ОРИГИНАЛЬНОЕ ИССЛЕДОВАНИЕ

ORIGINAL STUDY

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НЕПЕРЕНОСИМОСТЬ КАРОТИДНОГО ПЕРЕКРЕСТНОГО ЗАЖИМА ПРИ КАРОТИДНОЙ ЭНДАРТЕРЭКТОМИИ В УСЛОВИЯХ РЕГИОНАРНОЙ АНЕСТЕЗИИ

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Во время хирургической эндартерэктомии для артериотомии и удаления бляшек необходимо поперечное пережатие сонной артерии. Поперечное пережатие сонной артерии уменьшает приток крови к кругу Виллиса, и у некоторых пациентов отмечается непереносимость временной окклюзии внутренней сонной артерии (ВСА).

Цель. Продемонстрировать безопасность локо-регионарной анестезии у пациентов с непереносимостью каротидного перекрестного зажима (КПЗ) и факторами риска, прогнозирующими это состояние.

Материал и методы. Все пациенты, перенесшие хирургическую каротидную эндартерэктомию в период с января 2019 г. по декабрь 2020 г. (n=53, 29 мужчин, возраст (медиана с диапазоном) – 78 (56-90) лет), были включены в ретроспективный анализ. Показанием к хирургическому лечению была выраженность стеноз ВСА 70-99% или симптоматический характер стеноз.

Хирургическая техника. По переднему краю грудино-ключично-сосцевидной мышцы делают разрез и выделяют общую сонную артерию (ОСА) из окружающих тканей с рассечением и продолжением в направлении бифуркации. Далее изолируют внутреннюю и наружную сонные артерии. Гепарин (500 Ед) вводят внутривенно, систолическое артериальное давление поддерживают на уровне более 160 мм рт. ст. На следующем этапе выполняется испытание на допуск поперечного зажима в течение 60 с. Во время пережатия тщательный контроль за неврологическим статусом пациента. В случае непереносимости поперечного зажима операция продолжается с использованием имплантации временного шунта. Артериотомия начинается в общей сонной артерии и продолжается до ВСА. Бляшка полностью удаляется, а артериотомический разрез покрывается пластырем. Перед завершением шва зажимы частично удаляются, чтобы смыть мусор с помощью кровотока. Теперь можно освободить наружную и общую артерии и, наконец, снять зажим ВСА.

Результаты. Восемь пациентов имели непереносимость теста толерантности к перекрестному зажиму, и во всех этих случаях хирургическая процедура была продолжена с помощью шунта. Дальнейший ход операции был рутинным. Госпитальная летальность была нулевой, и только в одном случае произошла транзиторная ишемическая атака. Ишемическая болезнь сердца (ИБС) [отношение шансов (ОШ) 12,65, 95% доверительный интервал (ДИ) 1,43-112,50], цереброваскулярные события в анамнезе [ОШ 10,50, 95% ДИ 1,83-60,30] и контралатеральный стеноз 70% и более [ОШ 26,66, 95% ДИ 2,29-304,37] продемонстрировали значимую ассоциацию с непереносимостью перекрестного зажима и необходимостью шунтирования.

Выводы. Регионарная анестезия является безопасным методом выявления пациентов с непереносимостью перекрестного зажима и безопасного выполнения хирургической процедуры. Контралатеральный стеноз ВСА и наличие в анамнезе цереброваскулярных событий являются значимыми факторами для прогнозирования непереносимости перекрестного зажима.

Ключевые слова: *эндартерэктомия; каротидное поперечное пережатие; с непереносимостью поперечного пережатия; локо-регионарная анестезия.*

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CAROTID CROSS-CLAMP INTOLERANCE DURING CAROTID ENDARTERECTOMY IN REGIONAL ANESTHESIA

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During surgical endarterectomy, carotid cross clamping is needed for arteriotomy and plaque removal. Carotid cross clamping reduces the blood flow to the circle of Willis, and some patients show intolerance to the temporary occlusion of the internal carotid artery (ICA).

Aim. This study demonstrates locoregional anesthesia's safety in patients with carotid cross clamping intolerance (CCI) and the risk factors that predict this condition.

Materials and Methods. All patients who underwent surgical carotid endarterectomy between January 2019 and December 2020 (n=53, 29 were male, age (median with range) – 78 (56-90) years) were identified in a retrospective review. The indication for surgical treatment was made for a stenosed ICA of 70-99% or in the case of symptomatic stenosis.

