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Klasik Karotis Endarterektomilerinde Anestezi Tiplerinin Etkilerinin Karşılaştırılması

Comparison of the Effects of Anesthesia Types in Classical Carotid Endarterectomies

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ÖZ

Giriş: Karotis endarterektomi operasyonları sırasında birçok anestezi yöntemi kullanılmasına rağmen, herhangi bir yöntemin üstünlüğüne dair kanıtlanmış veri bulunmamaktadır. Bu retrospektif çalışmanın amacı, aterosklerotik karotis arter stenozu nedeniyle karotis endarterektomisi uygulanan hastalarda kullanılan farklı anestezi tiplerini değerlendirmektir.

Yöntem: Etik Kurul onayı alındıktan sonra, Aralık 2012 ile Aralık 2020 tarihleri arasında karotis endarterektomi operasyonu geçiren 83 hastanın verileri retrospektif olarak incelendi. Hastalar değerlendirme için Grup GA, Grup RA ve Grup SA olmak üzere üç gruba ayrıldı. Gruplar yaş, cinsiyet, boy, kilo, Amerikan Anesteziyoloji Derneği (ASA) skoru, anestezi türü, operasyon tarafı, operasyon süresi, karotis klempleme süresi, postoperatif görsel analog skala (VAS) skorları, ek analjezik gereksinimi ve bir aylık mortalite açısından karşılaştırıldı.

Bulgular: Gruplar arasında yaş, kilo, boy, ASA skorları, operasyon tarafı, karotis arter lümen darlığı dereceleri, operasyon süresi ve hastanede kalış süresi açısından istatistiksel olarak anlamlı bir fark saptanmadı (p>0,05). Karotis klempleme süresinin Grup GA'da Grup SA'ya göre anlamlı olarak daha uzun olduğu bulundu (p=0,006). Gruplar arasında 6, 12 ve 24 saatlik VAS skorlarında anlamlı fark gözlendi ve skorlar Grup SA'da Grup RA'ya göre istatistiksel olarak anlamlı derecede yüksekti (sırasıyla p=0,030, p=0,030 ve p=0,029).

Sonuç: Bu çalışmanın sonuçları karotis endarterektomi operasyonlarında genel anestezi altındaki hastalarda karotis klempleme süresinin daha uzun olduğunu ve rejyonal anestezinin sedoanaljeziye göre daha etkili postoperatif ağrı kontrolü sağladığını göstermiştir.

Anahtar Kelimeler: karotis endarterektomi, servikal pleksus bloğu, rejyonel anestezi, genel anestezi, sedasyon

ABSTRACT

Objective: Despite the use of numerous anesthetic methods during carotid endarterectomy operations, there is a lack of proven data regarding the superiority of any particular method. The purpose of this retrospective study was to evaluate the various types of anesthesia used in patients who underwent carotid endarterectomy for atherosclerotic carotid artery stenosis.

Method: After obtaining Ethics Committee approval, the data of 83 patients who underwent carotid endarterectomy operation between December 2012 and December 2020 were retrospectively analyzed. The patients were divided into three groups for evaluation: Group GA, Group RA and Group SA. The groups were compared in respect of age, gender, height, weight, American Society of Anesthesiology(ASA) score, type of anaesthesia, operation side, operation time, carotid clamping time, postoperative visual analog scale (VAS) scores, additional analgesic requirement, and one-month mortality.

Results: No statistically significant difference was determined between the groups in respect of age, weight, height, ASA scores, operation side, carotid artery lumen stenosis grades, operation time, and length of hospital stay (p>0.05). Carotid clamping time was found to be significantly longer in Group GA than in Group SA (p=0.006). A significant difference was observed between the groups in the 6, 12, and 24-hour VAS scores, with scores being statistically significantly higher in Group SA compared to Group RA (p=0.030, p=0.030, and p=0.029, respectively).

Conclusion: The results of this study demonstrated that in carotid endarterectomy operations, carotid clamping time was longer in patients under general anaesthesia, and more effective postoperative pain control was provided by regional anaesthesia than sedoanalgesia.

