Real-Time Transcranial Doppler Monitoring and Correlation with Cerebral Oximetry During Carotid Endarterectomy

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Introduction

Carotid artery stenosis is one of the major causes of ischemic stroke. Surgical revascularization through carotid endarterectomy (CEA) is not without risk; it is performed to remove carotid plaque, a source of emboli to the brain causing stroke. Intraoperative embolization and hemodynamic changes during carotid occlusion, release and shunt insertion can be assessed by real-time transcranial doppler (TCD) monitoring. Routine shunt insertion may be able to prevent cerebral ischemia, but it can increase risk of stroke caused by embolism. The purpose of this study was to evaluate the correlation between mean flow velocity (MFV) of middle cerebral artery (MCA) by TCD and cerebral oximetry via near-infrared spectroscopy (NIRS) to decide whether shunt is necessary.

Methods

A total of 15 patients (10 male,5 female) of median age 70 (59-85) were studied who underwent CEA from 2018-2020. Of the 15 patients, 4 had previous history of CEA and one patient had TCAR. All the patients underwent TCD monitoring using either Spencer (manual TCD) or Lucid (Robotic TCD: NovaGuide System, Novasignal, Los Angeles, CA). All the procedures were performed under general anesthesia. Patients demographics such as age, gender, co-morbidities, risk factors and degree of stenosis was collected. MFV, mean arterial pressure (MAP) and NIRS were recorded. CEA was divided into 4 phases: Clamping, shunting, shunt and clamp removal. Shunt insertion was recommended in our protocol when MCA MFV dropped more than 50% after clamping.

	Baseline	*Clamping*	*Shunting*	*Clamp Release*
With Shunt (n=7)	39.28±16.73	11.28±9.48 (p=0.004)	44±18.75 (p=0.002)	54.85±26.4 (p=0.049)
Without Shunt (n=8)	44.37±23.59	39.75±24.60 (p=0.24)		58.1±30.41 (p=0.0140)

Tab. 1: MFV changes during phases of CEA

	Baseline	*Clamping*	*Shunting*	*Clamp Release*
With Shunt (n=7)	69.85±5.45	66.57±8.07 (p=0.14)	68.28±8.11 (p=0.15)	72.42±4.89 (p=0.02)
Without Shunt (n=8)	72.87±8.47	66.37±7.36 (p=0.05)		58.75±5.25 (p=0.233)

Tab. 2: NIRS changes during phases of CEA

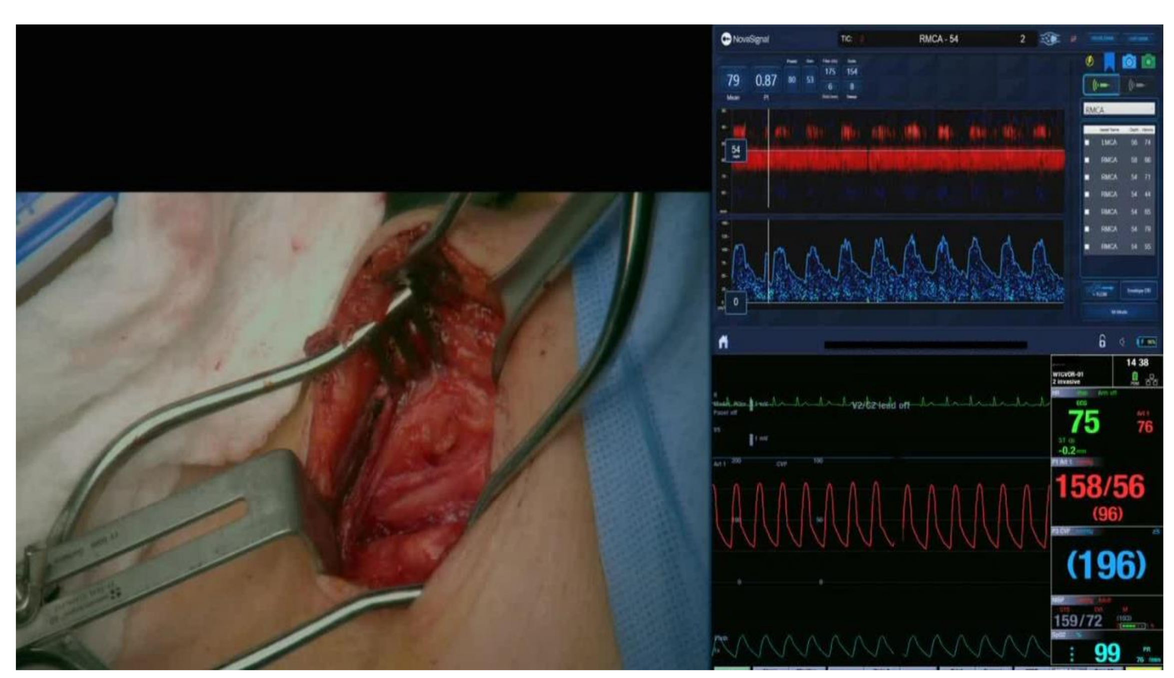

Fig. 1: Real-time TCD Monitoring during CEA

Fig. 2: Cerebral Oximetry

Results

In patient's without shunt, MFV of MCA and NIRS decreased with cross clamp; however, there was no statistically significant difference (p=0.24). There was significant increase in MFV of MCA at clamp release (p=0.0140) whereas NIRS showed no change. We found significant correlation between MFV and NIRS (p=0.013) during clamping. In patient's with shunt, MFV of MCA decreased with Clamping (p=0.004), increased with shunt (p=0.002) and increased above baseline after clamp release (p=0.049)-All values were significant. NIRS values decreased with cross clamp, increased during shunt and increased above baseline after clamp release. Correlation of MFV and NIRS during clamping (p=0.0001) and shunting (p=0.008) were significant. MAP changes were not significant for all phases during the cases.

Outcomes

Post-op neurological symptoms were observed in 3 patients : 2 patients who underwent CEA without shunt and 1 patient with shunt. Mild symptoms were observed which resolved within 24hours and improved on follow up. No further intervention was required

Conclusion

MFV changes of MCA at clamping can assist the surgeon in deciding whether a shunt is necessary and by avoiding shunt placement, we can decrease carotid injury and improve end point visualization in the carotid. Our study showed significant correlation between MFV changes and NIRS values during clamping. Although they correlate in terms of flow-the most common reason for stroke is embolization, which NIRS cannot detect. Also, if NIRS does not detect hyper-perfusion it may increase risk of bleeding. Several studies have been published on cerebral oximetry during CEA, but there are few studies available on correlation with TCD.

References

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