluded from the study. Demographic data (age, gender, education), information related to addiction and co-morbidities were noted. Type and duration of surgery was noted in both the groups.

A day prior to surgery, patients were counselled regarding the study and assessment of the baseline cognitive function tests was done. During this screening for cognitive impairment, patients scoring 23 or less were excluded. For illiterate individuals, SPMSQ was used preoperatively instead of MMSE. High correlation between SPMSQ and MMSE has been found [8]. Tests were conducted pre-operatively and post-operatively at days 1, 3, 7 and the day of discharge. The MMSE was done post-operatively along with other tests and the criterion to define decline in cognitive function is a decrease of 2 or more points compared to pre-operative values [9].

The MMSE is a screening test that quantitatively assesses cognitive impairment by asking variety of questions that test various cognitive domains including orientation to time and place, repetition, verbal recall, attention and calculation, language and visual construction. (Refer Annexure I). The aim of the MMSE examination is to: screen for cognitive impairment, assess the severity of any impairment, and monitor change by serial testing.

The Short Portable Mental Status Questionnaire (SPMSQ) is used for the assessment of organic brain deficit in the elderly patients (Refer Annexure II). In SPMSQ, total number of errors is recorded (maximum being 10 errors) which is used to grade intellectual impairment into mild, moderate and severe. Any decrement from existing grade was considered positive for POCD.

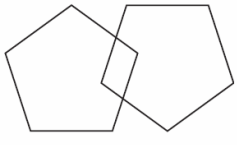
For assessment of memory, the Memory Impairment Screen (MIS) was used (Refer Annexure III). The maximum score for MIS is 8 with score of 4 or less indicative of possible cognitive impairment. All the tests were translated in Hindi and Marathi languages to overcome language barrier.

Annexure-I

The Mini-Mental State Exam

Patient_____ Examiner _____ Date_____

Maximum	Score	
		Orientation
5	( )	What is the (year) (season) (date) (day) (month)?
5	( )	Where are we (state) (country) (town) (hospital) (floor)?
		Registration
3	( )	Name 3 objects: 1 second to say each. Then ask the patient all 3 after you have said them. Give 1 point for each correct answer. Then repeat them until he/she learns all 3. Count trials and record. Trials _____
		Attention and Calculation
5	( )	Serial 7's. 1 point for each correct answer. Stop after 5 answers. Alternatively spell "world" backward.
		Recall
3	( )	Ask for the 3 objects repeated above. Give 1 point for each correct answer.
		Language
2	( )	Name a pencil and watch.
1	( )	Repeat the following "No ifs, ands, or buts"
3	( )	Follow a 3-stage command: "Take a paper in your hand, fold it in half, and put it on the floor."
1	( )	Read and obey the following: CLOSE YOUR EYES
1	( )	Write a sentence.
1	( )	Copy the design shown.



_____ Total Score

ASSESS level of consciousness along a continuum _____

Alert Drowsy Stupor Coma

"MINI-MENTAL STATE." A PRACTICAL METHOD FOR GRADING THE COGNITIVE STATE OF PATIENTS FOR THE CLINICIAN. *Journal of Psychiatric Research*, 12(3): 189-198, 1975. Used by permission.

Annexure-II

SPMSQ

PFEIFFER
SHORT PORTABLE MENTAL STATUS QUESTIONNAIRE

INSTRUCTIONS: Ask the subject questions 1-10, record answer, and enter as "1" under appropriate column (correct/error). All responses, to be scored correct, must be given by subject without reference to calendar, newspaper, birth certificate or other memory aid.

