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General or Spinal Anesthesia: Which is Better in the Elderly?

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Surgery and anesthesia are associated with higher morbidity and mortality during the perioperative period in the elderly as compared to their younger counterparts. Psychological problems, such as preoperative anxiety, postoperative confusion, and memory impairment may contribute to this morbidity.[1,2] The role of anesthesia is difficult to assess, and, in particular, the consequences of different types of anesthesia. Valentin *et al.*[3] found that there was no difference in the long-term survival between general and spinal anesthesia in a large prospective study of hip surgery in elderly patients. Psychological issues and rehabilitation were not addressed.

There are few studies of mental function after general or spinal anesthesia, and the findings are not in agreement. Rollason *et al.*[4] found that, after spinal anesthesia, mental function was reduced 5 days postoperatively. All their patients, however, had their spinal anesthesia supplemented with light general anesthesia. Thompson *et al.*[5] showed that there was no significant decrease in psychological function 1–2 days postoperatively after general anesthesia. Hole *et al.*[6] found the incidence of postoperative mental deterioration was lower in patients following epidural anesthesia, compared to general anesthesia. No psychological testing, however, was used. Riis *et al.*[7] reported short-term impairment in elderly patients within the first postoperative week after both epidural and general anesthesia; Bigler *et al.*[8] found no impairment in mental function after either type of anesthesia. In neither study were mental tests performed during the perioperative period. The use of intraoperative sedation during spinal anesthesia was either not documented,[6,7] or rather large doses were used.[8] The use of postoperative medications, such as analgesics, hypnotics, and antiemetics, was also not documented. Transient decrease in mental performance could be caused by such drugs, rather than the type of anesthesia used. This may, in part, explain the conflicting results in the literature. We, therefore, compared mental function during the perioperative period in elderly patients receiving either spinal or general anesthesia.

MATERIAL AND METHODS

The study was approved by our University Human Subjects Review Committee. We studied 44 patients who were scheduled for transurethral resection of prostate or pelvic floor repair. Inclusion criteria were patients who were 60 yr old or more; unremarkable in mental status; capable of giving informed consent; with no clinical evidence of cardiorespiratory problems, such as congestive heart failure, recent myocardial infarction, orthopnea, and paroxysmal nocturnal dyspnea; and with no medical contraindication to either general or spinal anesthesia. Those patients with senile dementia, psychiatric history, previous stroke, head trauma, inadequate command of English to participate in the tests, and/or an unwillingness to be randomized to either kind of anesthesia were excluded. No premedication was given. The patients were randomly allocated to general or spinal anesthesia. Two patients randomly assigned to the spinal group were, however, given general anesthesia, because the subarachnoid space could not be located.

General anesthesia was induced with thiopental 2–5 mg/kg and fentanyl 2 μg/kg iv. Following 3 mg d-tubocurarine and 1.5 mg/kg succinylcholine iv, the trachea was intubated. Anesthesia was maintained with a nitrous oxide-oxygen mixture (30–40% oxygen) plus intermittent isoflurane 0–0.5% in a semi-closed circle system using intermittent positive pressure ventilation. Patients also received d-tubocurarine iv for muscle relaxation, based on observation of a peripheral nerve stimulator-induced twitch tension or train of four response, and fentanyl 50–150 μg was given iv for added analgesia. After surgery, neuromuscular blockade was reversed with atropine 0.02 mg/kg and neostigmine 0.05 mg/kg iv.

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Spinal anesthesia was administered through a 22- or 25-gauge spinal needle in the midline of L3-4 or L4-5 interspace with the patient in the lateral decubitus position. A single dose of tetracaine, 10–14 mg diluted in 10% dextrose solution, was injected into the subarachnoid space. If the decrease in systolic arterial blood pressure exceeded 30% of the preoperative value, in spite of iv crystalloid administration, iv ephedrine was given in 10-mg boluses. Intraoperative sedation consisted of verbal reassurance by the anesthetists. If patients were very anxious, small doses of iv droperidol or fentanyl were used.

