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# Carotid Endarterectomy in Women versus Man: Patient Characteristics and Perioperative Complication (<30 Day)

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## Abstract

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**AIM:** Compare the basic characteristics of patients and to examine the existence of higher rates of perioperative complications (0 - 30 days) in women versus men after carotid endarterectomy (CEA).

**METHODS:** This is a retrospective-prospective study included 270 patients with significant stenosis of carotid in whom CEA was performed, during the period from 2012 to 2017. Patients they were divided: group 1 - 100 female patients, group 2 - 170 male patients.

**RESULTS:** No statistically significant age difference was observed between the two groups, group 1 - 66.01 years (SD 8.42, 46 to 86 years), group 2 - 66.46 years (SD 8.03, 47 to 85 years) ( $p = 0.659$ ). Risk factors represent a greater prevalence in group 2, but the observed difference is not statistically significant. The average duration of surgery and the time of carotid artery clamping time were longer in group 1: ( $p = 0.002$ ;  $p = 0.005$ ). The number of classic endarterectomy with the patch was higher in women (41 (41%) versus 31 (18.2%),  $p = 0.005$ ), while the number of bilateral CEAs was not statistically significant.

**CONCLUSION:** The results of this study did not indicate a greater presence of perioperative complications (< 30 days) in women versus male patients after CEA.

## Introduction

Cerebrovascular insult (CVI) is the third most common cause of death in industrialized countries, the most common neurological diagnosis requiring hospitalization [1] and the leading cause of disability in the world [2] [3], while not all CVI - s are caused by atherosclerotic carotid artery disease (stenosis, occlusion).

After the first carotid endarterectomy (CEA) performed by De Bakey, the method was established as a safe and effective way to reduce the

risk of CVI in patients with critical stenosis of carotid arteries. Today, CEA is a surgical method with low mortality and acceptable incidence of perioperative complications (30 days) in most centres dealing with this issue [4] [5]. Also, the superiority of surgical treatment in patients with symptomatic [6] and asymptomatic carotid artery stenosis is well known [5] [7]. CEA can cause severe perioperative complications (i.e. stroke, death). It is presumed that women may have an increased risk of perioperative complications and that this risk may negate the overall benefit of the procedure in women, particularly in lower - risk subgroups with medication therapy for stroke prevention. Current literature provides

contradictory evidence of CEA risk in women compared to men. Some studies point to a higher rate of perioperative complications in women [8] [9] [10], while others found no difference between women and men [6] [11] [12] [13] [14] [15] [16].

The study aimed to compare the basic characteristics of patients and to examine the existence of higher rates of perioperative complications (0 - 30 days) in women versus men after CEA.

## Patients and Methods

This was a retrospective-prospective observational clinical cohort study conducted in the period from January 2012 to October 2017. Patients with stenosis of carotid arteries in whom CEA was performed at the Clinical Center of the University of Sarajevo were included.

Depending on the sex of the patients were divided into two groups: group 1, consisting of 100 female patients, group 2 - consisting of 170 male patients. The preoperative risk factors were compared between the two groups: hypertension (HTA), hyperlipidemia (HLP), smoking, diabetes mellitus (DM), non - surgical coronary artery disease (CAD) as well as demographic factors, significant stenosis of carotid arteries, the presence of preoperative neurological symptomatology (vertigo, transient ischemic attack (TIA), amaurosis fugax and small CVI). From the perioperative results, the total duration of the operation (time from the first surgical incision to the last suture expressed in minutes), the length of clamping of internal carotid artery (ICA) (expressed in minutes), prosthetic material used in closing the arteriotomy in the classical endarterectomy as well as the history of contralateral side CEA. Of the perioperative complications (< 30 days), CVI and mortality were analysed.

The exclusion criteria included: patients with restenosis of carotid arteries, stenosis of carotid arteries with associated stenosis of supraorbital branches, aneurysms of carotid arteries, carotid artery dissection, CEA and peripheral revascularisation performed in the same patient.

The CEA was performed with the eversion (E - CEA) and the classic (C - CEA) technique with Dacron patch, without the use of a shunt. Surgical treatment is indicated in asymptomatic patients with stenosis of 70 to 99 %, and in symptomatic patients with stenosis > 60 % (criteria for inclusion in the study). Stenosis is determined by Doppler ultrasound and CT angiography or MRI angiography. Basic data sources were computerised databases and standard histories of hospitalised patients (history, operating list, temperature list, letter of release).

Anesthesiologists, vascular surgeons, participated in the evaluation of patients' clinical condition independently of each other.

Eversion carotid endarterectomy (E-CEA) technique implied carotid bifurcation level transection and removal of atherosclerotic plaque by artery eversion of ICA, then removal of plaque from an external carotid artery (ECA) and common carotid artery (CCA) and anatomic reimplantation of ACI. **Classical** carotid endarterectomy (C - CEA) technique was performed by longitudinal arteriotomy of CCA and ICA and by removal of atherosclerotic plaque. Arteriotomy was closed using a prosthetic patch. **The later** was used in cases of the small diameter of CCA and ICA (< 5 mm).

