Does scalp block with general anesthesia in craniotomy affect the intraoperative course and outcome in geriatric patients?

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Background
The noxious stimuli during supratentorial brain tumor resection in geriatric patients result in a vigorous hemodynamic response and stress response, which represents a challenge during anesthesia.

Patients and methods
A total of 80 patients were enrolled in the study. There were 43 male and 37 female patients undergoing elective supratentorial craniotomy. Patients were randomly assigned into two equal groups: group B patients had scalp block using bupivacaine (0.5%) and epinephrine (1 : 400 000) and group F patients received fentanyl 2 μg/kg (during maintenance of general anesthesia (GA)). Heart rate (HR), mean arterial pressure (MAP), plasma cortisol level, and intracranial pressure (ICP) were recorded at baseline (before induction of anesthesia), 1 min after intubation, 1 min after skin incision, 1 min after dural incision, 1 min after dural closure, 1 min after skin closure, and 1 min after extubation. ICP measurement ceased at dural incision. Time to recovery from anesthesia was also recorded.

Results
MAP, HR, and plasma cortisol level showed significant differences between groups, wherein group F had higher MAP, HR, and plasma cortisol level than group B. Group B had rapid recovery period.

Conclusion
Scalp block with 0.5% bupivacaine with adrenaline 1 : 400 000 can be used as an alternative to general anesthesia with fentanyl in preventing the increase in arterial blood pressure (ABP), HR, ICP, cerebral perfusion pressure (CPP), and cortisol level, and also it allows early extubation and assessment of conscious level.

Keywords:
geriatric anesthesia, plasma cortisol level, scalp block, supratentorial craniotomies

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Introduction

Geriatric patients receive a disproportionate amount of surgery, and their numbers are steadily increasing. Treatment of an elderly patient requires a more gentle touch. Lower opioid concentrations are needed to produce the same effect in elderly patients. Intracranial surgery on patients with increased intracranial pressure (ICP) poses a unique challenge to the anesthesiologist. Many noxious events occur during intracranial surgery. These events include laryngoscopy, insertion of cranial pins, skin incision, and periosteal–dural contact. These noxious events can result in sudden increase in blood pressure and heart rate (HR), which can cause potential morbidity because of further increase in ICP in patients with intracranial pathology, and a greater risk for rupture in patients with intravascular aneurysms especially in geriatric patients who are more vulnerable to these harmful effects. Therefore, a method to blunt these noxious stimuli would be valuable.

Scalp blockade of the nerves that supply the involved region of the scalp may be an effective, alternative technique to the usage of opioids in reducing hypertension, tachycardia, and neuroendocrinal stress (plasma cortisol level).

Patients and methods

This study was conducted in the Neurosurgical Theater in Kasr El-Aini Hospital including 80 patients suffering from supratentorial brain tumor after obtaining informed written consent from the patients and approval of the Ethics and Scientific Committees of Anesthesia Department, Cairo University. The patients were excluded from the study when there was disturbed conscious level (Glasgow coma scale <14), huge tumors with midline shift, extensive surgeries lasting more than 6 h, incision extending beyond the areas covered with scalp-nerve block, uncontrolled hypertension, proven or suspected allergy to local anesthetics, antiplatelet treatment or coagulopathies,

intracranial vascular malformations, or any complications during procedure such as massive intracranial hemorrhage.

Small 20-G intravenous cannula was inserted on the dorsum of the hand under local anesthesia. No premedication was given. Full monitoring was applied, including 5-lead ECG, noninvasive blood pressure, and pulse oximeter, and ICP probe was inserted by the surgeon into the contralateral frontal region for ICP monitoring under local anesthesia and a baseline reading was taken. After induction of anesthesia, invasive blood pressure monitoring, central venous pressure monitoring, core temperature monitoring by a nasopharyngeal probe, capnography, peripheral nerve stimulator, and indwelling urinary catheter were all established.

