Indocyanine Green Videoangiography in Clipping of Paraclinoid Aneurysms

Paraklinoid Anevrizmaların Kliplenmesinde Indosiyanin Yeşil Videoanjiyografi

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ABSTRACT

AIM: To evaluate the use of indocyanine green (ICG) videoangiography in surgical clipping of paraclinoid aneurysms.

MATERIAL and METHODS: Intraoperative ICG videoangiography was used as a surgical adjunct in 60 patients with 65 paraclinoid aneurysms. The findings on ICG videoangiography were compared with postoperative imaging.

RESULTS: All 65 paraclinoid aneurysms were clearly identified by intraoperative ICG videoangiography and obliteration was documented in each case. Findings on ICG videoangiography matched with postoperative angiography.

CONCLUSION: ICG videoangiography is a useful adjunct to the surgical management of paraclinoid aneurysms.

KEYWORDS: Paraclinoid aneurysm, Indocyanine green videoangiography, Clipping

INTRODUCTION

More recently, indocyanine green (ICG) has been safely adapted from ophthalmic use to neurosurgical applications (10,12). Combined with the use of near-infrared video technology in current microscopes, surgeons can evaluate intraoperative blood flow with a simple intravenous injection. Previous studies have reported its use in cerebral arteriovenous malformations, aneurysms, and extracranial-intracranial bypasses with good results (12-17). This study is dedicated to present our experience with the use of ICG videoangiography in surgical clipping of paraclinoid aneurysm.

MATERIAL and METHODS

We began using ICG videoangiography at our center in 2003. Between 2003 and 2009, 60 patients with 65 paraclinoid aneurysms were treated by surgical clipping. The indications for surgery vs. endovascular embolization of aneurysms were summarized in Table I. All of these patients underwent intraoperative ICG videoangiography as part of their procedure. All patients underwent surgical exposure of the lesions through a cranial approach. Before and after surgical clipping of the aneurysm, ICG was administered intravenously to identify the aneurysm neck, obliteration rate and patency of the parent internal carotid artery (ICA) (Figure 1A-H). All patients received a 25-mg intravenous dose dissolved in 5ml of 0.9% saline and given as a bolus. The dye was visualized using a Pentoro (Carl Zeiss Co., Oberkochen, Germany) or Leica OH4 (Leica Co. Wetzlar, Germany) fluorescent microscopes. All patients underwent postoperative angiography to verify the results noted on ICG videoangiography.
Liu J. et al: Indocyanine Green Videoangiography in Clipping of Paraclinoid Aneurysms

Indocyanine Green Videoangiography in Clipping of Paraclinoid Aneurysms

Liu J. et al. reported on the use of indocyanine green videoangiography in clipping of paraclinoid aneurysms. Among 5 patients harboring bilateral "mirror aneurysms", a posterior communicating artery aneurysm was the most common associated aneurysm, seen in 3 of the 14 patients, followed by anterior communicating artery aneurysm in 2, cavernous aneurysm in 2, and middle cerebral artery aneurysm in 2. Of the 14 patients with additional associated aneurysms, subarachnoid hemorrhage (SAH) was caused by the associated aneurysm in 50% of the patients (7/14). Giant aneurysms (>25 mm) were seen in 16 (26.7%) patients. Aneurysm locations according to Barami's classification were summarized in Table III. All patients receive surgical treatments. DSA is performed for clinical diagnosis and postoperative follow-up examination.

### Surgical Approach

Rupture aneurysm, giant aneurysm and superiority body-side quantitative aneurysms were treated with priority. Pterional craniotomy is performed and the Sylvian cistern is opened. The proximal and distal dural rings are resected. The sphenoid crest is removed and if necessary, anterior clinoid process, the superior and lateral wall of optic canal would be removed for exposure of paraclinoid aneurysm. Yasargil aneurysm clips (Aesculap Co. Ltd.) are chosen for aneurysm clipping. In patients with rupture or giant aneurysms, the proximal and distal parts of the ICA are successively clipped temporarily (Figure 1A-H). After the aneurysm is clipped, the temporary clips are dismantled from the distal to the proximal part.

