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1 **Treatment of carotid restenoses after endarterectomy: A retrospective monocentric study**

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13

14 **ABSTRACT**

15 **Objective:** To compare the different techniques for the treatment of carotid restenosis after carotid
16 artery endarterectomy (CAE).

17 **Methods:** Among 1218 carotid surgeries carried out in our center between January 2010 and
18 November 2017, 45 procedures were performed for carotid restenosis after CAE, including 11 by
19 iterative conventional surgery and 34 with endovascular techniques (seven angioplasties alone (TLA),
20 nine carotid artery stenting (CAS), and 18 angioplasties with active balloons (DCB)). Perioperative
21 data (cumulated rate of morbi-mortality: CRMM, duration of hospitalization) and postoperative
22 results (survival, symptomatic restenoses > 50% or asymptomatic stenoses > 70% on ultrasound,
23 reinterventions) were collected retrospectively and analyzed with Fisher's exact test. The long-term
24 results were estimated according to Kaplan-Meier and were compared with the Log Rank test
25 ($p < 0.05$ was regarded as significant).

26 **Results:** There was one secondary death due to a massive postoperative stroke in the endovascular
27 group (ENDO). No significant difference regarding CRMM (2.9%, $p = 0,756$) between the iterative
28 conventional surgery (OS) and the ENDO groups of was observed. Three hematomas were found in
29 the OS group versus one in the ENDO group ($p = 0.04$). The length of hospital stay was shorter in the
30 ENDO group ($p < 0,001$). No difference was found between the ENDO group and the OS group
31 regarding the two-year survival or the survival without recurrent restenosis (86% vs 100%, Log Rank =
32 0.804, and Log Rank = 0.114). There were five restenoses >70% and two reinterventions in the ENDO
33 group ($p > 0.05$). The comparison of the different endovascular techniques did not show significant
34 differences regarding the CRMM, the one-year overall survival, the survival without recurrent
35 restenosis, or the survival without reintervention (89% in the DCB and CAS groups vs 100% in the PTA

36 group, Log Rank = 0.286; 87% in the DCB group vs 100% in the PTA and CAS groups, Log Rank = 0.137;
37 and 94% in the DCB group vs 100% in the PTA and CAS groups, Log Rank = 0.585, respectively).

38 **Conclusion:** In our experience, endovascular procedures are equivalent to iterative conventional
39 surgery for the treatment of carotid restenoses in terms of major complications, new restenoses or
40 survival with less hematoma and a shorter duration of hospitalization. We however could not identify
41 the best endovascular strategy in this indication, and a controlled study comparing the various
42 endovascular strategies is proposed.

43 INTRODUCTION

44 The surgical treatment of carotid stenoses remains the reference when these stenoses meet the
45 criteria defined by the French High Health Authority (HAS) ¹ and the European Society for Vascular
46 Surgery (ESVS). ² Carotid restenoses are not very frequent. They classically appear three to nine
47 months after the intervention and are then related to a phenomenon of intimal hyperplasia. On
48 the other hand when they develop in a period exceeding two years, they are rather the consequence
49 of atheroma. ³ Several risk factors of restenoses have been reported such as tobacco, arterial
50 hypertension, diabetes, the female gender, the small diameter of the carotid artery, the
51 postoperative presence of a residual stenosis and direct closure after endarterectomy. ⁴ The 5-year
52 rate of carotid restenosis $\geq 70\%$ varies from 6.5% to 10.5%. ⁵⁻⁸ The clinical consequences of these
53 restenoses are discussed but a recent meta-analysis ⁸ found a significantly higher risk of ipsilateral
54 stroke (CVA) among patients presenting a restenosis $\geq 70\%$ after endarterectomy (5.2% at four years).
55 The management of carotid restenoses is also discussed, in particular for asymptomatic restenoses.
56 The last recommendations of the ESVS ² recommended surgical treatment in patients presenting a
57 symptomatic restenosis $\geq 50\%$ which can also be proposed in the event of asymptomatic lesions
58 $\geq 70\%$. When the surgical indication has been established, the choice between iterative conventional
59 surgery and an endovascular procedure remains difficult in the absence of randomized controlled
60 studies. The literature does not find a difference between the two techniques in terms of rates of
61 cumulated morbi-mortality (TCMM) and restenosis, ⁹⁻¹⁵ but it reported a high risk of peroperative
62 nervous lesions (5.5%), generally temporary, and of hemorrhagic complications after iterative
63 surgery. On these arguments, endovascular techniques were gradually preferred in our center for the
64 treatment of carotid restenosis after endarterectomy.

65 The objective of this study was to report our experience by comparing the various techniques
66 used in the treatment of carotid restenoses after endarterectomy, in terms of morbi-mortality and
67 mid-term patency.

68

69 MATERIAL AND METHODS

70 **Study design and data collection**

71 This was a retrospective and analytical descriptive study which protocol was approved by the
72 National Commission on Informatics and Liberty (CNIL) (n°2017-044). The data of the patients having
73 a carotid surgery were collected retrospectively in an anonymous dedicated database. Collected
74 information was obtained from the medical files of the patients and included health data, dates of
75 visits, preoperative characteristics, radiological examinations (reports and images), operative details
76 (operative reports, operating room records, anesthesia records), immediate postoperative course as
77 well as follow-up data (reports of the follow-up consultation and duplex examinations).

78 **Patients and operative indications**

79 The general population consisted of all the patients operated for a carotid surgery between January,
80 2010 and November, 2017. The patients treated by endovascular route in first intention were
81 excluded. The included patients were those operated for carotid restenosis after endarterectomy, by
82 iterative conventional surgery or endovascular or techniques. The therapeutic indications were either
83 an asymptomatic restenosis $\geq 70\%$ according to the “North American Symptomatic Carotid
84 Endarterectomy Trial” (NASCET) classification, or a symptomatic restenosis $\geq 50\%$. All the patients
85 had a preoperative cervical duplex ultrasound examination and a scanner (CT) or a magnetic
86 resonance imaging (MRI) of the supra-aortic trunks to determine the degree of stenosis and to
87 evaluate the other arterial axes involved in the cerebral perfusion.