Intravenous induction of anesthesia was achieved with propofol (1.5 mg/kg), atracurium (0.5 mg/kg as a bolus dose over 30 s), fentanyl (2 μg/kg), and lidocaine (1.5 mg/kg 90 s before endotracheal intubation) to minimize stress response to intubation. After controlled mechanical ventilation with isoflurane (0.8–1.5%) in oxygen for 3 min ended with tracheal intubation with armored tube was performed, atracurium infusion at a rate of 0.5 mg/kg/h was used to maintain muscle relaxation; end-tidal carbon dioxide monitoring was performed; temperature probe was applied after intubation; and 20-G catheter was placed in the radial artery on the nondominant hand after negative Allen's test for invasive arterial blood pressure monitoring and repeated arterial blood gas analysis. The patient was placed in the supine position with head elevated at 15–30°.

Mechanical ventilation was instituted to keep $PaCO_2$ at 30–35 mmHg. Mannitol (0.5 g/kg over 20 min after induction of anesthesia), ondansetron (8 mg), and phenytoin (5 mg/kg if already loaded with 15 mg/kg) were given. Crystalloid was limited to 3 ml/kg/h of normal saline with replacement of blood losses by an equal volume of blood or colloids. In all patients, if mean arterial pressure (MAP) increased more than 20% compared with baseline, sodium nitroglycerine infusion was initiated (1 μg/kg/min) and increased gradually until MAP was controlled.

The patients were randomly allocated — through computer-generated random numbers — into two equal groups; each one included 40 patients by closed envelope chosen by the surgeon. Group F received 2 μg/kg fentanyl as the analgesic components of the balanced anesthesia conducted. Group B received skull block with bupivacaine 0.5% with epinephrine 1 : 400 000 as an alternative to narcotics. Scalp block was performed in group B by blocking the supraorbital nerve with 1.5 ml LA solution at the supraorbital notch, which is located at the supraorbital ridge above the pupil, the supratrochlear nerve with 1.5 ml of local anesthetic (LA) solution injected at superior medial corner of the orbital ridge with the needle introduced perpendicular to the skin, and the auriculotemporal nerve by injecting 3 ml of local anesthetic solution 1.5 cm anterior to the ear at the level of the tragus. With the needle perpendicular to the skin, infiltration of 1.5 ml is made under the deep fascia and another 1.5 ml is injected superficially as the needle is withdrawn; the postauricular branches of the great auricular nerve was blocked with 3 ml of local anesthetic solution between skin and bone, 1.5 cm posterior to the ear at the level of the tragus. The greater, lesser, and least occipital nerves were blocked in a band-like extension from posterior occipital protuberance to immediately behind the ear; the subcutaneous tissue of the anterior temporal region was blocked by forming a bridge between the area already anesthetized around the zygomatic arch to the supraorbital ridge and into the pterional area. The proposed incision was infiltrated with 0.5% bupivacaine with epinephrine 1 : 400 000 for hemostasis. Injection must be given into the subcutaneous tissue. An additional 10 ml of this solution is injected deep into the temporalis muscle through to the bone. The dura has been anesthetized with a gauze soaked with lidocaine 1% without adrenaline placed over the dura for 15 min. At the end of dural closure, in both groups atracurium infusion was ceased. At the end of skin closure, isoflurane was discontinued and neuromuscular block was reversed. All patients were extubated after eye opening to command.

The MAP and HR were recorded at baseline, 1 min after intubation, 1 min after skin incision, 1 min after dural incision, 1 min after dural closure, 1 min after skin closure, and 1 min after extubation.

The ICP was measured through ICP probe (Codman ICP Express; Codman & Shurtleff Inc., Raynham, Massachusetts, USA), which was inserted by the surgeon through a burr hole made under local anesthesia into the contralateral frontal region for ICP monitoring. The ICP was recorded at baseline, 1 min after intubation, 1 min after skin incision, 1 min before dural incision, 1 min after skin closure, and 1 min after extubation. The CPP (MAP–ICP) was measured at the same intervals.

The number of patients who required sodium nitroglycerine to control MAP throughout the study was recorded.

