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SHORT REPORT

Reducing the Risk of Intraoperative Neurological Complications during Carotid Endarterectomy with Early Distal Control of the Internal Carotid Artery

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Aim of the study. *To assess the feasibility and effectiveness of a modified surgical technique with early clamping of the distal internal carotid artery (ICA) during carotid endarterectomy in a single centre experience.*
Study design. *Retrospective study, teaching hospital.*
Material and methods. *Between 1996 and 2002, 2235 CEAs were performed. Until April 1999, the intra-operative strategy consisted of standard isolation and dissection of the carotid bifurcation preliminary to ICA clamping (group 1; 1090 interventions). Starting from May 1999, we performed early isolation and clamping of the distal ICA, followed by dissection of the carotid bifurcation and clamping of the external and common carotid artery (group 2; 1145 interventions).*
Results. *The modified technique was feasible in all the patients of group 2. In group 2 there was a significantly lower incidence of neurological deficit on waking than in group 1 (0.4% and 1.8%, respectively;* $p = 0.02$*).*
Conclusions. *Early distal control of the internal carotid artery during CEA is feasible and could contribute to reducing intra-operative neurological events.*

Keywords: Carotid endarterectomy; Surgical technique; Internal carotid artery clamping; Cerebral monitoring.

Introduction

Although carotid endarterectomy (CEA) is a well-accepted treatment for stroke prevention in symptomatic and asymptomatic patients with severe carotid stenosis,[1–3] there are few studies concerning the different methods of cerebral protection during exposure and dissection of the carotid artery.

The use of early distal clamping of the ICA, preliminary to carotid bifurcation exposure, has been recently described;[4] however, we are not aware of previous studies comparing the results of carotid surgery with different techniques of carotid exposure.

The aim of this study is to focus on the feasibility of this modified technique and retrospectively evaluate our results.

Materials and methods

A post-hoc analysis of a prospectively compiled database containing all CEAs carried out at our Institution between 1996 and 2002 was performed. All the interventions were performed under general anaesthesia: somatosensory evoked potentials (SEPs) were used to monitor cerebral status during surgical intervention and to indicate when the use of a shunt was necessary.[5]

Surgical strategy substantially changed during the years: until April 1999, we used a standard surgical approach to the carotid bifurcation, consisting of

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dissection and isolation of the bifurcation followed by dissection and cross-clamping of the distal ICA (Group 1). Since May 1999, we have been using a modified surgical approach, consisting of preliminary isolation and clamping of the distal ICA (Group 2).

Technique

After using a standard skin incision, the dissection was focused in the area immediately under the angle of the jaw. At that level the distal path of the ECA and ICA are usually easily seen. This exposure allows control of the ICA above its origin and beyond the limits of the carotid plaque which is usually located at bulb and bifurcation area.

Careful and gentle digital palpation by the surgeon allows identification of the distal limit of the carotid plaque and to assess the presence of a soft part of the ICA where a clamp can be applied.

The patient is heparinised and then a soft atraumatic clamp (usually a 'bull-dog' clamp) is applied (Fig. 1). After clamp application, vascular tapes are applied to the distal ICA. Intervention proceeds with gentle dissection and sequential clamping of the ECA (with retraction of the vascular tapes) and of the common carotid artery (with a soft clamp or with a tourniquet). If, during these first minutes, SEP values remained unchanged, isolation and dissection of the carotid bifurcation is performed; in the presence of significative SEP reduction, a rapid dissection of the bifurcation is performed and a shunt is inserted after arteriotomy.

Standard longitudinal endarterectomy with a wide exposure of the proximal and distal limits of the plaque is then performed. In both groups, a policy of selective patching for carotid reconstruction on the basis of age, sex, size of ICA and distal extension of the plaque was used.

Ipsilateral neurological deficits on recovery were assessed by a vascular surgeon. Neurological deficits in the two groups were then compared by means of the Chi-squared test or Fisher test when appropriate. Multivariate analysis for the risk of intraoperative neurological events was performed.

Results

2235 CEAs were performed in 1857 patients in the study period. Intervention was bilateral in 294 patients. The two groups included 1090 and 1145 interventions, respectively. Early distal control of ICA was feasible in all the patients in group 2. There were no differences between the two groups in terms of sex, age, common risk factors for atherosclerosis and comorbidity, except for a slightly higher prevalence of arterial hypertension in group 2.

In group 2 there was a higher incidence of asymptomatic patients than in group 1 (55 and 48%, respectively; $p=0.002$); in group 2 there was a significantly greater use of patch reconstruction than in group 1 (78 and 50%, respectively; $p<0.001$). The mean duration of cerebral ischemia during carotid clamping was significantly increased in group 2 (33.5 min $\pm$ 7.8) over group 1 (28.3 min $\pm$ 8.9; $p<0.001$, CI 95% 30.6–31.4).

