Plikacija notranje karotidne arterije: naše izkušnje

Internal carotid artery plication following carotid endarterectomy: our experience

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Izvleček

Namen: *Namen: Zožitev notranje karotidne arterije lahko povzročita elongacija ali pentljavost arterije. Kirurško je tako stanje mogoče popraviti s plikacijo. Namen raziskave je predstavitev naših izkušenj pri plikaciji notranje karotidne arterije po opravljeni endarteriektomiji (CEA).*

Metode: *Raziskava je bila retrospektivna in je zajela bolnike v letih od 2000 do 2006. Vključenih je bilo 323 bolnikov (v poprečju starih 67 let), pri katerih je bilo opravljenih 376 posegov (CEA). Indikacije za poseg so bile pri 34 bolnikih (9 %) ipsilateralna možganska kap, pri 81 bolnikih (21,5 %) TIA, pri 15 bolnikih (4 %) amaurosis fugax, 246 bolnikov (65,5 %) pa je bilo asimptomatskih. Pri vseh bolnikih so bile pred operacijo napravljene ultrazvočna barvna dvojna doplerska*

Abstract

Purpose: *Apart from obliterative processes, carotid insufficiency may be caused by stenosis due to abnormal elongation and kinking of the vessel. Among shortening procedures to correct elongation, we prefer the plication technique. The aim of this study was to present our experience with internal carotid artery (ICA) plication following carotid endarterectomy (CEA).*

Methods: *A retrospective study was conducted on 323 patients (mean age 67 years) with 376 CEA performed between January 2000 and January 2006. Indications for operation included ipsilateral stroke in 34 (9 %), TIA in 81 (21.5 %), amaurosis fugax in 15 (4 %) and asymptomatic stenosis or nonhemispheric symptoms in 246 (65.5 %). All patients had preoperative and postoperative duplex*

preiskava ter TCD in CT preiskava. Pri vseh bolnikih je bila po operaciji v rednih intervalih opravljena barvna dvojna doplerska ultrazvočna preiskava. Uporabljena je bila konvecionalna kirurška tehnika z zapiranjem arterije z dakornsko krpo. Pri 32 bolnikih (8,5 %) je bila napravljena plikacija notranje karotidne arterije. Zgodnji pooperativni rezultati so bili ocenjeni na osnovi embolizacij, ugotovljenih s TCD (> 25 embolov na katerikoli 10-minutni interval), pooperativne kapi ali smrti. Sekundarna ocena je temeljila na oceni pooperativne zožitve (> 50 %), poškodb možganskih živcev in drugih zapletov, povezanih s kirurškim posegom.

Rezultati: *Pri 32 bolnikih, kjer je bila opravljena plikacija, ni bilo intra ali pooperativnih zapletov. Pri 1 bolniku (3,1 %) se je rezidualna zožitev pokazala teden dni po posegu, pri 2 (6,2 %) kasneje. Noben bolnik v tej skupini ni umrl. Pri ostalih 344 bolnikih sta 2 bolnika po posegu umrla (0,6 %), 7 pa jih je dobilo možgansko kap (2 %). 1 bolnik v prvi skupini (3,1 %) in 18 bolnikov v drugi skupini (5 %) je po posegu zaradi povečanega števila embolov prejelo dekstran. Razlika ni bila statistično pomembna (hi kvadrat = 0,27, p > 0,5). Tudi v pogostnosti rezidualnih zožitev med skupinama ni bilo statistično pomembnih razlik (hi kvadrat 0,1, p > 0,5).*

Zaključek: *Raziskava je pokazala, da je plikacija notranje karotidne arterije po opravljeni endarteriektomiji s predstavljeno kirurško tehniko varen postopek. V naši raziskavi ta postopek ni bil povezan s povečano pogostnostjo zapletov.*

scan. All patients had extended clinical and biochemical assessment and a preoperative duplex, CT and TCD scan. Conventional surgical technique was used with general anesthesia, perioperative and postoperative transcranial Doppler monitoring, regular shunting and routine patching. In 32 (8.5 %) CEAs, we found it necessary to shorten a segment of the ICA by plication. Early postoperative results were assessed on the basis of clinically significant postoperative embolization (defined as >25 emboli in any 10 minute period) and or any stroke or death. Secondary endpoints included residual and recurrent stenosis (>50%) on operated artery, operative site hematomas, cranial nerve injury and other complications, related to surgery.