Blood samples (2 ml of venous blood) were withdrawn from each patient (from 8 a.m. to 2 p.m.) in blank

vacutainers to measure plasma cortisol level; they were left to clot and centrifuged at 1000 rpm. The sera were divided into aliquots. The sera may be stored for 7 days at 2–8°C or 3 months at −20°C until the time of assay, freeze once only. Serum cortisol level was estimated from patient's sera using competitive electrochemiluminescence immunoassay (Elecsys Cortisol Reagent Kit, Roche Diagnostics GmbH, D-68298 Mannheim, Germany). Blood samples were withdrawn at the following intervals: at baseline, 1 min after intubation, 1 min after skin incision, 1 min after dural incision, 1 min after dural closure, 1 min after skin closure, and 1 min after extubation, where samples were sent to the hospital laboratory for measuring plasma cortisol level.

Time to recovery was measured from discontinuation of isoflurane to eye opening to command.

Statistical analysis

A sample size of 33 per group was sufficient to detect a moderate to large treatment effect (0.7 SD) in the primary outcome measure with 80% power at *P* value less than 0.05. This difference is equivalent to 5 mmHg in the MAP, which was considered a clinically relevant difference. The required sample size was increased by 20–40% to account for errors in parameter estimates. Sample size was determined using the software package nQuery Advisor v 7.0 (Statistical Solutions Ltd, Cork, Ireland). The collected data were presented as mean ± SD, ranges, numbers, and ratios as appropriate. Demographic data were compared using the χ^2-test, the Fischer exact test, or Student's *t*-tests as appropriate. HR, MAP, ICP, plasma cortisol level, time to recovery, and pain scores were compared using the unpaired *T*-test or univariate (methods for analyzing data on a single variable at a time) two-group repeated measures analysis of variance as appropriate. Dunnett's test was used as a post-hoc procedure for comparisons against baseline values to further investigate any statistically significant findings. Statistical calculations were performed using SPSS (version 15, 2006; SPSS Inc., Chicago, Illinois, USA) for Windows statistical package. Results were considered statistically significant if *P* value was less than 0.05.

Results

There was nonsignificant ($P > 0.05$) difference between both study groups with respect to patients' demographic data (Table 1). MAP showed a significant difference between both groups. MAP measurements were higher in group F than in group B initiating at 1 min after each of skin incision, dural incision, dural closure, skin closure, and extubation ($P < 0.05$) (Table 2). HR showed a significant difference between both groups. HR measurements were higher in group F than in group B initiating at 1 min after each of skin incision, dural incision, dural closure, skin closure, and extubation ($P < 0.05$) (Table 3). ICP showed a significant difference in the same group. ICP measurements were low with respect to the baseline in the same group initiating at 1 min after skin incision, 1 min before dural incision, 1 min after dural closure, 1 min after skin closure, and 1 min after extubation, whereas there was no significant difference between the two study groups ($P < 0.05$) (Table 4). CPP showed a significant difference between the two study groups and in the same group. CPP measurements were high

Table 1 Characteristics of the patients

Clinical parameters	Group B ($n = 40$)	Group F ($n = 40$)	*P* value
Age (years)	69.7 ± 2.14	70.6 ± 1.93	0.093
Sex (male : female)	21 : 19	22 : 18	1.0
Hypertension	10	7	0.585
Diabetes	13	11	0.807
ASA grade			
I	9	10	0.789
II	25	26	
III	6	4	

Data are presented as mean ± SD or numbers.

Table 2 Mean arterial pressure measurements recorded throughout the study (mmHg)

Time interval for mean arterial pressure	Group B ($n = 40$)	Group F ($n = 40$)	*P* value
Baseline	92.1 ± 4.86	93.1 ± 4.77	0.424
1 min after intubation	96.4 ± 4.97†	98.6 ± 4.90†	0.089
1 min after skin incision	94.1 ± 4.67*†	100.3 ± 4.79†	<0.001
1 min after dural incision	92.5 ± 4.68*	98.1 ± 4.80†	<0.001
1 min after dural closure	91.2 ± 4.66*	96.6 ± 4.45	<0.001
1 min after skin closure	91.5 ± 4.55*	95.5 ± 4.56	0.001
1 min after extubation	92.6 ± 4.48*	96.1 ± 4.61	0.004

Data are expressed as mean ± SD. *Significant difference between the study groups ($P < 0.05$). †Significant difference versus baseline values within the same group.

