COMPARISON GENERAL ANESTHESIA AND COMBINED SCALP BLOCK WITH ROPIVACAINE 0.5% ON MEAN ARTERIAL PRESSURE, HEARTRATE AND FENTANYL CONSUMPTION DURING CRANIOTOMY.

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ABSTRACT

Surgical craniotomy such as skin incisions, head pinning, periosteal-dural contact, dura closure, bones and skin can cause of nociceptive stimulation. These actions are stimuli to the nerves that can stimulate stress response. The stress response to surgery is characterized by increased secretion of the pituitary hormone and activation of the sympathetic nervous system. Hypothalamic activation of the sympathetic autonomic nervous system results in increased secretion of catecholamines from the adrenal medulla and the release of norepinephrine from the presynaptic nerve terminal. Objectives: This study is a single blind experimental, 14 patients with ages 18-60 years physical status ASA (American Society of Anesthesiologists) 1-3, with elective craniotomy surgery. This study was divided into two groups of subjects, group A with seven craniotomy subjects with general anesthesia and group B with seven craniotomy subjects combined with scalp block using ropivacaine 0.5%. Data collected then analyzed with SPSS. We found a decrease in MAP (Mean Arterial Pressure) and heart rate in the scalp block group during scalp incision (MAP p=0.002; HR p=0.029), periosteal contact (MAP p=0.025; HR p=0.039) significantly, as well as the use of fentanyl during surgery was significantly decreased (p=0.0001). General anesthesia with scalp block is more effective in reducing the increase in MAP, heart rate and fentanyl consumption during craniotomy.

Keywords : *Craniotomy, fentanyl, heart Rate, MAP, scalp block.*

ABSTRAK

Operasi kraniotomi seperti insisi kulit, pemasangan pin penyangga kepala, kontak periosteal-dural, penutupan dura, tulang dan kulit dapat menimbulkan rangsangan nosiseptif. Hal ini merupakan stimulus terhadap syaraf yang dapat merangsang respon stres. Respon stres terhadap pembedahan ditandai dengan peningkatan sekresi hormon hipofise dan aktivasi sistem saraf simpatik. Perubahan sekresi pituitari memiliki efek sekunder pada sekresi hormon dari target organ. Aktivasi hipotalamus dari sistem saraf otonom simpatis menghasilkan peningkatan sekresi katekolamin dari medula adrenal dan pelepasan norepinefrin dari terminal saraf presinaptik. Obyektif: Penelitian ini merupakan penelitian experimental single blind. Subjek penelitian 14 pasien dengan usia 18-60 tahun dan status fisik ASA (*American Society* *of Anesthesiologists*) 1-3yang dilakukan operasi kraniotomi elektif. Terbagi menjadi dua kelompok, kelompok A terdiri dari tujuh subjek yang diberi anestesi umum dan kelompok B terdiri dari tujuh subjek yang diberi anestesi umum dikombinasikan scalp block menggunakan ropivacain 0,5%. Data yang terkumpul dianalisa dengan SPSS. Kami dapatkan penurunan MAP (*Mean Arterial Pressure*) dan nadi pada kelompok scalp block saat insisi scalp (MAP p=0,002; Nadi p=0,029), kontak periosteum (MAP p=0,025; Nadi p=0,039) secara bermakna, demikian juga penggunaan fentanil selama operasi didapatkan penurunan secara bermakna (p=0,0001). Anestesi umum dengan scalp block menggunakan ropivacaine 0,5% efektif untuk menurunkan MAP dan nadi serta kebutuhan fentanil selama operasi kraniotomi dibandingkan anestesi umum sendiri.

Kata Kunci : Kraniotomi, Fentanil, MAP, Nadi, *Scalp Block*

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INTRODUCTION

In the field of medicine, craniotomy is an operative procedure which is performed by partially opening of the skull bones with certain indications, such as biopsy or resection of intracranial tumors, treatment of intracranial vascular pathology, treatment of epilepsy, and management of trauma (Vacas and Van de Wiele, 2017).. In the United States in 2007, the amount of craniotomy procedure that has been done for tumors are about 70,849, 2,237 craniotomies for vascular surgery and 56,405 craniotomies for other purposes. Whereas in Dr. Soetomo General Hospital Surabaya in 2013, a total of 1,411 people with brain injury, 166 patients with severe brain injury and craniotomy surgery involving between 18.87% - 25.27% of all brain injury patients (Wahyuhadi *et al.*, 2014).

