

Carotid Endarterectomy: Eversion Technique

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Abstract: The aim of this article is to explain technique of eversion CEA (carotid endarterectomy), as well as to determine that eversion CEA is more effective than conventional CEA. Eversion CEA can be performed in two methods. When atherosclerotic process mostly involves common carotid artery, the procedure should start with common carotid transection, followed by eversion CEA in cranial and then in caudal direction. The final step is reanastomosis. If atherosclerotic process is mostly localized at the internal carotid artery origin, procedure begins with origin transection. The following steps are eversion endarterectomy of the internal carotid artery, then endarterectomy of carotid bifurcation if it is necessary, and reimplantation of the internal carotid artery. There is no obvious consensus that eversion CEA is superior in regard to conventional one. However, eversion CEA is anatomic procedure that reduces ischemic and total operative time, as well as restenosis and false anastomotic aneurysms occurrence during the follow-up period. It excludes the usage of patches and enables simultaneous correction of the joined kinking or coiling. Eversion CEA, performed by an experienced surgeon is safe, effective, and durable procedure.

Key words: carotid, endarterectomy, eversion.

1. Introduction

Unfortunately, in the period between 1968 and 1994, former Yugoslavia was at the world top according to the annually stroke rate [1]. This negative trend is continued until now. The most frequent death cause among women in Belgrade in the last few years, was ischemic stroke, as well. Because of that, the treatment of carotid artery disease is very important in Serbia. More than 600 carotid procedures are performed annually at the Clinic for Vascular and Endovascular Surgery of Serbian Clinical Centre. Our preferable surgical method for the treatment of carotid artery stenosis is eversion CEA (carotid endarterectomy).

2. Review

Eversion CEA can be performed in two different methods. When atherosclerotic process mostly involve common carotid artery, the procedure described by De

Bakey in 1959 [2] and by Etheredge 10 years later [3] is method of choice in our Clinic. This procedure should start with common carotid artery transection near to the bifurcation. An eversion endarterectomy of the internal and external carotid artery is the following step (Fig. 1). An eversion endarterectomy of the common carotid artery follows (Fig. 2), while the final step is reanastomosis (Fig. 3).

However, if atherosclerotic process is mostly localized at the internal carotid artery origin, the procedure popularized by Kinney, Kasprzak, Raithel and Vanmale is performed at our Clinic [4-6]. This procedure begins with internal carotid artery transection at origin (Fig. 4). The following steps are distal eversion endarterectomy (Fig. 5), then endarterectomy of carotid bifurcation if it is necessary (Fig. 6), and reimplantation of the endarterectomized internal carotid artery (Fig. 7).

Numerous studies have compared standard CEA plus patching with eversion once [7-18]. Regarding the total operating and ischemic time, as well as perioperative

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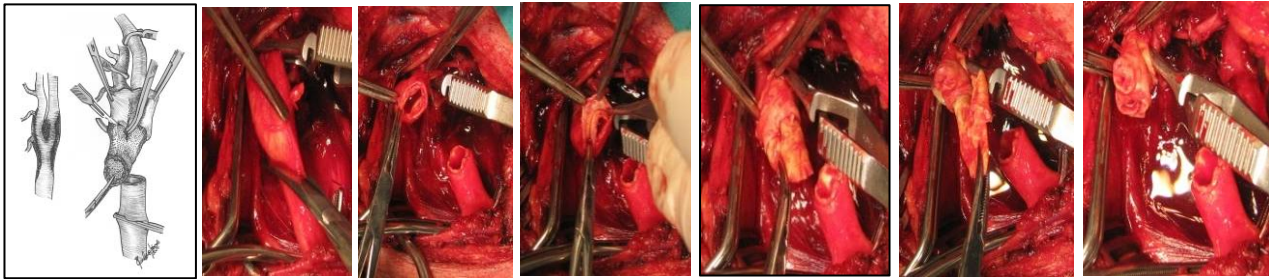


Fig. 1 DeBakey/Etheridge's version of eversion CEA. Transection of the common carotid artery is followed by eversion CEA of the internal and external carotid arteries.

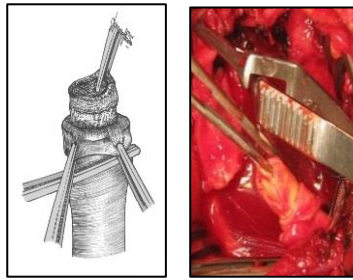


Fig. 2 DeBakey/Etheridge's version of eversion CEA. Eversion endarterectomy of common carotid artery.

