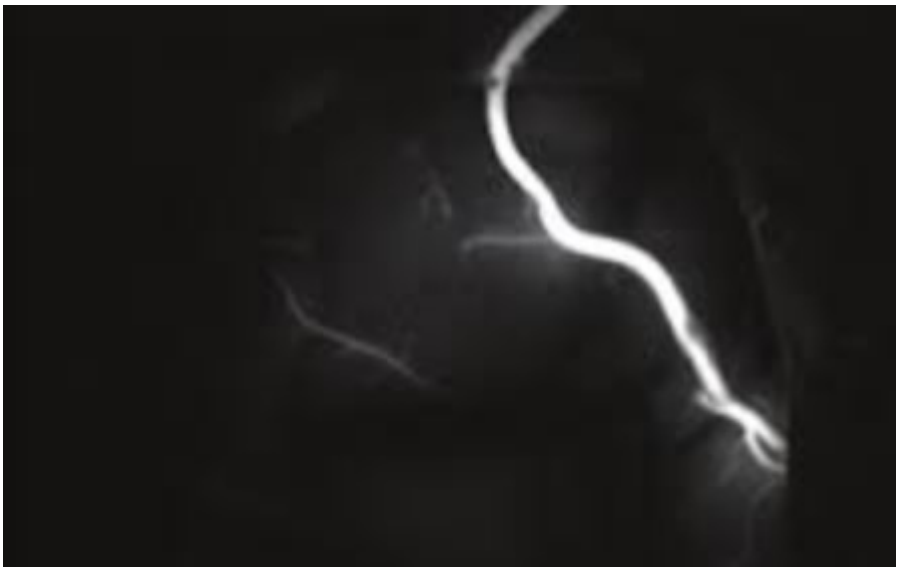
Indocyanine green videoangiography for intracranial aneurysm



Indocyanine green videoangiography for intracranial aneurysm is applied in order to assess intra-operatively both aneurysm sac obliteration and vessel patency after clipping.

Although digital subtraction angiography (DSA) may be considered the gold standard for intraoperative vascular imaging, many neurosurgical centers rely only on indocyanine green videoangiography (ICG-VA) for the evaluation of clipping accuracy.

In a Systematic Review and Meta-Analysis of Riva et al., from Brussels, Leuven, Belgium, Monza, Italy and Chicago, Illinois because a proportion of mis-clippings cannot be identified with ICG-VA, this technique should still be considered complementary rather than a replacement to DSA during aneurysm surgery. Incorporating other intraoperative tools, such as flowmetry or electrophysiological monitoring, can obviate the need for intraoperative DSA for the identification of vessel stenosis. Nevertheless, DSA likely remains the best tool for the detection of aneurysm remnants [1)].

Its a safe and effective modality of intraoperative blood flow assessment and reduces the incidence of postoperative ischaemic complications [2)].

However, ICGV-derived data have been reported to be misleading at times. Della Puppa et al., noted that a simple intra-operative maneuver (the “squeezing maneuver”) allows the detection of deceptive ICGV data on aneurysm exclusion and allows potential clip repositioning. The “squeezing maneuver” is based on a gentle pinch of the dome of a clipped aneurysm when ICGV documents its apparent exclusion.

Data from 23 consecutive patients affected by intracranial aneurysms who underwent the “squeezing maneuver” were retrospectively analyzed. The clip was repositioned in all cases when the dyeing of the sac was visualized after the maneuver.

In 22% of patients, after an initial ICGV showing the aneurysm exclusion after clipping, the squeezing maneuver caused the prompt dyeing of the sac; in all cases the clip was consequently repositioned. A calcification/atheroma of the wall/neck was predictive of a positive maneuver (p= 0.0002). The aneurysm exclusion rate at post-operative radiological findings was 100%.

With the limits of this small series, the “squeezing maneuver” appears helpful in the intra-operative detection of misleading ICGV data, mostly when dealing with aneurysms with atheromasic and calcified walls [3)].

