Changes in cerebral hemodynamic and cognitive parameters after external carotid–internal carotid bypass surgery in patients with severe steno-occlusive disease: A pilot study

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ABSTRACT

Background: The direct impact of external carotid–internal carotid (EC-IC) bypass surgery on cognition of patients with severe steno-occlusive disease of internal carotid (ICA) or middle cerebral artery (MCA) is unknown. In this pilot study, we evaluated changes in cerebral hemodynamic and cognition in these patients.

Methods: Patients with severe steno-occlusive disease and impaired cerebral vasodilatory reserve (CVR) with transcranial Doppler (TCD) breath holding index (BHI) and acetazolamide-challenged HMPAO-Single Photon Emission Tomographic (SPECT) imaging were offered EC-IC bypass surgery. CVR and cognitive performance using a formal neuropsychological battery were evaluated before and 3–6 months after surgery.

Results: Nine patients and 9 matched controls were recruited. Significant CVR improvement from TCD-BHI [median 0 (Inter-quartile range 0.45) to 1.10 (IQR 0.73), p = 0.001] and SPECT (p < 0.001) was observed in surgery patients. EC-IC bypass patients had significant improvement in verbal memory (p = 0.037) and executive function (p = 0.043) and a trend of improvement in visual memory (p = 0.052) compared to controls. Conclusion: EC-IC bypass surgery in carefully selected patients could improve cerebral hemodynamics and verbal memory and executive function.

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1. Introduction

The intracranial atherosclerotic disease or stenosis is considered as a global disease burden, as it is prevalent in the majority of the world’s population (i.e., Asians, Hispanics, and Africans) and accounts for as high as 50% of all stroke patients in Asians [1]. These patients are at a high risk for cerebral ischemic events, 17.1% in the first year and 8.6% in the second year after the first acute ischemic stroke [2]. Ischemic stroke is a recognized risk factor for vascular cognitive impairment (VCI) and post-stroke VCI is prevalent (44%) [3] with significant functional consequences [4,5]. Hence, it is important to establish an effective intervention to prevent cognitive and functional decline consequent to intracranial stenosis.

Superficial temporal artery-to-middle cerebral artery (STA-MCA) bypass is a direct revascularization surgical intervention [6] reported to improve cerebral blood flow and has been successfully applied to moyamoya disease [7]. However, STA-MCA bypass surgery failed to reduce the risk of ischemic stroke despite improving cerebral hemodynamic parameters in patients with carotid artery occlusion in adult patients [8,9]. The direct impact of STA-MCA bypass surgery on cognition was not evaluated in these studies. Only a few studies examined the within group changes of cognitive performance consequent to STA-MCA bypass. A recent study evaluated the change in cognitive performance over 12 month in 20 patients with chronic hemodynamic insufficiency who underwent EC-IC bypass surgery [10]. In this study, evident improvement in vasomotor reactivity was observed 6 months after surgery. In addition, significant cognitive improvement was observed in global intelligence, attention, visual spatial memory and psychomotor speed. However, such cognitive improvement could have occurred due to the natural recovery following stroke rather than a consequence of the EC-IC bypass surgery as there was no control group. Therefore, in this pilot study, we matched our patients with a control...