Patient Name: _____

Date: _____

	CORRECT	ERROR
1. WHAT IS THE DATE TODAY? Month_____ Day_____ Year_____ (Score correct only when the exact month, day and year are given correctly.)		
2. WHAT DAY OF THE WEEK IS IT? Day_____		
3. WHAT IS THE NAME OF THIS PLACE? _____ (Score correct if any correct description of the location is given: "My home," accurate name of town, city or name of residence, hospital, or institution (if subject is institutionalized) are all acceptable.)		
4. WHAT IS YOUR TELEPHONE NUMBER? (If none see 4A below) (Score correct when the correct number can be verified or when subject can repeat the same number at another point in question.) #_____ 4A. WHAT IS YOUR STREET ADDRESS? (Ask only if subject does not have a telephone.) _____		
5. HOW OLD ARE YOU? AGE:_____ (Score correct when stated age corresponds to date of birth.)		
6. WHEN WERE YOU BORN? Month_____ Day_____ Year_____ (Score correct only when exact month, date, and year are all given.)		
7. WHO IS PRESIDENT OF THE UNITED STATES NOW?_____ (Only the last name of the President is required.)		
8. WHO WAS THE PRESIDENT BEFORE HIM?_____ (Only the last name of the previous President is required.)		
9. WHAT WAS YOUR MOTHER'S MAIDEN NAME?_____ (Does not need to be verified. Score correct if a female name plus last name other than subject's is given.)		
10. SUBRACT 3 FROM 20 AND KEEP SUBTRACTING 3 FROM EACH NEW NUMBER ALL THE WAY DOWN. ____ ____ ____ ____ ____ ____ ____ (The entire series must be performed correctly in order to be scored correct. Any error in series or unwillingness to attempt series is scored as incorrect.)		
TOTAL NUMBER OF ERRORS		
*ADJUSTMENT FACTOR		
A) SUBTRACT 1 FROM ERROR SCORE IF SUBJECT HAS HAD ONLY A GRADE SCHOOL EDUCATION		-
B) ADD 1 TO ERROR SCORE IF SUBJECT HAS HAD EDUCATION BEYOND HIGH SCHOOL		+
TOTAL ADJUSTED ERRORS		

SCORING KEY: 0-2 errors = intellectually intact; 3-4 errors = mildly impaired; 5-7 errors = moderately impaired; 8-10 errors = severely impaired.

INFORMATION OBTAINED BY: _____ DATE: _____

 Reference: E. Pfeiffer, A Short Portable Mental Status Questionnaire for the Assessment of Organic Brain Deficit in Elderly Patients. Journal of the American Geriatrics Society, Vol. 23:433-441, 1975.

Annexure-III

Memory Impairment Screen (MIS)

Word	Cue	Free recall (2 pts.)	Cued Recall (1 pts)
Checkers	Game		
Saucer	Dish		
Telegram	Message		
Red Cross	Organization		

Scoring

The maximum score for the MIS is 8.

- 5-8 No cognitive impairment
- ≤ 4 Possible cognitive impairment

2.1 Statistical analysis

The sample size was 71. Thirty-five patients received general anaesthesia while 36 got operated under regional anaesthesia. A minimal sample size of 35 was determined by using power analysis based on alpha error of 0.05, beta error of 0.2 and the assumption that the incidence of postoperative cognitive impairment at one hour after anaesthesia would be 50%. Statistical analyses were performed using SPSS Statistics software.

3. Observations and Results

A total of 81 patients were enrolled in the study out of which 10 could not participate due inability to interpret tests, postoperatively. So, 71 patients undergoing elective surgeries under either regional (n=36) or general anaesthesia (n=35) were included in the study. The mean age for entire sample was 65.93 ± 6.52 years (range: 60-95 years). (Table I).

Table I: Age and gender distribution

			Regional Anaesthesia						General Anaesthesia					
Age	**Overall Total**		**Total**		**Male**		**Female**		**Total**		**Male**		**Female**	
	T	**A**	**T**	**A**	**T**	**A**	**T**	**A**	**T**	**A**	**T**	**A**	**T**	**A**
60-65	45	18	25	11	23	11	3	0	20	7	7	2	13	5
66-70	13	4	6	2	6	2	0	0	7	2	3	1	4	1
71-75	8	3	4	1	4	1	0	0	4	2	3	1	1	1
76-80	3	2	0	0	0	0	0	0	3	2	2	2	1	0
81-85	0	0	0	1	0	1	0	0	0	0	0	0	0	0
86-90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>90	1	1	0	0	0	0	0	0	1	1	0	0	1	1
Total	71	29	36	15	33	15	3	0	35	14	15	6	20	8
Mean age ± SD	65.93 ± 6.52		65.11 ± 5.58						66.77 ± 7.27					
Affected %	40.84%		41.66%						40% p>0.05					
M:F ratio				16.5:1						01:1.33				

T= Total; A= Affected

About 40% of sample showed cognitive dysfunction, whereas there was no significant difference in general and regional anaesthesia groups, (p>0.05). Surgeries were pertaining to geriatric population, mainly gastrointestinal, Uro-genital and miscellaneous. The mean duration of surgery in Regional Anaesthesia group was 76.25 ± 31.17 min and in General Anaesthesia group was 120.57 ± 42.02 min, (Table II and III).

