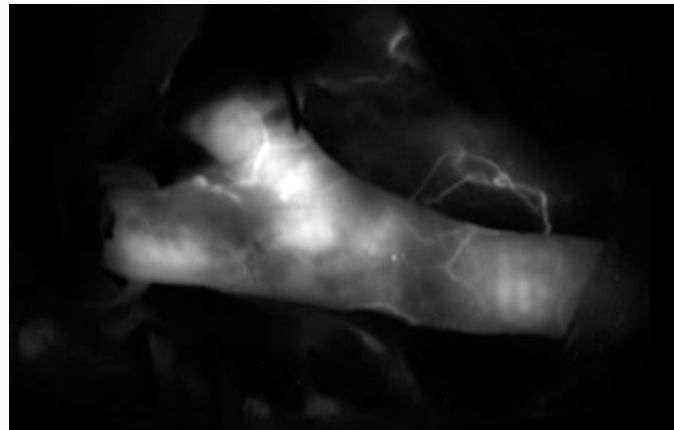


# Georgia Neurosurgical Society Spring 2015

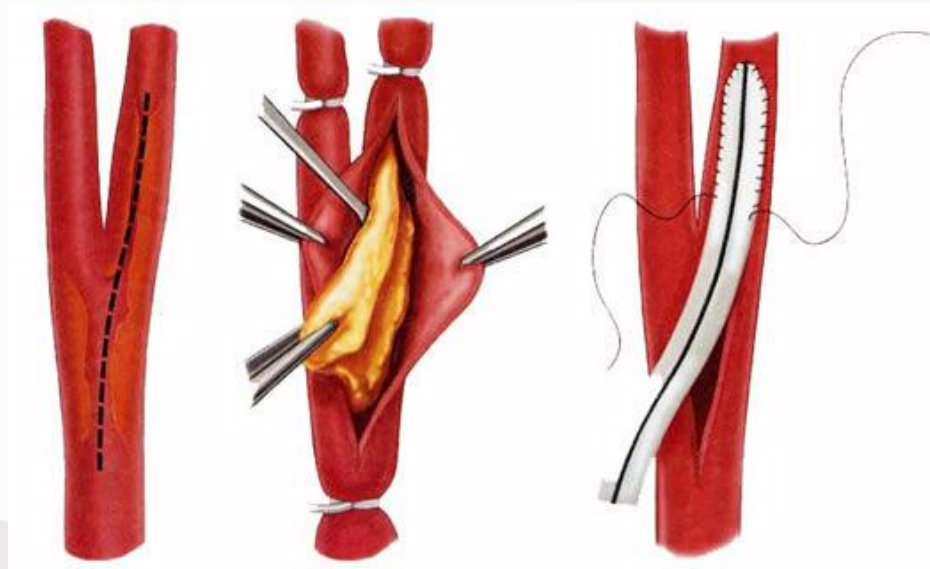


Intraoperative assessment of CEA using near-infrared  
indocyanine green videoangiography

Nathan Todnem

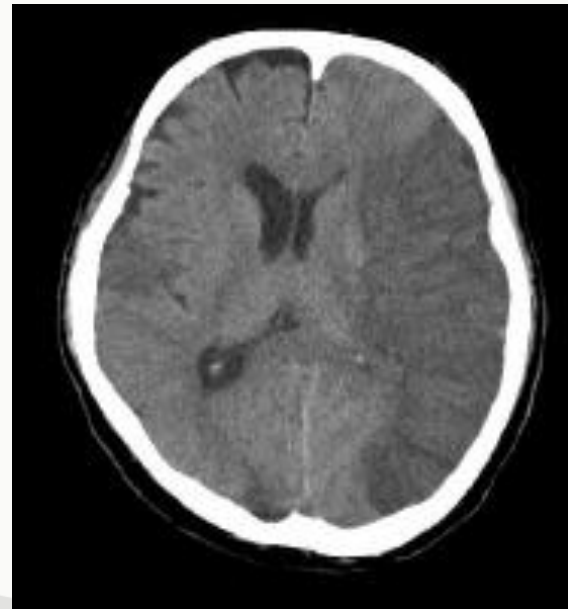
# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- The indications and benefits of CEA in the treatment of Carotid artery stenosis have been thoroughly evaluated and documented <sup>1,2</sup>