88 **Surgical techniques**

89 All surgical operations were carried out by vascular surgeons exerting in our center with the
90 peroperative systemic administration of heparin (50 IU/kg). The choice of the procedure was left at
91 the discretion of the surgeon.

92 ***Iterative conventional surgery.*** Iterative operations were carried out under general anesthesia
93 through the same carotid approach and with control on vessel loops of the common, the internal and
94 the external carotids. The residual stump pressure was measured to decide of the use of a shunt, and
95 carotid endarterectomy was performed according to the evaluation of the surgeon of the
96 peroperative observations.

97 ***Endovascular procedures.*** All the endovascular procedures were carried out in the operating theatre
98 or in a hybrid room, under general or local anesthesia. The approaches (common femoral puncture,
99 common femoral and common carotid accesses), the material used (stent, standard balloon or drug-
100 coated balloon), and the use of a cerebral protection device were determined by the surgeon. We
101 preferentially used Vivexx® carotid stents (Bard Peripheral Vascular, Inc., Tempe, AZ, USA), but also
102 one Atrium Advanta™ V12 stent (MAQUET, Getinge, Courtaboeuf, France) and one RX Acculink®
103 carotid stent (ABBOTT Vascular, Chicago, IL, USA). Stent remodeling was systematically carried out

104 after deployment by transluminal angioplasty with a standard balloon. Angioplasties without stenting
105 were carried out with Powerflex Pro® (Cordis) standard balloons and/or Lutonix® active balloons
106 coated with paclitaxel (Bard Peripheral Vascular, Inc., Tempe, AZ, USA). The closure of the artery was
107 obtained with a percutaneous closure system (Starclose SE®, FemoSeal™ or Angio-Seal™) after
108 percutaneous puncture and with purse-string sutures in case of surgical accesses. All the patients
109 received a postoperative dual antiplatelet therapy associating clopidogrel, 75mg/d, and aspirin, 75-
110 320mg/d for three months, followed by a lifelong antiplatelet treatment by aspirin or clopidogrel.

111 **Early postoperative evaluation and follow-up**

112 Early postoperative surveillance consisted in a neurological, cardiac, and blood pressure monitoring
113 in the department of vascular surgery of our center. Major neurological events were defined as the
114 occurrence of focal symptoms and signs persisting more than 24 hours. Major adverse cardiologic
115 events (MACE) were defined as an increase in the troponin level more than twice the normal in
116 association with an ECG modification in favor of a myocardial distress, and/or thoracic pain or
117 comparable symptoms suggesting myocardial ischemia. After discharge, the patients were re-
118 examined by a vascular surgeon after one-three months with a control duplex ultrasound
119 examination. The long-term follow-up was left at the discretion of the vascular physician and
120 consisted generally of an ultrasound monitoring at six months then annually.

121 The CRMM or “death-stroke” rate was defined by the occurrence of a major neurological
122 event and/or death during the first 30 postoperative days. The long term patency was defined as the
123 absence of significant restenosis (asymptomatic $\geq 70\%$ or symptomatic $\geq 50\%$) during follow-up.

124 **Descriptive and statistical analyzes**

125 The results were expressed as average \pm standard deviation or as median and extremes. The
126 descriptive analyzes comparing the different interventional techniques were carried out using the
127 Chi-2 test or the Fischer exact test for qualitative variables and with the Student’s t test or an ANOVA
128 test for quantitative variables. Overall survival as well as the survival without adverse events
129 (reinterventions, CVA, significant second restenosis) were analyzed by using the Kaplan-Meier
130 estimator and the comparison between the groups was made with the Log Rank test. The statistical
131 significance was defined by $p < 0.05$. The statistical analyzes were carried out with the SPSS 24.0
132 software (SPSS, Inc., Chicago, IL, USA).

133 **RESULTS**

134 **Population**

135 Between January 2010 and November 2017, 1218 carotid interventions were carried out in our
136 center. Three primary angioplasties performed for radiation stenosis were excluded. Among the

1215 remaining interventions, there were 45 (3.7%) surgeries for restenosis in 42 patients (41 unilateral surgeries and two bilateral). Twenty-nine (64.4%) of these procedures were carried within two years of the first surgery. We carried out 11 (24.4%) iterative conventional surgeries and 34 (75.6%) endovascular procedures. After 2013, most interventions were carried out with endovascular techniques (87%) (Fig. 1). Three restenoses were symptomatic with one ischemic CVA, middle-cerebral transient ischemic attacks (TIA) and recurring hemodynamic TIAs on low flow favored by a bilateral restenosis. The average time before restenosis was 35.9 ± 47.18 months with a median of 15 months [2 - 183]. The average duration of follow-up after surgery for restenosis was 40.3 ± 27.1 months. Overall, the patients had a follow-up of at least six months, and 98% had a follow-up of more than one year, 71% of more than two years and 58% of more than three years.

The initial surgical operation consisted of an eversion endarterectomy in 41 cases (91.1%). The other procedures were one Chevalier eversion CAE, two conventional endarterectomies with patch closure and one bypass. One postoperative death occurred due to a stroke. The overall CRMM was 2.2%.

151 **Iterative conventional surgery (OS) versus endovascular surgery (Endo)**

The 11 iterative surgeries were carried out under general anesthesia without shunt, and the residual stump pressure was measured in five cases (45.5%). A patch angioplasty was performed in three cases (27.25%) including two with iterative endarterectomy; a saphenous vein bypass was the option in five cases (45.5%) and a prosthetic bypass in three cases (27.25%). The 34 endovascular procedures were nine (26.5%) carotid stentings (CAS) (seven with Vivexx® stents, one with an Atrium Advanta™ V12 stent and one with an RX Acculink® carotid stent) and 25 (73.5%) balloon angioplasties including seven (20.6%) with a Powerflex Pro® standard balloon (PTA) and 18 (52.9%) with a Lutonix® drug-coated balloon (DCB), preferentially used from 2015. These procedures were carried out under general anesthesia in 33 cases (97.1%) and under local anesthesia in one case (2.9%). A cerebral protection system was used in one case (2.9%). One peroperative surgical conversion (2.9%) was needed, due to the post-dilation thrombosis of the carotid bulb. Thromboaspiration was attempted but failed, and a prosthetic bypass was performed.