Table II: Type of surgery

Type of surgery	**Total number of patients**	**Regional Anaesthesia**		**General Anaesthesia**	
		Total	**Affected**	**Total**	**Affected**
Gastro-intestinal surgeries	19	0	0	19	8
Lower limb	1	1	0	0	0
Upper limb	1	0	0	1	1
urology/hernia/perineal	37	30	14	7	4
Miscellaneous (breast, thyroid,etc.)	13	5	1	8	1

Table III: Duration of surgery

Duration (min)	**Regional Anaesthesia**		**General Anaesthesia**	
	Total	**Affected**	**Total**	**Affected**
0-30	4	1	1	0
31-60	5	2	2	1
61-90	19	8	5	1
91-120	5	2	12	5
121-150	2	1	8	2
151-180	0	0	6	5
181-210	0	0	0	0
211-240	0	0	1	0
Mean ± SD	76.25 ± 31.17		120.57 ± 42.02	

The distribution for the scoring tests applied is given in table IV and V.

Table IV: Scoring system- distribution

Day	MMSE				SPMSQ		MIS	
	RA		GA		RA	GA	RA	GA
	Total	Affected	Total	Affected				
Pre-operative	20	-	9	-	16	26	36	35
Day-1	20	11	9	3	16	26	36	34
Day-3	0	0	0	0	0	1	0	1

Table V: Scoring system- affected individuals

SPMSQ- Grading					
Day		Intact	Mild	Moderate	Severe
Pre-operative	RA	10	5	1	0
	GA	13	9	4	0
Day-1	RA	7	6	2	1
	GA	10	8	6	2
Day-2	RA	0	0	0	0
	GA	0	1	0	0
SPMSQ- Affected					
	RA		GA		Total
Affected	4		11		15
Not Affected	12		15		27
Total	16		26		42

Association of literacy status on cognitive dysfunction is evident. Lower education levels showed more incidence of POCD. (Table VI).

No association could be ascertained to addiction and incidence of POCD. (Table VII).

Table VI: Literacy and Education level

	RA		%	GA		%	Overall		%
Literacy	**Total**	**Affected**		**Total**	**Affected**		**Total**	**Affected**	
Literate	20	11	55	9	3	33.33	29	14	48.27
Illiterate	16	4	25	26	11	42.3	42	15	35.71
Education Level	**Total**	**Affected**	**%**	**Total**	**Affected**	**%**	**Total**	**Affected**	**%**
≤ Middle school	16	4	25	26	11	42.30	42	15	35.71
High School	15	8	53.33	7	3	42.85	22	11	50
Graduation	5	3	60	2	0	00.00	7	3	42.85

Table VII: Co-morbidities and addiction

Co-morbidities and addiction	RA		GA	
	Total	Affected	Total	Affected
Co-morbidities	10	3	13	6
Addiction	14	6	4	2
Total	24	10	17	8
Total no. of patients having serious co-morbidities/ addiction	41/71			57.75%
No. of patients affected out of those having serious co-morbidities/addiction	18/41			43.9%

4. Discussion

Post-operative cognitive dysfunction [POCD] is a recognized clinical phenomenon. As early as 1955, it was described by Bedford in the Lancet under the designation "adverse cerebral effects of anaesthesia on old people" [10]. POCD is diagnosed using neuropsychological tests pre-operatively and post-operatively. It may be detected days to weeks [4] after surgery and may persist as a permanent disorder leading to significant impairment and socioeconomic burden for long periods after procedure.

Early cognitive dysfunction is common in all age groups after surgery but the elderly is at significant risk for long-term cognitive dysfunction.

