The Expanding Role of Fluorescent Angiography in Wound Care and Limb Preservation

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Disclosures

- Member of Novadaq speakers bureau
- Member of KCI speakers bureau
- The opinions or assertions contained here in are the private views of the author and are not to be construed as official or reflecting the views of the Department of the Army or the Department of Defence
Measurement of Tissue Perfusion

- Critical to every component of a limb preservation initiative: Vascular, Podiatric and Wound care
Measurement of Tissue Perfusion

- Clinical Judgment
- ABIs, Toe Pressures, Toe Wave Forms
- Forefoot PVR
- Duplex scan
- tcPO2
- SPP
Measurement of Tissue Perfusion

- Current methods utilized to evaluate tissue perfusion are often limited by medial calcinosis, scarring, wounds, prior amputations and infection.
- Current methods can be technically challenging, costly and time consuming and don’t measure global perfusion of the foot.
- Fluorescent Angiography offers an additional option to measure tissue perfusion.
Fluorescent Angiography

Visualize and quantify micro circulation
See what the eye can’t see
 Definitions

- Fluorescent angiography is a diagnostic technique that uses IV fluorescent dye Indocyanine Green (ICG) injected IV to allow the sequential visualization of skin perfusion
Indocyanine Green

- Strong record of safe clinical use
- Excreted hepatically – not contraindicated in patients with compromised renal function
- 3-5 minute half-life
- Only contraindication – should be used with caution in patients that have a history of sensitivity to iodides
Fluorescent Angiography

Following IV injection of cyanine fluorescent dye, a fluorescence imaging system provides clinicians with a real-time visual assessment of tissue perfusion in patients.
Currently utilizing Imaging in our outpatient Vascular/LPS/Wound Care clinic and also utilizing imaging in the OR with any procedure requiring a flap.
Clinical Applications of Fluorescent Angiography in Limb Preservation

- **Clinic**
  - Assess baseline skin perfusion
  - Assess perfusion pre and post vascular intervention
  - Predicts wound healing
  - Predict level of healing (Amputations)
  - Aid to Debridement and assessment of advanced wound care modalities

- **OR**
  - Assess viability of flaps – pre and post closure
Vascular Interventions

- Fluorescence Angiography can help answer critical questions
  - Is revascularization required
  - Did revascularization provide adequate tissue perfusion to the involved angiosome
  - If a procedure is planned following revascularization, when is maximal perfusion established – timing of a podiatric procedure
History

- 72 y/o male with severe ischemic rest pain L foot and an ulcer between 4\textsuperscript{th} and 5\textsuperscript{th} toes and an ulcer at base of 5\textsuperscript{th} toe
- 19 Aug 2014 – arteriogram with placement of 8x61 self expanding iliac stent
- **Fluorescent Angiography** studies obtained prior to intervention and in subsequent days
8/18/2014 - Rest Pain with Dependent Rubor and Pallor on Elevation

Dependent Rubor

Pallor on Elevation
Pre Treatment and Immediate post treatment
101% improvement in Ingress rate
Immediate post treatment compared to 1 day post treatment.
Perfusion continued to improve with a 35% improvement in ingress.
The role Fluorescent Angiography in Vascular Surgery

- Assess the need for revascularization
- Assesses adequacy of perfusion following revascularization – involved angiosome
- Assesses time of maximum perfusion – aids in timing of a secondary procedure
Assessing Perfusion to Determine Amputation Level
Hallux Amputation for Gangrene
Osteomyelitis, cellulitis and abscess
History

- 79 y/o diabetic male with multiple comorbidities admitted with gangrene, osteomyelitis and cellulitis right great toe and dorsal foot
- 2-3 week history of pain and swelling
- Poor historian – not sure of trauma
- History of DVT with chronic venous insufficiency, PAD and atrial fibrillation
History

- Positive blood cultures for MRSA
- Started on Broad spectrum IV antibiotics with resolution of cellulitis on dorsum of foot
- 4 Feb 2015 – Right hallux amputation
Pre-op
Pre-op
Pre-op MRI

- Abscess surrounding the flexor hallucis longus
- Tendon is concerning for infective tenosynovitis
- Moderate osteoarthritis of the right foot.
Pre–op Vascular Assessment

- ABIs – non compressable vessels with ABIs greater than 1.5
- Biphasic wave forms at right ankle
- Right toe pressure not obtainable
Management Questions

