Cutaneous angiosarcoma is a rare malignant neoplasm of endothelial cell origin, with a high rate of recurrence and significant risk of lymph node and systemic metastasis. It tends to occur in the head and neck region of elderly patients, presenting with what often looks like an enlarging bruise, a purple-black nodule, or an unhealed ulcer. The multicentric nature of the disease and extensive microscopic spread make gross assessment of the surgical margins difficult. Previous studies have reported that intraoperative frozen sections of the margins or Mohs surgery do not increase the likelihood of obtaining tumor-free margins. The overall survival rate is approximately 40%, whereas the disease-free survival rate is approximately 35% at 5-year duration. Poor prognostic indicators include positive excision margins, lesions >5 cm in size, and high histopathologic grade.

The commonest treatment is wide excision with adjuvant radiotherapy.

Fox and Wood first described the physical and physiologic properties of indocyanine green (ICG) in 1960. It is a tricarbocyanine dye with a molecular weight of 775, which strongly binds with proteins and does not easily escape from the capillaries. The first-pass effect in the liver is efficient and limits the recirculation phenomenon. ICG absorbs and reflects in the near-infrared portion of the spectrum 805 and 835 nm, respectively. Even if the fluorescence is only a small fraction of the excitation intensity, a good signal-to-noise ratio can be attained. A brightly fluorescing object, therefore, can be clearly seen on a dark background.

In plastic surgery, ICG fluorescence has been used to monitor blood flow in free and pedicled flaps and mastectomy skin flaps. Recent studies have reported excellent results using ICG videoangiography to evaluate blood flow in microsurgical resection of brain tumors. In our case, the Fluobeam clinical system was used. It is a handheld real-time ICG fluorescence imaging system manufactured by a French company Fluoptics.

We postulated that intraoperative ICG videoangiography may provide guidance on the gross extent of the macroscopic lesion and thus the excision margins of these vascular lesions.

**CASE REPORT**

An 81-year-old Chinese man presented to our Combined Cutaneous Oncology clinic with a discoloured plaque on his scalp of 6-month duration. The lesion gradually increased in size, without any ulceration or bleeding. The gentleman was being treated for hypertension and hyperlipidemia but was otherwise in good health. On examination, there was a 7×13-cm erythematoviolaceous plaque over the right parietal scalp with some bogginess on palpation and some depressed areas near the vertex (Fig. 1). The lesion demonstrated limited...
mobility over the skull. There was no palpable cervical lymphadenopathy.

An incisional biopsy revealed tumor cells dissecting the dermal collagen, forming anastomosing slit-like spaces containing red blood cells and was deemed to be compatible with a diagnosis of angiosarcoma. A subsequent Positron emission tomography-computed tomography with contrast demonstrated mild 2-deoxy-2-(18F)fluoro-D-glucose uptake (standardized uptake value max 4.0) over the area of the thickened lesion at the right parietal scalp, with no gross radiolabeled 2-deoxy-2-(18F)fluoro-D-glucose-avid metastases detectable. There was no evidence of cranial or intracranial involvement by the tumor. Blood tests including liver function tests were normal. In view of the apparently isolated cutaneous tumor and the patient’s good functional status, aggressive surgical treatment consisting of wide local excision with reconstruction with a free anterolateral thigh flap was performed.

The scalp was clipped just before surgery, and the visible extent of the lesion was marked carefully under good lighting using 3.5× magnification loupes. The lesion measured 13 cm at its widest and 8 cm perpendicular to this. An additional marking of 3 cm from the edges of the lesion was drawn to delineate the planned excision margins. An amount of 12.5 mg of ICG was injected intravenously, and a near-infrared fluorescence probe (Fluobeam) was held a meter away from the lesion; the main lesion “lit up” a few seconds after injection, and almost immediately, the signal extended further inferomedially (Fig. 2). The ICG washed out gradually from the lesion after half a minute.

Taking this immediate flaring of the signal inferomedially as a possible indication of extension of the lesion beyond the obvious macroscopic margin, an extra 1-cm margin was taken in addition to the 3-cm margin previously marked. The lesion was excised to include the pericranium under the extent of the macroscopic lesion; the resultant defect was 13 × 18 cm. An anterolateral thigh flap with 2 intramuscular perforators was harvested from the left thigh and inset into the defect, with the pedicle anastomosed with the right superficial temporal artery and vein (Fig. 3). A partial thickness skin graft from the right thigh is used to cover the cutaneous defect of the left thigh.