Keywords: carotid endarterectomy, cervical plexus block, regional anesthesia, general anesthesia, sedation

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INTRODUCTION

Carotid endarterectomy (CEA) is a well-established surgical method used to prevent cerebrovascular events in patients with symptomatic or asymptomatic carotid stenosis. Landmark trials, including the European Carotid Surgery Trial (ECST) and the North American Symptomatic Endarterectomy Trial (NASCET), initially demonstrated the superiority of surgery over best medical therapy (1). Despite these early findings, contemporary guidelines continue to recommend CEA as the preferred treatment for appropriately selected patients, reflecting both updated evidence and advances in perioperative care (2,3).

Achieving adequate hemodynamic stability, proper brain perfusion and oxygenation, tolerable analgesia, and avoiding a surgical stress response without increasing cardiac strain are the objectives of the anesthetist in CEA (4,5). Because of the growing use of nerve blocks and ultrasonography (USG) and the decreased risk of complications, carotid endarterectomy can be carried out under sedoanalgesia (SA), general anesthesia (GA), and regional anesthesia (RA) (4).

Although many anaesthetic methods are used for CEA, there are no proven data demonstrating which anesthetic method is superior. The aim of this retrospective study was to compare the diffirent anaesthesia types in patients undergoing CEA for atherosclerotic carotid artery stenosis.

MATERIALS AND METHODS

Study Design

A retrospective analysis was made of the data of 106 patients who underwent classical CEA operation in our hospital between December 2012 and December 2020. The study exclusion criteria were defined as incomplete or inappropriate records (n=4), the use of shunts or patches (n=14), simultaneous coronary bypass surgery (n=3), or intraoperative change in anaesthesia method (n=2). A total of 83 patients were included in the study in three groups according to the anaesthesia types. Group SA consisted of patients who received sedoanalgesia, Group RA, patients who received regional anaesthesia, and Group GA patients who received general anaesthesia. The groups were analyzed and compared in respect of age, gender, height, weight, percentage of carotid stenosis, American Society of Anesthesiology (ASA) score, type of anesthesia, side of operation, operation time, carotid clamping time, postoperative VAS scores at 6, 12, and 24 hours, postoperative complications, postoperative analgesic requirement and 1-month mortality.

Anesthesia Application

In the preoperative evaluation room, two distinct intravenous channels were ensured, and 0.9% NaCl saline infusion was started. In the operating room, radial artery catheterization and arterial pressure monitoring were performed in addition to standard anaesthesia monitoring (pulse oximeter, non-invasive blood pressure, heart rate). These procedures were performed as standard in all patients.

In Group SA, an intravenous (IV) bolus of midazolam (0.3-0.5 mg/kg) and propofol (1-1.5 mg/kg) was followed by an IV infusion of remifentanil (0.25-0.5 μg/kg/min). During maintenance, intermittent boluses of propofol (10-20 mg) and remifentanil infusion rates were titrated between 0.1-0.5 μg/kg/min to maintain a RASS score between 0 and -2, particularly before carotid clamping to facilitate neurological assessment.

Patients in Group RA were positioned supine with the head turned approximately 30˚ to the opposite side after standard anaesthesia monitoring in the block application room. Neck anatomy and the presence of structural differences were checked on USG, then Combined (superficial and deep) cervical plexus blocks were performed. A superficial cervical plexus block was applied with a mixture of 5 mL 0.5% bupivacaine, 3 mL 2% lidocaine and 2 mL saline injected to the posterior edge of the sternocleidomastoid muscle. A deep cervical plexus block was executed at the transverse processes of the second, third, and fourth cervical vertebrae, utilizing 5 mL of a local anesthetic mixture comprising 2.5 mL bupivacaine, 1.5 mL lidocaine, and 1 mL saline, administered at each level. Sensory skin tests and muscle strength evaluations of the the hand and shoulder joints were made at 20 mins after the block application. The patients were examined for any complications before entering the operating room. Equipment and personnel were available to switch to general anaesthesia in case of a possible failure.