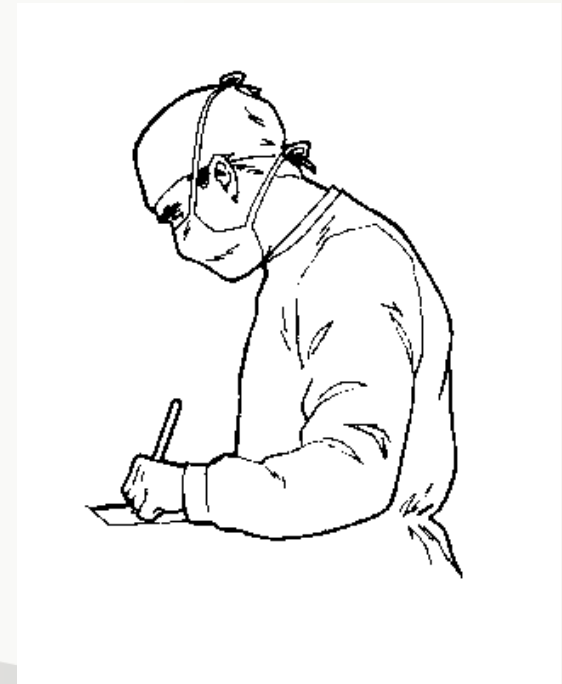
# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- In carefully selected patient, surgical intervention is known to be superior to medical therapy for both symptomatic and asymptomatic patients in the prevention of stroke <sup>1,2</sup>



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- The operative benefit is dependent on the surgeons ability to perform the procedure with a very low incidence of perioperative stroke.



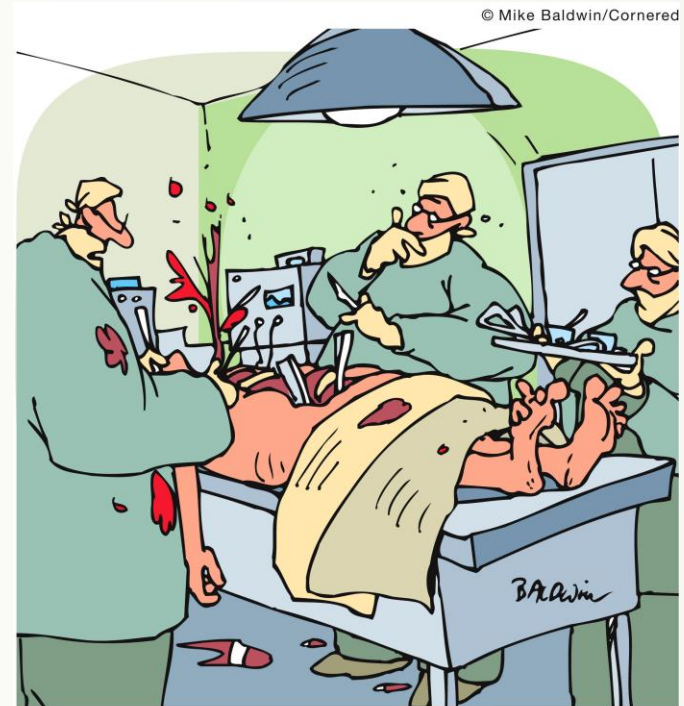
# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

-The goal is to achieve zero post operative strokes



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- Most perioperative strokes are due to thromboembolic events (63.2%) often secondary to technical defects identified on re-exploration and can frequently be preventable. <sup>4,5</sup>