In the postoperative period, meperidine 50–75 mg im every 4–6 h as needed was given for 24–48 h, followed by acetaminophen with 30 mg codeine every 4–6 h as required. An antiemetic, dimenhydrinate 50 mg im every 4–6 h, was given as needed for nausea and vomiting. If hypnotics were required, haloperidol 0.5–1 mg was given. Benzodiazepines were avoided because they decreased mental function and slowed psychomotor performance, at a dose of 2.5 mg diazepam in the elderly.[9]

Hemoglobin, blood sugar, serum electrolytes, analysis of arterial blood gases, chest roentgenogram and electrocardiogram were measured preoperatively. These tests, as well as liver and renal function tests, were repeated on the first and third days.

All psychological measures were made by the same psychiatrist who was unaware of the type of anesthetic given. First, the Mini-Mental State (MMS), as shown in the appendix, was performed. This cognitive screening test was selected because it combines a high validity and reliability with brevity and ease of application, thereby avoiding fatigue of elderly subjects.[10] This instrument lends itself to serial testing in conditions which tend to fluctuate, *e.g.*, postoperative delirium. MMS consists of 11 questions probing for orientation to time and place, registration, attention, calculation, short-term recall, language ability, and constructional ability (Bender-Gestalt design). The maximum score is 30 points, with 24 being the cutoff for cognitive impairment. The test was given preoperatively and postoperatively at 6 h, 1 day, 3 days, 5 days, and 1 month. Secondly, the Geriatric Mental Status Examination (GEMS) was performed. GEMS has been developed for use in diagnostic studies in the elderly. This standardized clinical interview schedule inquired into physical health; anxiety and tension; level of energy; somatic complaints; depressive and hypomanic mood; thought and perceptual disorder; and alcohol and drug abuse. It provided a record of ratings and a potential score. This was done preoperatively and 1 month after the anesthetic. The Anxiety Visual Analogue Scale (VAS) measures subjective anxiety levels. It is sensitive to changes in mood and correlates highly with standardized clinical interview schedules.[11] A line of 10 cm was used to measure anxiety. Patients were asked to indicate their perceived level of anxiety by marking this line: the left end indicated no anxiety, and the right maximum anxiety. This was done preoperatively and 1 day postoperatively.

TABLE 1. Demographic Data

	General Anesthesia (n = 24)	Spinal Anesthesia (n = 20)
Sex	12 Male 12 Female	10 Male 10 Female
ASA	II III	II III
Number of Patients:	12 12	9 11
Age (yr)	71.5 (60–93)	73 (60–89)
Duration of surgery (min)	69 ± 4.2	65 ± 4.6
Alcohol consumption 1–2 drinks/day	12.5%	25%

Each anesthetic group was examined by sex, age, procedure, social background, and postoperative medication. The profiles on MMS were examined for individual patients. Statistical significance between the two groups was analysed by the two-sided Student's *t* test, an analysis of variance, or the Chi-square test.

RESULTS

There was no statistically significant difference between the general anesthetic (GA) and spinal anesthetic (SA) groups with respect to age, sex, ASA class, or duration of anesthesia. Also, there was no statistically significant difference between the GA and SA groups with respect to marital status, education, drinking and smoking history, and stress suffered in the past year, such as illness or death in the family (table 1).

There was no statistically significant difference between GA and SA groups in respect to analgesia and hypnotic requirements in first 24 h and 72 h postoperatively (table 2). Fifteen of 20 patients in SA group did not require intraoperative sedation. Five required intraoperative sedation of fentanyl and droperidol; the mean dose of fentanyl was 80 μg, and the mean dose of droperidol was 0.9 mg iv. Significantly, more antiemetic was required by women having GA compared to SA. Male patients did not require any antiemetic, whether in the GA or SA group. Nausea and vomiting, a major complication following general anesthesia, occurred in 41.7% of the patients. None of the male patients required meperidine for postoperative analgesia. A few

