

Simultaneous Bilateral Carotid Endarterectomy: Our First Experience

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Indications for and against bilateral carotid surgery as a simultaneous or a staged procedure and patient selection criteria for simultaneous bilateral carotid endarterectomies (SBCE) are discussed.

Methods: Six patients who underwent 12 SBCE (group A) were compared with 20 patients who underwent 40 bilateral staged endarterectomies (group B). The indications and surgical management were similar and the accompanying risk factors were comparable in both groups. A shunt or patch was not used and the occlusion time was $12.5 \pm 2'$. Total occlusion time in the SBCE was $25 \pm 2.5'$.

Results: The results are comparable in both groups. In the SBCE group no major neurological complications were noted except for a transient hypoglossal paresis. In group B, a case with transient ischemic attack (TIA) was noted; however no mortality, myocardial infarct, respiratory problems or permanent damage of the central nerves were observed in either groups.

Conclusion: Although our number of patients was not satisfactory to yield a conclusion, our results, together with that of the international literature were encouraging for SBCE. SBCE can be safely performed, in experienced hands with a better preoperative assessment of the function of the circle of Willis in association with meticulous surgical technique and proper patient selection. (*Ann Thorac Cardiovasc Surg* 2001; 7: 292–6)

Key words: carotid stenosis, endarterectomy, carotid surgery

Introduction

After the first successful carotid endarterectomy (CEA) performed by De Bakey in 1953, carotid endarterectomy has been widely used for its relief of symptoms as well as for its prevention of strokes. Either unilateral or staged bilateral CEA has a prophylactic character and must be accompanied by low morbidity and mortality. On the other hand, performance of simultaneous bilateral carotid endarterectomy (SBCE) is very rare; we could only find a limited number of publications in the international literature (Table 1).¹⁻¹⁰⁾

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Reports supporting SBCE,⁴⁻¹⁰⁾ point out the increased danger arising from double anesthetic and surgical procedures and post operative stay in the intensive care unit (ICU) or acute intraluminal bleeding of the carotid following the administration of heparin during the operative procedure of the first carotid and the difficulty of getting the patient to accept the doubled risk of permanent brain damage as a possible complication of the proposed operation.¹¹⁾ Finally, others report a lower incidence of cerebral damage, later on, following bilateral endarterectomy as compared with unilateral endarterectomy.¹²⁾ However some have not encouraged this kind of procedure because they believed that a more pronounced incidence of injury to the cerebral nerves, strokes and respiratory problems would occur.^{1,6,7)}

Herein, our experience with SBCE as compared with bilateral staged endarterectomy is presented.

Table 1. Simultaneous bilateral carotid endarterectomy

Year	Author	No.of cases
1969	Young et al.	2
1974	Sensening	3
1975	Pillone et al.	1
1976/1985	Clauss	37
1978	Ketonen et al.	80
1990	Toung	1
1992	Pizetti	85
1996/2000	Dimakakos	17

Materials and Methods

This study was approved by the Medical Research Ethics Committee and informed consent was obtained from each patient as well.

A total of 128 carotid endarterectomies were carried out during the period of January 1992 to October 1997, where 52 (40.6%) of the endarterectomies were bilateral.

The above patients were allocated into 2 groups: Group A included 12 SBCE in 6 patients, group B 40 staged bilateral endarterectomies in 20 patients (Table 2).

There were 22 males and 4 females, aged 62.4 ± 7.9 years (48-77 years). Of these 16 (61.5 %) were symptomatic and 10 (38.4%) were asymptomatic. Presentation of the patients in group A and B were shown in Table 3.

The accompanying risk factors of both groups are shown comparatively in Table 2. Twenty-one (80.7%) were smokers of whom 19 (73.8%) smoked 1 packet or more cigarettes a day.

All patients were subjected to a preoperative neurological examination, Doppler-ultrasonography, digital subtraction angiography and in recent years magnetic resonance imaging (MRI). Digital subtraction angiography confirms the function of the circle of Willis and yields precise results on the degree of the stenosis.

