

Improved Outcomes in Surgical Reconstruction of Skin Defects: A Case Series Utilizing Fluorescence Imaging for Infection Management and Wound Bed Preparation

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Introduction and Background

- Surgical reconstruction for complex chronic wounds requires meticulous wound bed preparation to minimize postoperative complications.
- Non-viable tissues, pathogenic bacteria, and biofilms must be removed to prevent post-operative infections.
- Traditional methods of wound assessment frequently fail to identify bacteria and biofilms [1,2], and historically post-operative infection rates can reach up to 50% [3], often prolonging healing times and leading to sub-optimal outcomes.
- Point-of-care fluorescence imaging (MolecuLight®) has emerged as a promising tool for real-time infection detection and management, potentially improving outcomes in skin and soft tissue reconstruction.

This case series aims to evaluate the impact of intraoperative fluorescence imaging for guided wound bed assessment and preparation for surgical reconstruction, with a focus on minimizing postoperative complications and improving healing rates.

Material and Methods

- A fluorescence (FL) imaging device (MolecuLight iX) was utilized during complex wound cases involving surgical debridement, reconstruction, and skin graft or substitute placement.
- Positive FL indicated the presence of pathogenic bacterial loads >10⁴ CFU/g.
- Red FL indicated Gram +/- bacteria and cyan FL indicated *Pseudomonas aeruginosa*, while normal tissues fluoresced green.



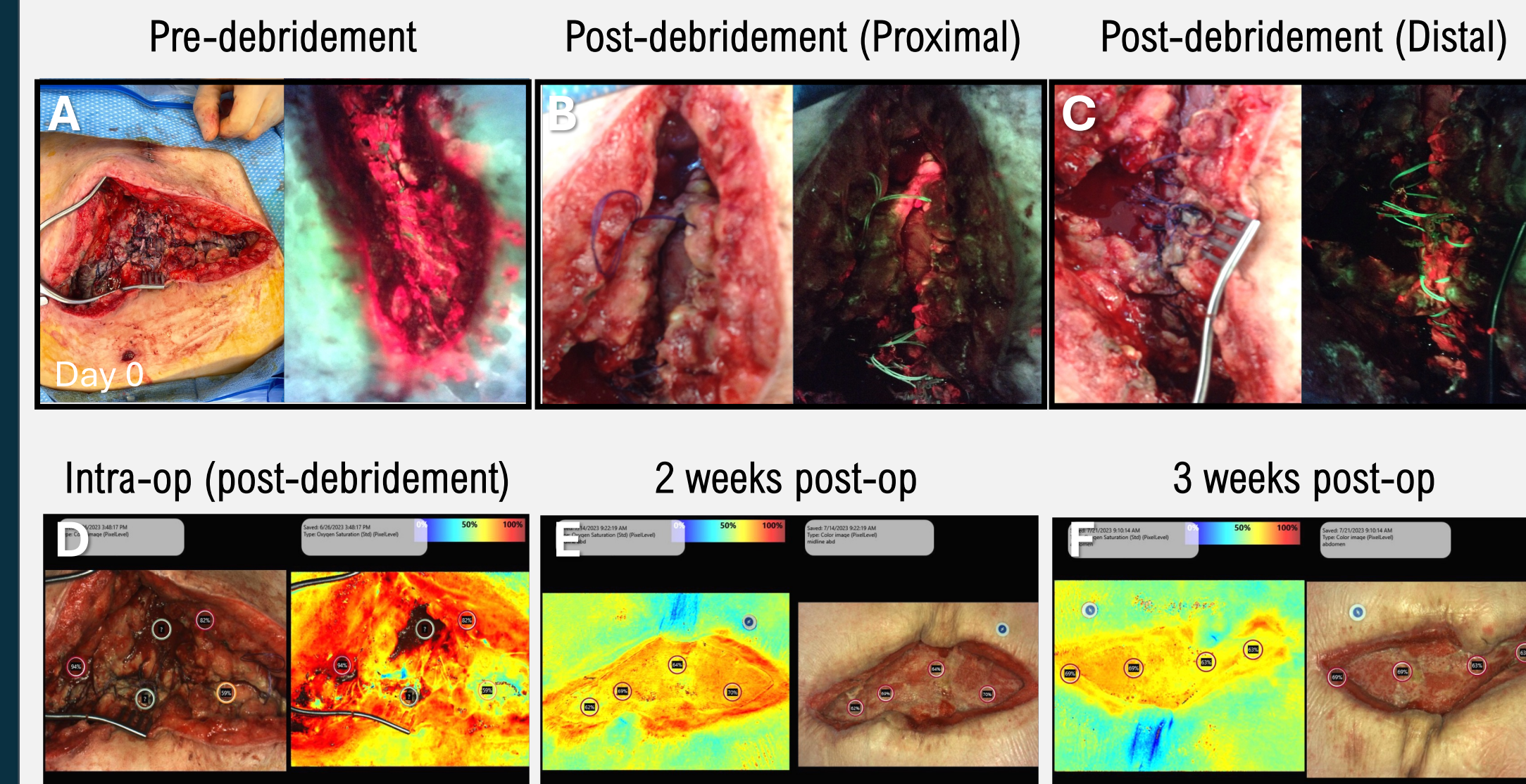
Caution must be exercised when FL imaging near tendons and bones, as they may appear similar to cyan FL signals. To reduce uncertainty, standard and FL images must be compared to rule out the presence of these structures.