TABLE 2. Intraoperative and Postoperative Data

	General Anesthesia		Spinal Anesthesia	
Anesthetic				
	Thiopental	222 ± 16 mg	tetracaine	10 ± 0.2 mg
	Succinylcholine	107 ± 5 mg		
			Intraop. Sedation	
	d-Tubocurarine	20 ± 2 mg	none	n = 15
			sedation	n = 5
	Fentanyl	108 ± 5 μg		
			fentanyl	100 ± 58 μg
			droperidol	1 ± 0.4 mg
Postoperative medication				
Antiemetic				
dimenhydrinate	Female	98 ± 13 mg	Female	25 ± 4 mg*
	Male	0	Male	0
Analgesic				
meperidine (0–24 h)	Female	242 ± 66 mg	Female	198 ± 55 mg
	Male	0	Male	0
meperidine (0–72 h)	Female	367 ± 97 mg	Female	218 ± 61 mg
	Male	0	Male	0
Hypnotic				
Haloperidol	Female	0.42 ± 0.2 mg	Female	0.5 ± 0.1 mg
	Male	0.83 ± 0.3 mg	Male	0.2 ± 0.4 mg

* $P < 0.05$ compared to general anesthesia.

male patients required acetaminophen with 30 mg codeine for pain relief.

The only major surgical complication encountered was secondary bleeding 1 week posttransurethral resection of prostate in one GA patient. Only one patient in the SA group developed postoperative headache. There was no significant difference between GA and SA groups with respect to preoperative and postoperative laboratory blood tests, arterial blood gases, and electrocardiograms.

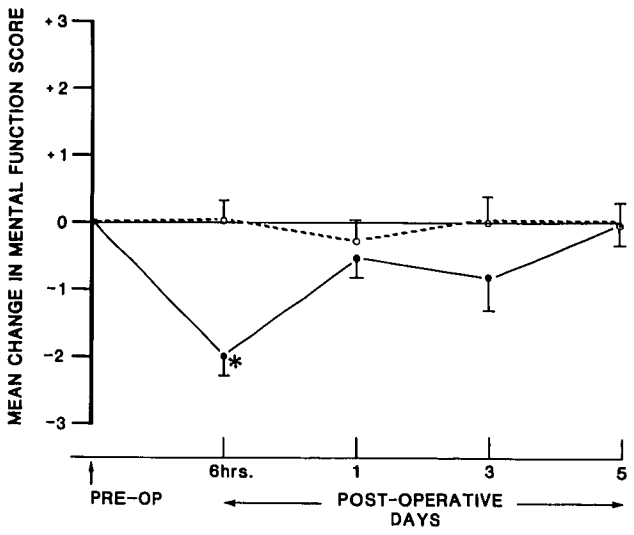

FIG. 1. Mean change in Mini-Mental State score for general anesthesia (- ● -) and spinal anesthesia (-- O --) groups. *Indicates significant difference ($P < 0.001$) between groups.

The VAS score showed that these patients undergoing transurethral resection of prostate and pelvic floor repair had very low levels of anxiety, both preoperatively and postoperatively. There was no statistically significant association between preoperative and postoperative assessment of anxiety.

There was no difference in the MMS score between the two groups in the preoperative period (GA = 28.3 ± 0.4; SA = 28.0 ± 0.5). The analysis of variance showed that MMS score in SA patients was better overall than the GA patient postoperatively ($P < 0.05$). Mean MMS score decreased significantly in the GA group compared to the SA group 6 h postoperatively ($P < 0.001$) (fig. 1). This decrease was the same in both male and female patients. Of the five sections tested in the MMS (orientation, registration, recall, attention and calculation, and language tests), the scores were decreased in the GA group only in recall, attention, and calculation. MMS score in the GA group returned to preoperative value at 5 days postoperatively, whereas, in the spinal group, MMS score was at the preoperative value at 6 h postoperatively. GEMS examination showed that all patients were of unremarkable mental status, with no difference between the GA and SA groups preoperatively and postoperatively.

There were three confused patients out of 44 patients (6.8%). All three had received GA, representing an in-

cidence of 12.5% for this group. The confusion occurred on the third day postoperatively, was of short duration, and was more common at night. None of the patients in the SA group showed evidence of confusion. Two of these three confused patients were using tricyclic antidepressants at night. One patient was taking amitriptyline 25 mg h.s., and the other doxepin 25 mgm h.s. In the SA group, there were also two patients using medications at night; one amitriptyline, and the other triazolam. These SA patients, however, did not develop postoperative confusion.

