Carotid artery stenting in the elderly.
Are there differences between open and closed cell stents?

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INTRODUCTION: *We reviewed our experience of carotid artery stenting (CAS) in patients older than 75 years treated with open or closed cell stents. The aim of our paper is to evaluate if there are differences between the two groups in term of clinical outcomes, neurological impairment and survival.*
MATERIAL AND METHODS: *CAS consecutively performed from March 2000 and December 2016 in elderly patients were rectrospectively collected. We classified them into two groups: closed cells (group A) and open cells stent (group B). Perioperative and long term events were observed (death, major cerebrovascular and cardiovascular events, in-stent restenosis).*
RESULTS: *We collected 429 CAS, 259 (60.37%) male with median age of 79 years (range 77-82). Group A collects 247 (57.98%) patients, 142 (33.3%) in group B. The other 40 patients were treated with hybrid stents or just ballooning. In perioperative period we had not death but 2 patients (0.8%) in group A had a transient ischemic attack (TIA) due to immediate stent thrombosis, 2 patients (1 per group) had an ipsilateral major stroke and 8 patients had a TIA (3 in group A and 5 in group B). Median follow up was 686 days (IQR 267-1299 days). Freedom from complications at 12, 36 and 60 months was 99.4 ± 0.5%, 97 ± 1.5% and 90.08 ± 4.3% respectively. Survival at 12, 36 and 60 months was 77.4 ± 7.5%, 51.6 ± 8.9% and 16.1± 6.6% respectively.*
CONCLUSION: *Our data show CAS as a safe procedure also for people older than 75 years in terms of perioperative and long term complications and cerebral events without any significant difference between the different type of stent. Further studies are requested to better clarify its role in symptomatic patients.*

KEY WORDS: Carotid stenting, Carotid treatment, Old people

Introduction

In literature carotid endarterectomy (CEA) is the gold standard for the treatment of carotid stenosis in symptomatic or asymptomatic patients [1]. Carotid artery stenting (CAS) is still considered as an alternative of CEA also in patients older than 75 years. In fact, increasing age of the population, wide diffusion of chronic diseases and the expectancy of higher quality of life invite to be more aggressive to treat carotid stenosis by means of a less invasive techniques. Therefore not only endovascular treatment seems to be an important topic, but also different type of carotid design stents. Carotid stents are typically divided depending on the density and the area of the cells in open and closed cells stent [2] with specific haemodynamic tools [3]. First group is characterized by large uncovered gaps, second one by small free cell areas between struts [4].
We report our experience of endovascular treatment of carotid stenosis in patients older than 75 years in order to explore if there are some differences using open or closed cell stents regarding clinical outcomes and neurological impairments and furthemore immediate and long term survival.

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Materials and Methods

We retrospectively analyzed all the patients symptomatic and asymptomatic older than 75 years treated from March 2000 and December 2016. Four-hundred-twenty-nine patients underwent CAS at our institution for symptomatic stenosis higher than 50% (ECST) or asymptomatic higher than 70%. Two-hundred-forty-seven patients received a closed cell stent (group A) and 142 an open cell stent (group B). Our indications for carotid stenting were the clinical high-risk or if the patient suffered a previous neck radiation or surgery.
Contraindications were represented by severe carotid tortuosity or calcifications of the aortic arch or S-shaped hemorrhagic carotid plaque, contralateral carotid occlusion or recent thrombosis, severe renal impairment, if a major stroke occurred in the previous 3 weeks or any contraindications to antiplatelet therapy. All patients were preoperatively investigated with a duplex ultrasound (DUS) and computed tomography angiography (CT angio) or magnetic resonance (MR) of supraortic vessels, intracranial circulation and aortic arch to evaluate angles, calcifications and origin of the branches. About neurological assessment asymptomatic patients were not evaluated by neurologist before the intervention, in postoperative they were examined just in case of onset of any neurological symptoms. The choice between closed or open cells stent was usually based on images of CT angio and DUS evaluating the morphology of the plaque, if it is soft or hard. The patients received dual antiplatelet therapy usually with aspirin, 100 mg, and a thienopyridine, with a loading dose of 300 mg, before the procedure and postoperatively 75 mg for 90 days and after three months continuing with one anti-platelet agent lifelong (aspirin 100 mg or clopidogrel 75 mg). Other patients were treated with aspirin and ticlopidine 250 mg twice daily. The interventions are performed in operating room by vascular surgeon with local anaesthesia and awake patients. Distal or inverting flow device for embolic protection were routinely employed in the most part of procedures and not used in selective cases. Procedure of choice is carotid primary stenting with usually postdilatation using 4.5-6.0 × 20 mm balloons; atropine is selectively administered in patients with bradycardia or hypotension at insufflation of the balloon or at deployment of the stent [5]. DUS was carried out at discharge and at 3, 6, and 12 months and then yearly after after the procedure. Demographic characteristics of the patient and his clinical status were analyzed as well the different type of stents. Moreover, perioperative and long term events were observed (death, major cerebrovascular and cardiovascular events, in-stent restenosis which was considered severe if the vessel diameter reduction was higher than 70%) [6].
Statistical analysis was performed using SPSS, values of .05 were considered statistically significant. $\chi 2$ Tests and Kaplan–Meier survival curves were performed.