In selected cases, endoscopic ICG angiographies (e-ICG-A) provides the neurosurgeon with information that cannot be obtained by microscopic ICG angiography (m-ICG-A). E-ICG-A is capable of emerging as a useful adjunct in aneurysm surgery and has the potential to further improve operative results [4)].

Indocyanine green (ICG) videoangiography (VA) in cerebral aneurysm surgery allows confirmation of blood flow in parent, branching, and perforating vessels as well as assessment of remnant aneurysm parts after clip application. A retrospective analysis from Two hundred forty-six procedures were performed in 232 patients harboring 295 aneurysms. The patients, whose mean age was 54 years, consisted of 159 women and 73 men. One hundred twenty-four surgeries were performed after subarachnoid hemorrhage, and 122 were performed for incidental aneurysms. Single aneurysms were clipped in 185 patients, and multiple aneurysms were clipped in 47 (mean aneurysm diameter 6.9 mm, range 2-40 mm). No complications associated with ICG-VA occurred. Intraoperative microvascular Doppler ultrasonography was performed before ICG-VA in all patients, and postoperative digital subtraction angiography (DSA) studies were available in 121 patients (52.2%) for retrospective comparative analysis. In 22 (9%) of 246 procedures, the clip position was modified intraoperatively as a consequence of ICG-VA. Stenosis of the parent vessels (16 procedures) or occlusion of the perforators (6 procedures), not detected by micro-Doppler ultrasonography, were the most common problems demonstrated on ICG-VA. In another 11 procedures (4.5%), residual perfusion of the aneurysm was observed and one or more additional clips were applied. Vessel stenosis or a compromised perforating artery occurred independent of aneurysm location and was about equally common in middle cerebral artery and anterior communicating artery aneurysms. In 2 procedures (0.8%), aneurysm puncture revealed residual blood flow within the lesion, which had not been detected by the ICG-VA. In the postoperative DSA studies, unexpected small (< 2 mm) aneurysm neck remnants, which had not been detected on intraoperative ICG-VA, were found in 11 (9.1%) of 121 patients. However, these remnants remained without consequence except in 1 patient with a 6-mm residual aneurysm dome, which was subsequently embolized with coils.

Its a helpful intraoperative tool and led to a significant intraoperative clip modification rate of 15%. However, small, < 2-mm-wide neck remnants and a 6-mm residual aneurysm were missed by intraoperative ICG-VA in up to 10% of patients. Results in this study confirm that DSA is indispensable for postoperative quality assessment in complex aneurysm surgery [5)].

During a period of 14 months, between November 2005 and December 2006, 289 patients with intracranial aneurysms were operated on in our institution. Intraoperative ICG-VA was performed during microneurosurgical clipping of 239 IAs in 190 patients. Postoperative computed tomography and computed tomography angiography (CTA) were performed for all patients. Intraoperative interpretation of ICG-VA in assessing the neck residual or the patency of vessels after clipping of each single aneurysm were recorded and correlated with postoperative CTA and/or digital subtraction angiography.

Postoperative imaging studies revealed no incomplete occlusions of aneurysm domes. Unexpected neck residuals were observed in 14 aneurysms (6%). There were no parent artery occlusions. Unexpected branch occlusions including both major and minor branching arteries were observed in 15

aneurysms (6%).

Indocyanine green videoangiograph is a simple and fast method of blood flow assessment with acceptable reliability. Indocyanine green videoangiograph can provide real-time information to assess blood flow in vessels of different size as well as the occlusion of the aneurysm. Intraoperative assessment of blood flow in the perforating branches is one of the most important advantages. In selected cases such as giant, complex, and deep-sited aneurysms or when the quality of image in ICG-VA is not adequate, other methods of intraoperative blood flow assessment should be considered [6].