Discussion

The clinical tools for measuring cognitive function following an anesthetic have not been standardized, and the timing of measurement has varied. Most standard psychometric tests which measure cognitive ability require a great deal of time to administer, making them impractical in testing elderly patients at the bedside. The Mini-Mental State Test (MMS), on the other hand, is a valuable and reliable screening test of cognitive function, separating patients with cognitive disturbance from those without such change.[10] It concentrates on the cognitive aspects of mental function, and excludes questions concerning mood, abnormal mental experiences, and the form of thinking. MMS has been incorporated into the Diagnostic Interview Schedule (DIS) of the National Institute of Mental Health (U.S.A.), and is being used in NIMH-sponsored research.[12] Anthony *et al.*[13] found a sensitivity of 87% and specificity of 82% in their evaluation of 97 consecutive medical admissions.

In the three previous studies cited on postoperative mental function outcome,[6–8] no measure of function was done on the day of operation or first postoperative day. Bigler *et al.*[8] found that patients after spinal anesthesia had a shorter time to ambulation than after general anesthesia, which may conceivably be a function of earlier mental alertness, as patients were drowsier and more sedated following general anesthesia. There may be a relationship between the alertness of the patient and lack of confusion in the perioperative period and the incidence of deep vein thrombosis and pulmonary embolism. Deep vein thrombosis and pulmonary embolization occurs less frequently following regional anesthesia compared with general anesthesia.[14] It would appear important to assess mental function at these early postoperative times.

In this study, patients having general or spinal anesthesia received no premedication. Patients receiving spinal anesthesia received minimal intraoperative sedation. Seventy-five percent of the patients received no intraoperative sedation. When sedation was needed, only small amounts of droperidol or fentanyl were used. The result of less perioperative mental deterioration in the spinal group, as compared to general anesthesia, may not be applicable if a different anesthetic approach is utilized. This may account for the difference in our results as compared to previous studies.[4,7]

Disturbance in memory function could lead to disorientation and a decrease in cognitive function, which could interfere with recovery and rehabilitation. In our study, patients having had spinal anesthesia had better mental function scores than the general anesthesia group during each time period over the first 5 days after operation. Patients in the general anesthesia group had the greatest deterioration at 6 h after their operation, as well as some degree of deterioration 3 days postoperatively. The transient postoperative mental disturbance affected mainly the subtests of recent memory recall, attention, and calculation. Mental function returned to normal by 5 days in both GA and spinal groups.

The pathogenesis of postoperative decreased mental function is not clear. Anesthesia decreases mental function in the presence of residual anesthetic agents, and there are changes in central nervous activity caused by anesthesia.[15,16] A higher percentage of patients receiving general anesthesia had periods of confusion, while none of the patients receiving spinal anesthesia showed signs of confusion. Although the period of confusion that occurred in the three patients was short, they did need extra nursing care on the third day. Their mental function, however, had returned to normal at the fifth day, and the duration of stay in the hospital was not extended. The long-term survival was not significantly different between the two groups,[3] but a short time of postoperative confusion may require extra nursing care, and could compromise rehabilitation.

Perhaps general anesthesia is a contributing factor in postoperative confusion. The use of an anticholinergic medication, such as atropine, as a reversal agent could be a contributing factor. The need for antiemetics in patients having general anesthesia could also contribute to a deterioration in mental function. Since there was no difference in MMS score between female and male patients, who received no analgesic or antiemetic medication, these drugs in the doses utilized apparently do not contribute to a reduction in cognitive function. Three out of 44 patients were taking tricyclic antidepressant as hypnotics, one in the spinal group and two in the general anesthesia group. These patients had no history of depression, and were of normal mental status preoperatively. Tricyclic antidepressants have anticholinergic and catecholamine uptake blocking properties.[17] They enhance the CNS depressant effect of barbiturates,[18] and potentiate anticholinergic drugs, such as atropine.[19] Nies *et al.* reported that increasing age is

correlated with increased serum level of tricyclic antidepressants.[20] Tricyclic and related antidepressants may interact with general anesthetic agents, to contribute to postoperative confusion.

