EEG Based Carotid Endarterectomy: A Case Report

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Received, 3rd July, 2010
Accepted, 26th July, 2010

Carotid endarterectomy (CEA) has been performed for over 6 decades for the treatment of stenotic and ulcerative lesions of the carotid artery. It improves the cerebral hypoperfusion caused by stenosis of the carotid artery or may prevents artery to artery embolism from ulceration of the atheroma. Although carotid stenting is getting more popular in the west, CEA is still a viable option in developing countries where interventional neuroradiology is not well developed.

We report a case of a 60-year-old female who had several episodes of transient ischemic attacks (TIAs) in the past one month. The symptom included right sided hemiparesis and aphagia together with amourosis fugax. Investigations revealed 80% carotid stenosis of her left internal carotid artery. She underwent CEA under general anesthesia with intraoperative electroencephalography (EEG) monitoring. EEG reading was recorded after induction of general anesthesia, during clamping and after the completion of CEA. Special focus was given on the difference in height and rate of waves between the two hemispheres during clamping. Since there was no difference in right and left sided EEG even after test clamping, CEA procedure was carried out without a shunt.

EEG based CEA as a useful tool to determine the need of temporary shunting during CEA surgery. The procedure also placed the surgeon at ease since he knew that the brain was not undergoing ischemia during surgery.

Key words: Carotid stenosis, CEA, EEG monitoring, TIA

Carotid endarterectomy (CEA) has been performed for over 6 decades for the treatment of stenotic and ulcerative lesions of the Carotid Artery. The procedure has stood the test of time over this period. Endarterectomy improves the cerebral hypoperfusion caused by stenosis of the Carotid Artery or may prevent artery to artery embolism from ulceration of the atheroma. Although carotid stenting is getting more popular in the west, CEA is still a viable option in developing countries where interventional neuroradiology is not well developed. EEG based CEA is a useful tool to determine the need of temporary shunting during CEA surgery. In this article, we describe the technicalities and rationale behind the procedure.

Case Report

A 60 yr old female from Kathmandu presented to our OPD with complaints of transient weakness of right upper limb one month back. There were several such episodes since then. She also had episodic slurring of speech which occurred especially after waking up and usually lasted for only abut 5 minutes. In addition, she also has history of brief loss of unilateral vision of her left eye.

Examination of the patient did not reveal any neurological deficit.Magnetic resonance imaging (MRI) of the brain was consistent with normal findings. Doppler study of the carotid revealed tortuous Lt. Carotid Complex with >80% stenosis. Computerized Tomogrphy (CT) Cerebral Angiography showed Severe to Critical Lt. ICA stenosis. Conventional Angiography was done to further assess the cross circulation from opposite side and posterior circulation. It showed severe stenosis at left ICA (**Figure 1**). There was good flow of contrast from the contralateral side to the left half of the brain when the ipsilateral ICA was manually occluded.

Figure 1: Conventional Angiography showing severe stenosis at Lt. ICA

After induction of general anesthesia, EEG electrodes were placed and EEG recorded. Arterial line was also placed. Linear incision was made along the anterior border of Sternocleidomastoid muscle (SCM). Cutting the Platysma and the Fascia Cervicalis, the Carotid Artery was approached along the anterior border of SCM. The Facial Vein can be sacrificed for the complete dissection of the Carotid Artery.At its bifurcation, the Common Carotid Artery (CCA) was infiltrated with Lignocaine to block carotid sinus reflex before the start of dissection. The Hypoglossal N. was identified superiorly running across the External Carotid Artery (ECA).

Large gel foam and patties were used to lift the Carotid A as the artery is better exposed this way and also that dissection could be carried out beneath the artery.

The Vagal and Superior Laryngeal Nerves beneath the Common and Internal Carotid were preserved.Bulldog clamp was applied on ICA for 3 mins during which EEG readings were closely scrutinized between the two hemispheres**(Figure 2)**. Since no changes were evident, it was decided that the operation would be carried out without shunting. Clamping of the CCA, ICA and ECA was done in sequence.