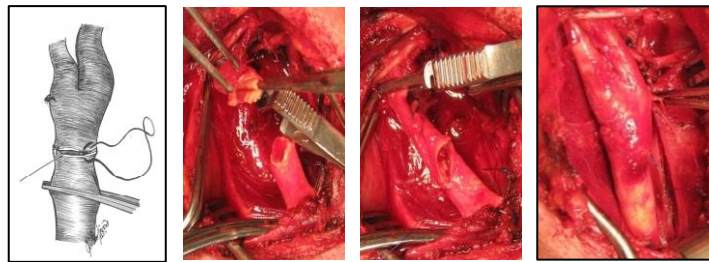


Fig. 3 DeBakey/Etheridge's version of eversion CEA. The reanastomosis.

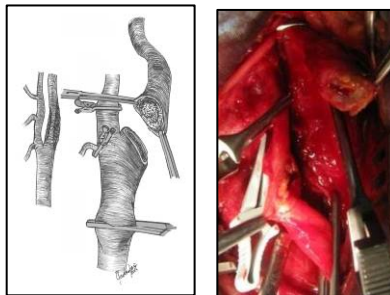


Fig. 4 Kinney/Kasprzak/Raithel/Vanmale's version of eversion CEA. Transection of the internal carotid artery origin.

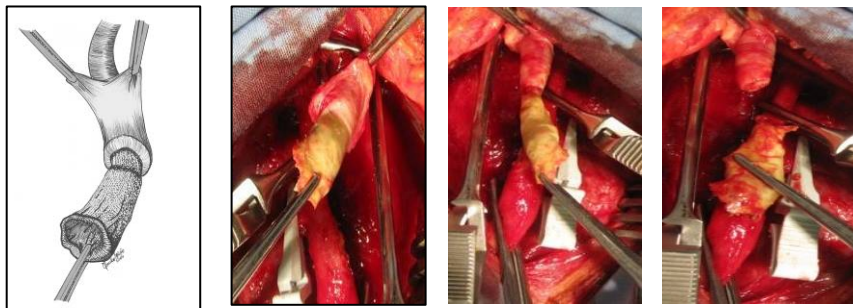


Fig. 5 Kinney/Kasprzak/Raithel/Vanmale's version of eversion CEA. Eversion CEA of the internal carotid artery.

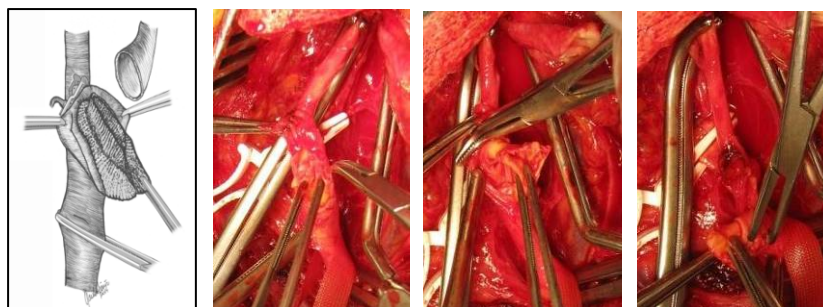


Fig. 6 Kinney/Kasprzak/Raithel/Vanmale's version of eversion CEA. Endarterectomy of the common and external carotid artery.

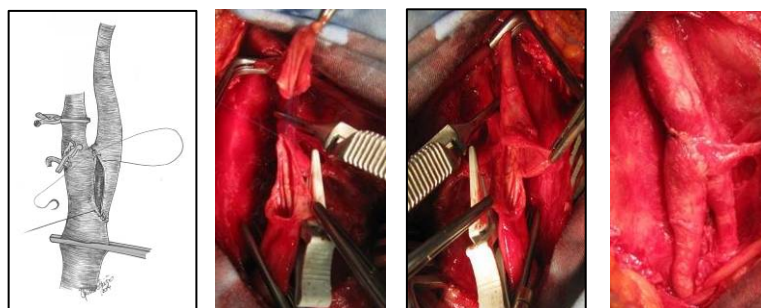


Fig. 7 Kinney/Kasprzak/Raithel/Vanmale's version of eversion CEA. Reimplantation of the endarterectomized internal carotid artery.

complications, first studies has favored to eversion CEA [7, 8]. One of these studies that compared conventional and eversion CEA has been conducted and designed in a truly interesting manner. Namely, on the one carotid artery at the same patient, Balotta and associates performed eversion, while on another side conventional CEA [9]. Regarding early and long term results, eversion CEA has been better [10].