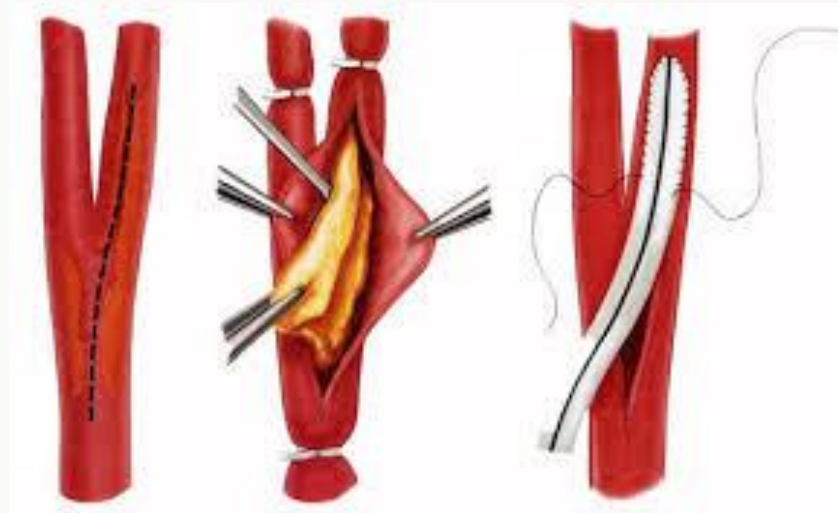


“Oh, man – how many times have I told you? Measure twice, cut once.”

# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

## Technical defects included-

- irregularities in the suture lines
- intimal flaps
- residual plaque
- thrombus
- dissection
- stenosis



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- Several studies have concluded that otherwise occult technical defects can be detected with with intraoperative imaging and effectively corrected to avoid post operative stroke. <sup>8-17</sup>





# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- By using intraoperative imaging- intraluminal defects are reported to occur in 6 - 30% of patients after CEA and the surgical intervention to correct these defects ranges from 3.5 – 10%<sup>8-17</sup>



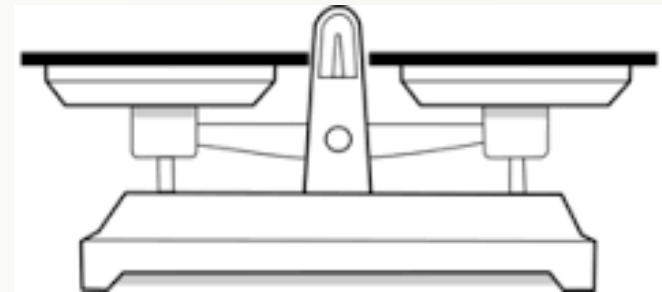
# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- The majority of all surgeons do not routinely use any type of formal imaging study and rely solely on technique and clinical inspection of the arterial repair.<sup>3</sup>



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- Traditional Intraoperative techniques for CEA evaluation include duplex U/S and arteriography
- Both intraoperative duplex and arteriography are found to have equivalent sensitivities for identifying major defects, but the sensitivity is believed to be higher for duplex (87% vs 59%) in identifying minor defects. <sup>18-23</sup>



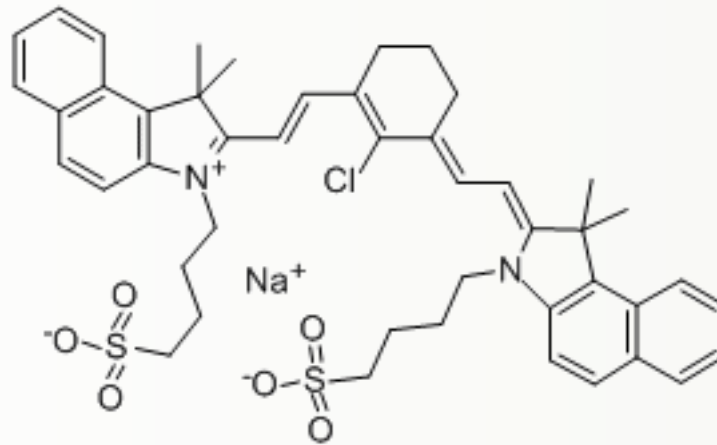
# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- We have begun to use intravenous ICGVA to evaluate for residual stenosis and technical defects during CEA surgery
- a real time technique for intraoperative flow assessment