- Does the patient need a CTA, or Arteriogram
- If these studies are performed does he need vascular intervention – (vascular disease will be seen)
- Based on the arterial studies should a BK be performed
Pre–op Fluorescence Angiography
Intra-Op Fluorescence Angiography
Amputation

Flap revision following intra-op Fluorescence Angiography
Amputation following excision of ischemic distal flap
Amputation

Flap Closure
Fluorescence Angiography Following Closure
Post Op

2 days po

5 days po
The use of fluorescent angiography in limb salvage

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INTRODUCTION

Peripheral arterial disease is a critical component of morbidity and mortality related to pedal ulcerations. Non-invasive vascular testing is the first step in determining a viable level of amputation when a patient presents with a diabetic foot ulceration compromised by arterial insufficiency. Current non-invasive vascular testing methods have significant limitations. The cases above demonstrate how non-invasive vascular studies would have prompted for a higher level of amputation. However, the use of fluorescence angiography revealed adequate distal perfusion resulting in a more distal procedure for limb salvage. Fluorescent angiography is a useful tool to assess areas of viability and determine a level of amputation most likely to heal. The procedure is an easily reproducible qualitative study which is minimally invasive, with minimal patient risk that can be used in patients with renal insufficiency to provide site specific assessment of cutaneous arterial perfusion for limb salvage procedures.

DISCUSSION

A 92 year-old male with a past medical history significant for: gout, venous insufficiency, peripheral vascular disease, uncontrolled diabetes with peripheral neuropathy, and CKD Stage III presented with a left hallux full thickness wound measuring 2.5cm x 2cm x 1.5cm which probed to bone. The wound continued to deteriorate despite advanced local wound care. Radiographs revealed osseous changes concerning for osteomyelitis. The patient was referred for non-invasive vascular studies to determine a viable level of amputation. An ABI was performed but due to non-compressible arteries viable results could not be ascertained. TcPO2 (DID TCPO2 CORRELATE TO A HALLUX AMPUTATION LEVEL?) and fluorescent angiography revealed adequate perfusion for a left hallux amputation. The patient subsequently underwent amputation of the left hallux amputation which healed uneventfully at X weeks.

A 96 year-old female with a past medical history of hypothyroidism, peripheral vascular disease, and a prior amputation of 2nd digit of the left foot presented with dry gangrene of the plantar medial left hallux. The patient reported that the ulceration began as a callus on her left big toe. The patient was referred for non-invasive vascular studies to determine a viable level of amputation. The ABI was 0.5. The TBI was 0.38 which is just at the level that primary healing would be likely. Fluorescent angiography revealed adequate perfusion for a left hallux amputation. The patient subsequently underwent amputation of the left hallux amputation which healed uneventfully at X weeks.

REFERENCES: Available upon request
Perfusion Assessment
Intra operatively
History

- Obese poorly controlled diabetic with previous history of Charcot reconstruction.
- Not compliant with off loading or follow-up
- Admitted with foot ulceration, abscess and exposed hardware
- I&D abscess, Antibiotics and elective BK Amputation
Intraoperative Fluorescent Angiography

- Following flap formation an area of poor perfusion identified and excised
- Flowing closure two areas of poor perfusion identified. After two sutures removed perfusion returned.
Intra Operative Assessment
Pre Suture Removal
Pre Suture Removal
Post Suture Removal
BK Amputation Closure
Aid to debridement and response to demal matrix tissue
History

- 9 Dec 2014 - 81 y/o admitted with congestive failure and recurrent venous ulcer with cellulitis
- Previous history of recurrent venous ulcers treated with perforator ligation and compression.
- 11 Dec 2014 - debridement in wound care clinic followed Luna study with additional debridement
Pre Debridement
Post Debridement
1 week post Debridement
Application of Dermal Matrixx
1 Week Post Application
2 Weeks Post Application
Increased Perfusion in Wound
4 weeks Post op
12 Weeks Post Application
Monitoring response to advanced wound care treatment

- NPWT
- Provant® Therapy
- Biologic tissues
- HBO
- ArtAssist
Conclusion

- Fluorescent Angiography offers an additional option to measure tissue perfusion

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- OR
  - Assess viability of flaps – pre and post closure
Conclusions - Fluorescent Angiography

- Critical component of a Limb Preservation Program
- Provides critical information to each of the components of a Wound/Limb Preservation Initiative
  - Vascular Surgery
  - Wound Care
  - Podiatric Surgery


Thank You
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