Table 3 Heart rate measurements recorded throughout the study (beats/min)

Time interval for heart rate	Group B ($n = 40$)	Group F ($n = 40$)	*P* value
Baseline	74.5 ± 7.63	75.9 ± 7.51	0.477
1 min after intubation	76.6 ± 7.55	76.1 ± 7.63	0.8
1 min after skin incision	79.4 ± 7.78*†	85.5 ± 7.55†	0.003
1 min after dural incision	78.2 ± 7.44*	85.6 ± 7.88†	<0.001
1 min after dural closure	77.1 ± 7.59*	85.9 ± 7.32†	<0.001
1 min after skin closure	80.7 ± 7.21*†	87.1 ± 7.40†	0.001
1 min after extubation	82.7 ± 7.45*†	89.2 ± 7.12†	0.001

Data are expressed as mean ± SD. *Significant difference between the study groups ($P < 0.05$). †Significant difference versus baseline values within the same group.

with respect to the baseline in the same group starting at 1 min after skin incision, 1 min before dural incision, 1 min after dural closure, and 1 min after skin closure. CPP measurements were higher in group F than in group B initiating at 1 min after skin incision, 1 min before dural incision, 1 min after dural closure, 1 min after skin clousre, and 1 min after extubation ($P < 0.05$) (Table 5). The number of patients who required nitroglycerine infusion to control MAP throughout the study was statistically significant between both groups. Three patients in group B required nitroglycerine infusion, whereas 12 patients in group F required nitroglycerine infusion ($P < 0.05$) (Table 6).

Plasma cortisol levels showed a significant difference between both groups. Plasma cortisol level measurements were lower in group B than in group F initiating at 1 min after each of skin incision, dural incision, dural closure, skin closure, and extubation ($P < 0.05$) (Table 7). The mean duration of surgery was without significant difference between both study groups. Time to eye opening was significantly shorter in group B than in group F (Table 8).

Discussion

The aim of this study was to compare two different anesthetic techniques in geriatric patients regarding obtaining better hemodynamic stability and decreasing neuroendocrinal stress response and to provide better recovery criteria.

A total of 80 geriatric patients who underwent elective craniotomy to remove supratentorial masses were randomized into two groups; group B receiving general anesthesia combined with skull block and group F receiving conventional general anesthesia with fentanyl were compared regarding hemodynamic stability, surgical stress response, ICP, emergence period, and postoperative pain.

Bupivacaine has been used in our study instead of lidocaine; lidocaine was used in the study conducted by Yang *et al.* [1] who performed a prospective randomized double-blind control study to observe hemodynamic changes caused by epinephrine-containing lidocaine solution in neurosurgical operations under general anesthesia. A total of 120 patients undergoing scheduled craniotomy were allocated randomly into four groups.

One of the crucial findings of our study was decreasing hypertension and tachycardia. The MAP and HR were higher in group F than in group B initiating at 1 min after each of skin incision, dural incision, dural closure, skin closure, and extubation, and this was attributed to

Table 4 Intracranial pressure measurements recorded throughout the study (mmHg)

The time interval for intracranial pressure	Group B ($n = 40$)	Group F ($n = 40$)	*P* value
Baseline	24.8 ± 1.33	24.1 ± 1.41	0.053
1 min after intubation	22.6 ± 1.23	23.8 ± 1.18	<0.001
1 min after skin incision	21.1 ± 1.38†	22.4 ± 1.32†	<0.001
1 min before dural incision	21.1 ± 1.26†	20.4 ± 1.41†	0.047
1 min after dural closure	15.8 ± 1.23†	16.3 ± 1.19†	0.115
1 min after skin closure	13.2 ± 0.97†	13.9 ± 1.12†	0.012
1 min after extubation	15.1 ± 0.84†	15.6 ± 0.93†	0.033

Data are expressed as mean ± SD. ICP, intracranial pressure. †Significant difference versus baseline values within the same group.