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- ICG is a NIR fluorescent dye approved by the FDA in 1956 for cardiocirculatory and liver function diagnostic uses



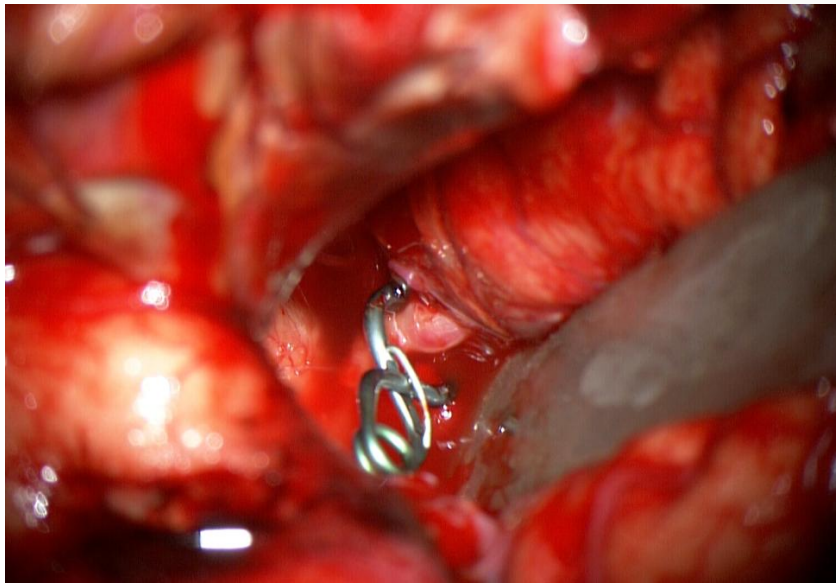
# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- Supplemental FDA approval for for ophthalmologist to asses retinal microcirculation in 1975



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- ICGVA was first reported in 2003 for aneurysm surgery





# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- Some believe routine use of ICGVA should be standard for vascular neurosurgeons when clipping aneurysms.
- Some institutions have abandoned angiography for ICGVA in evaluating clip placement and reserve post clip placement angiography for complex cases where ICGVA does not provide adequate evaluation.<sup>27</sup>

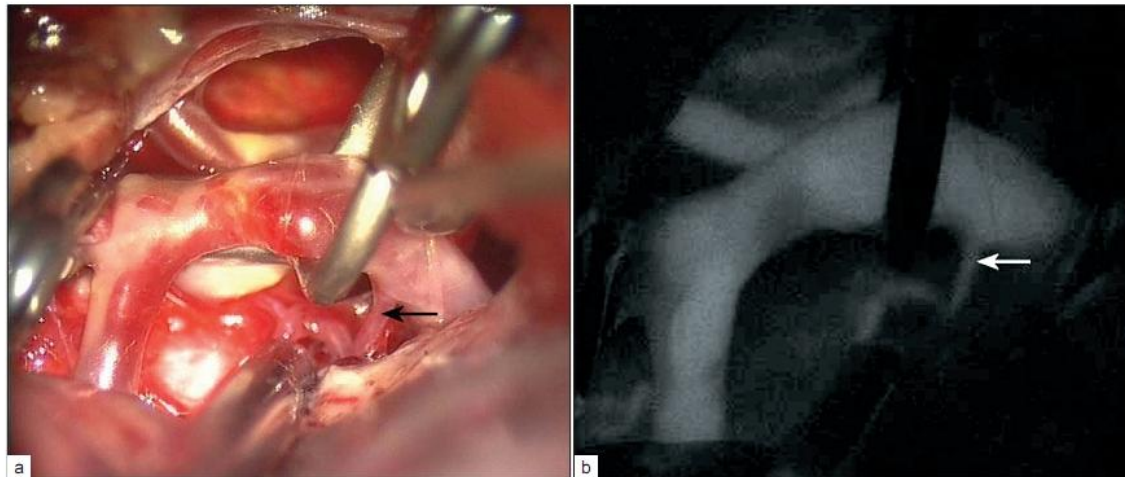


Figure 3 (a, b): Clipping the aneurysm definitively with two clips, intraoperative ICG angiography showing no stenosis of the PCA, aneurysm residual nor ICG traveling to the aneurysm body (the aneurysm was partly blocked by the clips), patency of the perforating artery toward the brainstem (arrow)