In Group GA, anesthesia induction was performed with intravenous administration of midazolam (0.01–0.05 mg/kg), fentanyl (1.5-2 μg/kg), propofol (1–2 mg/kg), and rocuronium (0.5-0.6 mg/kg). Orotracheal intubation was performed when the appropriate depth of anaesthesia was established. Anaesthesia was then maintained with 50% FiO2 and 1.5-2% sevoflurane. Mechanical ventilation parameters were adjusted to normocarbic end-tidal carbondioxide (ETCO2=35-40 mmHg). At the end of the surgery, the patients were extubated and sent to the cardiovascular intensive care unit.

Consciousness was assessed verbally in Groups RA and SA. Motor function was evaluated with a plastic toy in the opposite hand. In Group GA, sedation and level of consciousness were monitored with bispectral index (BIS) monitoring. If a sudden decrease in BIS value was observed, the surgeon was informed immediately. Near infrared spectroscopy (NIRS) is used in all groups to evaluate cerebral oxygenation. Adrenaline, ephedrine, esmolol and nitroglycerin were used for blood pressure regulation.

Surgical Approach

In the classical surgical technique, common, internal and external carotid arteries were found after skin incision. Supportive topical anaesthesia was performed with 5 mL 2% lidocaine. All surgical procedures were performed without the use of carotid shunting. Before carotid clamping, 75-100 IU.kg- heparin was administered, and controlled hypertension was maintained during carotid artery clamping. The common carotid artery was opened with a longitudinal incision, the atheromatous lesion between the tunica arteria media and the adventitia was excised, and the incision was then closed with carotid primary suturing under the microscope.

Analgesic Therapy and Pain Assessment

For postoperative analgesia, all pateints were administered 1gr paracetamol IV approximately 10 min before the end of the operation, and 1gr paracetamol was administered two more times at 8-hour intervals for standard postoperative analgesia. If patients needed additional analgesia, 2 mgkg- tramadol was used. All patients were followed up in the cardiovascular surgery intensive care unit for the first 24 hours postoperatively. The time at 0 hour was when the patients were taken into the postoperative recovery room. The VAS score assessments were made in the cardiovascular surgery intensive care unit according to this hour.

Statistical Analysis

Data from the study were statistically analyzed using IBM Statistical Package for the Social Sciences vn. 25 software (SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test was utilized to assess the variables' adherence to a normal distribution. The Kruskal-Wallis test was employed to compare continuous variables lacking normal distribution among groups of three or more. Upon identifying a significant difference by the Kruskal-Wallis test, the Mann-Whitney test with Bonferroni correction was conducted to ascertain the specific groups responsible for the difference. One-way analysis of variance (ANOVA) was used in the comparisons of variables showing normal distribution, and if a significant difference was found, Post-Hoc analysis was applied. Relationships between categorical variables were analyzed with Chi-square analysis. A value of $p < 0.05$ was accepted as the level of statistical significance.

RESULTS

Evaluation was made of a total of 83 patients with a mean ages of 70.19±8.46 years (range, 45 - 87 years) who underwent CEA between December 2012 and December 2020. Group SA included 38 (45.8%) patients, Group RA, 20 (24.1%) patients, and Group GA, 25 (30.1%) patients. Carotid artery stenosis was right-side in 39 (47.0%) patients, and left-side in 44 (53%) patients. (Table-I).

The mean weight of the patients was found to be 75.52±6.69 kg and the mean height of the patients was 170.16±7.02 cm. The percentage of carotid artery stenosis in the patients was found to be mean 76.87±11.75%, the operation time was mean 48.89±5.58 minutes, carotid clamp duration was mean 17.05±1.94 minutes, and the length of hospital stay was mean 2.63±1 days (Table-l).

When evaluated in terms of comorbidities, 43 (51.8%) patients had coronary artery disease, 78 (94.0%) had hypertension, and 72 (86.7%) had hyperlipidemia. Preoperative neurological deficits were identified in 35 patients (42.2%), and smoking was documented in 29 patients (34.9%).

No statistically significant differences were determined when the side of operation, age, weight, height, ASA scores, and degree of carotid artery lumen stenosis were examined according to the types of anaesthesia (Table-l).