Bilateral symptomatic stenosis >70%, ipsilateral symptomatic stenosis >70% and contralateral asymptomatic stenosis >80%, bilateral asymptomatic stenosis >80% constituted the indications for the staged bilateral carotid endarterectomies; where bilateral symptomatic stenosis >70% with intraplaque haemorrhage, ipsilateral symptomatic stenosis >70% and contralateral asymptomatic stenosis >80% with ulceration of the atheromatic plaque or intraplaque haemorrhage, bilateral asymptomatic stenosis >80% with intraplaque haemorrhage bilaterally, bilateral asymptomatic stenosis >80% and other urgent surgical procedures constituted indication for SBCE. The

Table 2. Patient characteristics and risk factors

Procedure	Group A	Group B	
Number of patients	6	20	
Number of operations	12	40	
Mean age	59.1	63.2	
Sex (male : female)	5 : 1	17 : 3	
Risk factors			Total
Diabetes mellitus	1	3	4 (15.3%)
Hypertension	3	11	14 (53.8%)
Coronary disease	2	9	11 (42.3%)
Peripheral arteriopathy	1	1	2 (7.6%)
Smoking	5	16	21 (80.7%)
Hyperlipidemia	5	11	16 (61.5%)

indication for a simultaneous procedure was not considered in patients who presented with elements indicative of a severe cerebrovascular insufficiency (risk class IV of Sundt and Coll).¹³⁾

All operations were performed by the same surgeon (EB) and the same surgical technique was applied for all patients: general anesthesia, stable hemodynamic condition during the clamping phase, administration of 5000 U of heparin five minutes prior to clamping, infiltration of the carotid bulb with 1% lidocaine solution, without the use of a shunt, with direct stitching of the vessels with 7/0 propylene sutures.

Heparin was not neutralized with protamine sulphate at the end of the operative procedure. Measurement of stump pressure and EEG monitoring was applied in all patients. In SBCE exposure of the both carotids were performed first. Either SBCE or staged bilateral endarterectomy; the precedence has always been given to the carotid hemodynamically more affected if it did not also coincide with the symptomatic side.

Results

Mean duration of clamping was $12.5 \pm 2'$. In the cases of SBCE the total clamping time for both procedures reached to $25 \pm 2.5'$. Clinical findings were summarized in Table 3. No patch was used and none of our patients were transfused.

All patients remained in the ICU on the day of operation. The next morning they were transferred to the ward, mobilized, fed liberally and prescribed 3×75 mg dipyridamol and 100 mg aspirin daily. Mean duration of the post-operative hospital stay was 4 ± 2 days, patients were discharged after a thorough neurological examination. In group B the average time between the two op-

Table 3. Clinical findings

	Group A	Group B
Patients		
Asymptomatic	2 (33.3%)	8 (40.0%)
Symptomatic	4 (66.6%)	12 (60.0%)
Presentation of the patients		
Stroke	1 (16.6%)	3 (15.0%)
Stroke and TIA	1 (16.6%)	2 (10.0%)
Hemispheric TIA	2 (33.3%)	2 (10.0%)
Nonhemispheric TIA	0 (0%)	7 (35.0%)

TIA: transient ischaemic attack.

erations was ten days (with a minimum of four and a maximum of thirty-three).

There were no major complications in both groups. No one from either group A or B died during the 30 post-operative days (Table 4). One patient from group B presented a slight weakness on the contralateral side of the extremity 2 hours after the operation. Ultrasonography and computerized tomography did not reveal any pathological findings. Another patient presented severe hematoma in the wound area on the first post operative night which required revision. In revision, suture line bleeding was observed.

None of the patients from group A, subjected to simultaneous bilateral endarterectomy, presented with any serious neurological complication.

A transient paresis of the hypoglossal nerve was noted in one patient from group A which recovered during the following 10 weeks.

Postoperative hypertension was noted in 4 (66.6%) patients of group A, 11 (55.0%) of group B. Postoperative hypertension was controlled easily by antihypertensive medication.

Discussion

Although there has been an advantage of surgery over conservative treatment in symptomatic stenoses >70%,¹⁴⁾ controversy still remains as to the indication of surgical treatment in relation to the degree of stenosis of asymptomatic carotid stenosis (Casanova, VAT)^{15,16)} and on bilateral lesions; whether to perform a staged or a SBCE.