Table 5 CPP measurements recorded throughout the study (mmHg)

Time interval for cerebral perfusion pressure	Group B ($n = 40$)	Group F ($n = 40$)	*P* value
Baseline	67.3 ± 3.85	69 ± 3.75	0.089
1 min after intubation	73.8 ± 3.90	74.8 ± 3.95	0.328
1 min after skin incision	73 ± 3.65*†	77.9 ± 3.70†	<0.001
1 min before dural incision	71.4 ± 3.68*†	77.7 ± 3.80†	<0.001
1 min after dural closure	75.4 ± 3.66*†	80.3 ± 3.45†	<0.001
1 min after skin closure	78.3 ± 3.55*†	81.6 ± 3.56†	<0.001
1 min after extubation	77.5 ± 3.48*	80.5 ± 3.61	0.002

Data are expressed as mean ± SD. *Significant difference between the study groups ($P < 0.05$). †Significant difference versus baseline values within the same group.

Table 6 The need for nitroglycerin infusion during emergence

Number of patients need nitroglycerin infusion	Group B ($n = 40$)	Group F ($n = 40$)	*P* value
Required nitroglycerin	3 (7.5)*	12 (30.0)	0.022
None	37 (92.5)*	28 (70.0)	

Data are expressed as patients' number (%). *Significant difference between the study groups ($P < 0.05$).

Table 7 Plasma cortisol levels measured throughout the study (mg/dl)

Time interval for plasma cortisol level	Group B ($n = 40$)	Group F ($n = 40$)
Baseline	12.5±2.24	12.6±2.01
1 min after intubation	11.6±2.31	12.4±2.42
1 min after skin incision	9.9±2.63*†	11.9±3.81
1 min after dural incision	8.6±2.74*†	12.4±4.23
1 min after dural closure	9.2±1.72*†	16.4±4.19†
1 min after skin closure	13.7±1.86*	20.7±3.57†
1 min after extubation	14.5±1.72*	22.2±3.15†

Data are expressed as mean ± SD. *Significant difference between the study groups ($P < 0.05$). †Significant difference versus baseline values within the same group.

Table 8 Duration of surgery and time to recovery

Duration of surgery and time to recover	Group B ($n = 40$)	Group F ($n = 40$)
Duration of surgery (min)	291.3 ± 24.51	283.5 ± 27.23
Time to eye opening (min)	7.4 ± 2.32*	11.7 ± 2.67

Data are expressed as mean ± SD. *Significant difference between the study groups ($P < 0.05$).

the effect of scalp block with bupivacaine, but MAP did not show a significant difference at baseline and 1 min after intubation in both groups as they received same anesthetic technique. These findings are in agreement with the results of Geze *et al.* [2] who studied the effect of scalp block versus local infiltration on the hemodynamic and stress response to skull-pin placement for craniotomy, where 45 ASA I or II patients, scheduled for elective craniotomies, were enrolled in a prospective, randomized, placebo-controlled study.

In addition, Mohammadi *et al.* [3] studied the effect of scalp infiltration with bupivacaine on early hemodynamic responses during craniotomy under general anesthesia, where 36 patients were prospectively randomized to receive bupivacaine scalp infiltration (group B) or saline control (group S) as an adjuvant to general anesthesia.

Bloomfield *et al.* [4] concluded that the use of 0.25% bupivacaine with epinephrine (1 : 200 000) was successful at certain points in blunting the intraoperative but not the immediate postoperative hemodynamic response. A sufentanil-based anesthetic technique was probably responsible for maintaining intraoperative hemodynamic stability. Bloomfield and colleagues results simulate our results where the use of 0.25% bupivacaine with epinephrine (1 : 200 000) was successful at certain points in blunting the intraoperative hemodynamics (MAP and HR). However, it was in contrast to our study, as it was not successful in blunting the immediate postoperative hemodynamic response. The difference in our study design was that we used a higher concentration of bupivacaine 0.5% combined with adrenaline (1 : 400 000) to perform scalp block instead of scalp infiltration at the beginning of surgery to help us cover the whole duration of surgery and the early postoperative period.