The two groups were comparable on the clinical characteristics, except in terms of average time to restenosis (67.6 months \pm 58.6 months vs 25.7 months \pm 38.5 months, $p < 0.05$) and duration of follow-up (62.5 months \pm 20.8 months vs 33.1 months \pm 25.1 months, $p < 0.05$), which were longer in the surgery group (Table I).

Significant differences were however observed regarding the operating time (51.5 min \pm 22.6 min vs 111.9 min \pm 26.5 min, $p < 0.001$), the length of hospital stay (1.58 ± 0.9 days vs 4.64 ± 1.96 days, $p < 0.001$) and minor complications such as hematomas (2.9% vs 27.3%, $p = 0.04$), in favor of

171 endovascular techniques. There was however no difference in the other parameters such as the
172 number of reinterventions, CRMM, MACE or peripheral nervous complications (2.9% vs 9.1%, $p >$
173 0.05). At two years, the analysis of the survival curves did not highlight any significant difference in
174 terms of overall survival (100% vs. 91%, $p = 0,804$ Log Rank, Fig. 2), cumulated survival without
175 significant second restenosis (100% vs 85%, $p = 0,114$ Log Rank, Fig. 3) or without reintervention
176 (100% vs 97%, $p = 0,278$ Log Rank). One secondary death with a massive CVA occurred after three
177 years in in a patient of the surgery group who did not undergo regular monitoring by ultrasound. The
178 CVA-free survival was then 89% at four years. In the ENDO group three secondary asymptomatic
179 recurrent stenoses $\geq 70\%$ were diagnosed during follow-up (two progressive evolutions $\geq 70\%$ at one
180 year and two years, and one discovered at three years after a loss to follow-up). Two patients were
181 reoperated, one at one year with a prosthetic bypass (with a persistent 50% residual stenosis at six
182 months) and the other at three years with a new balloon angioplasty with a standard balloon. In this
183 patient, the control angiography identified a persistent asymptomatic residual stenosis $\geq 70\%$ which
184 remained stable on the follow-up duplex examinations during the three following years. It was
185 decided not to reoperate this last patient due to the asymptomatic and refractory character of the
186 stenosis. The third patient did not wish to be reoperated and did not present any stroke over the
187 three following years of follow-up. There was no new symptomatic recurrence.

188 **Comparison of the endovascular techniques**

189 The groups were comparable for the various clinical characteristics (Table II), except for peripheral
190 artery occlusive disease (POAD) which was more frequent in the CAS group (66.7% vs 14.3% and
191 16.7% for ATL and DCB; $p < 0.05$). With regard to this criterion, the side-by-side comparison of the
192 groups found a significant difference for CAS vs DCB ($p = 0.026$) but not for ATL vs DCB ($p = 1$) and
193 ATL vs CA ($p = 0.06$). In the group CAS, the follow-up time (51.6 ± 35.1 months vs 43.6 ± 19.3 months
194 and 19.8 ± 9.7 months for ATL and DCB; $p < 0.05$) and the time to restenosis (63 ± 60 months vs $16 \pm$
195 9 months and 11 ± 12 months for ATL and DCB; $p < 0.001$) were also significantly longer.

196 Regarding operative data, no difference was observed in the duration of intervention, the
197 time of fluoroscopy, the amount of irradiation and the quantity of product of contrast injected. The
198 access carried out was significantly different between the groups, with more percutaneous accesses
199 in the PTA and DCB groups (94.4% and 71.4%) and more surgical accesses in the CAS group (66.7%).

200 The duration of hospitalization was significantly shorter in the DCB group (1.18 ± 0.4 days vs
201 2 ± 0.7 days and 2 ± 1.5 days for CAS and PTA, respectively; $p = 0.03$). A 64 year old patient with
202 bilateral symptomatic restenosis $> 90\%$ with recurring middle cerebral artery hemodynamic TIAs,
203 presented a massive immediate postoperative hemorrhagic CVA leading to death. There were no
204 other neurological or cardiologic major events during the first 30 postoperative days (CRMM: 2.9%).

205 At day 30, no significant difference was found for the CRMM, major cardiologic events or minor
206 complications. At one year, the results remained equivalent in terms of survival (89% for CAS and
207 DCB vs 100% for PTA, $p = 0.286$ Log Rank, Fig. 4), cumulated survival without significant recurrent
208 restenosis (100% for PTA and CAS vs 87% for DCB, $p = 0.137$ Log Rank, Fig.5) or without
209 reintervention (100% for PTA and CAS vs 94% for DCB, $p = 0.585$ Log Rank).

210 **DISCUSSION**

211 In our study, the rate of surgery for carotid restenosis was 3.7% (2.3% at 2 years, 3% at 5 years and
212 3.4% at 10 years). This is not really a restenosis rate, but it remains a good indication in the context
213 of a monocentric study with 6.9% of patients lost to follow-up and a good surveillance by the
214 vascular physicians. Ninety-three percent of these restenoses were asymptomatic. This rate seems to
215 be lower than that described in the literature in which the incidence of restenoses $\geq 70\%$ is between
216 3.4% and 6.3% at two years^{4,5,8} and between 6.5% and 10.5% at five years,⁵⁻⁷ with a 3.4% 5-year
217 reintervention rate.¹⁶ Nevertheless, being a retrospective study, this study probably underestimated
218 the rate of restenosis because of bias of lost to follow-up or recruitment.

