

## The Cerebral Hyperperfusion Syndrome: What Every Family Doctor Should Know

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The authors of the article on hyperperfusion syndrome that appears in this issue of *IMAJ* [1] should be congratulated on bringing to center stage this not so rare syndrome with its considerable morbidity and mortality. Cerebral hyperperfusion syndrome as a potentially devastating complication of carotid endarterectomy or carotid artery stenting has been widely reported in the surgical literature. It may occur within hours to 3 weeks after carotid endarterectomy and is characterized by symptoms ranging from headaches, fits, confusion, focal neurologic signs to intracerebral hemorrhage [2,3]. This syndrome may be more common and more variable in clinical presentation than previously thought [3].

It is believed that cerebral hyperperfusion is caused by loss of cerebral autoregulation resulting from chronic cerebral ischemia and that it occurs preferentially in patients with severe ipsilateral or contralateral carotid disease, increased intraoperative cerebral perfusion, or severe perioperative hypertension [4–6]. It is tempting to regard this subgroup of patients as those at increased risk of developing hyperperfusion syndrome, yet newly published data did not corroborate this common belief. It remains uncertain whether high middle cerebral artery flow velocities and severe hypertension after seizure onset are the cause or the effect. When examined closely, seizure was not associated with age, gender or pre-procedural presentation. Perioperative cerebral ischemic events, cerebral infarction (new and old), and the use of post-procedure anticoagulation therapy may be important but solid proof is lacking [7–10].

The incidence of intracranial hemorrhage after surgical carotid endarterectomy is approximately 0.6%, and after carotid artery stenting about 1.4% [4]. Clinically, cerebral hyperperfusion is defined as hypertension with symptoms of severe headache, seizures, and/or confusion. Physiologically, it is defined as a doubling of intraoperative cerebral blood flow values. Since the clinical findings in cerebral hyperperfusion syndrome may be subtle, ancillary investigations examining post-procedural cerebral blood flow such as brain perfusion computerized tomography, nuclear medicine single-photon emission CT, xenon CT, and transcranial Doppler sonography have been proposed as a means of detecting patients at risk [11–15]. All of these tests are expensive and time consuming and require special dedicated equipment and trained personnel. At the present time these tests are not

performed often, and one may expect a significant reporting bias that may skew the published data [5]. Newly published data indicate that recently performed contralateral carotid endarterectomy (<3 months) as well as a decrease in cerebral reactivity measured preoperatively by looking at acetazolamide-induced changes in cerebral blood flow (Diamox test) [10,16] appear to be predictive for identifying patients at risk for the development of CHS.

Modern clinical guidelines for carotid artery endarterectomy and carotid artery stenting call for short hospital stay and early discharge. The use of an anticoagulant is routine after stenting as well as after surgery. In many vascular units patients are admitted on the day of operation and discharged within 48–72 hours, and carotid artery stenting is even becoming a 1 day or even “same day” procedure. When patients are discharged so early, the post-procedure complication can develop quite late; thus it is of paramount importance that the information regarding cerebral hyperperfusion syndrome be part of the formal database of every family physician and primary care doctor. Unfortunately, clinicians treating these patients in acute medical units are generally unaware of the “post-carotid endarterectomy hyperperfusion syndrome” and tend to treat the patients and the ominous hypertension less aggressively [13].

In an effort to improve the early diagnosis of CHS the authors of the article in this journal recommend routine performance of transcranial Doppler in all patients “at risk” to develop the syndrome [1]. Unfortunately this is not a realistic or practical recommendation. We are yet uncertain as to who the patients at risk are, neither do we have any idea for how long such surveillance is needed. Furthermore, the role of transcranial Doppler is still under investigation and the technology is not readily available in most clinics and hospitals. The early discharge of most patients precludes any meaningful implementation of such a recommendation.

In the current atmosphere of economic restraints, rigid clinical guidelines and short hospitalizations, one cannot justify the costs of additional tests and prolong hospital stay on the grounds of the existing evidence. Until a simple and reliable method of identifying patients at risk for post-procedure CHS is developed, it will continue to be the family doctors, the primary care physician and the emergency room staff who take care of these patients. As the use of carotid artery stenting becomes widespread, it is absolutely

CHS = cerebral hyperperfusion syndrome

crucial that these doctors are aware of this complication, its clinical pattern and the need for aggressive antihypertensive therapy.