Table 1. Comparison of Sociodemographic and Preoperative Medical Characteristics of Patients According to Anesthesia Types

Parameters	Grup SA (n=38)		Grup RA (n=20)		Grup GA (n=25)		Total (n=83)		*p*
	n(%)	**Mean±SD**	**n(%)**	**Mean±SD**	**n(%)**	**Mean±SD**	**n(%)**	**Mean±SD**	
Female Gender	5 (13.2%)		6 (30.0%)		3 (12.0%)		14 (16.9%)		-
Side of operation R/L	20/18		5/15		14/11		39/44		0.075*
Age (year)		69.24±9.66		69.45±8.1		72.24±6.5		70.19±8.46	0.353**
Weight (kg)		75.13±6.57		76.55±5.92		75.28±7.57		75.52±6.69	0.816***
Height (cm)		171.13±6.27		168.4±7.94		170.08±7.33		170.16±7.02	0.526***
ASA 2	14 (36.8%)		7 (35.0%)		9(36.0%)		30(36.1%)		0.990*
ASA 3	24 (63.2%)		13 (65.0%)		16(64.0%)		53(63.9%)		
Degree of stenosis (%)		76.05±11.34		74.45±9.72		80.04±13.49		76.87±11.75	0.282***
Comorbidities n(%)									
Coroner arter disease	21 (55.3%)		8 (40.0%)		14 (56.0%)		43 (51.8%)		0.478*
Hypertension	36 (94.7%)		18 (90.0%)		24 (96.0%)		78 (94.0%)		-
Hyperlipidemia	36 (94.7%)		15 (75.0%)		21 (84.0%)		72 (86.7%)		-
Diabetes	**16 (42.1%)**		**15 (75.0%)**		**8 (32.0%)**		**39 (47.0%)**		**0.012***
Smoking	12 (31.6%)		6 (30.0%)		11 (44.0%)		29 (34.9%)		-
Vertigo	**31 (81.6%)**		**9 (45.0%)**		**21 (84.0%)**		**61 (73.5%)**		**0.004***
Neurological deficit	19 (50.0%)		7 (35.0%)		9 (36.0%)		35 (42.2%)		0.413*
COPD	2 (5.3%)		3 (15.0%)		5 (20.0%)		10 (12.0%)		-

Mean±SD: Mean±Standart deviation, R: right, L: left, kg: kilogram, cm: centimeter, ASA: American Society of Anesthesiology, COPD: Chronic obstructive pulmoner disease
* Chi-square Analysis , ** One-Way Analysis of Variance, ***Kruskal Wallis Test.

In the analysis of comorbidities according to anaesthesia types, no significant correlation was found between the groups in terms of coronary artery disease and preoperative neurological deficit (p=0.478, p=0.413, respectively) (Table-l). In the evaluations of hypertension, hyperlipidemia and nicotine exposure, only frequencies and percentages were given as the assumptions of the Chi-square analysis between the groups were not met. The rate of patients with diabetes who underwent RA (75%) was significantly higher than the rate of patients with diabetes who underwent GA (32%) (p=0.012) (Table 1). A significant difference was found between the groups in terms of the presence of vertigo. The rate of patients with vertigo (84%) who underwent GA was significantly higher than the rate of patients with vertigo (45%) who underwent RA (p=0.004).

No significant difference was observed between the groups regarding operation time (p = 0.363) and length of hospital stay (p = 0.306). However, the carotid clamp duration was significantly longer in the GA group compared with the SA group (p = 0.006) (Table II). The VAS scores at 6, 12, and 24 hours differed significantly between anesthesia types (p = 0.030, p = 0.030, and p = 0.029, respectively). These scores were significantly higher in the SA group compared with the RA group (Table II). The need for additional analgesia was not statistically significant between the groups, but fewer Group RA patients required additional analgesia than in the other two groups. No additional postoperative analgesia was required by 60 (72.3%) patients, with no significant difference determined between the groups (p=0.118).

Complications developed in 8 (9.6%) patients during the postoperative follow-up period, and the most common complication type was cough and nausea in 3 (3.6%) patients.

No newly developed neurological deficits were observed in any of the patients in the intraoperative or postoperative period. One patient in Group GA, who also had heart failure, mortality occurred on the 4th postoperative day (Table-ll).

