A 20-year Experience with Surgical Management of True and False Internal Carotid Artery Aneurysms

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WHAT THIS PAPER ADDS?
This study provides an insight of the contemporary management of internal carotid artery aneurysms and pseudo-aneurysms and of its early and long-term results. The growing role of endovascular surgery also in this field of application is underlined.

Aim of the study: The aim of this study was to retrospectively analyse early and late results of surgical management of internal carotid artery (ICA) true and false aneurysms in a single-centre experience.
Materials and methods: From January 1988 to December 2011, 50 consecutive interventions for ICA aneurismal disease were performed; interventions were performed for true ICA aneurysm in 19 cases (group 1) and for ICA post-carotid endarterectomy (CEA) pseudo-aneurysm in the remaining 31 (group 2).
Early results (<30 days) were evaluated in terms of mortality, stroke and cranial nerves' injury and compared between the two groups with χ^2 test.
Follow-up results (stroke free-survival, freedom from ICA thrombosis and reintervention) were analysed with Kaplan–Meier curves and compared with log-rank test.
Results: All the patients in group 1 had open repair of their ICA aneurysm; in group 2 open repair was performed in 30 cases, while three patients with post-CEA aneurysm without signs of infection had a covered stent placed. There were no perioperative deaths. Two major strokes occurred in group 1 and one major stroke occurred in group 2 ($p = 0.1$). The rates of postoperative cranial nerve injuries were 10.5% in group 1 and 13% in group 2 ($p = 0.8$).
Median duration of follow-up was 60 months (range 1–276). Estimated 10-year stroke-free survival rates were 64% in group 1 and 37% in group 2 ($p = 0.4$, log rank 0.5); thrombosis-free survival at 10 years was 66% in group 1 and 34% in group 2 ($p = 0.2$, log rank 1.2), while the corresponding figures in terms of reintervention-free survival were 68% and 33%, respectively ($p = 0.2$, log rank 1.8).
Conclusions: Surgical treatment of ICA aneurismal disease provided in our experience satisfactory early and long-term results, without significant differences between true and false aneurysms. In carefully selected patients with non-infected false aneurysm, the endovascular option seems to be feasible.

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Extracranial carotid aneurysms (ECAs) are uncommon[1] and are usually distinguished in true aneurysms and so-called pseudo-aneurysms.[2–6] While the former are atherosclerotic, the latter are the result of dissection, neck injury or, more frequently, post-carotid endarterectomy (CEA) with patching. Due to the substantial risk of neurological or local complications if untreated, their surgical repair has been recommended,[1,2] and open repair has been described to provide good early and long-term results,[1–4] even if most reports include different aetiologies and approaches with regard to patient anatomy, co-morbidities and physician preference. In the last few years, with the increasing use of endovascular procedures, an endovascular approach has been advocated for these patients, too;[7] however, the applicability of such techniques in this kind of lesions and its effectiveness are still controversial.

The aim of this study was to retrospectively review our experience with open and endovascular treatment of true and post-CEA ECAs in the last two decades, analysing early and long-term results.

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PATIENT POPULATION AND METHODS

From January 1988 to December 2011, 6830 consecutive interventions (4630 in males and 2200 in females) for extracranial carotid artery disease were performed at our academic institution.

Data concerning these interventions were prospectively collected in a dedicated database whose characteristics have been already described.[8] A post-hoc analysis of this database was performed and 53 interventions for ECA were found: the interventions were performed for true ECA in 19 cases (group 1) and for carotid pseudo-aneurysm in the remaining 34 (31 post-CEA, two iatrogenic and post-traumatic in the remaining one). For homogenisation sake, we excluded patients with traumatic lesions from the study and we considered only the 31 patients with post-CEA aneurysms (group 2).

The two groups of patients were compared in terms of demographic data, common risk factors for atherosclerosis and co-morbidities. Risk factors and co-morbidities included arterial hypertension (defined as blood pressure greater than 140/85 mmHg or the need for anti-hypertensive drugs), hyperlipaemia (defined as both triglycerides and cholesterol values $>$200 mg dl), coronary artery disease (history of myocardial infarction, angina, previous coronary revascularisation), diabetes mellitus (defined as the need for specific drugs to maintain metabolic control) and peripheral arterial disease (ankle/brachial index $<$0.9).