Results: *Among 32 plicated patients there were no intra or postoperative neurological events. Postoperatively the incidence of residual stenosis on the one week scan was 3.1 % (1 CEA) and that of recurrent (> 50 %) restenosis 6.2 % (2 CEAs). There was no mortality in the plicated group. Among 344 non-plicated CEAs there were two perioperative deaths (0.6 %) and seven postoperative strokes (2 %). One patient in plication group (3.1%) and 18 patients in simple CEA group (5%) received Dextran postoperatively on the basis of significant postoperative embolization (hi square=0,27, p>0.5). Differences were not statistically significant. The incidence of residual stenosis was 3.5 % (7 CEAs) and of recurrent stenosis 4.9 % (17 CEAs)–hi square 0.1, p>0.5. Differences were not statistically significant.*

Conclusion: *ICA plication during CEA can be performed safely. In our study the presented technique was not associated with an increased incidence of perioperative and early postoperative complications.*

INTRODUCTION

Apart from obliterative processes, carotid insufficiency may be caused by stenosis due to abnormal elongation and kinking of the vessel. Internal carotid artery (ICA) elongation is found in up to 34 % of the hypertensive adult population (1, 2). It is observed in 5 to 16 % of patients submitted to angiograms (3, 4). It is known that abnormal kinking may cause stenosis of ICA and cerebrovascular symptoms (5–8). In severe penetrating atherosclerosis and elongation of ICA carotid endarterectomy (CEA) may produce a paper-thin arterial wall and kinking of ICA, which is hemodynamically even more unfavourable than it was before the operation (7, 8). This is why a variety of techniques are used to correct severe angulation of

Table 1. *Indications for carotid endarterectomy and Dacron patch angioplasty*

	With carotid plication (n = 32)	Without carotid plication (n = 344)	All (n=376)
Asymptomatic stenosis and nonhaemispheric symptoms	10 (31.2 %)	236 (68.9 %)	246 (65.5 %)
Transient ischemic attacks	19 (59.4 %)	62 (18 %)	81 (21.5 %)
Cerebrovascular accident	1 (3.1 %)	33 ((9.6 %)	34 (9 %)
Amaurosis fugax	2 (6.3 %)	13 (3.8 %)	15 (4 %)

ICA (7, 9, 10, 11). At our institution we prefer the plication technique.

The aim of this study was present our experience with posterior transverse plication (PTP) of the carotid artery after CEA, combined with dacron patch angioplasty.

MATERIAL AND METHODS

Study design. At our Department of Vascular Surgery, a retrospective study was conducted on a consecutive series of 376 CEAs performed in 323 patients (median age 67 years, 197 men, 126 women) between 1 January 2000 and 1 January 2006. The indications for surgery are presented on table I.

Preoperative assessment. All patients had extended clinical and biochemical assessment and a preoperative duplex and TCD scan. Angiography was undertaken in less than 5% of patients (Fig. 1.). CT scan with 3D reconstruction was undertaken in all patients. In 32 cases elongation with kinking of ICA was found. In 4 cases kinking of ICA was combined with fusiform aneurysm involving carotid bifurcation (Fig. 2.). Aspirin (75-150 mg daily) and/or dipyridamole (300-600 mg daily) was continued throughout the operative period, with patients receiving their usual antiplatelet therapy early in the morning, prior to CEA. Duplex scanning was re-

Figure 1. *Angiography showing kinking of internal carotid artery.*

Figure 2. *Anterioposterior arteriography showing fusiform aneurysm involving carotid bifurcation and kinking of internal carotid artery.*