Table 2. Comparison of Intraoperative and Postoperative Medical Characteristics According to Anesthesia Types

Parameter	Group S.A. (n=38)		Group R.A. (n=20)		Group G.A. (n=25)		Total (n=83)		*p*
	n(%)	Mean±SD	n(%)	Mean±SD	n(%)	Mean±SD	n(%)	Mean±SD	
Operation time (min)		47.92±5.34		49.75±5.66		49.68±5.86		48.89±5.58	0.363*
Carotid clamping time (min)		16.42±1.84		17.15±1.53		17.92±2.10		17.05±1.94	0.006*[a]
VAS 6		2.76±1.34		1.9±0.85		2.52±1.42		2.48±1.30	0.030*[b]
VAS 12		2.61±1.17		1.85±0.59		2.52±1.26		2.40±1.13	0.030*[c]
VAS 24		2.42±0.83		1.8±0.70		2.16±0.94		2.19±0.86	0.029*[d]
Postoperative analgesics need	12(31.6%)		2(10.0%)		9(36.0%)		23(27.7%)		0.118**
Postoperative complications	2		3		3		8		-
Cough	1		1		1		3		-
Dysphagia	0		1		0		1		-
Nausea	1		0		2		3		-
Hoarseness	0		1		0		1		-
One month mortality	0		0		1		1		-
Length of hospital stay (day)		2.53±0.83		2.55±1.36		2.84±0.90		2.63±1.00	0.306*

Mean±SD: Mean±Standart Deviation, VAS: Visual analog scale
* Kruskal Wallis Test
a Post-hoc Bonferroni-corrected Mann–Whitney U tests revealed a significant difference only between the Group SA and Group GA groups (p = 0.004).
b Post-hoc Bonferroni-corrected Mann–Whitney U tests revealed a significant difference only between the Group SA and Group RA. (p = 0.024).
c Post-hoc Bonferroni-corrected Mann–Whitney U tests revealed a significant difference only between the Group SA and Group RA. (p = 0.029).
d Post-hoc Bonferroni-corrected Mann–Whitney U tests revealed a significant difference only between the Group SA and Group RA. (p = 0.024).
** Chi-square Analysis

DISCUSSION

Stroke is among the leading causes of death in patients with cardiovascular disease, and remains a disease with currently high morbidity and mortality rates (6). Since the population suitable for surgery usually includes patients who are elderly and have significant comorbidities, attention to comorbidities in the preoperative period may lead to better results in terms of anaesthesia (7). However, many types of anaesthesia can be used in the intraoperative period in CEA, one of which is RA. The advantages of RA are that it enables faster and more reliable neurological monitoring, reduces pulmonary and cardiovascular complications, and shortens the length of intensive care and hospital stay (1,8). Regional anesthesia has also been shown to reduce intraoperative hypotension and the need for vasopressor support during carotid endarterectomy (9). The advantages of USG-guided RA are direct visualization of the target structures, ensuring needle localisation and local anesthetic spread, and reduction of RA-related complications. (10). However, RA also has disadvantages such as difficulties in claustrophobic patients, requiring quieter and more controlled intraoperative behavior, and lack of airway control (5).

The refusal of RA by a patient or the inability to establish cooperation leads to the preference for SA or GA. SA can be applied to patients who are predicted to have delayed postoperative extubation, patients to whom GA or RA cannot be applied, and when equipment and specialists for neurological monitoring are not available.

Induction constitutes an important stage in GA, and both hypotension and hypertension should be avoided. While providing safe airway and ventilation, GA can negatively affect cerebral autoregulation and cognitive functions in the early postoperative period (6). For neurological evaluation under GA, methods such as electroencephalography, transcranial Doppler, somatosensory evoked potentials and various combinations of these are used, all of which require special equipment, technicians, and specialists to evaluate the results (11).

Some studies in literature have compared RA and GA in CEA operations, and there are also studies that have compared SA techniques and superficial and deep cervical blocks (12,13). In the current study, a retrospecitve analysis was made of the differences between 3 different anaesthesia techniques in classical CEA. Although there was no significant difference between the groups in terms of postoperative analgesic requirements, the postoperative 6, 12 and 24-hour VAS scores were statistically significantly lower in Group RA, suggesting that RA provides more effective postoperative analgesia than the other types of anesthesia.