A small incision was made first on CCA by a blade. Then, the arteriotomy was extended to the ICA**.** The plaque was separated from the wall of the CA in one layer. The proximal and distal edges of the intima were sharply cut by microscissors. Plaque was removed completely.The arteriotomy was closed using a running suture with 6-0 prolene **(Figure3)**.

Declamping was done in the sequence of ECA, CCA followed ~10 seconds later by ICA. The whole procedure

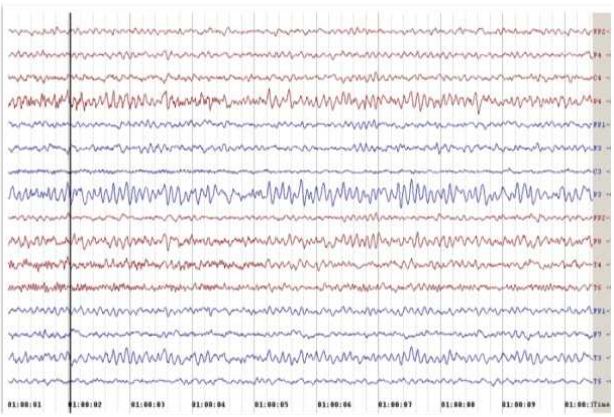

Figure 2: EEG reading during IC clamping

was done under high BP. Drain was placed and closure was done in layers.During the whole procedure, the EEG readings did not show changes predictive of ischemic changes.

Discussion

Indications for CEA include severe stenosis of the Carotid Artery (defined as a lumen <2mm in diameter or >70% stenosis in diameter) & significant ulceration of the atheromatous plaque. Clinically, patients with Transient Ischemic Attacks (TIA) or with minor neurologic deficits are good candidates for the operation.

Though shunting is carried out routinely at different centers during CEA, it hasn't been without its fair share of fallacies. Post procedural ischemic or embolic strokes are common in this group of patients undergoing CEA.There are different ways to know in advance whether the brain is undergoing or likely to undergo ischemic changes during surgery.

EEG based surgery is a very reliable and viable option in such scenario **(Figure 4)**. Normal Cerebral Blood Flow (CBF) is 70-100 ml/100 gm of brain/min. EEG changes are evident when CBF drops to <25 ml/100 gm of brain/min. Irreversible ischemic changes occur in brain when the CBF <10-15 ml/100 gm of brain/min.

So this window gives ample time to revert to shunting if need be.Furthermore, preoperative evaluation of the cerebral vessels- both structurally and functionally as with conventional angiography helps make preemptive decisions regarding shunting during CEA. Another parameter that can add to the merit of this procedure is the measurement of Stump Pressure.

Conclusions

We found EEG based CEA as a useful tool to determine the need of temporary shunting during CEA surgery. The EEG is a valuable monitoring technique that indicates when