In bilateral carotid stenosis; serious ischemic episodes, permanent hemiplegia, which occurs 6-10% or 2-3 times higher than in unilateral stenosis, limitation of quality of life and even mortality advocates some authors towards the bilateral surgical intervention with a slightly higher operative risk.¹⁷⁾

Table 4. Hospital results

	Group A (6 Patients)	Group B (20 Patients)
Death	0	0
Stroke	0	0
TIA	0	1
Hypoglossal dysfunction	1	0
Postendarterectomy hypertension	4	11
Hematoma	0	1

TIA: transient ischaemic attack.

We have had no mortality but our patients with bilateral lesions whom were mostly symptomatic, experienced such episodes and limited quality of life.

According to the joint study progress report,¹⁸⁾ a discrepancy was not observed as to TIA between the groups subjected to surgical and non surgical treatment in patients with unilateral stenosis; however in cases with bilateral stenosis there was a significantly statistical difference in favour of the group with the operated patients. During their follow-up, TIA occurred in 38% of the patients which was due to the unoperated side,¹⁸⁾ which means that the other side must not be disregarded.

In our group of patients we have not experienced a serious problem due to the unoperated side, except for a case with a slight weakness in the early post operative period. It is not only the degree of stenosis that is important but the pathological findings of the plaque should also be taken into account. During endarterectomy, acute intraplaque hemorrhage of the other carotid, after the administration of heparin, carries serious consequences.

Ketonen⁹⁾ has reported a higher rate of neurological complications in simultaneous bilateral carotid endarterectomy. Damage to the central nerves is, however, very often iatrogenic (bad preparation, traction, electrocoagulation, asymmetric inflation of endotracheal tube, edema) which may be avoided.^{5,19,20)} During the operation, meticulous attention was paid on preparation and on gentle traction of the central nerves.

Excluding iatrogenic damage to cranial nerves, which can be avoided with an accurate surgical technique, the reported pathogenesis of the brain damage in CEA is due to emboli, thrombosis, hypotension, and hemorrhage.²¹⁾ These complications are in some measure avoidable or can be controlled, except for the hemorrhage, which in some cases is related to a hyperperfusion induced by the CEA. Cerebral blood flow measurements have shown, in patients with a high degree of carotid stenosis, a very low ipsilateral flow and have also shown an increase of

up to three to four times the normal flow after a CEA performed on a nearly complete stenosis.

The combination of hyperperfusion and loss of brain circulation autoregulation may explain the possibility of vessel rupture or hemorrhagic infarct, especially in areas where capillary permeability is altered by ischemia. For these reasons, in bilateral cases, the surgical approach has been cautious and the operations have usually been performed in separate stages.

We have also found, although not accompanied by reference to specific clinical cases, clear advice not to perform simultaneous CEA operations, particularly in the presence of very tight stenosis,²²⁾ because of the risk of possible complications such as respiratory distress, post-operative hypertension, brain ischemia, and worsening of neurological defects already present.²³⁾

There is no doubt that a bilateral injury of the hypoglossal or recurrent laryngeal nerves leads to disastrous consequences²⁴⁾ and a staged BCE would have the advantage of postponing the endarterectomy of the other side. This is the main reason why most surgeons suggest staged BCE as the method of choice in bilateral occlusive disease. We have also had a case with hypoglossal nerve paresis which recovered in the following 10 weeks. But on the other hand, we must keep in mind that we are presenting to our patients, the risk of double anesthesia, operative procedure, ICU stay and, above all, a single procedure saves the patient from a second grave psychological insult represented by the worry of having to undergo another operation that will expose him or her to the risk of a stroke and acute intraplaque hemorrhage for a staged bilateral carotid endarterectomy.^{5,8)}

Sensening²⁾ reported a stroke one day following unilateral endarterectomy in a patient with bilateral stenosis, coming from the non-operated carotid, a fact which led him to carry out a simultaneous endarterectomy of both carotids in 1974. Later a lower incidence of cerebral damage was also reported following bilateral as compared with unilateral endarterectomy.¹²⁾ While the natural evolution of unilateral as well as staged bilateral carotid endarterectomy has been cited in the literature,¹²⁾ the literature is, nevertheless, quite inadequate with regard to simultaneous endarterectomy of both carotids.