## Statistical analyses

The statistical analyses were performed with SPSS (v. 21.0, SPSS Inc., Chicago, Illinois, USA). We compared clinical characteristics between group 1 and group 2 for qualitative variables using Mann - Whitney U test and Student's t-test. Chi-squared, using Yates correction and Fisher's exact probability test, was used to compare categorical variables. A probability value of < 0.05 was considered statistically significant.

## Results

Of the 270 patients involved in the study, group 1 had 100 female patients and in the group 2 170 male patients. The mean age in group 1 was 66.01 years (SD 8.42, ranging from 46 to 86 years), in group 2 66.46 years (SD 8.03, ranging from 47 to 85 years). Dacron patch (in C - CEA patients) was used in 41 subjects in group 1 (41%) and in 31 group 2 (18.2%). The risk factors (smoking, DM, HTA, HLP, CAD) indicates a higher number in group 2 but the observed difference is not statistically significant: smoking: 46 (46%) versus 73 (42.9%);  $p = 0.717$ , HTA: 92 (92%) versus 148 (87.1%);  $p = 0.295$ , HLP: 87 (87%) versus 141 (82.9%);  $p = 0.475$ , DM: 35 (35%) versus 55 (32.4%);  $p = 0.751$  and CAD: 20 (20%) versus 44 (25.9%);  $p = 0.342$ , (Table 1).

**Table 1: Patient's demographic data, risk factors, and comorbidities**

|                         | Group 1 (N = 100, 37%) | Group 2 (N = 170, 63%) | P-value |
|-------------------------|------------------------|------------------------|---------|
| Mean age (yr)           | 66.01 ± 8.42           | 66.46 ± 8.03           | 0.659   |
| Arterial hypertension   | 92 (92%)               | 148 (87.1%)            | 0.295   |
| Diabetes mellitus       | 35 (35%)               | 55 (32.4%)             | 0.751   |
| Hyperlipidemia          | 87 (87%)               | 141 (82.9%)            | 0.475   |
| Smoker                  | 46 (46%)               | 73 (42.9%)             | 0.717   |
| Coronary artery disease | 20 (20%)               | 44 (25.9%)             | 0.342   |

HTA - Arterial hypertension; DM - Diabetes mellitus; HLP - Hyperlipidemia; CAD - Coronary artery disease.

The incidence of symptomatic stenosis of

carotid arteries was not statistically significant between groups (group 1: 62 (62%) and in group 2: 103 (60.3%),  $p = 0.921$ ). A statistically significant difference between symptoms of carotid stenosis in groups was observed only in patients with TIA (group 1: 19 (19%) versus group 2: 14 (8.2%),  $p = 0.016$ ), vertigo (group 1: 23 (23%) versus group 2: 46 (27.1%),  $p = 0.682$ ), small CVI (group 1: 11 (11%) versus group 2: 24 (4.1%),  $p = 0.582$ ), amaurosis fugax (group 1: 9 (9%) versus group 2: 19 (11.2%),  $p = 0.719$ ). There was no statistically significant difference in the number of asymptomatic patients between groups (group 1: 38 (38%) versus group 2: 67 (39.4%),  $p = 0.92$ ), patients with bilateral stenosis (group 1: 32 (32%) versus group 2: 72 (42.4%),  $p = 0.119$ ) and contralateral occlusion (group 1: 11 (11%) versus group 2: 9 (5.3%),  $p = 0.137$ ).

The average duration of surgery and clamping time was statistically significantly lower in group 2: duration of surgery (group 1: 103.45 min (SD 15.41) ranging from 75 min to 130 min versus group 2: 97.46 min (SD 13.87) ranging from 75 min to 130 min,  $p = 0.002$ ), carotid artery clamping time (group 1: 19.58 (SD 5.43) in the range of 11 min to 32 min versus group 2: 17.61 (SD 4.82) in the range of 10 min to 35 min,  $p = 0.005$ ). In women, the number of C - CEA in which patch was used was statistically significantly higher than in man (41 (41%) versus 31 (18.2%),  $p = 0.005$ ), while the number of bilateral CEAs (formerly CEA contralateral) was not statistically significant between groups (group 1 10 (10%) versus group 2 21 (12.4%),  $p = 0.695$ ), (Table 2).

