# Mental State Change after General and Regional Anesthesia in Adults and Elderly Patients, a Randomized Clinical Trial

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**Abstract**

**Background :** Mental state changes after anesthesia seemed to be more frequent in older patients, but the results were still unclear.

**Objective :** To compare the mental scores between adults and elderly patients after general and regional anesthesia.

**Methods :** This was a stratified randomized trial with factorial design. Sixty patients ≥ 60 years old and sixty patients < 60 years old were randomly assigned to receive general or regional anesthesia. Their mental states were assessed blind by investigators, using the Thai Mental State Examination score.

**Results :** The two anesthetic groups showed no difference in the mental scores, but the two age groups showed significantly different scores. The components of mental states that were significantly different were orientation and recall. There were no significant differences in registration, attention, calculation and language. The model for predicting the score included age, education level and narcotics given within six hours before assessment. Sex, weight, intraoperative hypotension, blood loss and duration of anesthesia could not explain the change in the scores.

**Conclusion :** Age, but not anesthetic technique, affected the mental scores after anesthesia.

**Key word :** Anesthetic Technique, General Anesthesia, Regional Anesthesia, Mental State Change in Adults and Elderly Patients

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Modern anesthesia strives to have patients recover fast and well, be it after general, regional or local anesthesia. However, there have been reports of emotional change, confusion, mental state deterioration including tiredness, lack of concentration, difficulty in recall and learning, and deterioration in verbal capabilities in the postoperative period[1,2].

Studies in patients who received general anesthesia (GA) have reported cognitive deficit when comparing the preoperative state and the state recorded within days after surgery[3] and when comparing cognitive state following GA with the state following local anesthesia[4,5]. Another study, however, found no difference between outpatients receiving GA and those receiving local anesthesia[6]. Change in mental state after GA has also been compared to the change after regional anesthesia (RA) for inpatients[7,8] but these studies were not designed as randomized trials and the results may have been influenced by other factors. In one study[8] memory was tested for both recall and recognition by using lists of 10 words each of a different category. There was a significant decrease in the ability to recognize words after RA but not after GA. Clinical indications for RA might have contributed to cognitive deterioration in these patients. Chung F, et al in 1990 applied four mental tests to 40 patients who received GA then compared recovery between the old and the young. They found that the elderly's performance was impaired more than the young in one test and only on the first postoperative day[9] and concluded that there were no differences between age groups; but there was no RA group for comparison. Other randomized trials[10-12] allocated patients to general or regional anesthesia but all patients were in age group > 60. In another study[13], there was no stratification by age and effects on the elderly might have been diluted by those of younger patients.

The objectives of this study were:

1. To compare the mental states before and after general anesthesia and regional anesthesia, and between patients younger than 60 years old and those who were 60 years or older, using the Thai Mental State Examination (TMSE).

2. To compare the changes among components of the mental score.

3. To find other factors that influenced the mental score, i.e., sex, education level, blood loss more than 30 per cent of blood volume, intraoperative hypotension, low intraoperative oxygen saturation, and sedative or narcotic drug given within 6 hours before the assessment of mental state.

## METHOD

This was a stratified randomized controlled trial, with factorial design. One hundred and twenty patients who came to have surgery in the Department of Gynecology, Orthopedics and Surgery of Siriraj Hospital, Mahidol University in Bangkok were included. They were inpatients, with American Society of Anesthesiologists' Functional Class I-II. All of them had no contraindication to either GA or RA. They were literate, willing to cooperate with the study and signed the consent forms. Patients with diagnosis of mental problems were excluded. The study was approved by the Human Rights in Research Review Board. There were 60 patients in the adult group (younger than 60 years) and 60 patients in the elderly group (60 years or above). Within each age group, patients were randomized by using block randomization to receive general or regional anesthesia.

General anaesthesia (GA) was given according to an agreed protocol (thiopentone, isoflurane, nitrous oxide and oxygen, opioids and muscle relaxant) with tracheal intubation and controlled ventilation. All were reversed with atropine and prostigmine. Regional anesthesia (RA) was spinal block or epidural block using 0.5 per cent bupivacaine. Sedative drugs, opioids, vasopressor and other drugs could be given according to the anesthetist's judgment and were recorded. Low hemoglobin oxygen saturation (<92%), hypotensive events (blood pressure dropped >20% of baseline more than 5 min) and significant blood loss (>30% blood volume) during anesthesia were also recorded.

