Cerebral blood flow measurement using near infrared spectroscopy in cerebral endarterectomy

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To evaluate cerebral blood flow (CBF) during carotid endarterectomy (CEA) is very crucial. However, it is difficult to measure CBF in the operating room. Recently, near-infrared spectroscopy (NIRS) with high accuracy has developed, which enables to measure regional cerebral blood flow by injection of indocyanine green. Kubler et al. reported that regional cerebral blood flow derived from NIRS correlated well with values assessed by radioactive microspheres in pigs. (Kubler WM, et al. J cereb Blood Flow Metab 1998; 18: 445-56) Therefore, we conducted to measure the regional cerebral blood flow derived from NIRS during CEA.

Subjects: Patients undergoing elective CEA

Methods: After induction of general anesthesia, NIRS sensor was placed bilaterally 1cm above eyebrow on the scalp.

1. Pre carotid cross clamping
2. During carotid cross clamping
3. After carotid unclamping.

Materials: The kinetics of an intravenous bolus of indocyanine green was monitored by NIRS (NIRO 200NX, Hamamatsu Photonics, Hamamatsu, Japan)(Figure 1).

Measurement: Blood flow index (BFI) was calculated using slope of the concentration of indocyanine green. (Figure 2)

The impact of the carotid cross clamping on BFI was evaluated.

Results

• We studied 11 patients (ten male, one female; aged 73±6). (Figure 3)
• BFI of diseased side significantly decreased during carotid cross clamping compared to the level of pre carotid cross clamping. (from 0.15± 0.047 μmol/l/s to 0.096± 0.042 μmol/l/s ) (p<0.01) (Figure 4)
• After unclamping the carotid artery, BFI recovered to the level of pre-clamping. BFI of healthy did not show significant change during the surgery. (pre clamping: 0.15± 0.062 μmol/l/s; during clamping: 0.13± 0.057 μmol/l/s; after unclamping: 0.15± 0.069 μmol/l/s, p = 0.099)
• Tissue oxygenation index (TOI) of diseased side is not affected by clamping. (Figure 5)
• The blood pressure during carotid cross clamping was managed significantly high. (Figure 6)

Discussion

• BFI of diseased side decreased significantly by carotid cross clamping. Regional cerebral blood flow decreased about 30% by carotid cross clamping.
• Even if blood pressure was elevated, cerebral blood flow was decreased.
• BFI can be measure the cerebral blood flow more sharply than TOI.

Conclusion

• BFI as regional cerebral blood flow of the diseased side significantly decreased during clamping the common carotid artery. However, BFI of the healthy side did not show the significant change.
• BFI derived from NIRS measurement can provide the information of regional cerebral blood flow during the operation.