The results of Claus,⁵⁾ Pizzetti,⁸⁾ and Dimakakos^{9,10)} for simultaneous bilateral endarterectomy are comparable with those of unilateral or staged carotid endarterectomy. With the above encouraging data and with our experience, after an initial cautious and staged approach in bilateral cases which were comparable with the literature,

we have more recently considered the possibility of simultaneous bilateral CEA operations, selecting patients without very tight stenosis or indirect signs of severe cerebrovascular insufficiency to reduce the risks related to the consequences of an excessive perfusion.

Disturbances of the microcirculation and multiple lacunar microinfarcts probably influence unfavourably the result of endarterectomy producing hyperperfusion syndrome (2-15%), with a mortality rate of 30-60%.^{15,25)} Although not used in routine practice; transcranial doppler, acetazolamide test and single photon emission tomography scanning (SPECT) can be used for further examination of patients vulnerable to hyperperfusion syndrome.

Preoperatively meticulous attention was kept on the morphology of the circle of Willis, preoperative EEG, stump pressure (=50 mmHg), preoperative and post-operative regulation of arterial blood pressure to eliminate hyperperfusion syndrome. Although we have not experienced it in our cases; in case of any hesitation; when stump pressure is <50 mmHg or there are EEG changes the patient should undergo a staged procedure. One case with TIA in a hypertensive patient was re-established within the next few hours and a transient hypoglossal nerve paresis was probably the result of mechanical injury due to traction.

Dimakakos¹⁰⁾ mentioned the dilemma in patients with bilateral symptomatic carotid stenosis and risky plaques, whether to proceed in a one or two stage operation. With strict selection criteria and meticulous pre-operative, pre-operative and postoperative evaluation we prefer SBCE for those patients.

The reported mortality and morbidity rates after staged BCE are lower than 5%. The complication rates for the second carotid is lower than the first endarterectomy, because the first is more often symptomatic and as a result of its restoration, the circle of Willis has a functional advantage over it. This can also be applicable, to a great extent, in SBCE as well.

The frequent appearance of postoperative hypertension and the correlation between stroke and hypertension²⁴⁾ has been reported for many years.

For this reason preoperative regulation is recommended. The occurrence of postoperative hypertension varies in the experience of various authors: some²⁶⁾ have observed a higher frequency after bilateral cases, others²⁷⁾ report the occurrence only when the second side has been treated more than six days after the first one, and others have not noticed substantial differences be-

tween unilateral and bilateral cases.²⁸⁾ In our series of patients we observed hypertension in 4 (66.6%) in SBCE and 11 (55.0%) in staged bilateral carotid endarterectomy which was managed in the ICU with medication, without any particular problems or serious effects.

With good surgical tactics, careful administration of anesthesia and correct patient selection, excluding patients with severe cerebral insufficiency which might cause postoperative bleeding (hyperfusion syndrome) and meticulous postoperative management SBCE can be safely performed in experienced hands.