For mental state assessment, we used the Thai Mental State Examination (TMSE) which is adapted from the Mini-Mental State Examination (MMSE) by neurophysicians to be applied to Thai patients. This questionnaire is composed of tests of orientation, registration, attention, calculation, language and recall. The total possible score was 30 (appendix 1). Two anesthesia residents were trained to administer the assessment. They were blinded to which technique of anesthesia the patients received. The assessments were done 1 and 3 days preoperatively, 1 day and three days postoperatively. Narcotics and sedatives given within 6 hours before evaluation were recorded.

Statistical analyses were done using SPSS 6.0 package. Patients' characteristics were compared among the four groups using ANOVA for continuous variables and Chi-square test for discrete variables. The total TMSE scores on the preoperative day, the first postoperative day and the third postoperative day were compared between the two technique groups, GA and RA, and between the two age groups, adults and the elderly, using general factorial ANOVA. Repeated measures ANOVA was used to compare the scores assessed at three different times between the two age groups. Variables potentially associated with the mental scores (sex, education level, type of surgery, duration of anesthesia, blood loss more than 30% of blood volume, hypotension lower than 20% of baseline for more than 5 minutes, hemoglobin oxygen saturation lower than 92%, sedative or narcotic drug given within 6 hours before evaluation of mental state) were analyzed first using ANOVA, *t*-test or a non-parametric equivalent. Difference was statistically significant when $p<0.05$. After univariate analysis, variables were entered into a multiple regression model if p-value<0.2.

## RESULTS

All 120 patients received the anesthetic techniques as randomized. Their characteristics and factors that might affect their mental states are shown in Table 1. There were no significant differences in weight, type of surgery, duration of anesthesia, incidence of significant blood loss, hypotension and narcotic drugs given within 6 hours before evaluation. No patient received sedative drug or cholinergic drug postoperatively. There was no significant difference for the education levels among the four groups.

The total mental scores assessed preoperatively, 1 and 3 days postoperatively of the 4 groups are reported in Table 2. Total TMSE scores were used to study the two factors of interest and are shown in Table 2. General factorial ANOVA showed that age

**Table 1. Patients' characteristics and anesthetic data of the four groups.**

| | Adult/GA n=30 | Adult/RA n=30 | Elderly/GA n=30 | Elderly/RA n=30 |
|---|---|---|---|---|
| Age (year) | | | | |
| Mean ± SD | 36.5 ± 12.8 | 37.9 ± 13.4 | 67.9 ± 5.7 | 67.2 ± 4.6 |
| Range | 15-56 | 16-57 | 60-77 | 60-78 |
| 95% CI | 31.7-41.3 | 32.9-42.9 | 65.8-70 0 | 65.5-69.0 |
| Sex | | | | |
| Male : female | 15 : 15 | 17 : 13 | 3 : 27 | 10 : 20 |
| Education | | | | |
| Elementary | 19 | 17 | 23 | 24 |
| Secondary | 7 | 9 | 4 | 5 |
| Vocational | 2 | 0 | 2 | 0 |
| College | 2 | 4 | 1 | 1 |
| Weight (kg) | | | | |
| Mean ± SD | 58.4 ± 10.4 | 56.9 ± 9.6 | 54.1 ± 10.1 | 58.9 ± 9.2 |
| Type of surgery | | | | |
| Orthopedic | 23 | 25 | 26 | 20 |
| Gynecologic | 7 | 4 | 3 | 6 |
| Urologic | 0 | 1 | 1 | 4 |
| Duration of anesthesia (min) | | | | |
| Mean ± SD | 139.7 ± 72.6 | 129.3 ± 64.3 | 146.5 ± 59.3 | 115.6 ± 53.6 |
| Range | 35-390 | 55-310 | 40-270 | 30-270 |
| 95% CI | 112.6-166.8 | 105.3-153.3 | 124.4-168.6 | 95.6-135.6 |
| Blood loss > 30% (no. of patients) | 3 | 2 | 1 | 0 |
| Hypotension (no. of patients) | 2 | 2 | 3 | 3 |
| $O_2$ sat < 92% (no. of patients) | 0 | 0 | 0 | 0 |
| Narcotic < 6 hours (no. of patients) | | | | |
| Preoperative | 1 | 0 | 1 | 0 |
| 1 day postop | 4 | 2 | 7 | 3 |
| 3 day postop | 0 | 0 | 0 | 0 |