The surgical procedure in craniotomy operations such as skin incisions, installation of head support pins, periosteal-dural contact, dural closure, manipulation of bone and skin can cause various levels of nociceptive stimulation. These various actions are a stimulus to nerves that can stimulate stress response (Desborough, 2000; Flood, Rathmell and Shafer, 2015; Gunadi and Suwarman 2013). The stress response to surgery is characterized by an increased secretion of the pituitary hormone and activation of the sympathetic nervous system. Changes in pituitary secretion have a secondary effect on hormone secretion from target organs. Hypothalamic activation of the sympathetic autonomic nervous system results in increased secretion of catecholamines from the adrenal medulla and release of norepinephrine from the presynaptic nerve terminal. The main function of norepinephrine as a neurotransmitter, but part of it is released from nerve terminals into the circulation. Effects of increased sympathetic nervous system activity and the release of a portion of norepinephrine into the circulation will produce cardiovascular effects such as tachycardia and hypertension. These cardiovascular changes can cause increased intracranial pressure (Akcil *et al.,* 2017; Flood, Rathmell and Shafer, 2015).

The Anesthesia techniques in craniotomy must be able to reduce the stress response to pain during intubation and surgical manipulation because it is associated with postoperative morbidity and mortality, one of the ways is by using high doses of opioids (Markovic *et al*., 2016)

Fentanyl is an opioid that is often used in the surgical process. In clinical practice, fentanyl is given in a wide dose range. Doses of 1-5 μg/kg intravenously are given to obtain analgesic effects. Fentanyl 2-20 μg/kg intravenously can be given to reduce the cardiovascular response to laryngoscopy and endotracheal intubation because it works to block pain stimuli, central sympathetic tone depression, and activation of vagal tone. Fentanyl at a dose of 2-20 μg/kg intravenously can also be used to treat sudden changes due to stimulation during surgery. While large dosages of fentanyl 50-150 μg/kg intravenously are used in surgical anesthesia as a single anesthetic drug (Solihat, 2013; Tuchida *et al*., 2010).

Although often being used, fentanyl is also not without problems, especially wuth the presence of side effects, including respiratory depression, nausea, vomiting and constipation. The use of fentanyl also has a risk of hyperalgesia triggered by fentanyl/opioid induced hyperalgesia (OIH), used both in the management of acute and chronic pain (Lyons *et al.,* 2015)

Pain management can be done with multimodal analgesia therapy. The therapy aims to provide analgesics at different capture points. In addition, the combination of systemic analgesics and scalp blocks can reduce the number of systemic opioids, thereby reducing the incidence of opioid side effects (Osborn and Sebeo, 2010)

Ropivacaine is a long-acting amide group which is commonly used in local anesthesia. Ropivacaine has less lipophilic properties compared to bupivacaine; this also influences its selective properties, therefore ropivacaine has a significantly higher threshold for the occurrence of cardinal and central nervous system toxicity compared to bupivacain in animal studies and healthy volunteers. Low lipophilicity of ropivacaine and bupivacain correlates with lower cardiodepressant effects of both ropivacaine isomers compared to bupivacain isomers in animal studies (Kuthiala and Chaudany, 2011; Stoelting, 1999; Takdir, 2019; Wall and Melzack's, 2013). Previous studies recommend bupivacaine 0.25%, 0.5% or using 0.5% ropivacaine with a total volume of 30-60 ml (Brydges *et al*., 2012)