219 The definition of restenosis varying from one study to another, it is difficult to compare
220 restenosis rates. Without consensus on this issue, we choose to study only the restenoses considered
221 as significant, namely asymptomatic $\geq 70\%$ or symptomatic $\geq 50\%$ stenoses because they represent a
222 theoretical surgical indication. In our study, most of the restenoses occurred within three years
223 (64.4% at two years and 75.6% at three years) with a 15-month median [2 - 183]. According to de
224 Borst and Moll,³ one can consider that treated restenoses were primarily related myointimal
225 hyperplasia. On the empirical basis that the dilation of a restenosis due to myointimal hyperplasia
226 carries a very low risk of emboli because of its histological composition essentially constituted by
227 smooth muscular cells, we choose not to use cerebral protection devices during the endovascular
228 procedures.

229 The significant difference in the number of patients treated by iterative surgery (11) and
230 endovascular procedures (34) can be explained by the evolution of our practices towards
231 endovascular techniques (Fig. 1) in these indications because of the lower risk of minor complications
232 such as hematomas, infections, and peripheral nervous lesions and shorter durations of hospital stay.
233 Many observational studies,^{10,12-15,17} as well as meta-analyses⁹ comparing iterative surgery and
234 angioplasty with stenting for the treatment of carotid restenoses, concluded in similar CRMMs with
235 these two techniques. These studies however reported a higher risk of bleeding and peripheral
236 nervous lesions, between 4.1% and 21.8% after iterative surgery. We observed the same results
237 concerning CRMM, survival, and the rate of recurrent restenosis or reinterventions, but without
238 significant difference for the occurrence of peripheral nerve lesions (9.1% vs 2.9%, respectively, $p >$

239 0.05), the lesion in the endovascular group being the consequence of a surgical approach of the
240 common carotid artery, complicated of a recurrent nerve paralysis. However, one can infer that
241 significance would be reached with larger numbers of patients. Being a retrospective study this
242 report probably underestimated the rate of nervous lesions because these complications are
243 generally transient and not systematically reported or sought during follow-up visits.

244 Compared to iterative surgery, the operative time and the length of stay were significantly
245 shorter after endovascular procedures (51 min vs 111 min, $p < 0.05$; and 1.58 vs 4.64 days, $p < 0.05$,
246 respectively), with a lower rate of complications such as hematomas (2.9% vs 27.3%, $p = 0.04$). The
247 studies reporting the endovascular treatment of carotid restenoses after carotid endarterectomy
248 primarily evaluated angioplasty with stenting, but few of them were carried out on the use of
249 standard balloon angioplasty¹⁸ and none related to the use of drug-coated balloons. Finally, studies
250 evaluating the use of active balloons related only to the treatment of intrastent restenoses^{19,20} or
251 their use in association with carotid stenting²¹ with encouraging results.

252 The comparison of these three endovascular techniques carried out in our center (standard
253 angioplasty, angioplasty with stenting, and angioplasty with drug-coated balloons) did not highlight
254 significant differences regarding perioperative data (CRMM, minor complications, operative time,
255 amount of radiation, and quantity of contrast used). Nevertheless the limited number of patients in
256 the different groups did not enable us to affirm these results because of a lack of statistical power.
257 The duration of hospitalization was significantly shorter in the DCB group, which could be explained
258 by the evolution of our practices towards the use of percutaneous approaches and closure systems
259 (94.4% for the angioplasties with DCB balloons, 71.4% for angioplasty only and 33.3% for CAS) which
260 permitted a fast discharge at day 1.

261 The analysis of the survival curves did not show any one-year significant difference between
262 standard angioplasty, angioplasty with stenting and angioplasty with drug-coated balloons, with
263 similar overall survival rates (100%, 89%, and 89%, respectively [Log Rank = 0.286]), survival rates
264 without significant recurrent restenosis (100%, 100%, and 87%, respectively [Log Rank = 0.137]), or
265 survival rates without reintervention (100%, 100%, 94%, respectively [Log Rank = 0.585]). Iterative
266 conventional and endovascular surgery for carotid restenosis offer similar short- and mid-term good
267 results. No technique was superior compared to the others. However we are at the beginning of the
268 endovascular techniques, and in particular of the use of drug-coated balloons and miss a sufficient
269 number of patients and follow-up (33% of the patients treated with DCB had a follow-up \geq two years)
270 to highlight a possible difference between these techniques.

271 **CONCLUSION**

272 In our experience, endovascular procedures are equivalent to iterative conventional surgery to treat
273 carotid restenoses in terms of serious complications, new restenoses or survival, with less
274 hematomas and a shorter length of hospital stay. However, we could not identify the best
275 endovascular strategy in this indication, and a controlled study between the different endovascular
276 strategies is proposed.

277

278 **LEGEND OF FIGURES**

279 Fig. 1. Distribution between conventional surgery and endovascular surgery between 2010 and
280 2017.

281 Fig. 2. Kaplan-Meier survival curves of endovascular surgery vs iterative conventional surgery.

282 Fig. 3. Cumulative Kaplan-Meier survival curve without recurrent restenosis for endovascular surgery
283 compared with iterative conventional surgery.

284 Fig. 4. Comparison of the overall Kaplan-Meier survival curves for the various endovascular
285 techniques.

286 Fig. 5. Comparison of the Kaplan-Meier survival curves without significant recurrent restenosis for
287 the various endovascular techniques.