**Table 2. Total Thai Mental State Examination (TMSE) scores in mean ± SD, (95% confidence interval) in the preoperative, one-day postoperative and three-day postoperative assessments. P-values were from general factorial ANOVA. (Data as mean ± SD (95% CI).**

| | Preoperative | | |
|---|---|---|---|
| | Adult (n=60) | Elderly (n=60) | |
| General (n=60) | 27.5 ± 0.3<br>(26.9-28.2) | 26.2 ± 2.2<br>(25.4-27.1) | p=0.531 |
| Regional (n=60) | 27.8 ± 2.2<br>(27.0-28.6) | 26.4 ± 1.9<br>(25.7-27.2) | |
| | p<0.001 | | |

| | One-day postoperation | | |
|---|---|---|---|
| | Adult (n=60) | Elderly (n=60) | |
| General (n=60) | 28.3 ± 1.4<br>(27.8-28.9) | 26.6 ± 2.3<br>(25.8-27.5) | p=0.506 |
| Regional (n=60) | 27.9 ± 2.1<br>(27.1-28.7) | 26.5 ± 2.3<br>(25.7-27.4) | |
| | p=0.001 | | |

| | Three-day postoperation | | |
|---|---|---|---|
| | Adults (n=60) | Elderly (n=60) | |
| General (n=60) | 28.5 ± 1.8<br>(27.9-29.2) | 27.1 ± 2.7<br>(26.1-28.1) | p=0.932 |
| Regional (n=60) | 28.4 ± 2.0<br>(27.7-29.2) | 26.2 ± 1.9<br>(26.5-27.9) | |
| | p=0.001 | | |

group was the significant factor that affected the TMSE scores at all three times of assessment (p= <0.001, 0.001 and 0.001 respectively), whereas anesthetic techniques did not affect the scores (p=0.531, 0.506 and 0.932 respectively). There was no interaction between age group and anesthetic technique (p=0.99, 0.69 and 0.86 respectively).

By repeated measures ANOVA, Table 3 showed the components of mental states when age groups were between-subject effect and days of assessment were within-subject effect. In orientation and recall components, there were statistically significant difference between the two age groups and among different days of assessment, orientation scores decreased but recall scores increased. In attention component, there was no difference between age groups but elderly patients' score had a statistically significant decrease in the first postoperative day. There were no significant differences in registration, calculation and language components.

For the preoperative total TMSE score, the factors that could significantly predict and were retained in the multiple regression model were education level and age. Education at primary, secondary and vocational school were no different from each other and were grouped together as a baseline group, only when the patients had college education did the education level become an important factor. The preoperative score = 28.31 + 2.19 (education) -0.03 (age) with $p<0.05$, $R^2$=13.6 per cent. From univariate analyses the only other factor apart from age that affected TMSE score one-day postoperatively was hypotension (p=0.017). So hypotension, sex (p=0.199) and narcotic drug given within 6 h before evaluation (p= 0.093) were entered in the multiple regression but only the latter significantly explained the change in TMSE. Therefore the predicting model for TMSE for one-day postop = 29.17 + 1.75 (education) -0.03 (age) -1.32 (drug) with $p<0.05$, $R^2$=18.0 per cent, again education level was the factor that carried the highest

**Table 3. Components of TMSE scores comparing between adult group (n = 60) and elderly group (n=60). P-values were from repeated measures ANOVA. (Data as mean ± SD).**

| Components of TMSE score (total mark) | Preoperative | One-day postop | Three-day postop | P |
|---|---|---|---|---|
| Orientation (6) | | | | |
| * Adult | 5.7 ± 0.6 | 5.5 ± 0.7 | 5.7 ± 0.6 | age = 0.006 |
| * Elderly | 5.7 ± 0.6 | 5.1 ± 0.9 | 5.3 ± 0.9 | day < 0.001 |
| Registration (3) | | | | |
| Adult | 3.0 ± 0 | 3.0 ± 0 | 3.0 ± 0 | age = 0.32 |
| Elderly | 3.0 ± 0.1 | 3.0 ± 0 | 3.0 ± 0 | day = 0.37 |
| Attention (5) | | | | |
| Adult | 5.0 ± 0 | 5.0 ± 0.3 | 5.0 ± 0 | age = 0.053 |
| * Elderly | 5.0 ± 0 | 4.8 ± 0.8 | 5.0 ± 0.2 | day = 0.007 |
| Calculation (3) | | | | |
| Adult | 2.3 ± 0.9 | 2.3 ± 0.9 | 2.4 ± 0.9 | age = 0.12 |
| Elderly | 2.0 ± 0.9 | 2.1 ± 1.0 | 2.2 ± 1.0 | day = 0.22 |
| Language (10) | | | | |
| Adult | 10.0 ± 0.2 | 10.0 ± 0.3 | 9.9 ± 0.3 | age = 0.24 |
| Elderly | 9.9 ± 0.4 | 9.9 ± 0.3 | 9.9 ± 0.4 | day = 0.59 |
| Recall (3) | | | | |
| * Adult | 1.7 ± 1.2 | 2.4 ± 1.0 | 2.5 ± 0.9 | age < 0.001 |
| * Elderly | 0.9 ± 1.0 | 1.8 ± 1.2 | 1.8 ± 1.3 | day < 0.001 |
| Total score (30) | | | | |
| * Adult | 27.7 ± 2.0 | 28.1 ± 1.8 | 28.5 ± 1.9 | age < 0.001 |
| * Elderly | 26.3 ± 2.1 | 26.6 ± 2.3 | 27.2 ± 2.3 | day < 0.001 |