Risk factors for postoperative cognitive dysfunction (POCD). [10] (Table VIII)

Table VIII: Risk factors for postoperative cognitive dysfunction (POCD)

Patient	advanced age; pre-existing cerebral, cardiac, or vascular disease; preoperative mild cognitive impairment (MCI); low educational level; history of alcohol abuse
Operation	extensive surgical procedure, intra- or postoperative complications, secondary surgery
Anaesthesia	long-acting anaesthetic, marked disturbance of homeostasis, organ ischemia due to hypoxia and hypoperfusion, intra- or postoperative anaesthestic complications

Increasing age is an important risk factor for POCD [11, 12]. Majority of patients in this study was in range of 60-70 years, mean age being 65.93 years. It is due to functional and structural changes in the ageing brain, the elderly is more vulnerable to the stress related to surgery and anaesthesia. In our study, we have tried to find out the incidence of POCD in the elderly and those receiving regional anaesthesia and general anaesthesia too. The mechanisms leading to cognitive impairment after anaesthesia and surgery are not yet fully clear, but the immune response to surgery plays an important role. As increasing age has emerged as a significant risk factor, POCD should be looked for and managed in all the elderly undergoing major surgery [1, 3, 11-14]. It not only has effect on the incidence but also on the mortality. Unlike other studies, females were not found to be at a greater risk than males [13].

The two anaesthetic technique groups were comparable with respect to age, ASA status, BMI, pre-medications but gender distribution and duration of surgery differed which was statistically significant. POCD was found to be in 40% of the patients. In accordance with previous studies, there was no significant difference between the two groups regarding POCD [11, 12, 15]. Though, it has been shown in a study that regional anaesthesia may decrease mortality and incidence of early POCD [15]. There has been no evidence to date of anaesthetic agents causing POCD or being neurotoxic. Also, our study, in line with published literature found no significant difference between regional and general anaesthesia. In fact, hospitalization itself is one of the contributory factor, which is evident when incidence of POCD is reduced in out-patient settings [16].

Although cognitive dysfunction is common after major surgery, only the elderly patients are at significant risk of developing long term POCD [1]. In this study, we used MMSE and SPMSQ for assessment of cognitive function; this is because of heterogenicity in sample population. MMSE is one of the most commonly used tests for POCD [4]. However, illiteracy limits its use. To overcome this limitation, we used SPMSQ for the illiterate patients, which is comparable to MMSE according to a study [8, 16].

The cut-off varied by education, but not by age. A high correlation was found between MMSE and SPMSQ scores. Lower level of education in our population can be a contributory factor for increased incidence of POCD. But our results differ; which may be due to the type of test employed for the illiterate which only included the verbal component and no writing or memorizing parameters as in MMSE. While other studies show association of lower level of literacy with increased incidence of POCD [13, 17].

According to a study, alcohol abuse may have an implication on occurrence of POCD [18]. The results of our study are similar to the same. Regarding the type of surgery, our results are in accordance with previous studies that POCD is [11, 19, 20] which may be time related. Duration of anaesthesia, surgical trauma, hospitalization, post-operative infections, and respiratory complications may explain higher incidence of POCD in major surgeries as compared to minor surgeries [17].

The decision whether an extensive procedure is required in an elderly should be made meticulously after taking into consideration the benefits and harms of the procedure. Disturbed homeostasis during surgery is associated with higher risk of POCD.

There are some limitations of the study which includes- Patients with pre-existing neuropsychological deficits were excluded from the study; hence implications of dementia on POCD could not be studied. Regional Anaesthesia group mainly consisted of male patients limiting the study of gender predisposition. Lower level of education, reluctance to follow up and lack of cooperation were other hurdles. A larger sample size and multiple neuropsychological tests are needed to establish better results.

5. Conclusion

POCD is a well-recognized clinical phenomenon of multifactorial origin. Advancing age, various co-morbidities and extensive surgery all increase the risk of POCD. Meticulous surgical planning and appropriate anaesthesia technique are important for preventing complications and keeping the risk of POCD to a minimum. It would be mandatory to find out which cognitive training might promote cognitive performance, in elderly patients, and thereby enable patients to enjoy a more rapid recovery and a better quality of life after anaesthesia and surgery.

Further research should be carried out focusing on the aetiology, pathophysiology, other risk factors, prevention and possible interventions devised.

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