### RESULTS

There was 1 death in the series, giving an overall mortality of 1.7% (1/60). This patient had a H&H grade III SAH with intracranial hematoma. Other complications were meningitis (1 patient), deterioration in vision (1 patient), and deep venous thrombosis (2 patients), which were managed accordingly, yielding an overall procedure-related morbidity of 6.7% (4/60), most of which was transient. In all cases, ICG videoangiography precisely demonstrated the aneurysm and documented its obliteration. There was no complication with the use of ICG. Postoperative angiography confirmed aneurysm obliteration.

### Follow-Up

Follow-up ranged from 2 to 72 months (mean, 26.7 months). Outcome was graded according to the Glasgow Outcome Scale (GOS) as described originally by Jennett and Bond (5). A total of 98.3% of patients had a good outcome (GOS 4 or 5). Most patients (94%) had normal or improved vision after surgery.

### DISCUSSION

Currently, intraoperative microscopes are modified to allow visualization of ICG (11). Since 2003, ICG has been used as an adjunct to surgical clipping of intracranial aneurysms (10). In 2005, Raabe et al (12) demonstrated that ICG corresponds to DSA in approximately 90% of cases, with only 2.7% surgically significant differences in aneurysm cases. In these cases, the time for ICG videoangiography is 5 to 10 minutes. We found

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<th>Table I: Indications for Surgical and Endovascular Treatment According to the Literature</th>
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<td>Sherif et al. (14)</td>
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<td>Nagasawa et al. (5)</td>
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<th>Table II: Demographics</th>
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<th>Table III: Aneurysm Locations According to Barami's Classification</th>
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that intraoperative ICG matched to postoperative angiography in all 60 cases. In previous studies, ICG videoangiography only added 1 to 3 minutes to the operating time. ICG was safe and no complication was found in our patient series. Although none of our patients had postoperative imaging demonstrating deficiencies in the ICG videoangiogram, it is important to note that the ICG can only be observed under the operating microscope. Therefore, it is important to expose the aneurysm for documentation of complete obliteration.

Using ICG videoangiography, the aneurysm enwrapped by fibrous tissue could be revealed clearly and clipped tentatively. After the fibrous tissue is removed, ICG videoangiography is performed again to determine whether aneurysm is completely clipped. If necessary, the clips are readjusted until the aneurysm is confirmed to be completely clipped and the parent artery and its branches are confirmed to be patent. For a partially thrombosed aneurysm, ICG videoangiography can ascertain the neck of the aneurysm before clipping for facilitating complete clipping. In patients with giant paraclinoid aneurysms with thrombus, the thrombus should be completely removed before the ICA is reconstructed. When the thrombus region is confirmed, aneurysm rupture could be predicted while the neurosurgeon removed the thrombus. Accordingly, sudden hemorrhage could be controlled in time. Furthermore, hemodynamic changes could be witnessed by ICG videoangiography: reverse blood flow firstly appears in the distal part of the ICA then flushes into the aneurysm sac; as the blood flow increases, the vortices begin to take shape. Under ICG videoangiography, real time blood flow vortices can be witnessed. Many papers have been published on surgery for paraclinoid aneurysms (2-4,6,7,9,13-15,18). The mean age of the patients in these studies is 42-50 years and the SAH rate is 0-80.8%, with mostly large and giant but some small aneurysms, which are comparable to those in our study. The studies report varied mortality from 0 to 13.8% and morbidity up to 26.8%. The complication rates associated with surgical treatment are 0%-25% and the complete obliteration rates of aneurysms are 66.7%-100%. Despite the new advantages and improvement in surgical techniques, there remains a significant morbidity and mortality associated with surgical treatment of these aneurysms. Ng PY et al. have used balloon...
occlusion and suction decompression as adjunct in 64% cases of large paraclinoid aneurysms and complete aneurysm obliteration was achieved in 82% of the cases (8). However, we did not use the endovascular technique intraoperatively. Our group of paraclinoid aneurysms, which includes small, large and giant aneurysms, had a procedure-related morbidity of 6.7%, and mortality of 1.7%. This compares favorably with the previously reported surgical series.

CONCLUSIONS

We have found ICG videoangiography to be a useful adjunct to surgical management of paraclinoid aneurysms. It is useful in monitoring hemodynamic changes and improves prognosis for paraclinoid aneurysms.

REFERENCES