* statistical significance

weight. For the three-day postoperative score, only age was an important factor and the score at three-day postop = 29.67 -0.04 (age) with $p<0.05$, $R^2=8.4$ per cent.

## DISCUSSION

Dyer CB, et al (1995) conducted on-line and manual searches on postoperative delirium for 1966 through 1992 and found that of the 371 citations found, after criteria of relevance and methodologic criteria for validity were applied, 26 studies were retained for final information synthesis(14). The incidence of postoperative delirium, defined as an acute change in cognitive status characterized by fluctuating consciousness and inattention occurring within 30 days after an operation, was 36.8 per cent (range, 0% to 73.5%). Primary reasons for this disparity were insufficient sample size and inconsistent application of numerous diagnostic tools.

A randomized trial with 57 old men showed no difference between GA and RA on diagnostic and statistical manual of mental disorders (DSM3) test although 44 per cent of patients developed confusion(10). This confusion was closely correlated with a history of mental depression and previous use of anticholinergic drug. Patients with confusion were associated with more postoperative complications and longer hospitalization, but confusion could also be the effect and not the cause. Four other randomized trials compared general to regional anesthesia, using various psychological and cognitive function tests, and found no difference. In one study in old age patients, 15 per cent of patients reported that their memory and concentration were worse than before the operation regardless of the anesthetic technique (11). The second study in old age patients compared the preoperative day with 3 months afterwards which might not reflect the condition of patients in the hospital(12). William-Russo (1995) applied a thorough neuropsychological assessment in randomized controlled clinical trial to compare the effect of general and regional anesthesia, all in older adults(15). She found no difference between the two techniques in within-subject change from baseline at 1 week and 6 months postoperatively. Our study did not find any difference at 1 and 3 days postoperatively. Two other studies randomized 40 and 44 old men who underwent a transurethral prostatectomy to general and regional anaesthesia and reported no difference[16,17].

We chose the factorial research design so that we could study two factors, anesthetic technique and age, at the same time. This study design allowed us to utilize the sample size of patients to the maximum advantage and was able to prove that there was no interaction between these two factors. Our result differed from Chung (1990) who reported no difference between elderly and young patients (total number = 40) after general anesthesia[9].

Results from trials comparing different techniques of anesthesia may be influenced by the tests used to assess mental function. In the studies reviewed previously, various tests were used, e.g., Symbol Digit Modalities Test, Trail Making Test, Mini-Mental State Examination and other cognitive function tests. The differences in test performance may account for differences in the study findings. Test of impact of anesthesia on mental function could also vary depending on culture. The effects of this change, when short-lived, could be missed depending on the time of assessment.

We chose TMSE score because this mental score can be assessed at the patient's bedside, needs no special sophisticated equipment and takes about 10 minutes to complete. The score is intended to be used as a screening test and to assess the function of different parts of the brain[18]. It has been slightly modified from the Mini-Mental State Examination (MMSE)[19] so that the questions are suitable for the population and culture of Thailand. MMSE was found to be 87 per cent sensitive and 82 per cent specific in detecting dementia and delirium[20].

The change in scores could be in two directions. When the mental state deteriorated, anesthesia has often been implicated. Since we have shown that regional anesthesia groups were not different from the general anesthesia group, having controlled for age, the decrease could not be the result of a specific technique as seen in orientation scores which decreased significantly after anesthesia in both age groups, more and longer in the elderly than in adults. We did not find any patient with marked disorientation although we showed in this study that this was the component of mental state that was most easily affected.

When the score increased, especially in the recall scores as in this study, the reason could have been the learning of the patients to remember the objects, here again the elderly lagged behind their younger counterparts. It is interesting to see that registration (immediate memory of three objects) was not different between adults and the elderly but the latter scored significantly lower in recall (recall of the previous three subjects). Because of the smaller decrease in orientation score and the larger increase in recall scores we found that the total TMSE scores increased at subsequent assessment, the elderly lagging behind at all times.

