Fluorescence-Guided Surgery (FGS) in Skin Cancer

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BACKGROUND

- **Skin cancer** is one of the most common cancers in the UK.
- **Surgical resection** is the main treatment of **non-melanoma skin cancer (NMSC)** and **melanoma skin cancer (MSC).**
- Identifying **tumour margins** remains difficult and can result in follow-up surgery if residual cancer is found [1]. Alternatively, over-excision results in the **loss** of **healthy skin tissue**, this is especially pertinent in sensitive areas, such as around the nose, eyelids and lips.
- **Mohs micrographic surgery (MMS)** is the gold standard for NMSC, however only 39 UK centres offer MMS [2].
- **Fluorescence-guided surgery (FGS)** is an emerging imaging-guided surgical technique that enables real-time visualisation of tumour margins and has been applied in other cancers in various surgical applications, such as in the identification of **solid tumour margins and sentinel lymph node (SLN) mapping** [1,3], however its use in skin cancer is uncommon.

HOW IT WORKS?

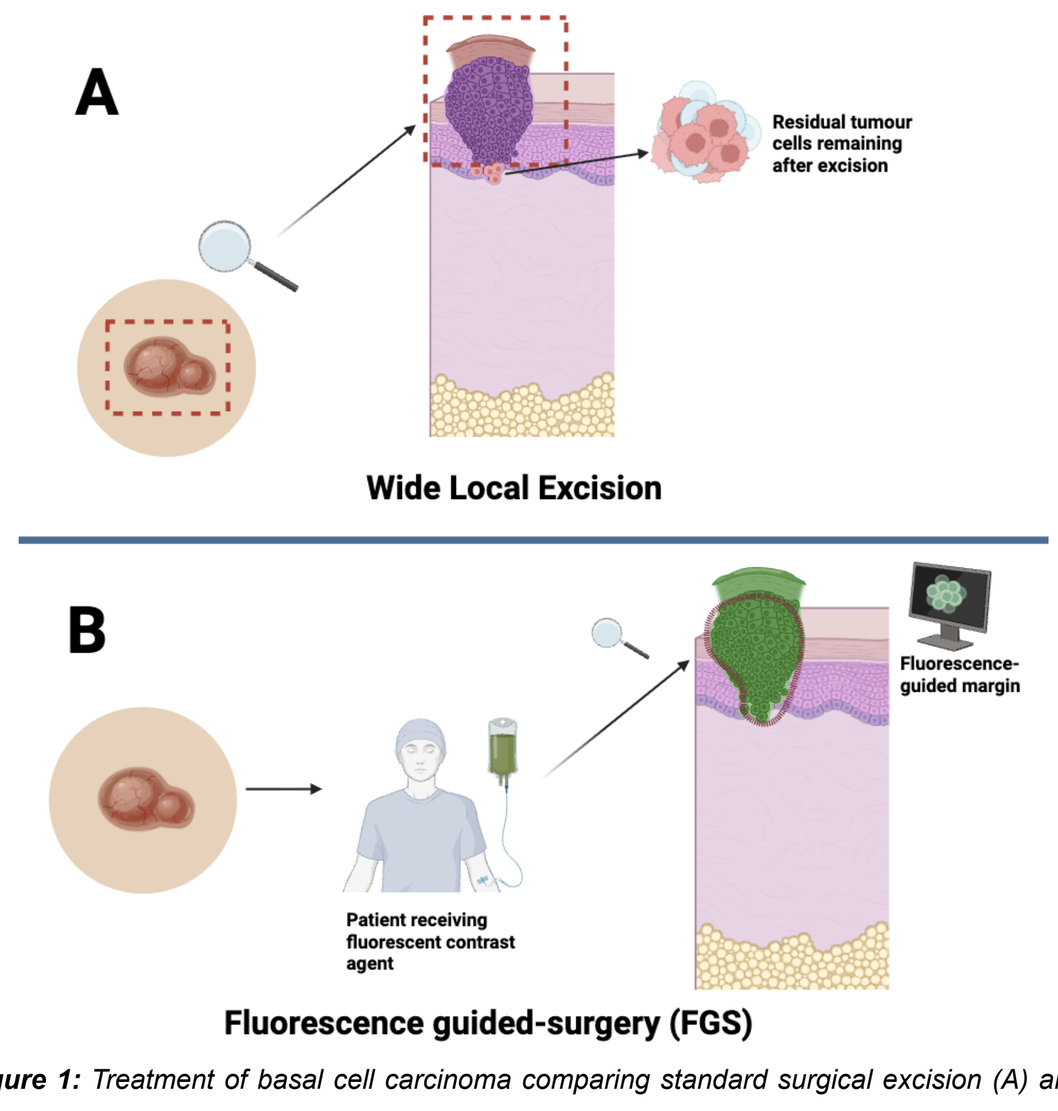

Figure 1: *Treatment of basal cell carcinoma comparing standard surgical excision (A) and fluorescence-guided surgery (B).* ***Image created in https://BioRender.com.***