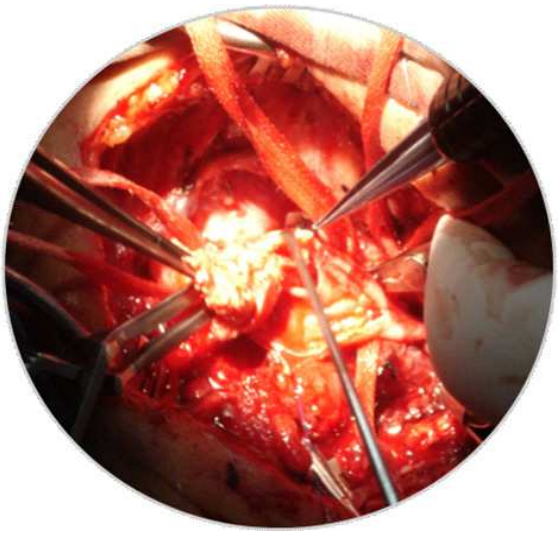

Fig ure 3: Plaque being separated from arterial wall

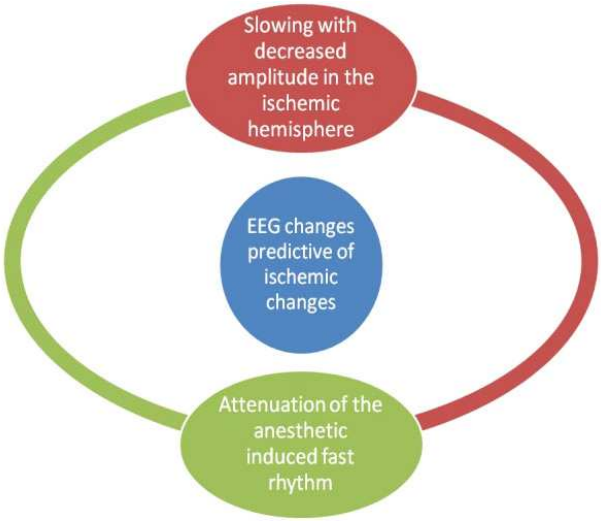

Figure 4: EEG changes predictive of ischemia

a shunt is required and informs the surgeon of the state of cerebral function not only during occlusion but also throughout the entire operative procedure.

References

1. Botes K, Le Roux DA, Van Marle J. Cerebral monitoring during carotid endarterectomy - a comparison between electroencephalography, transcranial cerebral oxymetry and carotid stump pressure. **S Afr J Surg 45:** 43-46, 2007
2. Ertl-Wagner B, Brüning R, HoffmannRT, Meimarakis G, Reiser MF. Diagnostic evaluation of carotid artery stenoses with multislice CT angiography. Review of thel iterature and results of a pilot study. **Radiologe 44:** 960-966, 2004
3. Flis V, Tetickovic E, Breznik S, Stirn B, Matela J, Miksiæ K. The measurement of stenosis of the internal carotid artery: comparison of doppler ultrasound, digital subtraction angiography and the 3D CT volume rendering technique. **Wien Klin Wochenschr 116:** 51-55, 2004
4. Frawley JE, Hicks RG, Beaudoin M, Woodey R. Hemodynamic ischemic stroke during carotid endarterectomy: an appraisal of risk and cerebral protection. **J Vasc Surg 25:** 611-619, 1997
5. Hanel RA, Xavier AR, Kirmani JF, Yahia AM, Qureshi AI. Management of carotid artery stenosis: comparing endarterectomy and stenting. **Curr Cardiol Rep 5:** 153-159, 2003
6. Katano H, Kato K, Umemura A, Yamada K. Perioperative evaluation of carotid endarterectomy by 3D-CT angiography with refined reconstruction: preliminary experience of CEA without conventional angiography**. Br J Neurosurg 18:** 138-148, 2004
7. Krohg-Sørensen K, Bakke SJ, Russell D. Operative and endovascular treatment of carotid stenosis—when is it indicated? **Tidsskr Nor Laegeforen 127:** 903-907, 2007
8. Kulkarni SR, Gohel MS, Bulbulia RA, Whyman MR, Poskitt KR. The importance of early carotid endarterectomy in symptomatic patients**. Ann R Coll Surg Engl 91:** 210-213, 2009
9. Lepore MR Jr, Sternbergh WC 3rd, Salartash K, Tonnessen B, Money SR. Influence of NASCET/ ACAS trial eligibility on outcome after carotid endarterectomy. **J Vasc Surg 34:** 581- 586, 2001
10. Sameshima T, Futami S, Morita Y, Yokogami K, Miyahara S, Sameshima Y et al. Clinical usefulness of and problems with three- dimensional CT angiography for the evaluation of arteriosclerotic stenosis of the carotid artery: comparison with conventional angiography, MRA, and ultrasound sonography**. Surg Neurol 51:** 301-308, 1999
11. Uretsky S.: Carotid artery surgery and carotid stenting in prevention of strokes. **Curr Opin Ophthalmol 19:** 485-492, 2008
12. Woodworth GF, McGirt MJ, Than KD, Huang J, Perler BA, Tamargo RJ. Selective versus routine intraoperative shunting during carotid endarterectomy: a multivariate outcome analysis. **Neurosurgery 61:**1170-1176, 2007