288

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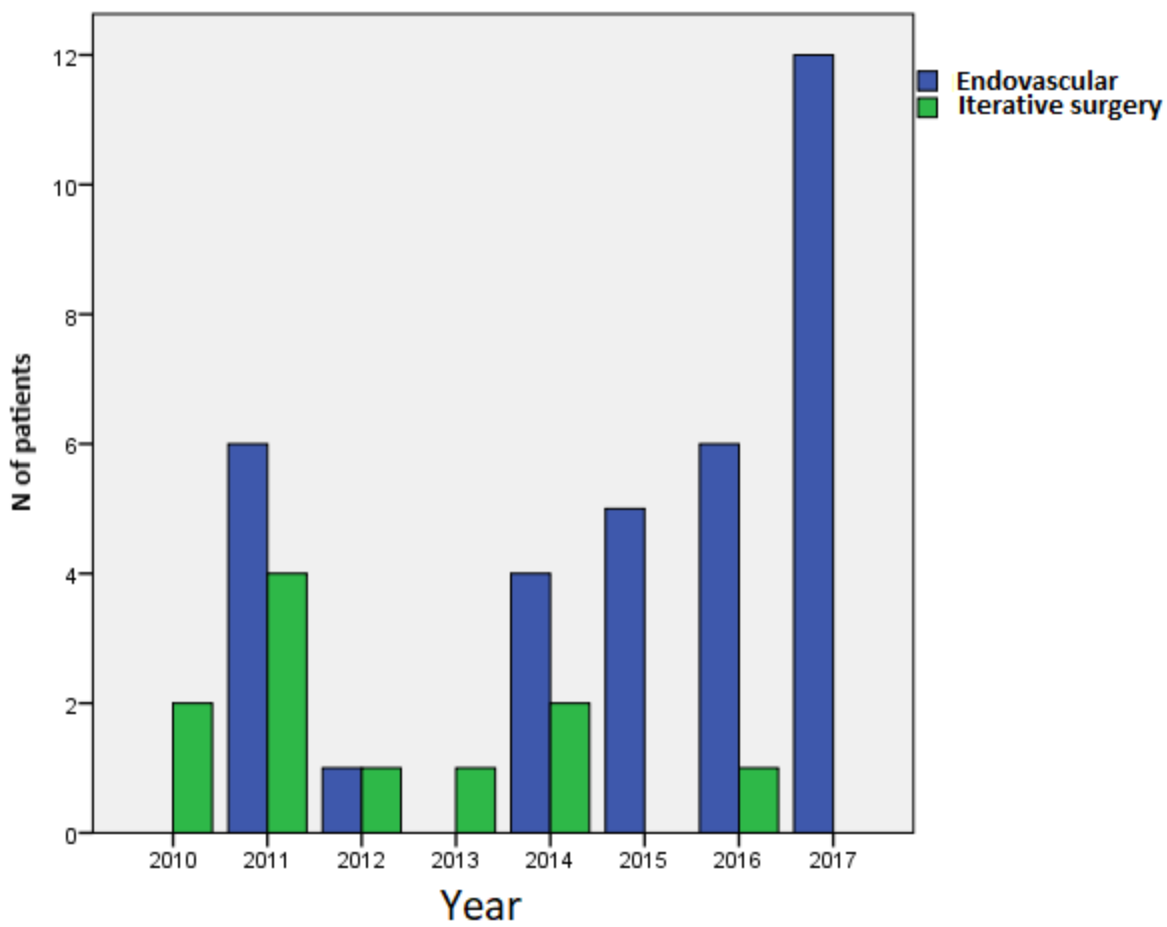
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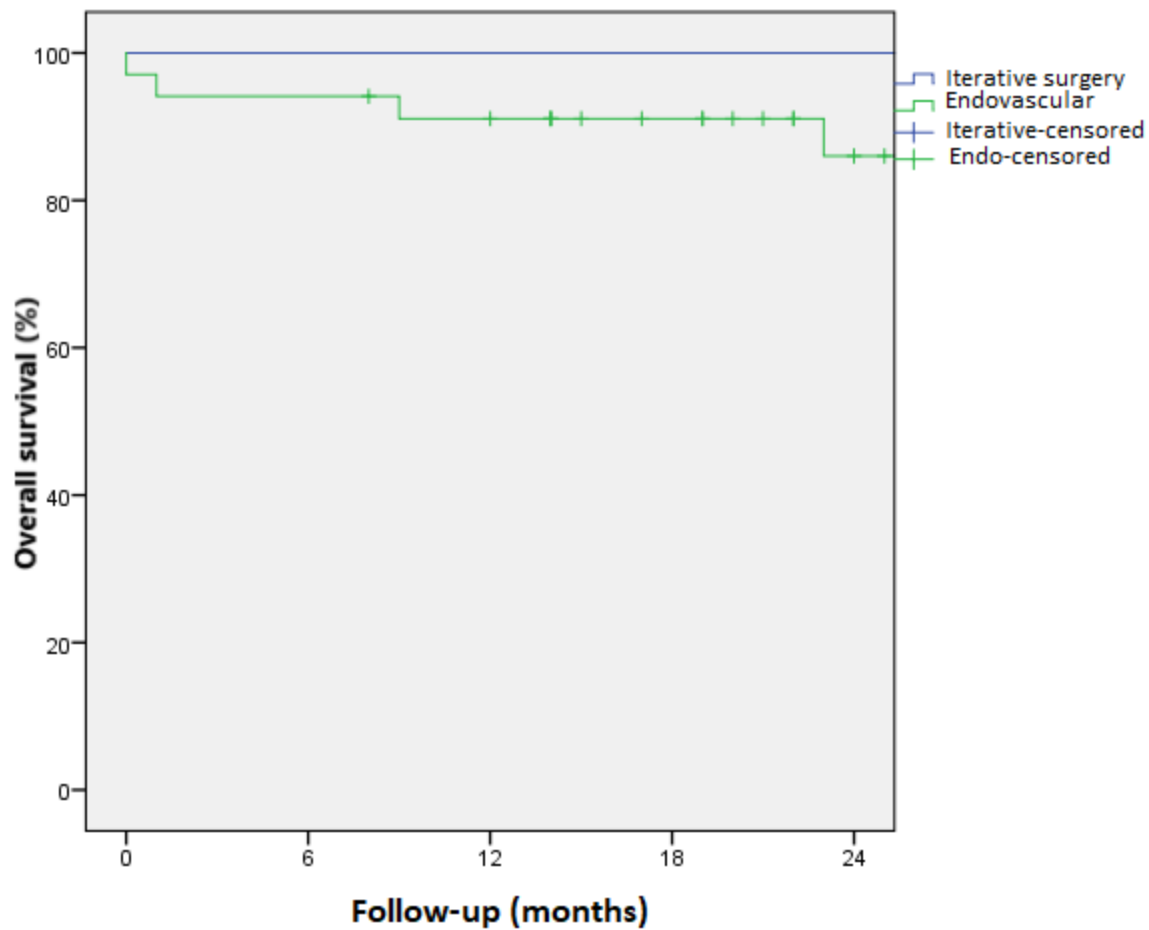