Here, we present 4 case examples of the utilization of FL imaging technology in the guidance of intraoperative debridement.

Conclusions

- The intraoperative use of FL imaging helped confirm the adequacy of surgical debridement regarding the presence of pathogenic bacteria/biofilm and prompted additional intraoperative excision in 3 of the 4 cases.
- In all cases, surgical healing progressed with no postoperative infection or complications.
- FL imaging is a valuable adjunct in the surgical management of skin defects to help reduce postoperative complications.
- By objectively assessing the wound bed and confirming the adequacy of wound bed preparation, FL imaging enables more complete bacterial removal and may lead to more successful surgical intervention.
- Further investigation of the impact of FL on postoperative outcomes in larger, controlled studies is needed.

Case 1 – Complex Abdominal Wound



Case Summary:

Intraoperative FL imaging revealed the presence of heavy bioburden as indicated by red FL signals. Following targeted debridement by FL imaging, a decrease in red signals was noted. The wound was left to heal by secondary intention while monitoring tissue perfusion via NIR imaging. At 3-weeks post-op, the wound was progressing well.

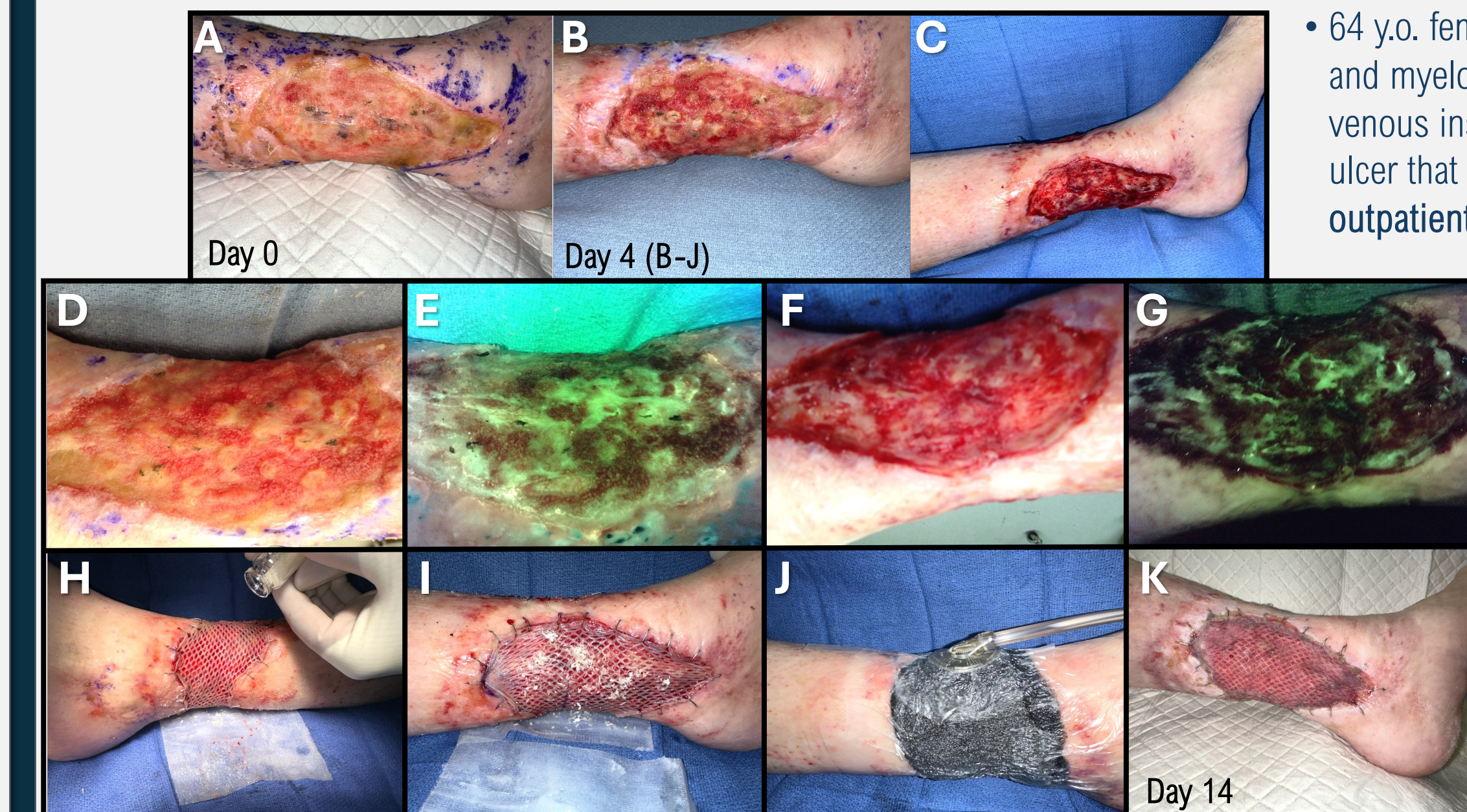
- Patient discharged and NPWT continued as outpatient.
 - NIR imaging (Kent Imaging) used to monitor tissue perfusion as an indication of healing (D).
- 2-3 weeks post-op:**
- Wound progressed towards healing by secondary intention, no reconstructive procedures were needed(E-F).