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- ICGVA has enhanced the efficacy and safety of aneurysm surgery <sup>28</sup>
- Because of its ease of use and reliability, some neurosurgeons have reported that ICGVA may replace angiography as the gold standard for intraoperative assessment of aneurysmal obliteration and patency of parent and perforating vessels <sup>28,29</sup>



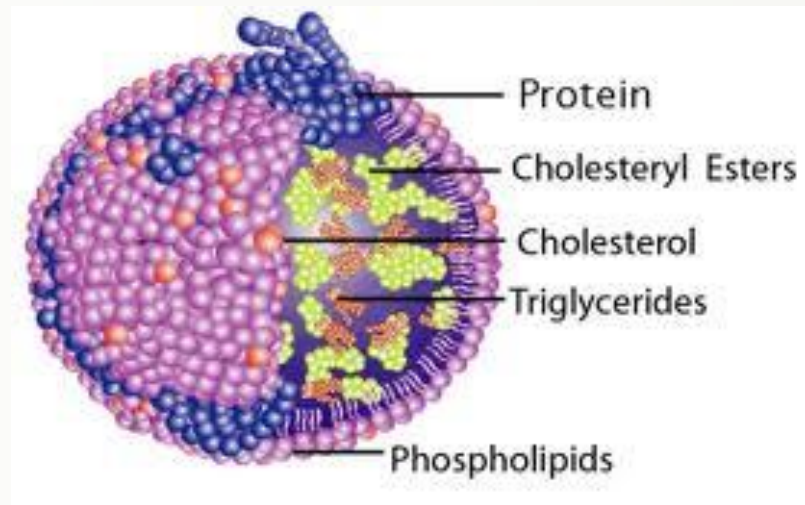
# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- The recommended dose for ICGVA is 0.2-0.5mg/kg and the maximal daily dose should not exceed 5mg/kg
- We used a standard dose of 25mg dissolved in 5ml water.



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

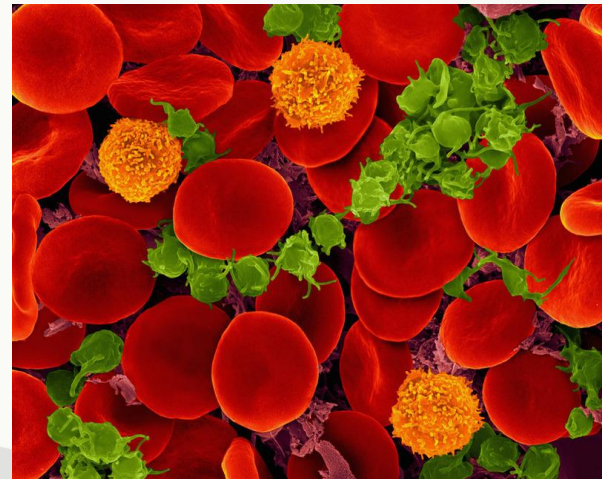
- After IV injection the ICG binds to globulins, such as alpha 1 lipoproteins within 1-2 seconds