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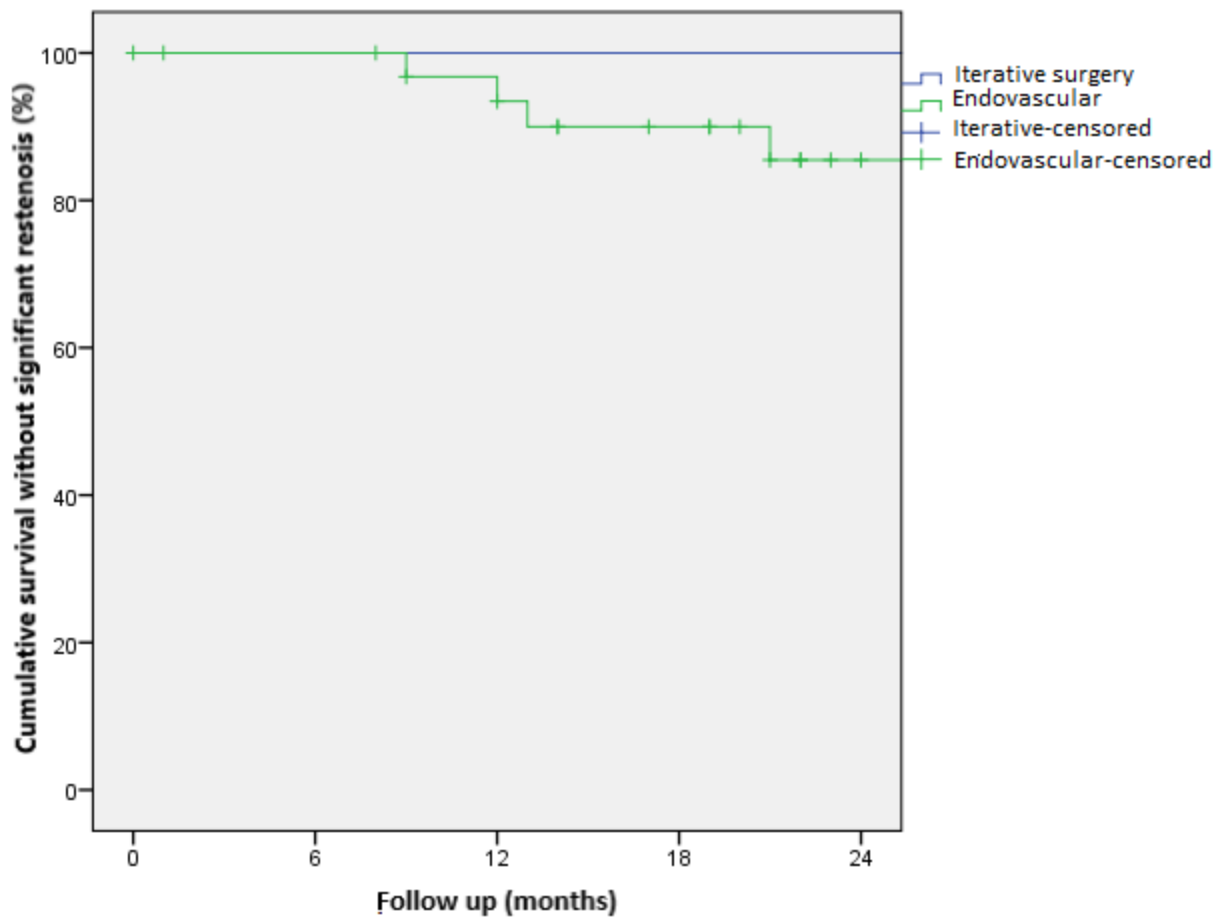
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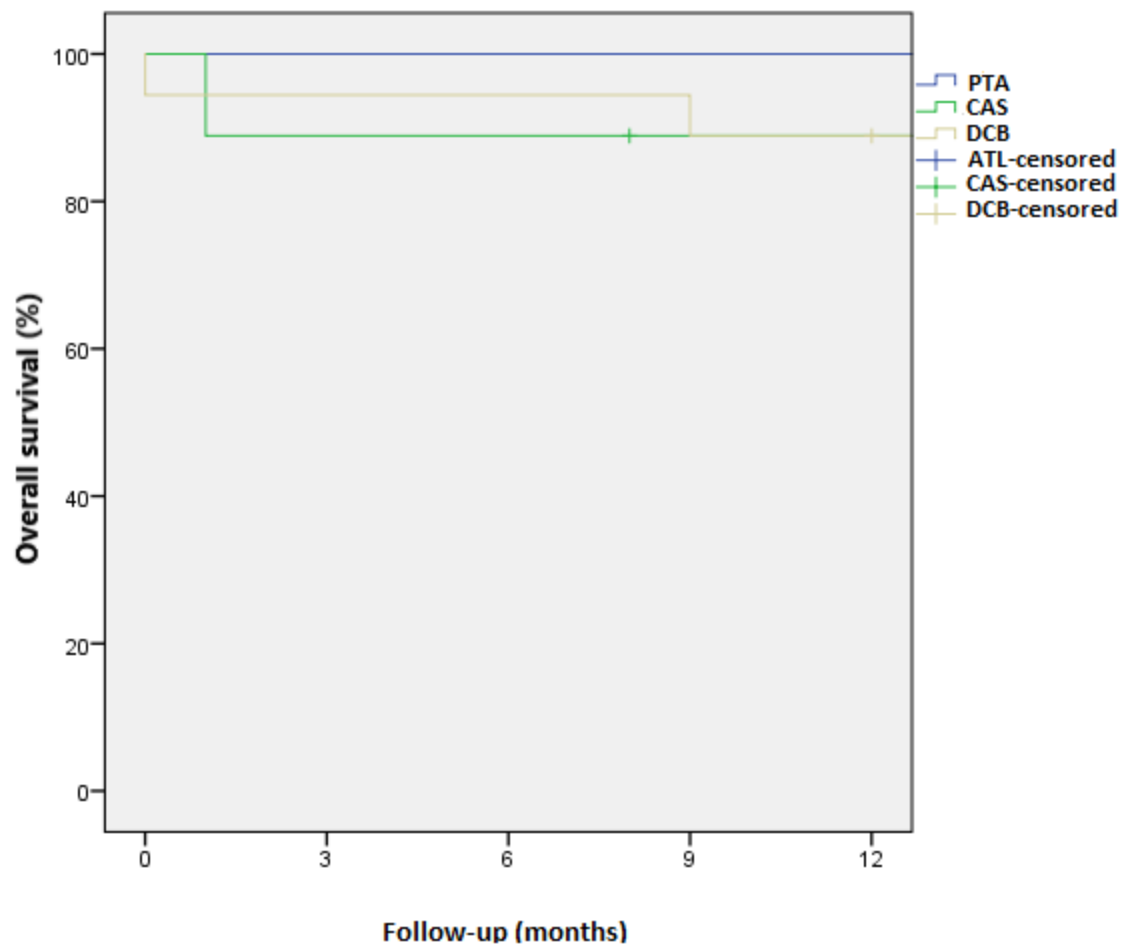