The technique was performed during 187 surgical procedures in which 124 aneurysms in 114 patients were clipped. Using a newly developed setup, the ICG technique has been integrated into an operating microscope (Carl Zeiss Co., Oberkochen, Germany). A microscope-integrated light source containing infrared excitation light illuminates the operating field. The dye is injected intravenously into the patient, and intravascular fluorescence from within the blood vessels is imaged using a video camera attached to the microscope. The patency of parent, branching, and perforating arteries and documentation of clip occlusion of the aneurysm as shown by ICG videoangiography were compared with intraoperative or postoperative findings on DS angiography. The results of ICG videoangiography corresponded with intra- or postoperative DS angiography in 90% of cases. The ICG technique missed mild but hemodynamically irrelevant stenosis that was evident on DS angiography in 7.3% of cases. The ICG technique missed angiographically relevant findings in three cases (one hemodynamically relevant stenosis and two residual aneurysm necks [2.7% of cases]). In two cases the missed findings were clinically and surgically inconsequential; in the third case, a 4-mm residual neck may require a second procedure. Indocyanine green videoangiography provided significant information for the surgeon in 9% of cases, most of which led to clip correction.

Microscope-based ICG videoangiography is simple and provides real-time information about the patency of vessels of all sizes and about the aneurysm sac. This technique may be useful during routine aneurysm surgery as an independent form of angiography or as an adjunct to intra- or postoperative DS angiography [7].

References

1)
Riva M, Amin-Hanjani S, Giussani C, De Witte O, Bruneau M. Indocyanine Green Videoangiography in Aneurysm Surgery: Systematic Review and Meta-Analysis. Neurosurgery. 2018 Aug 1;83(2):166-180. doi: 10.1093/neuros/nyx387. PubMed PMID: 28973404.
2)
Lai LT, Morgan MK. Use of indocyanine green videoangiography during intracranial aneurysm surgery reduces the incidence of postoperative ischaemic complications. J Clin Neurosci. 2014 Jan;21(1):67-72. doi: 10.1016/j.jocn.2013.04.002. Epub 2013 Oct 1. PubMed PMID: 24090515.
3)
Della Puppa A, Rustemi O, Rossetto M, Gioffrè G, Munari M, Charbel FT, Scienza R. The “Squeezing Maneuver” in Microsurgical Clipping of Intracranial Aneurysms Assisted by Indocyanine Green Video-angiography (ICGV). Neurosurgery. 2014 Mar 3. [Epub ahead of print] PubMed PMID: 24594928.
4)
Mielke D, Malinova V, Rohde V. Comparison of Intraoperative Microscopic and Endoscopic ICG-angiography in Aneurysm Surgery. Neurosurgery. 2014 Mar 10. [Epub ahead of print] PubMed PMID: 24618802.

5)

Roessler K, Krawagna M, Dörfler A, Buchfelder M, Ganslandt O. Essentials in intraoperative indocyanine green videoangiography assessment for intracranial aneurysm surgery: conclusions from 295 consecutively clipped aneurysms and review of the literature. Neurosurg Focus. 2014 Feb;36(2):E7. doi: 10.3171/2013.11.FOCUS13475. PubMed PMID: 24484260.

6)

Dashti R, Laakso A, Niemelä M, Porras M, Hernesniemi J. Microscope-integrated near-infrared indocyanine green videoangiography during surgery of intracranial aneurysms: the Helsinki experience. Surg Neurol. 2009 May;71(5):543-50; discussion 550. doi: 10.1016/j.surneu.2009.01.027. Epub 2009 Mar 27. PubMed PMID: 19328531.

7)

Raabe A, Nakaji P, Beck J, Kim LJ, Hsu FP, Kamerman JD, Seifert V, Spetzler RF. Prospective evaluation of surgical microscope-integrated intraoperative near-infrared indocyanine green videoangiography during aneurysm surgery. J Neurosurg. 2005 Dec;103(6):982-9. PubMed PMID: 16381184.