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

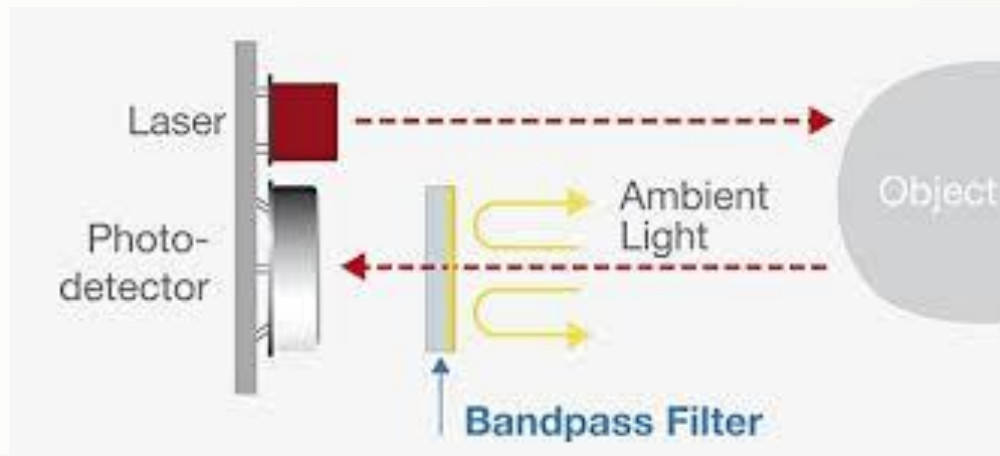
## ICG characteristics

- Remains intravascular
- Not metabolized
- Excreted by the liver
- Plasma  $\frac{1}{2}$  life is 3-4 min.
- Not reabsorbed and does not re-circulate<sup>24</sup>



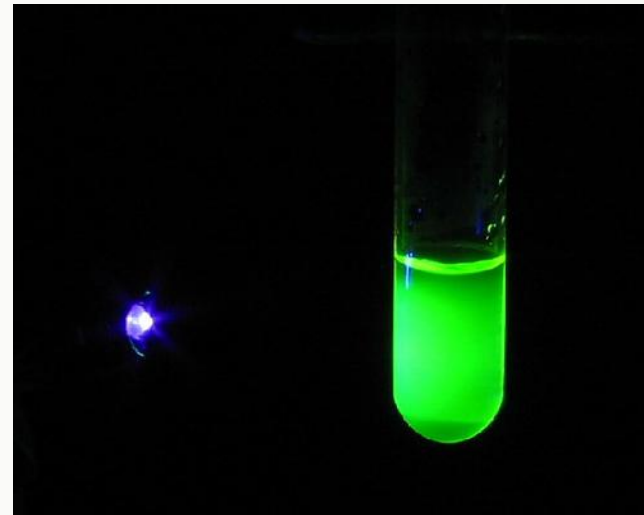
# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- NIR light is emitted by a laser source to induce ICG fluorescence.
- The fluorescence is detected and recorded with a digital video camera with an optical filter to block both ambient and laser light.



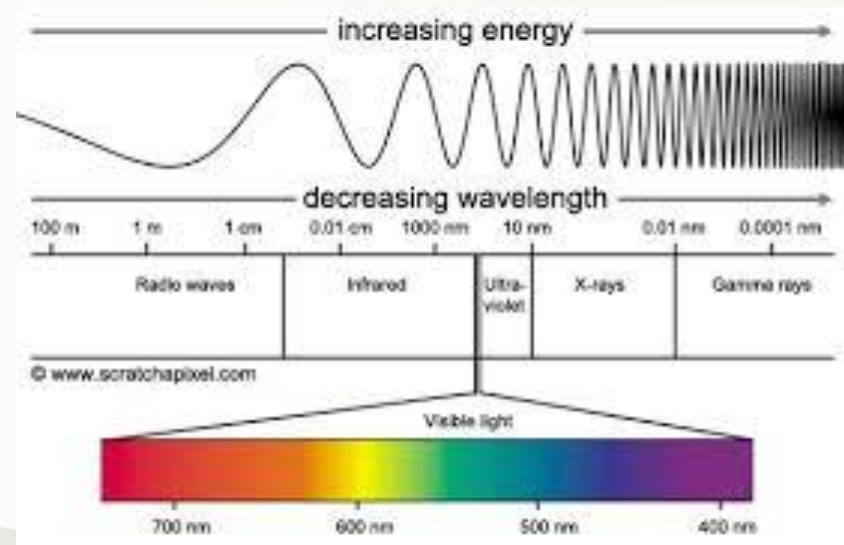
# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- Only the ICG induced fluorescence is observed.
- The images can then be reviewed in real time and saved.