## References

1. Streifler JY, Israel D, Melamed E. The hyperperfusion syndrome: an under-recognized complication of carotid endarterectomy. *IMAJ* 2004;6:54–6.
2. Ho DS, Wang Y, Chui M, Ho SL, Cheung RT. Epileptic seizures attributed to cerebral hyperperfusion after percutaneous transluminal angioplasty and stenting of the internal carotid artery. *Cerebrovasc Dis* 2000;10(5):374–9.
3. Morrish W, Grahovac S, Douen A, et al. Intracranial hemorrhage after stenting and angioplasty of extracranial carotid stenosis. *AJNR Am J Neuroradiol* 2000;21(10):1911–16.
4. Meyers PM, Higashida RT, Phatouros CC, et al. Cerebral hyperperfusion syndrome after percutaneous transluminal stenting of the craniocervical arteries. *Neurosurgery* 2000;47(2):335–43.
5. Phatouros CC, Meyers PM, Higashida RT, et al. Intracranial hemorrhage and cerebral hyperperfusion syndrome after extracranial carotid artery angioplasty and stent placement. *AJNR Am J Neuroradiol* 2002;23(3):503–4.
6. Hingorani A, Ascher E, Tsemekhim B, et al. Causes of early post carotid endarterectomy stroke in a recent series: the increasing importance of hyperperfusion syndrome [Review]. *Acta Chir Belg* 2002;102(6):435–8.
7. Coutts SB, Hill MD, Hu WY. Hyperperfusion syndrome: toward a stricter definition. *Neurosurgery* 2003;53(5):1053–8.
8. Hingorani A, Ascher E, Tsemekhim B, et al. Causes of early post carotid endarterectomy stroke in a recent series: the increasing importance of hyperperfusion syndrome [Review]. *Acta Chir Belg* 2002;102(6):435–8.
9. Naylor AR, Evans J, Thompson MM, et al. Seizures after carotid endarterectomy: hyperperfusion, dysautoregulation or hypertensive encephalopathy? *Eur J Vasc Endovasc Surg* 2003;26(1):39–44.
10. Ascher E, Markevich N, Schutzer RW, Kallakuri S, Jacob T, Hingorani AP. Cerebral hyperperfusion syndrome after carotid endarterectomy: predictive factors and hemodynamic changes. *J Vasc Surg* 2003;37(4):769–77.
11. Hosoda K, Kawaguchi T, Ishii K, et al. Prediction of hyperperfusion after carotid endarterectomy by brain SPECT analysis with semiquantitative statistical mapping method. *Stroke* 2003;34(5):1187–93. Epub 2003 Apr 17.
12. Ogasawara K, Konno H, Yukawa H, Endo H, Inoue T, Ogawa A. Transcranial regional cerebral oxygen saturation monitoring during carotid endarterectomy as a predictor of postoperative hyperperfusion. *Neurosurgery* 2003;53(2):309–14.
13. Ogasawara K, Yukawa H, Kobayashi M, et al. Prediction and monitoring of cerebral hyperperfusion after carotid endarterectomy by using single-photon emission computerized tomography scanning. *J Neurosurg* 2003;99(3):504–10.
14. Dalman JE, Beenackers IC, Moll FL, Leusink JA, Ackerstaff RG. Transcranial Doppler monitoring during carotid endarterectomy helps to identify patients at risk of postoperative hyperperfusion. *Eur J Vasc Endovasc Surg* 1999;18(3):222–7.
15. Gossetti B, Martinelli O, Guerricchio R, Irace L, Benedetti-Valentini F. Transcranial Doppler in 178 patients before, during, and after carotid endarterectomy. *J Neuroimaging* 1997(4):213–16.
16. D'Angelo V, Catapano G, Bozzini V, et al. Cerebrovascular reactivity before and after carotid endarterectomy. *Surg Neurol* 199;51(3):321–6.

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