METHODS

This research is a single blind randomized experimental trial. Two groups are made, the first group is given a combination of regional general scalp anesthesia using 0.5% ropivacaine, the second group is given general anesthesia without a combination. Each group will be given a special code and randomized. Special codes are unknown to the patient. Research samples 14 adult elective patients who underwent craniotomy under general anesthesia, with inclusion criteria: age 18-64 years, physical status ASA (American Society of Anesthesiologists) 1–3, GCS (Glasgow Coma Score) 15, CPOT (Critical Pain Observational Tools) Score ≤ 3, patients/families willing to sign informed consent to participate in the study. Exclusion Criteria: patients with abnormalities of anatomy, function and heart rhythm, impaired kidney and liver function, patients have a history of drug allergy used in the study. Drop Out criteria include: research data is incomplete, patients/families withdraw from participation. In group A the intravenous dose of fentanyl pump was one mcg/kg/hour while in group B the intravenous dose of fentanyl pump was one mcg/kg/hour tapering down and scalp block with 0.5% ropivacaine. Asepsis was performed in the area to be injected in the area of supraorbital as much as 2ml, supratrochlear 2ml, zygomaticotemporal 2ml, auriculotemporal 2ml, minor occipital nerve 2ml, and 2ml major occipital nerve. Injections are carried out on the right and left side of the head. The recording of the heart rate and MAP at the time of preoperation, during skin incision, when in contact with periosteal, and when opening durameter, as well as the amount of fentanyl requirements in both groups.

RESULTS

This study was conducted in patients diagnosed with brain tumors who underwent tumor excision craniotomy in the Central Surgical Hospital Dr. Ramelan with GCS 15 according to inclusion and exclusion criteria. A total of 14 patients were sampled from November to December 2019. Sample of this study was conducted on patients with an age range between 18 to 65 years. The number of subjects by age can be seen in the following table

Table 1.1. Age characteristics of research subjects

Age (years)	*Scalp* Blok (%)		Total	p
	Y 7 (50%)	N 7 (50%)	14 (100)	
< 20	0 (0)	1 (14.3)	1 (7.3)	0.948
21 – 30	0 (0)	0 (0)	0 (0)	
31 – 40	1 (14.3)	0 (0)	1 (7.3)	
41 – 50	1 (14.3)	3 (42.6)	4 (28.4)	
51 – 60	5 (71.4)	2 (28.8)	7 (49.7)	
61 – 65	0 (0)	1 (14.3)	1 (7.3)	
Average	48.42 ± 9.34	48.00 ± 14.29		

*Y: using regional scalp block; N: without regional scalp block; p: probability.

*Average (Mean±Standard Deviation).

Most patients were aged between 51-65 years with more than 49.7% and at the age of 21-30 years there were no patients with brain tumors that met the inclusion and exclusion criteria. Normality test results in this group are normally distributed with p-values greater than 0.05.

The recruitment of samples did not obtain specific criteria for the patient's body mass index.

Table 1.2. Characteristics of body mass index research subjects

BMI (kg/m^2)	*Scalp block* (%)		Total	p
	Y 7 (50%)	N 7 (50%)	14 (100)	
< 18.5	0 (0)	0 (0)	0 (0)	0.815
18.5 – 24.9	6 (85.8)	5 (71.6)	11 (78.7)	
25.0 – 29.9	1 (14.2)	2 (28.4)	3 (21.3)	
≥ 30	0 (0)	0 (0)	0 (0)	
Average	48.42 ± 9.34	48.00 ± 14.29		

*BMI: Body mass index; Y: using regional scalp block; N: without regional scalp block; p: probability.

*Average (Mean±Standard Deviation).

The study subjects did not get patients who are overweight or malnourished because the average is between 18.5-24.9. Free statistical test results show a p-value of more than 0.05.

The mean changes in MAP during craniotomy surgery in the two study groups can be seen in table 1.3.

Table 1.3. Average MAP in groups using scalp block and without scalp block.

		Regional *scalp block*		p
		Y	N	
1.	Preincision	84.00 ± 10.01	83.8 ± 6.36	0.97
2.	*Scalp incision*	83.57 ± 7.41	100.71 ± 9.28	0.002
3.	Periosteal contact	84.57 ± 4.75	97.85 ± 13.04	0.025
4.	Dura incision	91.00 ± 15.56	96.7 ± 9.30	0.140

*MAP: Mean arterial pressure; Y: using regional scalp block; N: without regional scalp block; p: probability.

At the time of preliminary assessment, the mean value of MAP (84.00 ± 10.01) was obtained, while those using single general anesthesia (83.8 ± 6.36), with a p-value = 0.97.