Results

Four hundred twenty nine patients older than 75 years were treated in our institution for carotid stenosis with CAS, 259 (60.37%) were male and the median age was 79 years (range 77-82). In 247 (57.98%) carotids a closed cell (group A) stent was deployed meanwhile in 142 an open cell stent (33.3%) (group B). The other 40 patients were treated with hybrid stents or just ballooning.
Demographic and clinical features of both groups are described in Table I.
In group A we treated, in 5 cases (2.02%), common carotid artery, in 23 cases (9.31%) a restenosis after CEA, in 3 cases (1.2%) an intrastent restenosis and in one case an ulcerated plaque. In group B we operated on 2 patients (1.4%) for a stenosis of common carotid artery,

TABLE I - *Demographic and clinical features. CAD: coronary artery disease; CRF chronic renal failure (creatininemia > 1.2 mg/dl).*

	Group A	Group B	p
Male	155 (62.75%)	83 (58.45%)	NS
Symptomatic	47 (19.03%)	23 (16.20%)	NS
CAD	91 (36.84%)	46 (32.39%)	NS
Diabetes	45 (18.22%)	30 (21.13%)	NS
Hypertension	182 (73.68%)	111 (78.17%)	NS
CRF	36 (14.57%)	20 (14.08%)	NS
Median age	79 yrs (76-91)	80 yrs (76-88)	NS
Contralateral stenosis>75%	10 (15.38%)	12 (20%)	NS
Contralateral occlusion	16 (24.62%)	12 (20%)	NS
Contralateral CAS	17 (26.15%)	11 (18.33%)	NS

TABLE II - *Intraoperative characteristics and material specifications.*

	Group A	Group B	p
Medium of contrast	70 ml (30-151)	60 ml(30-130)	NS
Median duration	40 min (10-185)	30 min (10-70)	NS
Distal Embolic Protection	232 (93,94%)	138 (97,18%)	NS
Proximal Embolic Protection	2 (0.80%)	None	NS
No embolic protection	13 (5.26%)	4 (2.82%)	NS
Balloon predilatation	15 (6.07%)	4 (2.82%)	NS
Balloon postdilatation	231 (93.52%)	134 (94.37%)	NS

TABLE III - *Type, design, free area cells and number of deployed stents[6].*

Stent type	N°	Stent design	Free cell area (mm^2)
Acculink	10	Open-cell	11.48
Carotid Wallstent	236	Closed-cell	1.08
Precise	112	Open-cell	5.89
Protegè	10	Open-cell	10.71
Vivexx	10	Open-cell	Not analyzed
Xact	11	Closed-cell	2.74

TABLE IV - *Perioperative and 30 days outcome*

	Group A	Group B	p
Death	0	0	NS
Stent thrombosis	2 (0.8%)	0	NS
Femoral pseudoaneurysm	1 (0.4%)	2 (1.4%)	NS
Wound haematoma	2 (0.8%)	0	NS
Myocardial infarction	0	1 (0.7%)	NS
Major stroke	1 (0.4%)	1 (0.7%)	NS
TIA	3 (1.2%)	5 (3.5%)	NS