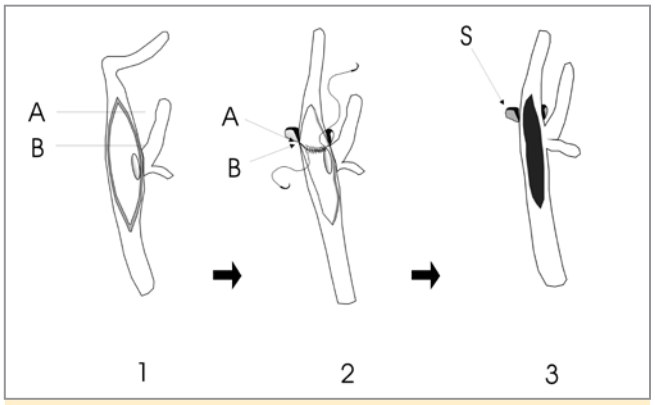

Figure 3. *Internal plication of ICA and Dacron patch angioplasty. A and B denotes the approximated parts of artery. S denotes the surplus remnants of arterial wall after posterior plication technique.*

Figure 4. *Intraoperative photograph showing plication of the internal carotid artery with a running suture.*

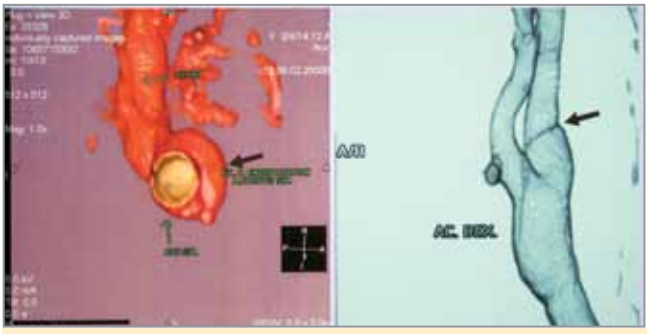

Figure 5. *Postoperative volume rendering CT showing the plication line (arrow).*

peated within 24 hours of surgery and all patients underwent TCD intraoperative and postoperative monitoring.

Operative technique. The basic technique of CEA (general anesthesia, systemic heparinization without reversal, loupe magnification, routine shunting (modified catheter shunt), patching with collagen impregnated Dacron graft) has remained unchanged since 1998. In 32 (8.5 %) CEAs, we found it necessary to perform additional carotid artery shortening by plication of the carotid artery, on the basis of potential kinking, if not corrected. In significant elongation of ICA and kinking, the posterior transverse plication technique was used (7) to exclude at least 10 mm or more of the wall from the vessel lumen (Fig. 3.). After endarterectomy, a 6/0 polypropylene running suture was used to perform the plication (Fig. 4.). In a great majority of cases, a segment of ICA was plicated. In two cases with fusiform aneurysm of carotid bifurcation, the external carotid artery was ligated and divided and plication performed more proximally. In this group there were 14 female and 18 male patients (ratio 1 : 1.3). Associated risk factors are presented on table II. All 376 procedures were performed by a consultant surgeon.

Intraoperative TCD monitoring. TCD monitoring was commenced after induction of anesthesia using a fixed 2 MHz head probe. The surgeon and anesthetist aimed

Table 2. *Risk factors of 323 patients undergoing carotid endarterectomy and Dacron patch angioplasty*

	With carotid plication (n = 32)	Without carotid plication (n = 344)
Hypertension	28 (87.5 %)	298 (86.6 %)
Coronary artery disease	23 (72 %)	189 (64.9 %)
Diabetes mellitus	6 (19 %)	58 (19.9 %)
Smoking history	18 (56 %)	206 (70.8 %)

to ensure that mean blood flow velocity in the middle cerebral artery (MCAV) was >15 cm/s at all times (12).

Postoperative TCD monitoring. Following recovering from anesthesia, the patient was transferred to the recovery room for a subsequent 3-hour period of TCD monitoring. All TCD data were digitally recorded (DAT) for subsequent of-line quantification of microemboli signals. Dextran 40 was administered to any patient who had (1) >25 emboli in any 10 minute period or (2) emboli that distorted the MCAV waveform. The threshold of >25 emboli per 10 minute period was based on the findings of an original pilot study (13). Intravenous dextran was administered as a 20 mL bolus and then at 20 mL/h, increased stepwise every 10 minutes to amaximum of 40 mL/h if there was no reduction in the rate of embolization. Once the rate of embolization stabilized or reduced, Dextran was continued at that dose for a further 12 hours.