At the time of a scalp incision using a combined general anesthesia with scalp block (83.57 ± 7.41), while in the group using general anesthesia only (100.71 ± 9.28), with a p-value = 0.002.

At the time of contact with periosteal using combined general anesthesia with scalp block (84.57 ± 4.75), while in the group with single general anesthesia (97.85 ± 13.04), with p-value = 0.025.

At the time of durameter incision using combined scalp block general anesthesia (91.00 ± 15.56), while in the group using single general anesthesia (96.7 ± 9.30) with a p-value = 0.14.

The mean heart rate changes during craniotomy surgery in the two study groups can be seen in table 1.4.

Table 1.4. Mean heart rates value in groups using scalp block and without scalp block

		Regional *scalp block*		p
		Y	N	
1.	Preincision	75.42±9.96	78.85±14.05	0.626
2.	*Scalp incision*	73.57±14.18	99.00±16.41	0.029
3.	Periosteal contact	78.85±14.05	94.00±10.11	0.039
4.	Dura incision	83.42±14.64	92.57±9.37	0.190

*Y: using regional scalp block; N: without regional scalp block; p: probability.

At the time of pre-incision, the mean heart rate values (75.42 ± 9.96) were obtained, while those using single general anesthesia (78.85 ± 14.05), with a p-value = 0.626.

At the time of a scalp incision using a combined general anesthesia and scalp block (73.57 ± 14.18), while in the group using general anesthesia only (99.00 ± 16.41), with a p-value = 0.029.

On contact with periosteal using combined general anesthesia and scalp block (17.85 ± 14.05), whereas in the group with single general anesthesia (94.00 ± 10.11), with p-value = 0.039.

At the time of durameter incision using combined general anesthesia and scalp block (83.42 ± 14.64), while in the group using single general anesthesia (92.57 ± 9.37) with a p-value = 0.19.

There were no significant differences using scalp blocks or without scalp blocks. In this study there were differences in the fentanyl amount at surgery in craniotomy patients using scalp blocks and without scalp blocks.

Table 1.5. Fentanyl amount in groups using scalp blocks and without scalp blocks

	Regional *scalp block*		p
	Y	N	
Fentanyl	190.96±32.15	591.78±157.02	0.0001

*Y: using regional scalp block; N: without regional scalp block; p: probability.

The table above illustrates that the need for fentanyl during craniotomy surgery with a scalp block (190.96 ± 32.15) is compared to the group without a scalp block (591.78 ± 157.02), with statistically significantly different values (p = 0.0001).

DISCUSSION

This study was done on two group subjects who got elective craniotomy operation, the first group got general anesthesia with intravenous fentanyl pump as control and the second group got general anesthesia combined scalp block. MAP and heart rate data were collected at the time of pre incision (basal), scalp incision, first contact with periosteal and durameter incision. There was recording number of fentanyl was used during craniotomy operation on two groups. The result of the two groups was analyzed by SPSS Program used independent T-test and Mann-Whitney test. Two groups age characteristic and body mass index has no significant, as pre incision (basal) MAP and heart rate.

This study result MAP and heart rate at scalp incision significantly, that prove to look on Mann-Whitney test statistic result with MAP (p=0,002) and heart rate (0,029).

MAP and heart rate at contact to periosteal have a significant result that proves from the Mann-Whitney test result with MAP (p=0,02) and heart rate (P=0,039). MAP and heart rate change in this study did not reach 20% so it is safe for brain perfusion.

This study is consistent with surgery theory on craniotomy operation like skin incision, head support pin mounting, contact of periosteal-dura, dura, bone and skin closing can provoke much nociceptive stimulation grade. That procedures are stimulus on nerves which stimulates pain response (Desborough, 2000; Flood, Rathmell and Shafer, 2015; Brydges *et al*., 2012). Pain respond to surgery was marked by increasing pituitary hormone secretion and sympathetic nervous system activation. Changes of pituitary secretion have the second effect on hormone secretion of organ target. Hypothalamus activation of the sympathetic autonomy nerve system result in increasing catecholamine from the the adrenal medulla and releasing norepinephrine from presynaptic nerve end. Norepinephrine's main function as a neurotransmitter, but its part is released from nerve end to circulation. Pain can give increasing sympathetic nervous system activation effect and releasing norepinephrine to circulation makes increasing cardiovascular activity as tachycardia and hypertension. A retrospective study on 30 intracranial tumor patients and nine vascular craniotomy patients result in decreasing heart rate and systolic blood pressure on patient who gets scalp block, but the decreasing was no more 20% from systolic blood pressure and heart rate base patient (Tonkovic *et al*., 2015). So this study makes the previous study proven during duramater incision has no significant or same between scalp block or without scalp block with MAP (p=0.140) and heart rate (p=0.194).