Patients in group 1 were more frequently females and were younger than patients in group 2; moreover, there was a trend towards a higher percentage of other aneurysms in different sites among them. Patients in group 2 had more frequently the presence of common risk factors for atherosclerosis and of cardiovascular co-morbidities, even if the difference with group 1 was not statistically significant (Table 1).

Patients were considered to be asymptomatic in the absence of neurological symptoms (transient ischaemic attack (TIA) or stroke) within 6 months from the intervention.

All these patients underwent duplex scanning of extracranial vessels and computed tomography (CT) of cerebral parenchyma. Until 2002, all patients used to undergo digital subtraction angiography of the arch vessels, whereas angio-CT scan of the intra- and extracranial vessels was performed in the last decade. In patients of group 2, a careful assessment for the presence of clinical (the presence of fever, of abscesses or fistulae with purulent secretion at the site of CEA) and radiological (pericarotid liquid or abscess) signs of infection was performed. In these patients, white blood cell (WBC) count and blood cultures were performed; moreover C-reactive protein (CRP) and, in last few years, pro-calcitonine levels were determined. The presence of an aneurysm exceeding 1.5 cm in diameter was considered an indication for treatment in group 1, while in the presence of post-CEA pseudo-aneurysms the intervention was performed regardless of both the diameter of the lesion and the presence of symptoms. Due to the frequent presence of preoperative symptoms and their high embolic potential, we preferred to treat all the patients in group 1 with open surgery; in group 2, we used an endovascular approach in selected patients once infection had been excluded. The interventions, both open and endovascular, were performed in the operating room. Patients operated on with open procedure had either general anaesthesia with cerebral monitoring with somatosensory evoked potentials (SEPs) and selective shunt insertion on the basis of SEPs abnormalities[9] or Cooperative Patient General Anaesthesia (CoPaGeA)[10] with clinical neurologic monitoring during carotid clamping and selective shunt insertion. Intra-operative medical treatment consisted of intravenous sodium heparin administration (30 IU kg^{-1}) at carotid clamping. The kind of arterial reconstruction and the material for reconstruction were chosen on the basis of the length and of the morphology of the aneurismal lesion and of status of arterial wall. A sample of the arterial wall was routinely excised and sent for pathological and bacteriological examinations. At the end of the intervention completion angiography was routinely performed. Patients operated on with endovascular procedure had local anaesthesia and clinical monitoring of cerebral functions. A cerebral protection device was selectively used on the basis of the morphological aspects of the lesion, the presence of thrombus and the type of the stent used. Intra-operative medical treatment consisted of intravenous sodium heparin administration (5000 IU) at the beginning of the procedure.

Postoperative medical treatment consisted of single or double anti-platelet treatment (acetylsalycilic acid, 150 mg once a day, and/or ticlopidine, 250 mg twice a day), at surgeon's discretion. In all the patients statin therapy was continued indefinitely.

Neurological evaluation at 30 days was independently performed in all the patients by an experienced neurologist, who assessed the presence of minor and major strokes. Minor stroke was defined as any postoperative neurological event lasting more than 24 h with recovery in the following days or weeks without or with minimal residual functional impairment. Major stroke was defined as any postoperative neurological event lasting more than 24 h with residual invalidity and/or inability. Otolaryngologist evaluation at 30 days in terms of vocal cords' motility and cranial nerves' injury was also performed in all the patients by a phoniatrist.

Perioperative ($<$30 days) results of interventions were analysed and compared in terms of stroke, death and cranial nerves' injuries with χ^2 test and Fisher's exact test, when necessary.

Table 1. Patients' demographic data, risk factors and comorbidities.

	Group 1 (19 pts.)	Group 2 (31 pts.)	*p*
Female gender	9 (47%)	4 (13%)	0.007
Median age (years)	66	72.8	0.1
Hyperlipaemia	7 (36%)	16 (51%)	0.3
Diabetes	2 (10.5%)	9 (29%)	0.1
Arterial hypertension	14 (73%)	27 (87%)	0.1
Coronary artery disease	4 (21%)	11 (35%)	0.2
Peripheral artery disease	5 (26%)	13 (42%)	0.3
Smoker or past smoker	8 (42%)	17 (55%)	0.3
Other aneurysms	5 (26%)	3 (10%)	0.1