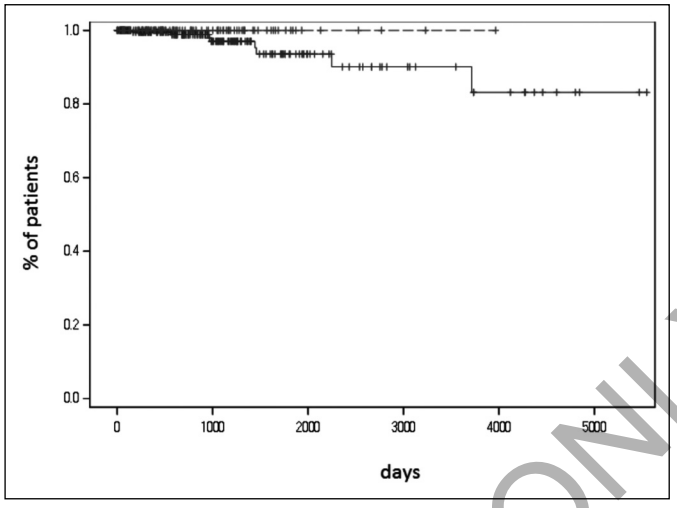

Fig. 1: Kaplan-Meier curve shows freedom from all types of complications. Blue line for closed cells, red for open cells group.

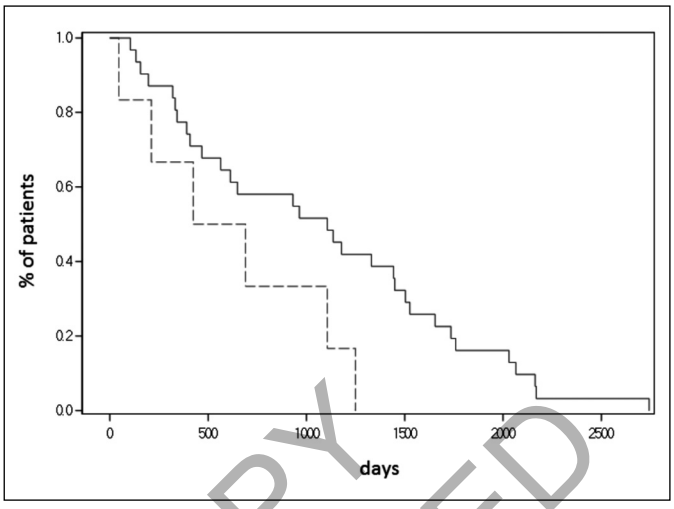

Fig. 2: Kaplan-Meier curve shows long term survival after CAS. Blue line for closed cells, red for open cells group.

in 13 cases (9.1%) for a restenosis after CEA, in one an intrastent restenosis and in one case an ulcerated plaque.

Intraoperative characteristics and material specifications are in Table II and different stents deployed and their peculiarities in Table III.

In perioperative 2 patients (0.8%) in group A had a transient ischemic attack (TIA) due to immediate stent thrombosis and a resolution of the cerebral syndrome after surgical conversion and stent removal, 3 patients (1 in group A) had a femoral pseudoaneurysm, 2 a wound heamatoma (group A) and 1 (group B) a myocardial infarction which needed a percutaneous transluminal coronaric angioplasty (PTCA).

At 30 days no death but 2 patients (1 per group) had an ipsilateral major stroke and 8 patients had a TIA (3 in group A and 5 in group B).

The median follow up period was 686 days (IQR 267-1299 days). We observed 37 deaths unrelated to cerebrovascular accidents 31 (12.5%) in group A and 6 (4.2%) in group B.

Long term complications were registered only in group A: in 7 cases an asymptomatic in-stent haemodynamic restenosis higher than 80% which required deployment of another stent in stent; in 2 cases a TIA without a carotid restenosis or occlusion (1 in symptomatic and 1 in asymptomatic patient).

Freedom from complications at 12, 36 and 60 months was 99.4 ± 0.5%, 97 ± 1.5% and 90.08 ± 4.3% respectively (Figure 1). Survival at 12, 36 and 60 months was 77.4 ± 7.5%, 51.6 ± 8.9% and 16.1± 6.6% respectively. (Fig. 2).

