

Surgical approach to carotid sinus syndrome and carotid body tumor

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Introduction In a large cohort of patients older than 40 years and suspected of having reflex syncope, carotid sinus massage (CSM) has been shown to be diagnostic for carotid sinus syndrome (CSS) in 12%.¹ When CSM reproduces the patient's symptoms with dominant cardiac inhibition, dual-chamber pacing is recommended as a class IIA indication treatment.² Nevertheless, pacing is inefficient in vasodepressor CSS and has limited efficacy in mixed types of CSS or in the case of cardioinhibitory CSS combined with the hypotensive phenotype of a positive response during tilt testing.³ That is why the established role of surgery in CSS^{4,5} should be further emphasized.

In this paper, we presented our approach to the surgical treatment of carotid artery-related structures in patients with CSS and carotid body tumor (CBT). We also discussed the early outcomes of extensive carotid artery denervation and safety issues related to autonomic cardiovascular control.

Methods Study population The following groups of patients were diagnosed and surgically treated: 9 patients with CSS (median age of 71 years), 3 patients with both CSS and CBTs (median age of 55 years), and 16 patients with CBT alone (median age of 42.5). Surgical procedures for CSS and/or CBTs were performed between 2010 and 2019 in the Department of Vascular Surgery of the Military Medical Institute, Warsaw, Poland.

All patients provided informed consent prior to surgery. The study complied with the requirements for retrospective studies of the local ethical board.

The evaluation of patients with syncope included: physical examination, 12-lead

electrocardiography, 24-hour Holter electrocardiographic monitoring, echocardiography, and tilt table testing. The diagnosis of CSS was finally validated by CSM performed according to the recommendations.^{2,6} In patients with CBTs, computed tomography and digital subtraction angiography confirmed the presence of an abnormal mass at the carotid bifurcation (Supplementary material, *Figure S1*).

Statistical analysis Statistical analysis was performed using the Statistica software, version 13.3 (StatSoft, Kraków, Poland). Normality was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Nonparametric data were expressed as median and interquartile range. In the case of nonnormal distribution, the study groups were compared with the nonparametric Kruskal–Wallis analysis of variance with post hoc tests. Categorical data were presented as percentages and compared using the Fisher exact test. The significance level was established at $P < 0.05$.

Results and discussion The clinical characteristics of the study patients are presented in **TABLE 1**. All patients from the CSS-alone and CSS-with-CBTs groups had syncope without any obvious triggering factors and had experienced more or less violent traumas when losing consciousness. Fainting spells, which increased in frequency up to several times a day, were an indication for surgery. Patients with CBT were referred for surgery for oncologic reasons.⁷

In all patients, a surgical technique specifically developed by our team was used. During surgery, the internal carotid artery (ICA), the external carotid artery (ECA),

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TABLE 1 Clinical characteristics of the study population according to the diagnosis determining the type of surgery

Variable	CSS (n = 9)	CSS with CBT (n = 3)	CBT (n = 16)	P value	
Female sex, n (%)	6 (66.7)	2 (66.7)	11 (69)	0.99	
Age, y, median (IQR)	71 (67–78)	55 (22–66)	42.5 (40–47) ^a	<0.001	
History of smoking, n (%)	6 (66.7)	1 (33.3)	11 (68.8)	0.5	
Diabetes, n (%)	4 (44.4)	1 (33.3)	2 (12.5)	0.14	
Hypertension, n (%)	5 (55.5)	2 (66.7)	7 (43.7)	0.7	
History of AMI, n (%)	2 (22.2)	1 (33.3)	2 (12.5)	0.63	
History of stroke, n (%)	2 (22.2)	1 (33.3)	0	0.1	
Type of CSS at CSM, n (%)	Cardioinhibitory ^b	4 (44)	2 (66.7)	NA	0.5
	Vasodepressor ^c	5 (56)	1 (33.3)		
	Mixed ^d	0	0		
Shamblin tumor classification type I, n (%)	NA	0	7 (44)	0.01	
Shamblin tumor classification type II, n (%)		1 (33.3)	9 (56)		
Shamblin tumor classification type III, n (%)		2 (66.7)	0		
Left-sided surgery, n (%)	6 (66.7)	3 (100)	11 (68.8)	0.51	

a The statistically significant difference between the CBT and the CSS-alone groups with post hoc tests

b Defined as asystole ≥ 3 seconds

c Defined as a systolic blood pressure drop >50 mm Hg

d Defined as asystole ≥ 3 seconds and a systolic blood pressure drop >50 mm Hg after intravenous administration of atropine 1 mg