Surgical technique. An incision is made at the front edge of the sternocleidomastoid muscle. The common carotid artery (CCA) is identified and isolated from the surrounding tissues with sharp dissection and continued toward the bifurcation. Next, the internal and external carotid arteries can be isolated. Heparin (5000 U) is administrated intravenously, and the systolic arterial pressure is increased and kept over 160 mm Hg. In the next step, the cross clamping tolerance test is performed for 60 s. During clamping, the patient is neurologically meticulously observed. In the case of CCI, the operation proceeds with the insertion of a temporary shunt. The arteriotomy is started in the CCA and continues to the ICA. The plaque is completely removed, and the arteriotomy incision is covered with a patch. Before completing the suture, the clamps are partially removed to flush out the debris using the blood flow. Now, the external and common artery can be released. Finally, the clamp of the ICA can be removed.

Results. Eight patients had cross clamping tolerance test intolerance. In all these cases, the surgical procedure was continued with a shunt. The further operation course remained uncomplicated. The in-hospital mortality was nil, and a transient ischemic attack occurred in only one case. Coronary artery disease (CAD) [odds ratio (OR) 12.65, 95% confidence interval (CI) 1.43-112.50], a history of cerebrovascular events [OR 10.50, 95% CI 1.83-60.30], and contralateral stenosis of 70% or more [OR 26.66, 95% CI 2.29-304.37] presented a significant association with the CCI and the need to shunt. The remaining factors showed no significant association with intolerance.

Conclusions. Regional anesthesia is a safe method for identifying patients with CCI and safely performing the surgical procedure. Contralateral stenosis of the ICA and a history of cerebrovascular events are significant factors to predict CCI.

Keywords: *endarterectomy; carotid cross clamping; with cross clamping intolerance; locoregional anesthesia.*

Carotid endarterectomy (CEA) is a safe and effective treatment for preventing stroke in patients with significant internal carotid stenosis [1-3]. This method is associated with lower perioperative stroke compared with interventional stenting [2-6].

During the surgical endarterectomy, carotid cross clamping is needed for arteriotomy and plaque removal. Carotid cross clamping reduces the blood flow to the *circle of Willis*, and some patients show intolerance to the temporary occlusion of the internal carotid artery [7-9]. In this case, the use of a temporary shunt is necessary. Locoregional anesthesia has been the first choice in our department since 2019.

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This study aims to demonstrate locoregional anesthesia's safety in patients with carotid cross clamping intolerance (CCI) and the risk factors that predict this condition.

Materials and Methods

All patients who underwent surgical carotid endarterectomy between January 2019 and December 2020 were identified in a retrospective review and analysis of a prospectively maintained database. The degree of internal carotid artery (ICA) stenosis and, consequently, surgical treatment followed the European Carotid Surgery Trial (ESCET) [10]. The indication for surgical treatment was made for stenosis of ICA between 70% and 99% or in case of *symptomatic stenosis*.

Locoregional anesthesia technique. The patient's head was rotated approximately 45 to 60 degrees to the contralateral side to perform the superficial cervical *plexus block*. By slightly lifting the head in this position, the sternocleidomastoid muscle's posterior border can be identified. The first injection site is located halfway between the mastoid process and the clavicle on the sternocleidomastoid muscle's posterior edge at the punctum nervosum (*Erb´s point*). After creating a local anesthetic skin wheal (3 ml *Mepivacaine* 1%), the needle is positioned 1 cm to 2 cm below the sternocleidomastoid muscle to inject the rest of the *Mepivacaine* 1% (7 ml). This is followed by a subcutaneous infiltration (up to 40 ml *Ropivacaine* 0.5%; max 3 mg/kg body weight) starting from the initial injection site in the direction of the mastoid, the clavicle, and the anterior border of the sternocleidomastoid muscle. The subcutaneous infiltration is completed by locating the second injection site at the sternocleidomastoid's anterior border from which the injection goes cranial to caudal. Due to the use of a retractor in the lower jaw area, which is often perceived as painful, the last injection is made from the angle of the jaw along the mandible. Any needle positioning must be done under aspiration to avoid intravenous administration of the local anesthetic.

Surgical technique. An incision is made at the sternocleidomastoid muscle's front edge. The common carotid artery (CCA) is identified and isolated from surrounding tissues with sharp dissection and continued toward the bifurcation. Now, the internal and external carotid arteries can also be isolated. *Heparin* (5000 U) is administrated intravenously, and the systolic arterial pressure is increased and kept over 160 mm Hg. In the next step, the cross clamping tolerance test is performed for 60 s. During clamping, the patient is neurologically meticulously observed. In the case of CCI, the operation proceeds with the insertion of a *temporary* shunt. The arteriotomy is started in the CCA and continued to the ICA. The plaque is completely removed, and the arteriotomy incision is covered with a patch. Before completing the suture, the clamps are partially removed to flush out the debris using the blood flow. Now, the external and common artery can be released. Finally, the clamp of the ICA can be removed.