An intense international multicenter study (ISPOCD1)[21], which recruited 1218 patients older than 60, reported the long-term postoperative cognitive dysfunction to be 25.8 per cent at one week and 9.9 per cent after three months. The neuropsychological tests used were visual verbal learning, concept shifting, Stroop and Letter-digit coding. The orientation section of the MMSE was also used to screen for confusion and delirium. Because of the long-term follow-up, 22 per cent of their patients did not have the three-month tests. Their results were similar to ours in that anesthetic technique, hypoxemia and hypotension were not related to the risk of mental state change.

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**Appendix 1**
The Thai Mental State Examination

| | | Total mark |
|---|---|---|
| Orientation | | 6 |
| - tell day, date, month, time, place and person | | |
| Registration | | 3 |
| - immediate memory of 3 objects (tree, car, hand) | | |
| Attention | | 5 |
| - tell names of 5 days in retrospective order | | |
| Calculation | | 3 |
| - deduct 7 from 100, 3 times | | |
| Language | | 10 |
| - tell names of 2 common objects | 2 | |
| - repeat a sentence after the evaluator | 1 | |
| - follow 3 verbal commands | 3 | |
| - read and follow command | 1 | |
| - draw a triangle and a rectangle | 2 | |
| - tell the similarity between a cat and a dog | 1 | |
| Recall | | 3 |
| - recall the previous 3 objects (tree, car, hand) | | |
| Grand total mark | | 30 |

Train The Brain Forum Committee, 1993

# การเปลี่ยนแปลงของสภาวะความรู้สึกตัวหลังจากได้รับการระงับความรู้สึกวิธีทั่วไปหรือวิธีเฉพาะส่วนในผู้ป่วยสูงอายุและผู้ป่วยผู้ใหญ่, การศึกษาแบบ randomized clinical trial

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**หลักการ** : ยังมีการถกเถียงกันอยู่ว่าวิธีระงับความรู้สึกมีผลต่อสภาวะความรู้สึกตัวของผู้ป่วยสูงอายุหรือไม่

**จุดประสงค์** : เพื่อเปรียบเทียบคะแนนความรู้สึกตัวระหว่างผู้ป่วยสูงอายุ และผู้ป่วยผู้ใหญ่หลังจากได้รับการระงับความรู้สึกวิธีทั่วไปหรือวิธีเฉพาะส่วน

**วิธีการ** : ทำการศึกษาแบบ stratified randomized trial with factorial design ผู้ป่วยที่มีอายุตั้งแต่ 60 ปีขึ้นไป 60 ราย และผู้ป่วยที่มีอายุต่ำกว่า 60 ปีอีก 60 ราย ถูกสุ่มแบ่งออกเป็นกลุ่มได้รับการระงับความรู้สึกวิธีทั่วไปหรือกลุ่มวิธีเฉพาะส่วน ผู้วิจัยที่ไม่ทราบว่าผู้ป่วยได้รับการระงับความรู้สึกวิธีใดเป็นผู้ประเมินความรู้สึกตัวหลังผ่าตัด โดยใช้คะแนน Thai Mental State Examination

**ผลการศึกษา** : วิธีระงับความรู้สึกที่ต่างกันไม่มีผลต่อคะแนนความรู้สึกตัว แต่อายุที่ต่างกันมีผลต่อคะแนนอย่างมีนัยสำคัญ ส่วนประกอบของความรู้สึกตัวที่ต่างกันระหว่างกลุ่มอายุอย่างมีนัยสำคัญ คือ orientation และ recall ส่วน registration, attention, calculation, และ language ไม่มีความแตกต่างกันระหว่างกลุ่มอายุ สมการที่สามารถพยากรณ์คะแนนความรู้สึกตัวได้ประกอบด้วยตัวแปร อายุ ระดับการศึกษา และการได้รับยาระงับปวดภายใน 6 ชั่วโมงก่อนการประเมิน สำหรับเพศ น้ำหนัก ภาวะความดันเลือดต่ำระหว่างผ่าตัด การเสียเลือด และระยะเวลาที่ระงับความรู้สึก ไม่มีผลต่อการเปลี่ยนแปลงของคะแนนความรู้สึกตัว

**สรุป** : อายุมีผลต่อคะแนนความรู้สึกตัวหลังผ่าตัด แต่วิธีระงับความรู้สึกไม่มีผล

**คำสำคัญ** : วิธีระงับความรู้สึก, การระงับความรู้สึกวิธีทั่วไป, การให้ยาชาเฉพาะส่วน, ผู้ป่วยผู้ใหญ่, ผู้สูงอายุ

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