References

1. Young JR, Humphries AW, Beven EG, De Wolfe VG. Carotid endarterectomy without a shunt. *Arch Surg* 1969; **99**: 293–7.
2. Sensening DM. Bilateral carotid endarterectomy at one operation. *J Maine Med Assoc* 1974; **65**: 304–5.
3. Pillone PP, Jacobs GB, Parikh S. Carotid endarterectomy utilizing the exclusion clamp. *Int Surg* 1975; **60**: 105–8.
4. Clauss RH, Bole PV, Paredes M, Doscher W, Adeyemo A, Kremnitzer MW. Simultaneous bilateral carotid endarterectomies. *Arch Surg* 1976; **111**: 1304–6.
5. Clauss RH, Babu SC, Patel KR, Singh BM, Shah PM, Siegel TS. Simultaneous bilateral carotid endarterectomy operations. *J Cardiovasc Surg* 1985; **26**: 297–9.
6. Ketonen P, Luosto R, Mattila S, Nemes A, Ketonen L. Surgical experience with simultaneous bilateral carotid endarterectomies. *Scand J Thorac Cardiovasc Surg* 1979; **13**: 321–6.
7. Young TJ, Sieber FE, Grayson RF, Derrer JA. Chemoreceptor injury, as probable cause of respiratory depression after a simultaneous bilateral carotid endarterectomy. *Crit Car Med* 1990; **18**: 1290–1.
8. Pizzetti F. Simultaneous bilateral carotid endarterectomy: a revision of concepts and strategies. *Vasc Surg* 1992; **26**: 135–40.
9. Dimakakos PB, Arapoglou B, Papisava M, Papadimitriou J. Our first experience applying simultaneous bilateral carotid endarterectomy. *Int Angiol* 1996; **15**: 9–13.
10. Dimakakos PB, Kotsis TE, Tsiligiris B, Antoniou A, Mourikis D. Comparative results of staged and simultaneous bilateral carotid endarterectomy: a clinical study and surgical treatment. *Cardiovasc Surg* 2000; **8**: 10–7.
11. Lmparato AM. Discussion. 24th Scientific Meeting of the International Cardiovascular Society, Albuquerque, N.M. June 19, 1976. *Arch Surg* 1976; **111**: 1306.
12. Riles TS, Imparato AM, Mintler R, Baumann FG. Comparison of results of bilateral and unilateral carotid endarterectomy five years after surgery. *Surgery* 1982; **91**: 258–62.
13. Sundt TM Jr, Ebersold MJ, Sharbrough FW, Piepgras DG, Marsh WR, Messick JM Jr. The risk benefit ratio of intraoperative shunting during carotid endarterectomy: relevancy to operative and postoperative results and complications. *Ann Surg* 1986; **203**: 196–204.
14. MRC European Carotid Surgery Trial. Interim results for symptomatic patients with severe (70–99%) or with mild (0–69%) carotid stenosis: European carotid surgery trialist's collaborative group. *Lancet* 1991; **337**: 1235–43.
15. Carotid surgery versus medical therapy in asymptomatic carotid stenosis: the Casanova study group. *Stroke* 1991; **22**: 1229–35.
16. Hobson RWI, Weiss DG, Fields WS, et al. Efficacy of carotid endarterectomy for asymptomatic carotid stenosis. *N Engl J Med* 1993; **328**: 221–7.
17. Fields WS. The asymptomatic carotid bruit-operate or not? *Stroke* 1978; **8**: 9–13.
18. Fields WS, Maslenikov V, Meyer JS, Hass WK, Remington RD, Macdonald M. Joint study of extracranial arterial occlusion. V: progress report of prognosis following surgery or nonsurgical treatment for transient cerebral ischemic attacks and cervical carotid artery lesions. *JAMA* 1970; **211**: 1993–2003.
19. Matsumoto GH, Cossman D, Callow AD. Hazards and safeguards during carotid endarterectomy. *Am J Surg* 1977; **133**: 458–62.
20. Bergan JJ, Flinn WR, Yao JST. Cranial nerve injury in carotid surgery. In: Bergan JJ, Yao JST eds.; *Cerebrovascular Insufficiency*. New York: Grune & Stratton, 1983; 327–41.
21. Steed DL, Peitzman AB, Grundy BL, Webster MW. Causes of stroke in carotid endarterectomy. *Surgery* 1982; **92**: 634–41.
22. Cooley DA. Carotid endarterectomy from first recorded case to present. *Texas Heart Inst J* 1988; **15**: 139–41.
23. Thompson JE. Bilateral carotid stenosis with non-lateralizing symptoms. In: Brewster DC ed.; *Common Problems in Vascular Surgery*. Chicago: Year Book Medical Publishers, 1989; pp 3, 35–8.
24. Caplan LR, Skillman J, Ojemann R, Field WS. Intracerebral hemorrhage following carotid endarterectomy: a hypertensive complication. *Stroke* 1978; **9**: 457–60.
25. Naylor AR, Ruckley CV. The post-carotid endarterectomy hyperperfusion syndrome. *Eur J Vasc Endovasc Surg* 1995; **9**: 365–7.
26. Wade JG, Larson CP Jr, Hickey RF, Ehrenfeld WK, Severinghaus JW. Effect of carotid endarterectomy on carotid chemoreceptor and baroreceptor function in man. *N Engl J Med* 1970; **282**: 823–9.
27. Satiani B, Vasco JS, Evans WE. Hypertension following carotid endarterectomy. *Surg Neurol* 1979; **11**: 357–9.
28. Corson JD, Chang BB, Leopold PW, et al. Perioperative hypertension in patients undergoing carotid endarterectomy: shorter duration under regional block anesthesia. *Circulation* 1986; **74**: 1–4.