The first randomized prospective multicenter study followed. It has been EVEREST (Eversion Carotid Endarterectomy versus Standard Trial Study) performed in Italy. A total of 1353 patients with carotid stenosis requiring surgical treatment were randomly assigned to received standard ($n = 675$) or eversion ($n = 678$). Primary endpoints included carotid occlusion, major stroke, death, and restenosis rate [11]. The phases of EVEREST trial will be showcased [11-14].

According to preliminary results, eversion CEA reduced clamping time and probability of restenosis [11]. Their next report also, has shown slightly higher incidence of mid-term restenosis after standard CEA, but without statistical significance [12]. The result of next publication has been controversial. Namely longer

term follow-up in the EVEREST trial demonstrated that patients who underwent eversion CEA had a lower incidence of restenosis, than those who underwent standard CEA. However, standard CEA with patch angioplasty had the lowest incidence of neurologic events. Both differences were not statistically significant [13]. Two years later, authors of EVEREST study concluded that reduced restenosis after eversion CEA, did not appear to be associated with clinical benefit in terms of reduced stroke risk, either preoperatively or later [14]. Two single center studies that emerged afterwards, did not show significant difference regarding long term restenosis between conventional and eversion CEA [15, 16].

Results of our prospective, randomized study which included 201 patients who were followed approximately 37.7 months, eversion CEA significantly reduces clamping and operating times, the early stroke rate, as well as long-term restenosis [17].

According to Cochrane review from 2009 that included a total of 2465 patients with 2589 arteries, there were no significant differences in the rate of perioperative stroke and/or death (1.7% vs. 2.6%, OR Z

0.44, 95% CI: 0.10e1.82) and stroke during follow-up (1.4% vs. 1.7%, OR Z 0.84, 95% CI: 0.43e1.64) between eversion and conventional CEA techniques [18]. Eversion CEA was associated with a significantly lower rate of hemodynamic significant restenosis during follow-up (2.5% vs. 5.2%, OR Z 0.48, 95% CI: 0.32e0.72). However, there was no evidence that the eversion technique for CEA was associated with a lower rate of neurological events when compared to conventional CEA [19].

Three years ago, we got a metaanalysis with more than 21 studies and 16,000 patients, that includes two studies from Serbia as well. One of them is from our hospital [17]. According to this metaanalysis, eversion CEA was associated with significant reduction in perioperative stroke (OR Z 0.46, 95% CI: 0.35-0.62, NNT Z 68, 95% CI: 56e96), death (OR Z 0.49, 95% CI: 0.34-0.69, NNT Z 100, 95% CI: 85-185) and stroke-related death (OR Z 0.40, 95% CI: 0.23-0.67, NNT Z 147, 95% CI: 115-270); the results were replicated at the subanalysis on PCEA (patch-CEA). Concerning long-term outcomes, eversion CEA presented with a significant reduction in late carotid artery occlusion (OR Z 0.48, 95% CI: 0.25-0.90, NNT Z 143, 95% CI: 100-769) and late mortality (OR Z 0.76, 95% CI: 0.61e0.94, NNT Z 40, 95% CI: 25e167); the subanalysis on PCEA replicated only the finding on late mortality [19].

There is no obvious consensus that one of these CEA techniques is superior to other. But let us face some facts. Eversion CEA is an anatomic procedure that reduces ischemic and total operative time [7, 8, 17]. Then, the usage of patch is excluded. Simultaneous correction of the joined kinking and coiling is possible, easy and safe [5] (Fig. 8). Eversion CEA, which employs a transverse arteriotomy and reimplantation of the internal carotid artery or end-to-end anastomosis between proximal and distal segments of the common carotid artery, is reported to be associated with low restenosis [7-19]. The false anastomotic aneurysms occurrence during the follow-up period is almost

impossible [17, 19].

However, the usage of carotid shunt during eversion CEA is not always simple, easy and safe (Fig. 9).