- A fluorescent dye **(fluorophore)** is administered to the patient commonly via the **intravenous or topical** route. Examples include indocyanine green (ICG), 5-aminolevulinic acid (5-ALA) and Methylene blue [4].
- The fluorophores accumulate in areas of **increased vascular permeability**, such as in **tumour cells** [3].
- When illuminated with light of a specific **wavelength**, the the dye emits fluorescence at a longer wavelength [3].
- The emitted light is captured by the machine and displayed on a monitor, where surgeons can see the tumour cells and margins in real time [3].

ADVANTAGES and DISADVANTAGES

Advantages	Disadvantages
Allows **real-time visualisation** of tumour margins [5].	Common fluorophores (e.g. ICG and methylene blue) are not **tumour-specific** and may produce **false-positive** signals in non-cancerous tissue, such as inflamed tissue [3].
Unlike Moh's surgery, FGS avoids the need for **multiple biopsies** or **frozen-section analysis [5].**	Fluorophore **tissue penetration is limited** (PpIX <1 mm[6], ICG = 5–10 mm[7]).
FGS can reduce the risk of **residual tumour cells** and cancer recurrence[1].	Clinical research of FGS in skin cancer treatment remains **limited**.
Machines are **portable**, have a **high sensitivity** and a lower **cost**.	ICG fluorescence requires a **dark environment [5].**

Current use of FGS in skin cancer

- A case series used **5-ALA imaging** to identify surgical margins in patients with **BCC, SCC and lentigo maligna**. The margins identified led to **complete excision** in all cases [8].
- **Zhou et al.(2023)** investigated the use of **ICG fluorescence-guided imaging (FGI)** in the management of SCC. They found a significant difference in **biopsy accuracy** (88.4% with FGI vs 66.1% without FGI). However, the difference in the **cancer recurrence** rate was not significant between the groups. (9.4% with FGS vs 11.4% without) [5].
- Other studies showed that ICG fluorescence imaging had a **high sensitivity** for **sentinel lymph node biopsy** in skin cancer. [5,9,10].

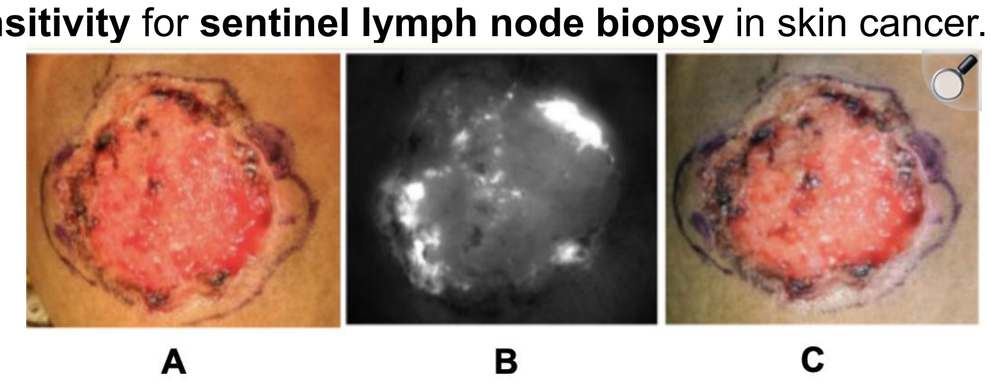

Figure 2: *Squamous cell carcinoma of the scalp. (A) Preoperative image. (B) Fluorescence image. (C) FGI-defined surgical margins. No recurrence at last follow-up.* ***Adapted from Zhou et al. (2023).***

CONCLUSION

Fluorescence-guided surgery (FGS) is a promising tool for biopsy selection, sentinel node biopsy, and tumour excision in skin cancer. **Larger multicentre RCTs** are required to validate its clinical use.

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- Figure 1 was created in https://BioRender.com
- Figure 2 adapted from Zhou (2023). Reference 5.
- AI was used to assist with research and to make text more concise.