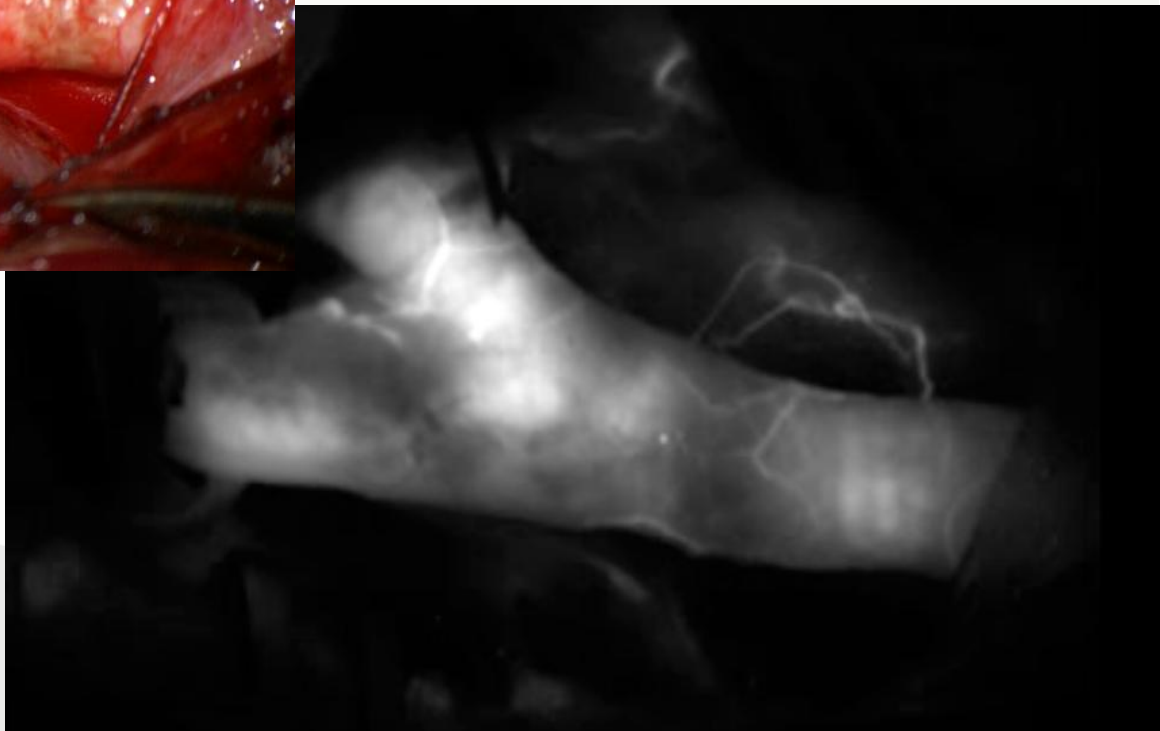
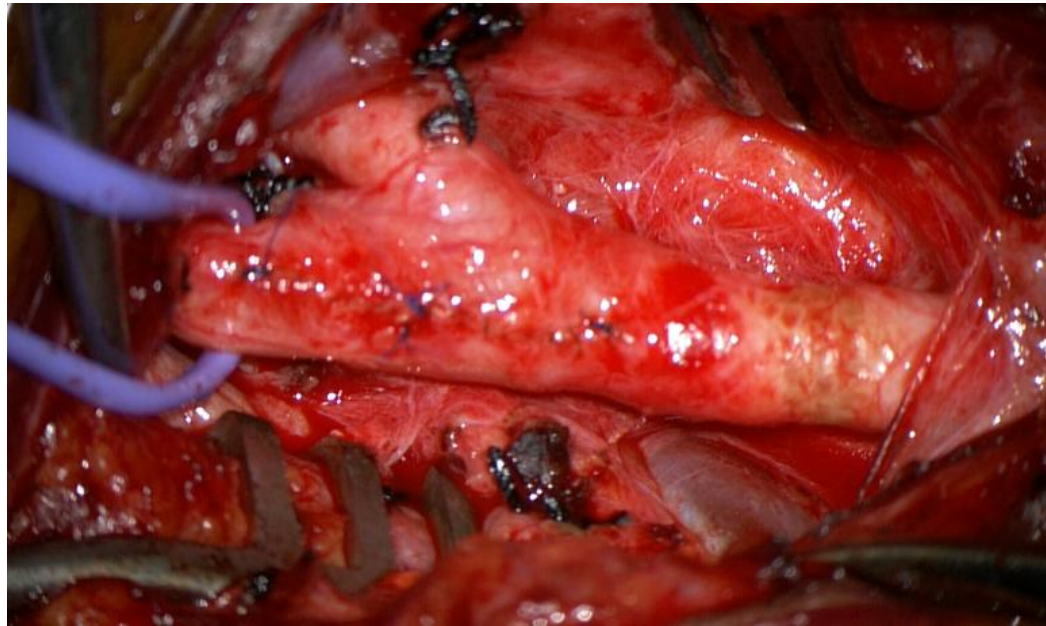


# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- The absorption and emission peaks of ICG (805 and 835nm)
- The NIR light penetrates several mm to a few cm through tissue



# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography





# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- **Japanese group- Haga et al. Near-infrared indocyanine green videoangiography for assessment of carotid endarterectomy 2011**
- 60 patients
- performed ICGVA before and after plaque excision and closure of ICA
- No side effects or allergic reactions
- 10-20sec latency after injection
- 22 exams were before arteriotomy- some case the exact area of stenosis was visualized before making the arteriotomy
- Added no more than 5 min to the usual operating time
- 30 days after the CEA there were no cerebrovascular events observed
- CT angiography was performed post op in all cases showing good correlation.
- Suggest using it before arteriotomy to determine excision range.
- They reported some spontaneous fluorescence from some of the vessels with very thick calcification and 1 vessel they were unable to clearly localize the area of stenosis before making the arteriotomy. <sup>25</sup>

# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- **Korean- Lee et al. An innovative method for detecting surgical errors using indocyanine green angiography during carotid endarterectomy: a preliminary investigation. 2012**
- 6 cases Excluded patients with previous drug allergy or hepatic dysfunction.
- performed ICGVA before and after the CEA.
- Before- They report observing the internal surface of the artery. They described severe stenosis as being visible by reduced signal intensity or signal distortions.
- After- checked for residual stenosis, atheroma, and new levels of flow
- All had greater than 60% stenosis, 3 were symptomatic and 3 were incidental.
- monitored 6 days post op- no adverse effects
- assessed blood flow for 30 seconds and followed up with doppler ultrasonography in all 6 cases. And were found to have flow within normal limits
- They report that in 1 of the 6 cases a technical error was discovered (fluttering atheroma) with ICG which required immediate repair which was not appreciated on US. They also report 1 patient had residual ICA stenosis distal to the endarterectomy site which was not appreciated with Doppler US<sup>26</sup>

# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

- **Conclusion** Intraoperative assessment of carotid endarterectomy using ICGVA could be used to enhance the safety and efficacy of CEA as it has with aneurysm surgery. This real-time technique for intraoperative flow assessment provides an alternative to intraoperative duplex and arteriography. ICGVA offers several advantages to intraoperative duplex and arteriography. There is no obstruction from needle punctures, as experienced in arteriography. No risk of traumatic dissection from contrast injection. No risk of air embolism. No radiation exposure for either the patient or the staff. This technique is already familiar to vascular neurosurgeons who perform aneurysm surgery and can easily be adapted to CEA. ICGVA is safe, easy to perform, interpret, and adds very little additional time to the procedure

# Intraoperative assessment of CEA using near-infrared indocyanine green videoangiography

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