Microscopic examination demonstrated spindle-shaped cells and some bizarre tumor cells dissecting the dermal collagen in a background containing extravasated red blood cells, hemosiderin deposits, lymphocytes, and plasma cells (Fig. 4). The spindle and atypical cells stained positive for cluster of differentiation 31 and cluster of differentiation 34 but negative for S-100 and AE1/AE3, supporting the diagnosis of angiosarcoma. The lesion was found to be completely excised with all the peripheral and deep margins >2 cm. With reference to inferomedial margin, the distance between tumor cells and the resection margin measured 2.7 cm.

Fig. 1. A huge 7×13-cm erythematoviolaceous plaque over right parietal scalp.

Fig. 2. Bright signal emitted from the scalp angiosarcoma after ICG injection. Arrow shows inferiomedial extension of the tumor as highlighted by the ICG dye.

Fig. 3. Day 1 after operation: scalp defect reconstructed with free anterolateral thigh flap.
No ICG-related adverse effects were observed. The patient recovered uneventfully and was discharged home on day 19 after the operation.

**DISCUSSION**

Since 1956, ICG has been approved for clinical use. It has been adopted for a variety of different clinical applications including retinal angiography, evaluation of intracranial blood flow, assessment of liver function, burn wound severity, sentinel lymph node biopsy, lymphography, and flap viability in perforator flap reconstruction. We decided to test the use of ICG videoangiography for the guidance of cutaneous vascular tumor resection.

After injection of ICG through peripheral venous access, the tumor is quickly filled with ICG dye and then, which under excitation, fluoresces. This allows the demarcation of the richly vascularized tumor from the surrounding normal tissue; the signal washes away within a minute. Video recording facility allows the results to be reviewed.

Clinical assessment of the macroscopic margins of cutaneous angiosarcoma can be misleading because of its multifocality and lateral spread. This case clearly illustrates how lesion delineation can be improved using ICG videoangiography.

In our case, we aimed to take a margin of 3 cm around the macroscopic border; however, we took an extra 1 cm inferomedially on account of the flare. In the end, microscopic examination demonstrated the microscopic clearance to be 2.7 cm at this point, which means that the microscopic margin correlated well with the extent of the flare and actually extended 1.3 cm beyond the visible microscopic margin.

**SUMMARY**

Achieving an adequate clear resection margin is an important determinant of disease recurrence and survival in angiosarcoma. The histopathologic finding in this case supports the use of intraoperative ICG in determining tumor extension and an additional 1 cm of margin inferomedially, which did not add any significant morbidity. Obviously, further work is required to clarify the exact correlation between the flare pattern and the tumor margins. Currently, the findings need to be used judiciously, particularly when significant additional morbidity would be involved.

**REFERENCES**

1. Pawlik TM, Paulino AF, McGinn CJ, et al. Cutaneous angiosarcoma of the scalp: a multidisciplinary approach. *Cancer* 2003;98:1716–1726.
2. Guadagnolo BA, Zagars GK, Araujo D, et al. Outcomes after definitive treatment for cutaneous angiosarcoma of the face and scalp. *Head Neck* 2011;33:661–667.
3. Kashyap A, Huntly M, Luft WC. An aggressive approach to an aggressive malignancy: a case report. *Vasc Endovascular Surg*. 1995;29:427–434.
4. Alander JT, Villet OM, Pätilä T, et al. Review of Indocyanine Green Imaging in Surgery. In: Dip DF, Ishizawa T, Kokudo N and Rosenthal JR (eds). *Fluorescence Imaging for Surgeons: Concepts and Applications*. Springer International Publishing; 2015:35–53.
5. Holm C, Tegeler J, Mayr M, et al. Monitoring free flaps using laser-induced fluorescence of indocyanine green: a preliminary experience. *Microsurgery* 2002;22:278–287.
6. Holm C. Perfusion zones of the diep flap revisited: a clinical study. *Plast Reconstr Surg*. 2006;118:816–817.
7. Kim EH, Cho JM, Chang JH, et al. Application of intraoperative indocyanine green videangiography to brain tumor surgery. *Acta Neurochir (Wien).* 2011;153:1487–1495; discussion 1494.
8. Kaiser M, Yafi A, Cinat M, et al. Noninvasive assessment of burn wound severity using optical technology: a review of current and future modalities. *Burns* 2011;37:377–386.
9. Polom K, Murawa D, Rho YS, et al. Current trends and emerging future of indocyanine green usage in surgery and oncology: a literature review. *Cancer* 2011;117:4812–4822.

**Fig. 4.** Histology of the lesion showed spindle-shaped cells and some bizarre tumor cells dissecting the dermal collagen in a background containing extravasated red blood cells, hemosiderin deposits, lymphocytes, and plasma cells. The findings are diagnostic for angiosarcoma (photograph acknowledgment: Aljawder A. Anwar Abdulla, Department of Anatomical and Cellular Pathology, Prince of Wales Hospital, Sha Tin, New Territories, Hong Kong).