In a previous case report, brainstem anesthesia — a rare complication characterized by inadvertent spread of local anesthetic to the brainstem, leading to neurological and cardiorespiratory symptoms — occurred in two patients following RA, whereas no such complications were observed in the RA group in the present study (14). In a retrospective study by Grief et al., cranial nerve damage was seen to develop less in patients who underwent CEA under RA (15). Although cranial nerve damage was not recorded in the clinical records in the current study, findings such as cough, hoarseness and dysphagia are likely to occur after cranial nerve damage. Cough was observed in one patient in each of the three groups, while hoarseness and dysphagia that resolved within hours developed in one patient in Group RA. In a study by Gabriel et al., RA was reported to be associated with more favorable postoperative nausea and vomiting outcomes compared withs GA (16). Consistent with these findings, nausea was observed in one patient in the SA group and two patients in the GA group, whereas no cases of nausea occurred in the RA group.

In the same study by Grief et al., the operation time and length of hospital stay were shorter in the RA patients, and Öztaş et al. also reported that RA decreased the operation time and duration of hospital stay (6,15). Kim et al. compared RA and GA in CEAs and found that RA reduced shunt utilization with a reliable vigilance test and RA shortened clamping and operative times, which in turn shortened hospital stay (17). In the current study, there was no significant difference between the groups in terms of operation time and hospitalization time. However, carotid clamping time was longer in the GA group, as in the other studies (17,18). This may be explained by the fact that GA allows the surgeon to work under less stress.

In a study by Umbrain et al. comparing inhaled anesthetic agents of isoflurane, desflurane and sevoflurane, postoperative consciousness was regained earlier in the desflurane group (19). In the current study, sevofluorane was used in Group GA and no adverse effects related to this agent were observed.

It has been shown in many studies that the anaesthesia technique used has no effect on patient survival (20). In the current study, one-month postoperative mortality was limited to 1 patient in Group GA, which was insufficient to evaluate the effect of anaesthesia types on mortality.

In a two-centre, randomized, controlled study, the effects of anaesthesia type in CEA on postoperative stroke were investigated and the risk of silent cerebral infarction was seen to be higher in patients receiving GA (21). In the current study, no significant difference was found in terms of complications according to anaesthesia types.

One of the reasons three distinct types of anaesthesia were used for CEA in this study, is that the anaesthesia type was selected on an individual patient basis, as recommended by Harky et al. (22).

This study possesses multiple shortcomings that warrant acknowledgment. First, its retrospective and single-center design inherently introduces the risk of selection bias and limits the generalizability of the findings. Second, the unequal sample sizes among the three anesthesia groups and the relatively small number of patients in the regional and sedoanalgesia groups may have reduced the statistical power and increased the likelihood of type II error. Third, the distribution of certain comorbidities, such as diabetes and vertigo, was not balanced across groups, which may have acted as potential confounding factors in the interpretation of outcomes. Fourth, only short-term outcomes, including perioperative variables and one-month mortality, were assessed; long-term neurological and functional results were not evaluated. Finally, the reliance on clinical records without standardized neurological assessments may have led to underreporting of minor complications. Future prospective, multicenter randomized trials with larger and more balanced sample sizes are needed to confirm and expand upon these findings.

CONCLUSION

The results of this study demonstrated that RA was not inferior to other anaesthesia techniques and even provided better pain scores in the postoperative period. The use of RA can also be considered beneficial as candidates for CEA surgery are more likely to be elderly patients with comorbidities. However, as all three anaesthesia techniques may have advantages and disadvantages, the medical condition of the patient should be taken into consideration when deciding on the anaesthesia technique.

Ethics Committee Approval: The study was approved by Afyonkarahisar Health Science University Non-interventional Clinical Research Ethical Committee (Decision no:127: , Date: 05.02.2021).

Author Contributions: Concept: BAB, TBS. Design: BAB, TBS. Data Collection or Processing: BAB, TBS. Analysis or Interpretation: BAB, TBS. Literature Search: BAB. Writing: BAB, TBS.

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Informed Consent: Owing to the retrospective design of the study and the use of anonymized patient data, informed consent was waived. The study was conducted with the approval of the institutional ethics committee, in accordance with the principles of the Declaration of Helsinki.

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