**Table 2: Clinical and anatomical features and surgical variable**

|                         | Group 1 (n = 100) | Group 2 (n = 170) | p - value |
|-------------------------|-------------------|-------------------|-----------|
| Preoperative symptoms   | 62 (62%)          | 103 (60.6%)       | 0.921     |
| TIA                     | 19 (19%)          | 14 (8.12 %)       | 0.016     |
| Amaurosis fugax         | 9 (9%)            | 19 (11.2%)        | 0.719     |
| CVI                     | 11 (11%)          | 24 (14.1 %)       | 0.582     |
| Vertigo                 | 23 (23%)          | 46 (27.1%)        | 0.682     |
| Asymptomatic patients   | 38 (38%)          | 67 (39.4%)        | 0.92      |
| Bilateral stenosis      | 32 (32%)          | 72 (42.4%)        | 0.119     |
| Contralateral occlusion | 11 (11%)          | 9 (5.3%)          | 0.137     |
| Time of clamping ICA    | 19.58 ± 5.43      | 17.61 ± 4.82      | 0.005*    |
| Operative time          | 103.45 ± 15.41    | 97.46 ± 13.87     | 0.002*    |
| Patch closure           | 41 (41%)          | 31 (18.2%)        | 0.005*    |
| Bilateral CEA           | 10 (10%)          | 21 (12.4%)        | 0.695     |

TIA - Transient ischemic attack; CVI - cerebrovascular insult; ICA - internal carotid artery.

Analysis of perioperative complications (< 30 days) CVI and/or mortality did not indicate a statistically significant difference between the analyzed groups 1 and 2 (stroke 7 (7%) versus 6 (3.5%),  $p = 0.242$ , death 2 (2%) versus 0.6%  $p = 0.557$ ; stroke/death 9 (9%) versus 7 (4.1%);  $p = 0.169$ , all retrospectively). The total incidence of perioperative complications during the study was 16 (5.9%), (Table 3).

**Table 3: Perioperative (< 30 days) complication**

|                           | Group 1 (n = 100) | Group 2 (n = 170) | p - value | Total (n = 270) |
|---------------------------|-------------------|-------------------|-----------|-----------------|
| Stroke                    | 7 (7%)            | 6 (3.5%)          | 0.242     | 13 (4.8%)       |
| Death                     | 2 (2.0%)          | 1 (0.6%)          | 0.557     | 3 (1.1%)        |
| 30 - day and Stroke/death | 9 (9%)            | 7 (4.1%)          | 0.169     | 16 (5.9%)       |

## Discussion

After the first CEA made by De Bakey [17], the same was established as a safe and effective method for lowering the risk of CVI in patients with significant stenosis of carotid arteries. Today, the CEA is a method with low mortality and incidence of perioperative complications, both in symptomatic [6] and in asymptomatic stenosis of carotid arteries [5] [7]. Two randomised studies of the 1990s have shown CEA's advantages over drug therapy for patients with moderate or severe internal carotid artery stenosis [7] [18]. The benefit of CEA in women remains, still, unclear.

The ACAS study showed a significant reduction of CVI risk in men versus women after CEA (66% versus 17%, retrospectively), most of these differences can be attributed to higher perioperative stroke and mortality rates in women compared to males (3.6 % versus 1.7 %, retrospectively) [7], other studies have reported similar results [4] [18] [19]. Recent large retrospective studies have been performed to assess the benefits and risks of CEA in women. Akbar et al. reported a series of 1298 CEA patients, of which 520 (40%) were women, with no differences in perioperative stroke between women and men (1.2% vs 1.7%, retrospectively). They concluded that female gender is not a risk factor for stroke, death or cardiac morbidity after CEA [15]. Also, Mattos et al. did not report an increased risk to a woman [14]. Similar results were found in our study where there was no statistically significant difference between female and male patients in perioperative complications (< 30 days) (9% versus 4.1%;  $p = 0.169$ , retrospectively). Unlike our research, there are newer researchers suggesting an increased risk for women [9]. Our research did not point a statistically significant difference in perioperative complications between men and women. Such results were obtained despite increased comorbidity (HTA, HLP, DM; smoking, CAD) in males, and despite smaller diameter of vessels and increased use of patch in women.

Like our study, Kapral et al. did not report a statistically significant difference in the presence of a contralateral occlusion in patients [20], and other studies did not report the correlation of contralateral occlusion and increased the perioperative risk of CVI and death [21] [22]. Statistically, significantly higher CEA using C - CEA (using prosthetic patch) technique is in women (41 (41%) versus 31 (18.2%),  $p = 0.005$ ) is associated with a smaller blood vessel diameter (CCA, ICA). There is also a markedly longer time for carotid artery clamping in women than in man (19.58 ± 5.43 versus 17.61 ± 4.82,  $p = 0.005$  retrospectively), and duration of surgery for women than man (103.45 ± 15.4 versus 97.46 ± 13.87,  $p = 0.002$ , retrospectively). More gracile blood vessels require the use of patch when

closing the arteriotomy (thereby reducing the possibility of restenosis), which in turn extends the time of clamping and thus the length of the operation. Study Doriga et al. [23] as our does not indicate a significant difference in the prevalence of symptomatic and asymptomatic stenosis of carotid arteries in women.

According to the results of this study, there is no statistically significant difference in perioperative complications (< 30 days) between women and men. Those results have been confirmed by previous studies. The reason for this kind of results can be found in a relatively small sample of the patients, and in larger studies, there is a possibility for different results.

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