Off line TCD data analysis. Postoperative off-line quantification of microembolic signals (MES) using DAT recordings was performed by an experienced neurologist using standard consensus criteria (14). MES were characterized by an amplitude of at least 3dB greater than that of background blood flow signal and lasting less than 300 ms.

End points. Primary endpoints were death for any reason or perioperative and late stroke or need for Dextran administering in early postoperative period. Stroke was defined as persistent neurologic deficit lasting >24 hours and generally confirmed by brain imaging. Secondary endpoints included residual and recurrent stenosis (>50%) on operated artery, operative site hematomas, cranial nerve injury and other complications, related to surgery.

Statistical analysis. Data were analyzed using STATISTICA (Statsoft, v9.0). Continuous nonparametric data were analyzed with the Mann-Whitney U-test. Discrete data were analyzed using hi square statistics. A P value of <0.05 was taken as significant.

RESULTS

Over the study period 385 patients were initially included in the study. 62 (16%) were excluded because no suitable acoustic window to enable TCD monitoring was found.

In 32 (8.5 %) of 376 consecutive CEAs, during the 10-year period additional shortening by plication of the carotid artery was performed. Table I compares the risk factors of this group with those of 291 patients undergoing 344 CEA without shortening of the carotid artery during the same period. Table II depicts the indications for CEA for both groups.

One patient in plication group (3.1%) and 18 patients in simple CEA group (5%) received Dextran postoperatively (Hi square=0,27, p>0.5). Differences were not statistically significant. It was not possible to predict patients destined to require post-operative Dextran based on the magnitude of embolization detected during the surgical procedure. Patient in the plication group had 1-10 emboli detected after removal of the surgical clamps. In the simple CEA group nine had no emboli detected during this period, 3 had 1-10 emboli, while 6 had more than 10 emboli detected.

Table 3. *Postoperative complications after carotid endarterectomy.*

	With carotid plication (n = 32)	Without carotid plication (n = 344)
Stroke	0	7 (2 %)
Death	0	2 (0.6 %)
Deep wound infection	0	1 (0.3 %)
Residual stenosis	1 (3.1 %)	7 (3.7 %)
Recurrent stenosis	2 (6.2 %)	17 (4.9 %) (hi square=0.1, p>0.5)

In 32 plicated CEAs, the average follow-up by duplex ultrasonography was 5.8 (range 1 - 37) months postoperatively. In 344 non-plicated CEAs, the average follow-up of 16.4 (range 1 - 58) months was obtained on 236 CEAs, all studied at least once a year by ultrasound examination. The incidence of residual stenosis on the one week scan in the plicated group was 3.1 % (1 patient) and that of recurrent (> 50 %) stenosis 6.2 % (2 patients). The incidence of residual stenosis in non-plicated CEAs was 3.7 % (7 patients) and of recurrent stenosis 4.9 % (17 patients) (hi square=0.21, p>0.5). Table III compares the postoperative complications for both groups. Differences were not statistically significant.

The 30-day stroke morbidity and mortality for patients undergoing PTP of the carotid artery in conjunction with endarterectomy was zero. Among 344 CEAs without plication, there were two (0.6 %) perioperative deaths (one after myocardial infarction and one after pulmonary failure) and seven (2 %) postoperative strokes (table III). There was one deep wound infection and postoperative aneurysm in the same patient. Differences were not statistically significant.

DISCUSSION

Few controversies in vascular surgery stir as much passion as management of carotid disease (15,16,17). In 2004 98000 carotid endarterectomies were performed in the United States only. Carotid endarterectomy (CEA) has a low margin of error and recommendations about surgical techniques are important (18,19), however, the debate as to how stroke and other cardiovascular complications might be prevented following CEA remains largely unresolved and has been inappropriately dominated by "single issue" subjects. Some of the most enduring single issue subjects are the role of shunting, controversies regarding patching and inevitable question as to whether eversion endarterectomy should be preferred option (18,19). Many of these issues are not resolvable in a simple way (19). The aim of our study was not to resolve these questions, neither to enter the discussion about CAS or CEA (16,17), but to present our experience with routine use of patch closure as we think that with presented technique it is less difficult to visualize the distal endpoint of the endarterectomy and less difficult to insert shunt. Beside this the evidence for clear benefit of eversion endarterectomy over conventional CEA with patching is lacking (18,19,20). We believe that important advantage of presented plication technique is the strengthening of arterial wall during suture placements as endarterectomized kinked ICA can be extremely fragile.