Elderly patients are also more likely to suffer from adverse drug interactions because they are often prescribed several drugs at a time. The decrease in renal and hepatic function results in prolongation of drug elimination half-life.[21] Thus, a preoperative review of drugs is important not only to anticipate interaction, but also to review the need to continue medications.

In summary, in this study, we have demonstrated that the maintenance of mental function was better following spinal anesthesia as compared to general anesthesia group. There was a significant impairment of cognitive function at 6 h postoperatively, and some impairment at 3 days postoperatively following general anesthesia. The interaction of tricyclic antidepressants and general anesthesia may contribute to postoperative confusion. In certain procedures, spinal anesthesia may be a better choice in the elderly, providing less deterioration in mental function, less incidence of postoperative confusion, and a reduced risk of drug interactions.

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Appendix

"Mini-Mental State"

Maximum Score	Score	
		ORIENTATION
5	( )	What is the (year) (season) (date) (day) (month)?
5	( )	Where are we: (state) (county) (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 learns all 3. Count trials and record.
		Trials _____
		ATTENTION AND CALCULATION
5	( )	Serial 7's. 1 point for each correct. Stop after 5 answers. Alternatively spell "world" backwards.

RECALL

3 ( ) Ask for the 3 objects repeated above. Give 1 point for each correct.

LANGUAGE

9 ( ) Name a pencil, and watch (2 points)
Repeat the following "No ifs, ands or buts." (1 point)

( ) Follow a 3-stage command:
"Take a paper in your right hand, fold it in half, and put it on the floor" (3 points)

( ) Read and obey the following:
CLOSE YOUR EYES (1 point)

( ) Write a sentence (1 point)

( ) Copy design (1 point)

30 ( ) Total score

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Glucose Concentrations for Routine Intravenous Infusion in Pediatric Outpatient Surgery

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The effects of preoperative fasting on perioperative blood glucose concentrations in healthy pediatric patients have been studied extensively.[1-8] Most children have normal levels of blood glucose in spite of fasting, and respond to anesthesia and surgery with an increase in blood glucose.[9] These findings have led some authors to advise that glucose-free solutions may be safely used during surgery in children.[5] Other authors, however, still recommend routine use of glucose-containing solutions.[1-4] We recently found that asymptomatic hypoglycemia may be present in some otherwise healthy children presenting for elective outpatient surgery.[1] Moreover, we found that, although the majority of healthy children have a significant hyperglycemic response to surgery, some fail to show an increase, or even manifest a decrease, in blood glucose concentrations after surgery. Administration of a 5% glucose-containing solution prevents hypoglycemia, but results in moderate to marked postoperative hyperglycemia.[1]

We first propose to evaluate the effect of preoperative fasting on blood glucose concentrations in children undergoing elective outpatient surgery; and, second, to determine whether the use of solutions containing less than 5% glucose would maintain physiologic blood glucose concentrations without inducing hyperglycemia.

METHODS

One hundred sixty-two children, ranging in age from 1 month to 6 yr, were studied. All were scheduled for elective outpatient surgical procedures associated with minimal blood loss, including inguinal hernia repair, circumcision, orchiopexy, and eye muscle surgery. Premature infants and children with cardiac, neurologic, endocrine, or metabolic diseases were excluded. The study was approved by our Institutional Review Board, and informed consent was obtained from the parent of each patient.

Parents were instructed not to allow their children to eat any solid food after midnight of the day preceding surgery. Infants less than 1 yr of age were allowed to drink clear liquids up to 4 h, and children 1-6 yr of age up to 6 h, before surgery. None of the patients received preoperative medication prior to surgery. Choice of anesthetic technique was made by the patient's anesthesiologist, and was not altered for the purpose of the study. Preoperative blood glucose determinations were performed using the blood sample for complete blood count drawn between 30 min and 4 h prior to induction of anesthesia. A second blood glucose determination was performed immediately following induction of anesthesia but prior to the iv infusion of any fluid.

Patients were randomly assigned to one of three groups for intraoperative iv fluid management; assignment was based on the day of the week on which sur-

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