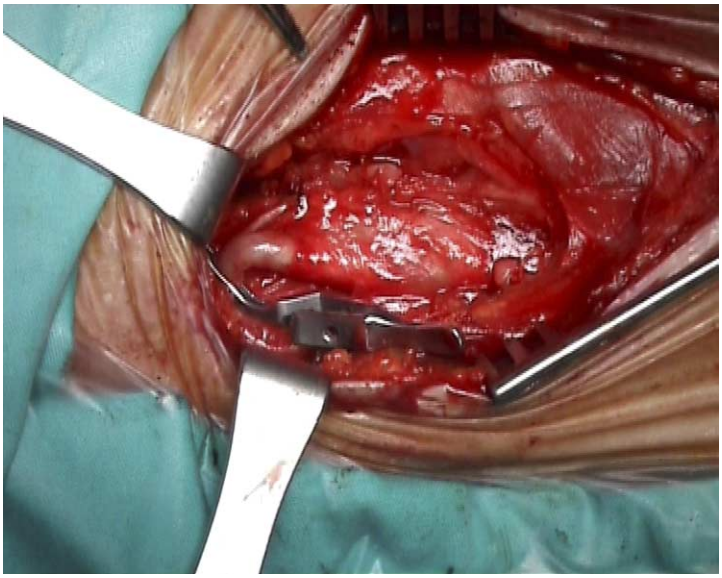

Fig. 1. Early clamping of distal ICA with a bull-dog clamp.

Table 1. Intraoperative features

	Group 1	Group 2	*p*
Patch closure	547 (50.1%)	898 (78.5%)	0.002
Shunt insertion	104 (9.5%)	106 (9.2%)	n.s.
- SEPs reduction	71 (6.5%)	67 (5.8%)	
- SEPs not evaluable	33 (3%)	39 (3.4%)	
Clamping mean duration	28.3 min	33.5 min	<0.001
Deficits at awake	20 (1.8%)	5 (0.4%)	0.002

Cumulative shunt insertion rate was 9.5 and 9.2% in the two groups, respectively ($p=$ns). The rate of neurological deficit on recovery was less in patients of group 2 (5 cases; 0.4%); the corresponding figure in group 1 was 1.8% (20 cases; $p=0.002$) (Table 1).

The use of this modified surgical strategy was an independent factor associated with a lower risk of developing intraoperative neurological deficit (OR 0.3; 95 CI 0.1–0.8; $p=0.02$).

Discussion

The reduction of perioperative neurological risk is crucial in assessing the benefit of carotid surgery over best medical treatment in stroke prevention. In recent years several methods have been proposed to reduce the risk of intraoperative complications. Poor attention has been paid to technical methods of cerebral protection during surgical exposure of the carotid bifurcation; the importance of a careful carotid dissection has been recognized in several reports,[6,7] and probably all vascular surgeons tend to perform it in daily practice.

The feasibility and effectiveness of early distal control of ICA has been recently demonstrated in the practice of a single surgeon,[4] and in our experience it was achievable in all the patients, even in those with a short neck, with long plaques or when a shunt was required.

This technique represents a sort of potential brain protection from microemboli that we can achieve during carotid dissection which has otherwise been proven to cause the most serious neurological accidents after CEA.[7] There was a significantly higher use of patch closure in group 2, and this could potentially represent a bias in our results, as patching has been reported to lead to a threefold reduction in perioperative thromboembolic events.[8]

The increase in mean duration of cerebral ischemia during carotid clamping in group 2 is probably the consequence of the higher incidence of patch closure, but it did not affect our results; this demonstrates that an attempt to obtain technical perfection and reduction of intraoperative thromboembolic risk, and not the crossclamp time, as previously believed, is the crucial factor in carotid surgery.

Another criticism that could be levelled at our series is the higher incidence of asymptomatic patients in group 2 than in group 1. The reduction of intraoperative events could be partially explained by this feature; in fact, the risk of cerebral embolism during carotid artery exposure is supposed to be higher in symptomatic patients with unstable plaque.[9]

Even in the presence of the described limits and possible bias of the study, the significant reduction of intraoperative neurological complications in group 2 demonstrates that this modified surgical strategy represents an independent factor affecting intraoperative events. In our opinion, it should be considered as a part of a multifactorial approach to carotid surgery aiming at reducing perioperative risk and including also careful cerebral monitoring with selective avoidance of shunts and a wide use of patch closure.

Conclusions

In our experience, early distal clamping of the ICA during carotid surgery represents a feasible and effective technical approach contributing, along with cerebral monitoring, brain protection and adequate arterial reconstruction, leading to a reduction in the intraoperative risk of neurological events.

In our opinion, this surgical strategy is not the 'ideal' approach to carotid interventions; however, it should be considered as a tool in vascular surgeons' hands in the attempt to improve their results and to obtain 'perfection' in carotid endarterectomy—a zero stroke rate.

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