In addition, our study is in agreement with the result of Pinosky *et al.* [5] who studied the effect of bupivacaine skull block on the hemodynamic response in 21 patients who underwent elective craniotomy for tumor resection requiring the use of head pinning. Patients were randomly allocated into the control group receiving skull block consisting normal saline and into the bupivacaine group receiving a skull block with 0.5% bupivacaine. Systolic, diastolic, and MAP were recorded at the following times: 5 min after induction of anesthesia, during performance of skull block, at 1 min after insertion of cranial pins, and 5 min after head pinning. At the time of head pining, if HR or MAP increased by more than 20% over baseline, the anesthiologist increased the concentration of isoflurane to maximum concentration of 1 MAC (1.15% end-tidal concentration). If the MAP and HR remained greater than 20% over baseline values, the patient was given a single dose of sodium thiopental (2 mg/kg). An esmolol bolus of 0.5 mg/kg was given, if prior maneuvers were not successful. The study demonstrated that a skull block using 0.5% bupivacaine successfully blunts the stress response to head pinning. Moreover, no patients who received a bupivacaine skull block required additional maneuvers to control the sympathetic response to head pinning, whereas nine of 10 patients without bupivacaine skull block required additional medications to control the hyperdynamic response, and this is in agreement with our study.

Regarding ICP, our results showed that no significant differences were found between the two study groups. However, ICP showed significant difference in the same group with respect to their baseline values, where ICP measurements were low with respect to the baseline initiating at 1 min after skin incision, 1 min before dural incision, 1 min after dural closure, 1 min after skin closure, and 1 min after extubation. In agreement with our results is the result of Jamali *et al.* [6] who showed that administration of bolus of fentanyl or sufentanil before skull-pin insertion was associated with stable CSF pressure.

Another crucial finding of our result was decreased neuroendocrinal stress response during skin incision, periosteal–dural contact, and skin closure, where plasma cortisol level showed significant decrease in group B compared with group F initiating from skin incision until after extubation, and this is supported by the study conducted by Geze *et al.* [2] who studied the effect of scalp block and local infiltration on stress response to skull-pin placement for craniotomy. Their patients were randomly allocated into three groups. The group L received 0.5% bupivacaine skin infiltration, whereas in group S, scalp block was performed using 20 ml 0.5% bupivacaine, and patients in the group C (the control group) received opioids to control hemodynamic stress responses. Blood samples were collected for cortisol and adrenocorticotropic hormone analysis 5 min before induction and 5 and 60 min after pin-holder insertion. They found that, in group S, the reduced plasma cortisol and adrenocorticotropic hormones level measured at the fifth and 60th minutes after head pinning were statistically lower than those in groups L and C ($P < 00.5$). Finally, they demonstrated that hemodynamic stability was better maintained using scalp-nerve block during initial surgery and that neuroendocrine responses decreased significantly after skull-pin holder application, and this supports our study.

Regarding recovery criteria, time to eye opening and extubation were significantly shorter in group B; this was due to the effect of fentanyl used in group F on

conscious level, as geriatric patients have delayed metabolism and delayed drug excretion, compared with bupivacaine used in group B, which has no effects on conscious level. The result of our study concluded that using scalp block with 0.5% bupivacaine in combination with adrenaline 1 : 400 000 decreased the requirement for additional anesthesia (narcotic) during skin incision, periosteal–dural contact, and skin closure, which allowed a better recovery profile for geriatric patients.

Conclusion

Scalp block with 0.5% bupivacaine with adrenaline 1 : 400 000 can be used as an alternative to general anesthesia with fentanyl in preventing the increase in ABP, HR, ICP, CPP, and cortisol level, and also it allows early extubation and assessment of conscious level.

Acknowledgements

Conflicts of interest

None declared.

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