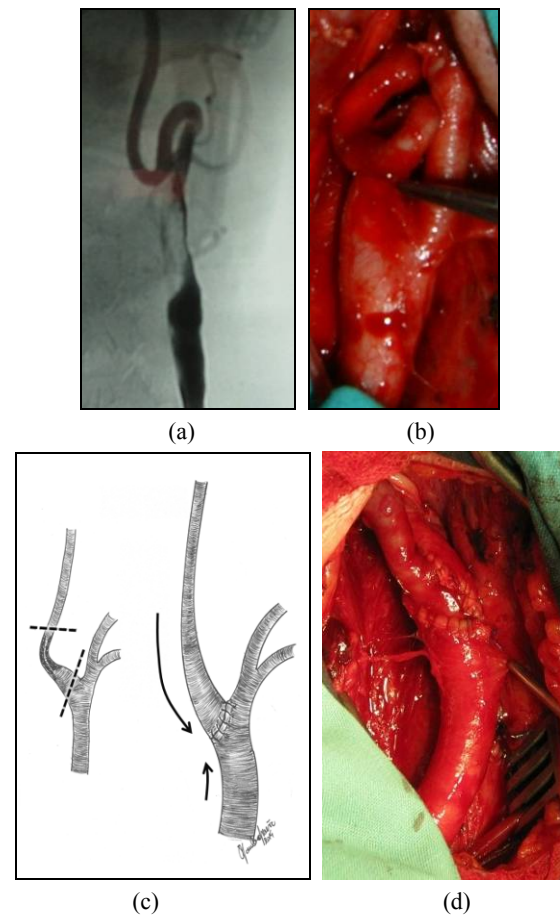


Fig. 8 Simultaneous correction of carotid stenosis with joined kinking/coiling.

(A) Preoperative DSA; (B) Perioperative finding; (C) Resection of a sufficient length of the stenosed and elongated part of the internal carotid artery; (D) Reimplantation of shortened internal carotid artery.

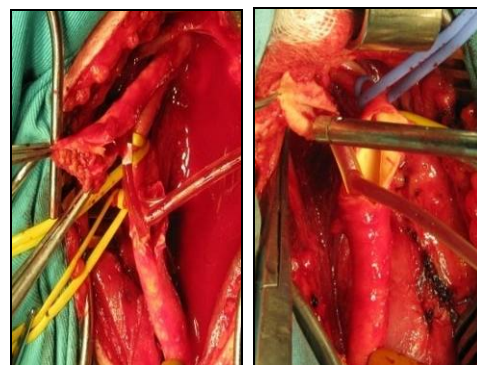


Fig. 9 Shunt used during eversion CEA.

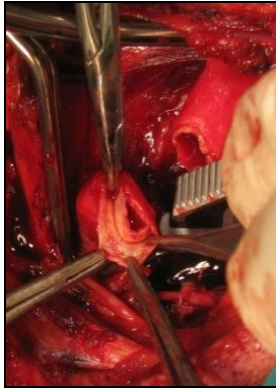


Fig. 10 Significant step (greater than 2mm) at the proximal end of the eversion CEA in case of extensive atherosclerotic stenosis of the common carotid artery.

Extension of the atherosclerotic process towards proximally or distally can make eversion CEA more difficult and risky. The first reason is an increased risk of complications associated with a distal intimal flap [19, 20]. In cases of extensive atherosclerotic stenosis of the common carotid artery, eversion CEA leaves a step at its proximal end. According to some opinions, the presence of a step greater than 2 mm could cause brain embolism and local restenosis [21] (Fig. 10). Because of that, in such cases we perform carotid graft replacement.

According to ESVS (European Society for Vascular Surgery) guidelines, the choice of the CEA depends on the surgical familiarity and experience [20]. The different strategy is used in our Clinic. We perform CEA under cervical plexus block anesthesia. Following carotid dissection, a trial carotid artery clamping is performed that lasts 3 min. If there are no changes in patient's neurological state after this period, an eversion CEA without the usage of shunt is performed. In case that neurological changes occur, clamping is stopped until patient recovery. Then new clamping follows, a common carotid artery is opened longitudinally, a shunt is placed and conventional CEA is performed [22, 23]. Thanks to previous strategy, we improved early results [17] and significantly reduced the usage of carotid shunt from 37% at the period between 2000 and 2003, to only 7% during last year. Beside well known advantages, the usage of carotid

shunt also has some disadvantages. Those are the possibility of air brain embolization and internal carotid artery dissection [20]. Finally, in the presence of the carotid shunt, sometimes it is not so easy to perform CEA.

3. Conclusion

Eversion CEA, performed by an experienced surgeon, is safe, effective, and durable procedure. It reduces ischemic and total operative time, as well as, restenosis and false anastomotic aneurysms occurrence during the follow-up period.

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