Discussion

Different guidelines and other important studies consider CEA the gold standard for the treatment of carotid stenosis particularly in patients older than 65 years [7,8]. CAS is preferred to CEA in selected cases or in symptomatic patients with a high operative risk with severe comorbidities. Despite these indications in experienced centers for both techniques, many patients out of randomized trial were submitted to carotid artery stenting in the daily practice [9].

A detailed study about surgical therapy for carotid stenosis in elderly patients concluded that, although similar outcomes in older and younger patients could be observed, nevertheless there were several variables that could affect the success of the CEA, primarily a poor preoperative cardiovascular and clinical state evaluation [10]. On the other side other authors do not consider the age as a contraindication for carotid artery stenting with good results of treatment in patients older than 80 years with both type of stents but they recommend an accurate preoperative selection for a good outcome [11]. A meta-analysis did not show any significant difference in term of cerebrovascular complications comparing open and closed cells at 30-days both in symptomatic or

asymptomatic patients [12].
SVS Vascular Registry in 2011 showed an in-hospital and 30-day outcomes after CAS not significantly influenced by stent cell design, but symptomatic patients had higher adverse events compared to the asymptomatic cohort without evidence about stent design [13,14]. The importance of cerebral embolism was analyzed by authors who considered clinical and MRI diffusion-weighted imaging for open and closed cells, furthermore there was no difference between open and closed cell stent design regarding cerebral embolization [15]. Park K and coll. found a strong association between open design and peripheral embolism in the symptomatic group with onset of new cerebral lesions [16].
The literature agrees with our data regarding the absence of any significant difference between open and closed cell stents even though symptomatic patients accounted for low numbers.

Conclusion

In conclusion our data show that carotid artery stenting is a safe procedure also for people older than 76 years in terms of perioperative and long term complications and cerebral events. Further studies are requested to better clarify its role in symptomatic old patients.

Riassunto

INTRODUZIONE: Abbiamo rivisto la nostra esperienza di stent carotideo nei pazienti oltre i 75 anni che abbiamo trattato con stent a celle aperte e chiuse. Lo scopo del nostro lavoro è di valutare se ci sono differenze fra i due gruppi in termini di clinica, complicanze neurologiche e sopravvivenza.
MATERIALI E METODI: Abbiamo retrospettivamente raccolto gli stent carotidei consecutivamente eseguiti tra Marzo 2000 e Dicembre 2016 nei pazienti al di sopra dei 75 anni. Essi sono stati classificati in due gruppi: celle chiuse (Gruppo A) e celle aperte (Gruppo B). Abbiamo osservato gli eventi perioperatori e a lungo termine (morte, complicanze cardiovascolari e cerebrovascolari maggiori, restenosi intra-stent).
RISULTATI: Abbiamo raccolto i dati di 429 stent carotidei, 259 (60.37%) maschi con un età mediana di 79 anni (range 77-82). Gruppo A raggruppa 247 (57.98%) pazienti, 142 (33.3%) nel gruppo B. Gli altri 40 pazienti sono stati trattati con stent ibridi o con il solo pallonamento della stenosi. Nel periodo perioperatorio non abbiamo registrato decessi, ma 2 pazienti (0.8%) nel Gruppo A hanno avuto un attacco ischemico transitorio (TIA) dovuto alla trombosi immediate dello stent, 2 pazienti (1 per ciascun Gruppo) hanno avuto un ictus ipsilaterale e 8 pazienti un attacco ischemico transitorio (3 nel Gruppo A e 5 nel Gruppo B). Il followup mediano è stato di 686 giorni (IQR 267-1299 giorni). La libertà da complicanze a 12, 36 e 60 mesi è stata rispettivamente di 99.4 ± 0.5%, 97 ± 1.5% and 90.08 ± 4.3%, mentre la sopravvivenza 77.4 ± 7.5%, 51.6 ± 8.9% and 16.1± 6.6% rispettivamente.
CONCLUSIONI: I nostri dati dimostrano che lo stent carotideo è una procedura sicura anche per i pazienti più anziani di 75 anni in termini di complicanze perioperatorie e a lungo termine ed eventi cerebrali senza differenze significative tra i diversi tipi di stent. Ulteriori studi sono necessari per chiarire più specificamente il ruolo dei diversi stent nei pazienti sintomatici.

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