Correction of a kinked ICA in most reports represents about 3 % to 7 % of the operations in carotid surgery (6–10, 21–25). It is a matter of discussion if a kinked ICA should be considered as dangerous as a. critical stenosis (10). It is known that in elongated ICA an obstruction of flow can be achieved in some positions of the head (7). Such dynamic clinical tests to provoke positional ischemic deficits can be dangerous (10). In majority of instances we deal most frequently with associated atherosclerotic disease of the carotid bifurcation and the two lesions should always be corrected at the same time by endarterectomy and additional shortening procedure.

In severe atherosclerosis CEA may produce very thin arterial wall and kinking not evident before operation. Such elongation can be easily corrected by patch closure (6,26,27, 28, 31). Leaving an excessive length of carotid artery will result in postoperative kinking (10, 30). For correction of kinked carotid artery many surgical techniques have been developed (7, 10,26,27). In the resection of the redundant vessel the fragility of the thin wall increases the risk for postoperative bleeding (7, 10). Transposition techniques offer several possibilities to correct kinking and stenosis (11). Among transposition techniques is reimplantation of the mobilized ICA after eversion endarterectomy quite often applied (10, 30–32). In transposition techniques insertion of a shunt can be problematic and is not recommended (10). As we believe that use of shunt improves the safety of procedure performed in general anesthesia (19), plication of kinked carotid artery can be performed more easily than resection and reinsertion (7, 25,26,27).

Among our carotid artery reconstructions, performed without PTP, we routinely use a shunt to lower the risk of cerebral ischaemia, secure calm operation and allow for enough time for meticulous suture placement. In moderate elongation of ICA we correct it simply by patch reconstruction (24). In significantly kinked ICA with angulation of 60 % or more, we prefer posterior plication technique combined with dacron patch angioplasty. Some authors suspect that in this technique there is some risk to create a rigid rim that could initiate early restenosis (10). We observed one such case. Nevertheless our results of PTP of the carotid artery after CEA can be compared with those of standard CEA combined with dacron patch angioplasty or eversion endarterectomy (33,34,35).

In early postoperative period patients were monitored with TCD. There is no direct correlation between applied surgical technique and postoperative quantification of microembolic signals with TCD (13). In our study as in some others (13) it was not possible to predict patients destined to require post operative Dextran based on the magnitude of embolization detected between the time of final flow restoration and closing the skin. However the high-risk cohort of patients, who are at risk of developing postoperative stroke and requiring Dextran can be identified by measuring the magnitude of embolization in the first three hours after surgery. Although causes of immediate postoperative stroke are heterogenous in their aetiology the magnitude of postoperative embolization may be taken as an indirect but important factor of quality control assessment. Patient in the plication group had 1-10 emboli detected after removal of the surgical clamps. In the simple CEA group nine had no emboli detected during this period, 3 had 1-10 emboli, while 6 had more than 10 emboli detected. Later on one patient in plication group (3.1%) and 18 patients in CEA group (5%) received Dextran postoperatively. Differences were not statistically significant. It is estimated that less than 15% of patients after carotid surgery will be in need to require Dextran therapy (13).

Even during long-term follow-up plication does not add to late morbidity. We have noted no late neurological complications in patients monitored 1 to 5 years after CEA and additional plication. In no case did recurrent stenosis become symptomatic. Similar reports were obtained by some other authors (2, 24, 36).

Although the numbers are not sufficient to make really valid conclusions, we feel that plication after carotid endarterectomy can be performed safely. In our study it was not associated with an increased incidence of perioperative and postoperative complications.

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