Abbreviations: AMI, acute myocardial infarction; CBT, carotid body tumor; CSM, carotid sinus massage; CSS, carotid sinus syndrome; IQR, interquartile range; NA, not applicable

the common carotid artery (CCA), the jugular vein, the vagus, hypoglossal nerves, and the sympathetic trunk were preserved. In most cases, it was not necessary to cut across the carotid arteries. The replacement of the ICA was required only in 2 patients in whom the artery was entrapped by a tumor (Shamblin type III). A 6-mm prosthetic Dacron graft was used as a conduit between the CCA and the distal section of the ICA. Circulation via the ECA was not restored.

Carotid denervation was performed with a minimum radius of 3 cm from the carotid bifurcation, that is, 3 cm below, and the distal dissection of the CCA, the ICA, and the ECA from the surrounding tissues (Supplementary material, *Figure S1*). There were much larger segments of surgical exposure than those described in the literature.⁴ When combined with chemodectoma excision, this margin of carotid artery preparation was inherent in the surgical procedure. We did not preoperatively embolize CBT arteries.⁸

Minor complications included wound hematoma (n = 2) and neuropraxia of the marginal mandibular branch (n = 4). We observed no significant alteration in systolic or diastolic blood pressure or heart rate. Sutures were removed 2 weeks after the surgery, and ultrasonography of the carotid arteries was performed on day 30. The study patients were completely free from their previous symptoms. The last surgical consultation

was conducted a year after the surgery. Despite the lack of direct evidence, no complaints from family doctors or local cardiologists and the patients themselves may suggest that the outcomes were acceptable and provided long-lasting effects.

For many patients with CSS, extensive adventitial stripping of the carotid arteries may be a reasonable alternative to pacemaker implantation or the treatment method of choice, since the vast majority of this population probably presents with a mixed CSS form with a significant vasodepressor component.⁴ In our study, all patients with CSS who received more extensive unilateral carotid artery denervation than demonstrated in other studies⁴ were symptom free at 30 days after surgery and, importantly, showed no clinically relevant impairment of cardiovascular autonomic control. In a study by Toorop et al,⁴ during such a period after carotid denervation by adventitial stripping of the ICA in patients with CSS, 93% of the subjects were free from symptoms. The retrospective analysis and additional examination of survivors from that study also suggested the long-term efficacy of the surgery and the lack of baroreflex failure.⁹

Carotid sinus syndrome is predominantly diagnosed in elderly people and associated with diabetes, hypertension, and atherosclerosis,^{4,10} ie, conditions accompanied by the structural modification of the carotid arterial adventitia and carotid extra-media thickness,¹¹ which in turn

might be causally involved in CSS. In our study, patients with CSS alone were between 59 and 80 years of age, whereas 2 of the 3 subjects with both CSS and CBTs were younger and matched the age range of the patients with CBT alone. This may suggest the presence of some distinctive pathophysiological features, ie, the mechanical irritation of respective autonomic structures by a tumor, especially because the 2 patients had Shamblin type III tumor (TABLE 1). Surgical tumor removal definitely eliminates not only CSS symptoms but also the need for using a pacemaker, which could be explanted,¹² probably as in the case of spontaneous healing of the carotid artery dissection responsible for transient cardioinhibitory CSS.¹³

Conclusions Extensive adventitial stripping of the carotid arteries should be validated as an alternative to pacemaker implantation in cardioinhibitory CSS or as a therapeutic option for the clinically relevant mixed and vasodepressor forms of CSS. When necessary, it is feasible to operate on patients with symptoms of both CSS and CBTs. Although extensive unilateral carotid denervation and CBT excision interfere with the integrity of the autonomic nervous system, they did not trigger any clinically relevant impairment of cardiovascular autonomic control.

SUPPLEMENTARY MATERIAL

Supplementary material is available at www.mp.pl/kardiologiapolska.

ARTICLE INFORMATION

CONFLICT OF INTEREST None declared.

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