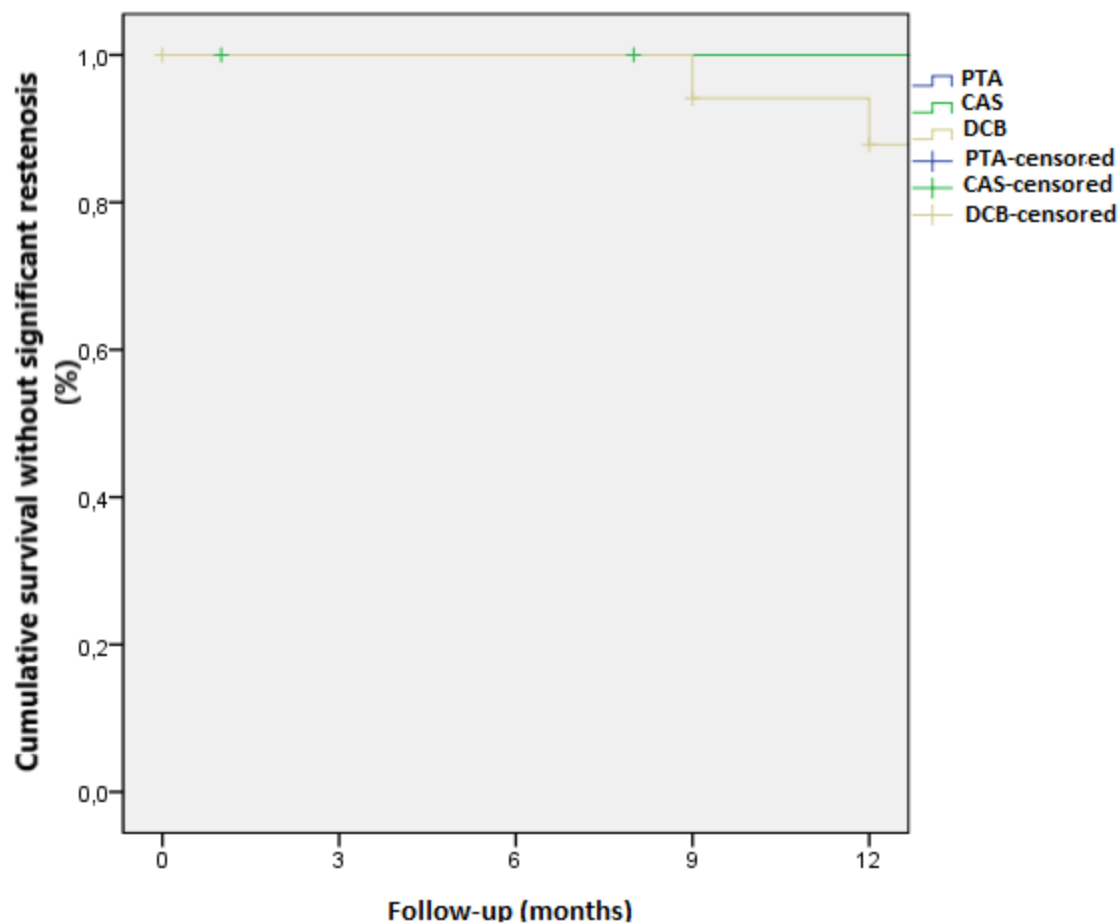
		6	12	18	24	p
ENDO	N° at risk	32	30	24	17	0.804
	Survival	94%	91%	91%	86%	
OS	N° at risk	11	11	11	11	
	Survival	100%	100%	100%	100%	



		6	12	18	24	p
ENDO	N° at risk	32	29	23	15	0.114
	Survival	97%	93%	90%	85%	
OS	N° at risk	11	11	11	11	
	Survival	100%	100%	100%	100%	



		3	6	9	12	P (Logrank)
PTA	N° at risk	7	7	7	7	0.286
	Survival	100%	100%	100%	100%	
CAS	N° at risk	8	8	7	7	
	Survival	89%	89%	89%	89%	
DCB	N° at risk	17	17	17	16	
	Survival	94%	94%	89%	89%	