This result is caused scalp block working by block peripheral nerve that innervate scalp skin like supraorbital nerve, occipital major nerve, supratrochlear nerve, zygomaticotemporal nerve, temporal nerve, occipital minor nerve, and all get injection both right and left side. Scalp block technic can be done with injection around the nerve that innervate scalp skin one by one (Cormack, Timothy and Fanzca, 2005)

Trigeminal nerves are the biggest cranial nerve that innervates face and head has three main branches, like ophthalmic nerve, maxillary nerve, mandibular nerve. The ophthalmic nerve is sensory nerve that innervate ipsilateral upper eyelid, cornea, forehead skin, eyebrow, and nose skin. The biggest branch from the optic nerve is the frontal nerve that through orbit to superior orbit fissure and divided two like supraorbital nerve and supratrochlear nerve. Supraorbital nerve foramen make a branch to two, superficial branch and deep branch who go through in aerolar between galeal and pericranium and through galeal in the coronary suture, while supratrochlear nerve through supraorbital foramen and innervate on the upper side of the eye, then ascend to forehead and branch to be medial and lateral , then go through frontalis and aponeurotic galea (Osborn and Sebeo, 2010; Cormack and Timothy, 2005).

On research about scalp block using bupivacaine 0.5% and normal saline fluid, the author examines the hemodynamic response during surgery. There are 21 patients who underwent elective craniotomy tumor excision that need the application of pinning in the head, so there are two groups, the control group and the bupivacaine group. Five minutes before surgery, a local anesthesia is infiltrated to supraorbital nerve and supratochlear nerve, postauricular branch from the major auricular nerve, auriculotemporal nerve, and occipital nerve. The case group shows a higher hemodynamic response than the scalp block group. This finding is reinforced by new study with double blind that showed scalp block using bupivacaine 0,25% have a better hemodynamic control than normal saline 0,9% on the first stage of frontotemporal craniotomy (Lee *et al*. 2006; Osborn and Sebeo, 2010), thereby this study support and reinforced previous study.

In addition, the amount of fentanyl used during surgery between the two groups was also different statistically and significantly (p = 0.0001). This theory supports previous theories about multimodal anesthesia.

Pain management can be performed with multimodal therapy. The aim is to provide analgesic at different points. Beside that, the combination of systemic analgesic and scalp blocks can reduce the amount of systemic opioids, thereby reducing the incidence of opioid side effects (Osborn and Sebeo, 2010). In a study of 60 patients with supratentorial tumor craniotomy, there was a significant decrease in fentanyl usage in patients using scalp block. This study corroborates previous research (Theerth *et al.,* 2018)

During this research, there are no side effects, such as the toxicity of local anesthetics.

CONCLUSION

General anesthesia combined scalp block with ropivacaine 0.5% in craniotomy patient is more effective in reducing MAP and heart rate during scalp incision and periosteal contact compared with general anesthesia. The use of general anesthesia combined scalp block using ropivacaine 0.5% in craniotomy patient does not differ between MAP and heart rate during durameter incision compared with general anesthesia. Consumption of the amount of fentanyl during craniotomy surgery in patient receiving anesthesia with a combination of scalp block with ropivacaine 0.5% was statistically significant (p = 0.0001) and clinically compared with the patient receiving general anesthesia. Anesthesia techniques in patient undergoing craniotomy surgery are advised to use general anesthesia in combination with a scalp block. Craniotomy surgery is recommended to give additional analgesics just before opening the durameter, both using general anesthesia or without scalp block with ropivacaine 0.5% . Further research needs to be done on the cost effectiveness that can result from anesthetic techniques combined with scalp block using ropivacaine 0.5%.

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