From January 2019 to December 2020, 53 patients were identified and included for further analysis. Of the recruited patients, 29 were male. Their baseline characteristics and risk factors are shown in Table 1. Arterial hypertension followed by coronary artery disease (CAD) are the most frequent risk factors.

Statistical analyses were performed using the IBM SPSS Statistical Software, Version 24 (IBM Corporation, Armonk, NY, USA). Continuous variables are described as means and standard deviations and compared with the Student's *t*-test. Chi-squared and Fisher's exact tests are used for comparing categorical variables. The statistically significant difference threshold was $p<0.05$.

Results and discussion

Eight patients (15%) had CCI, and in all cases, the surgical procedure was continued with a shunt. The further operation course remained uncomplicated. The in-hospital mortality was nil, and a transient ischemic attack occurred in only one case. The result of the univariate regression analysis is presented in Table 2. CAD [odds ratio (OR) 12.65, 95% confidence interval (CI) 1.43-112.50], a

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Table 1

Descriptive characteristics of included patients, n=53

Variable	Value
Age, years, median with range	78 (56-90)
Male/Female, n (%)	29 (54.7) / 24 (45.3)
Diabetes, n (%)	14 (26.4)
Hypertension, n (%)	45 (84.9)
Coronary artery disease, n (%)	23 (43.4)
History of cerebrovascular events, n (%)	16 (30.2)
Renal insufficiency, n (%)	10 (18.9)
Dyslipidemia, n (%)	30 (56.6)
Chronic obstructive pulmonary disease, n (%)	5 (9.4)
Smoking history, n (%)	20 (37.7)

Table 2

Logistic regression analysis of potential factors associated with perioperative shunt requirement

Variable	OR	CI, lower limit	CI, upper limit	*P* value
Age	0.98	0.90	1.07	0.627
Female	4.50	0.82	24.83	0.121
Diabetes	0.35	0.039	3.149	0.333
Hypertension	1.29	0.14	12.17	0.824
Coronary artery disease	12.69	1.43	112.50	**0.006**
History of cerebrovascular events	10.50	1.83	60.30	**0.003**
Renal insufficiency	1.54	0.26	9.08	0.630
Dyslipidemia	0.40	0.09	1.89	0.237
Chronic obstructive pulmonary disease	1.46	0.14	15.10	0.574
Smoking history	0.50	0.09	2.26	0.420
Contralateral stenosis over 70%	26.66	2.29	304.37	**0.009**
Symptomatic lesion	3.90	0.73	20.71	0.124

history of cerebrovascular events [OR 10.50, 95% CI 1.83-60.30], and contralateral stenosis of 70% or more [OR 26.66, 95% CI 2.29-304.37] presented a significant association with CCI and the need to shunt. The remaining factors showed no significant association with intolerance.

The carotid endarterectomy is a safe method for preventing stroke in cases of internal carotid stenosis. However, *carotid cross clamping cannot be tolerated by all patients*. The incidence of CCI is estimated to be between 7 and 30% [1]. In our cohort, it was 15%. The major benefit of locoregional anesthesia is the continuous neurological monitoring of awake patients. Locoregional anesthesia allows us to identify patients who need a shunt. In all cases, we could continue the open surgical procedure using an arterio-arterial shunt. This method can be complicated in restless patients. Lutz H.-J., et al. described the carotid endarterectomy in locoregional anesthesia as a safe method with better neurological outcomes [11]. A recent meta-analysis comparing locoregional anesthesia with general anesthesia showed that *locoregional anesthesia was associated with significantly less stroke, fewer cardiac complications, and lower hospital mortality* [12]. Our study had only one transient attack but no stroke or mortality. Some factors that predict CCI were previously discussed in the literature. Piffaretti G., et al. identified hypertension and symptomatic lesions as significant predictors [7], whereas Kretz B., et al. described renal insufficiency and contralateral carotid occlusion as predicting factors for clamp intolerance [13].

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We found that CAD, a history of cerebrovascular events, and contralateral stenosis of 70% or more as significant predicting factors of CCI. Other factors remain without a significant association. The importance of the *circle of Willis* must be mentioned. A statistically significant association between CCI and agenesia in the *circle of Willis* was reported [8,9]. However, our study's sample size is the main limitation. In addition, investigating the *circle of Willis* could provide us with additional information.

Conclusion

Regional anesthesia is a safe method for identifying patients with CCI and safely performing the surgical procedure. Contralateral stenosis of the ICA and a history of cerebrovascular events are significant factors for predicting CCI.

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Дополнительная информация [Additional Info]

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