Treatment:

Day 0:

- Inpatient wound care consultation secondary to wound dehiscence with purulence.
- Admitted as inpatient, started on IV antibiotics and NPWTi-d.
- Taken to OR for excisional debridement.
- Intraoperative FL imaging identified strong red FL signals (A), which were targeted with FL-guided debridement (B-C).

Case 2 – Venous Leg Ulcer Left Lower Extremity



Case Summary:

Despite previously unsuccessful outpatient wound management without FL imaging, intraoperative FL imaging was effective in identifying and targeting bacterial hot spots for debridement, which required multiple rounds, leading to the successful placement of skin allografts with healing progression and no complications.

- 64 y.o. female with a history of deep vein thrombosis and myelodysplastic syndrome presented with venous insufficiency and a long-standing venous leg ulcer that had failed to progress despite standard outpatient wound management.

Treatment:

Day 0:

- Admitted as inpatient (A), started on IV antibiotics and NPWTi-d (B).

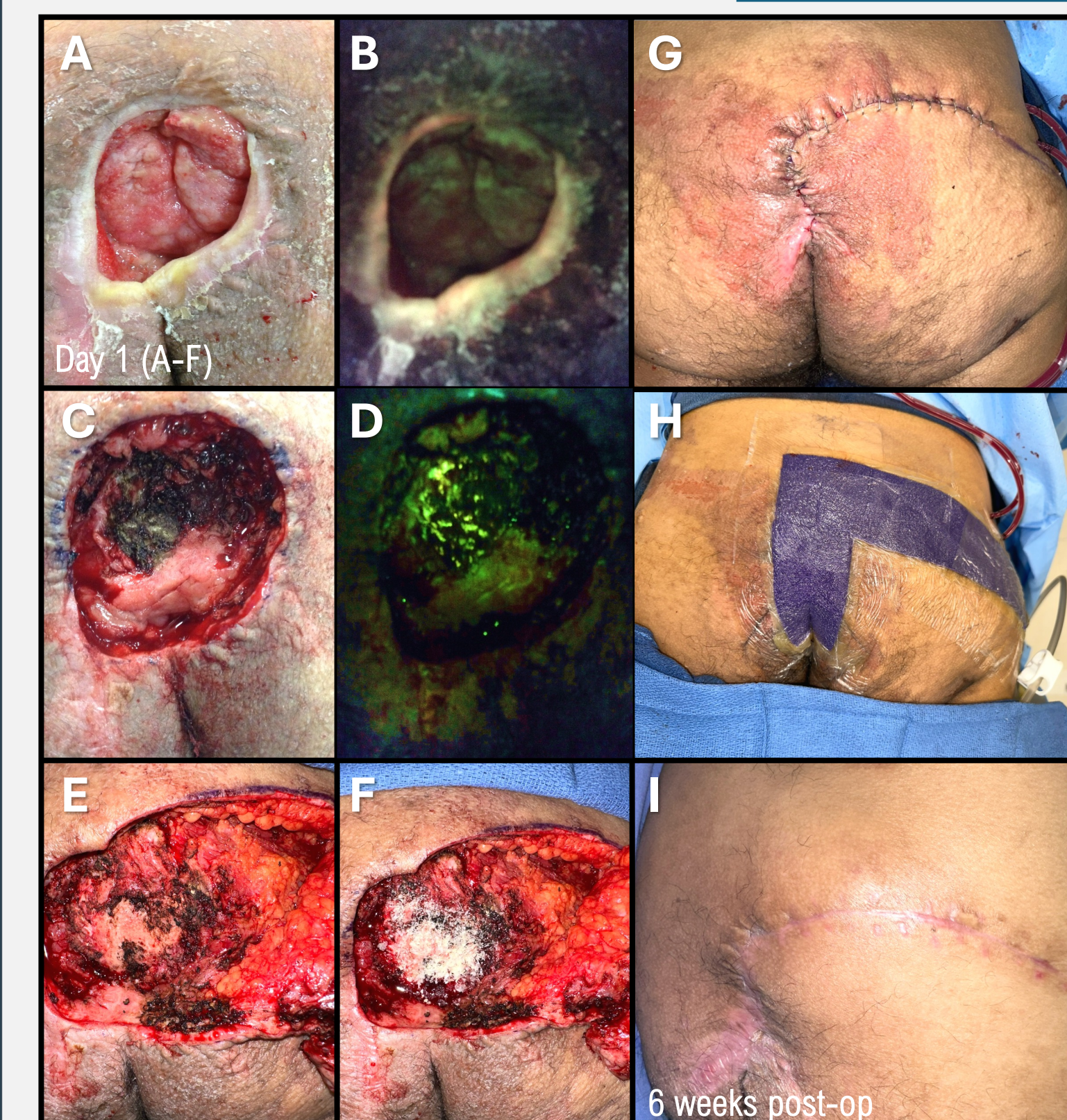
Day 4:

- Taken to OR for excisional debridement (C) guided by intraoperative FL imaging (D-E).
- Residual FL signals prompted additional FL-guided debridement (F-G) until FL negativity was achieved.
- Surgical reconstruction performed with split-thickness skin graft and placental allograft placed to optimize healing (H-I).
- NPWTi continued for 7 days postoperatively (J).

Day 14:

- Wound on healing trajectory (K).

Case 3 – Stage 4 Sacral Ulcer



- 31 y.o. male with a medical history of paraplegia post-GSW, neurogenic bladder and bowel, deep vein thrombosis, and a previous surgical history of a sacral flap surgery (2012).
- The patient presented for surgical wound reconstruction of a stage 4 sacral ulcer with previous infection and abscess.

Treatment:

Day 1:

- Taken to OR for ulcer excision and flap reconstruction.
- Fluorescence imaging identified red and yellow signals on the periwound (arrows), which were promptly debrided (A-B).
- Ulcer excised with partial osteotomy (C). Further excision until residual red fluorescence was eliminated (D).
- Surgical reconstruction performed with flap advancement (E).
- Placental allograft placed to optimize healing (F).
- Wound was closed (G) and NPWT utilized for incisional management (H), initiated immediately following closure.