		3	6	9	12	P (Logrank)
PTA	N° at risk	7	7	7	7	0.137
	Survival	100%	100%	100%	100%	
CAS	N° at risk	8	8	7	7	
	Survival	100%	100%	100%	100%	
DCB	N° at risk	17	17	17	15	
	Survival	100%	100%	100%	94%	

1 **TABLES**

2 Table I. Comparison of iterative surgery and endovascular techniques.

Variables	Endo (n = 34)	OS (n =11)	P
Average age (years)	70.2 ± 11.5	66.2 ± 8.5	0.290
<u>Gender:</u>			
- Women	8 (23.5%)	5 (45.5%)	0.156
- Men	26 (76.5%)	6 (54.5%)	
Smoking (active or stopped)	27 (79.4%)	6 (54.5%)	0.211
HBP	31 (91.2 %)	10 (90.9%)	0.689
Diabetes	10 (29.4%)	4 (36.4%)	0.467
Dyslipidemia	23 (67.6%)	8 (72.7%)	0.533
Ischemic heart disease	15 (44.1%)	7 (63.6%)	0.219
CRF	5 (14.7%)	1 (9.1%)	0.541
POAD	10 (29.4%)	6 (54.5%)	0.126
<u>Indications: restenosis</u>			
- Asymptomatic, ≥70%	31 (91.2%)	11 (100%)	0.422
- Symptomatic, ≥50%	3 (8.8%)	0	
Time to restenosis (months)	25.7 ± 38.5	67.6 ± 58.6	0.009
Median time to restenosis (months)	11 [2 – 183]	44 [5 – 167]	
Duration of follow-up (months)	33.1 ± 25	62.5 ± 20.8	0.001
OPERATIVE DATA AND FOLLOW-UP			
Operative time	51.47 ± 22.6	111.89 ± 26.49	<0.001
<u>CRMM:</u>			
- Death	1 (2.9%)	0	0.756
- Stroke	1 (2.9%)	0	
MACE at day 30	0	0	
<u>Hematoma:</u>			
- With reoperation	1 (2.9%)	3 (27.3%)	0.04
	0	2 (18.2%)	0.056
Peripheral nerve lesion	1 (2.9%)	1 (9.1%)	0.433
Length of stay (days)	1.58 ± 0.9	4.64 ± 1.96	<0.001
Recurrent significant restenosis	5 (14.7%)	0	0.228
Reintervention	2 (5.88%)	0	0.567

3 CRF: Chronic renal failure; CRMM: cumulative rate of mortality and morbidity; HBP: High blood
 4 pressure; MACE: Major adverse cardiac events; POAD: Peripheral occlusive arterial disease.

5 Table II. Comparison of the various endovascular techniques.

Variables	PTA (n = 7)	CAS (n=9)	DCB (n =18)	P
Average age (years)	69.9 ± 10.4	76.6 ± 13.1	67.2 ± 10.4	0.139
<u>Gender:</u>				
- Women	2 (28.6%)	0	6 (33.3%)	0.149
- Men	5 (71.4%)	9 (100%)	12 (66.7%)	
Smoking (active or stopped)	5 (71.4%)	8 (88.9%)	14 (77.8%)	0.245
HBP	6 (85.7%)	8 (88.9%)	17 (94.4%)	0.77
Diabetes	2 (28.6%)	3 (33.3%)	5 (27.8%)	1
Dyslipidemia	5 (71.4%)	5 (55.6%)	13 (72.2%)	0.632
Ischemic heart disease	1 (14.3%)	4 (44.4%)	10 (55.6%)	0.179
CRF	0	3 (33.3%)	2 (11.1%)	0.181
POAD	1 (14.3%)	6 (66.7%)	3 (16.7%)	0.02
<u>Indications:</u>				
- Asymptomatic	6 (85.7%)	8 (88.9%)	17 (94.4%)	0.77
- Symptomatic	1 (14.3%)	1 (11.1%)	1 (5.6%)	
Duration of follow-up (months)	43.6 ± 19.3	51.6 ± 35.1	19.8 ± 9.7	0.002
Time to restenosis (months)	15.6 ± 8.9	62.9 ± 60	11.1 ± 11.7	0.001
Median time to restenosis (months)	15 [6 – 28]	36 [3 – 183]	8 [2 – 54]	
OPERATIVE DATA				
Average operative time (min)	54 ± 40.9	60.2 ± 15.6	46.1 ± 14.6	0.303
Average fluoroscopy time (min)	7.6 ± 7.8	10.9 ± 10.1	10.3 ± 5	0.842
Average amount of radiation (Gy.cm ²)	4.37 ± 5.1	7.7 ± 9.8	14.7 ± 27.8	0.708
Average volume of contrast (mL)	30	64.2 ± 60.3	31.9 ± 31.5	0.296
Cerebral protection	0	1 (11.1%)	0	0.471
<u>Approach:</u>				
- Percutaneous (common femoral)	5 (71.4%)	3 (33.3%)	17 (94.4%)	
- Surgical (common carotid)	2 (28.6%)	5 (55.6%)	1 (5.6%)	0.03
- Surgical (superficial femoral)	0	1 (11.1%)	0	
Conversion	1 (14.3%)	0	0	0.206
Hematoma	1 (14.3%)	0	0	0.206
Peripheral nerve lesion	0	1 (11.1%)	0	0.471
Length of hospital stay	2 ± 1.5	2 ± 0.7	1.18 ± 0.4	0.03
<u>CRMM:</u>				
- Death	0	0	1 (5.6%)	1
- Stroke	0	0	1 (5.6%)	
MACE at day 30	0	0	0	
Recurrent significant restenosis	0	1 (11.1%)	4 (22.2%)	0.467
Reintervention	0	1 (11.1%)	1 (5.6%)	1

CAS: carotid artery stenting; CRF: Chronic renal failure; CRMM: cumulative rate of mortality and morbidity; DCB: Drug-coated balloon; HBP: High blood pressure; MACE: Major adverse cardiac events; POAD: Peripheral occlusive arterial disease; PTA: Percutaneous transluminal angioplasty.