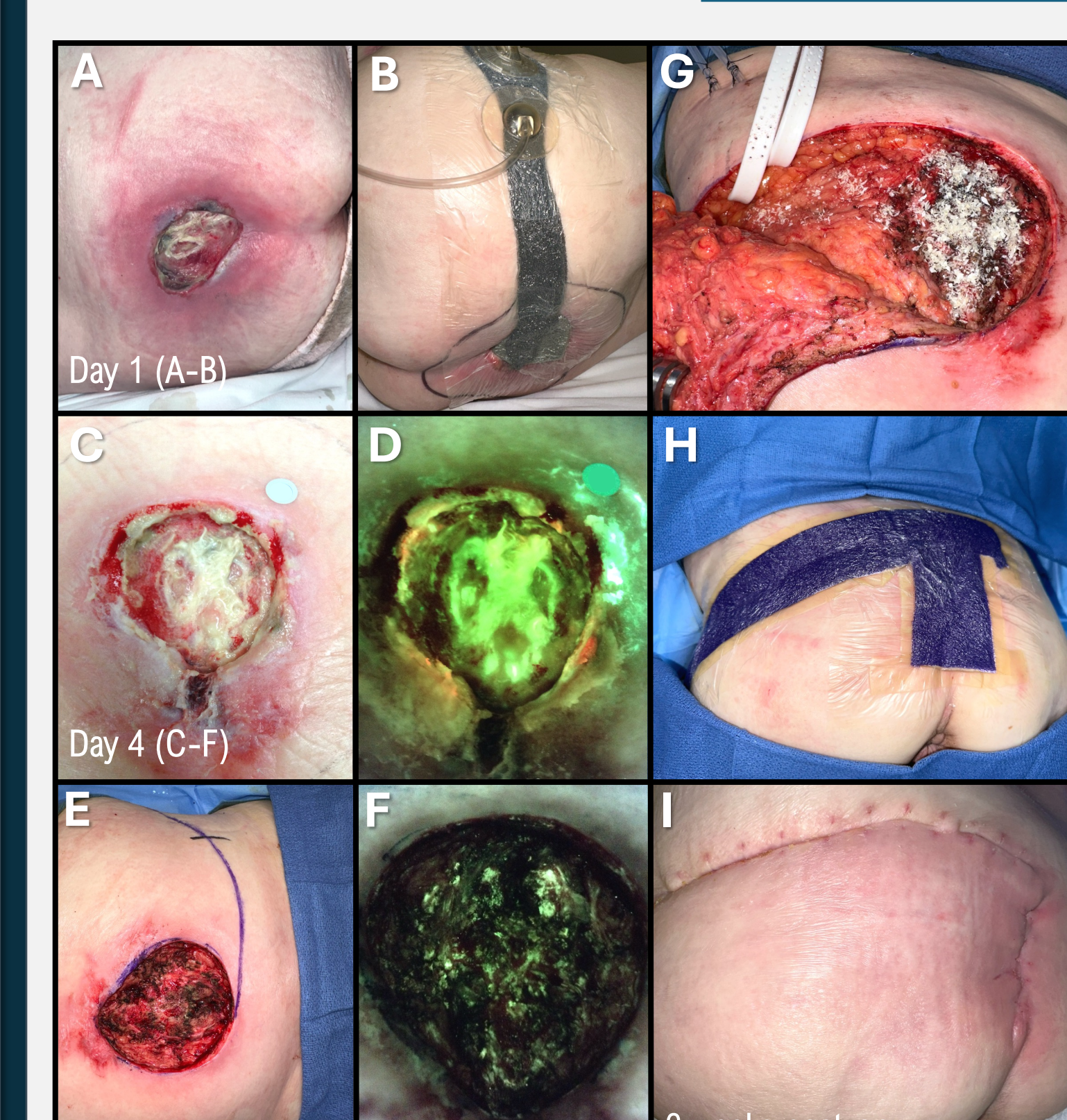
6 weeks post-op:

- Incision has healed well with no complications or infections (I).



Case Summary: Bacterial burden in this stage 4 sacral was promptly identified by FL imaging, which prompted further excision to reduce bacterial burden in order to optimize the wound bed for successful flap reconstruction.

Case 4 – Stage 4 Infected Sacral Ulcer



- 86 y.o. female with a history of end-stage multiple sclerosis, secondary paraplegia, and type 2 diabetes presented with a stage 4 sacral ulcer with active infection.

Treatment:

Day 1:

- Admitted as inpatient (A), started on IV antibiotics and NPWTi-d (B).

Day 4:

- Taken to OR for ulcer excision and flap reconstruction.
- FL imaging assessed bacteria/biofilm presence and location and guided initial debridement (C-D).
- Persistent FL prompted further debridement until complete removed (E-F).
- Surgical reconstruction performed with flap advancement and placental allograft was applied to optimize healing (G).
- NPWT utilized for incisional management immediately following closure (H).

6-weeks post-op:

- Wound healed without complications or infection (I).



Case Summary: In a sacral ulcer with an active infection, multiple rounds of FL-guided debridement led to the complete elimination of bioburden and prevented infectious complications post-reconstruction.