Indocyanine Green Angiography (ICGA) is a technology that has been described in the surgical literature as an instrument which can be used in the objective evaluation of skin perfusion. This novel technology uses a plasma protein bound dye (ICG) and a camera unit that is standardized to view the frequency emitted by the dye. The goal of this technology is to tend to instantaneous visualization of blood flow to skin and soft tissues in a manner that may assist in making decisions about closure or coverage of a surgical site based on blood flow.

Historically, clinical judgment based on visual inspection is the most common method for estimating blood flow, but is subjective and often unreliable. A plethora of technologies exist to assess blood supply clinically including CT/MR angiography or Doppler; however, none has gained universal recognition as a sensible choice in acute trauma of the foot.

We present 2 cases that help illustrate the role of ICGA as an assessment tool to guide therapy and decision-making in cases of pediatric trauma of the foot. In the foot and ankle literature on this topic is limited to case studies mainly focused on evaluating critical limb ischemia with little to no information on acute trauma cases.

Case Reports

ICGA imaging was performed as part of our initial assessment to evaluate the extent of tissue damage after acute pediatric trauma to the foot. Preprocedural and postprocedural imaging with ICGA was obtained which corresponded with clinical improvement.

Case #1: 6 y/o M pt presented to the ER after traumatic crush injury to right foot. Physical exam was significant for ecchymosis to right forefoot, dusky digits 2-4, 4 cm laceration to proximal phalanges centrally with exposed bone. Significant edema to foot/leg noted, pulses were palpable, CF greater than 3 seconds to digits 2 and 3 and sensation was intact to light touch. Patient able to extend and flex toes 1-5 of right foot. X-ray of right foot was significant for fracture of the medial aspect of the great toe with multiple punctate retained foreign bodies, dislocation of the second and third PIP and fourth DIP joints. After initial bedside irradiation, debridement and exam, decision was made for surgical intervention up to and including TMA. Prior to procedure, ICGA was utilized to better delineate tissue perfusion. Upon utilization prior to operation, the right 5th digit was the only digit found to have good blood flow. Attention was then directed operatively to the dorsal right mid foot. Two small stab incisions were made to better evacuate hematoma in an effort to re-perfuse right forefoot. 2 stab incisions were then made plantarly too as well to better evacuate hematoma from the right forefoot that has decreased blood flow. Intraoperatively, the fluorescence angiography was again utilized to verify the return of perfusion status to digits intraoperatively and postoperatively. Fluorescence angiography showed increase in perfusion of digits as well as right forefoot. 4th digit was retracted. With concerns for soft tissue integrity, 2nd digit was left partially relocated. Hallux open fracture was copiously irrigated and loosely approximated. All incisions were closed with 3.0 PDS save dorsal stab incisions, which remained open to allow for evacuation of additional hematoma. At 1 wk follow-up, fluorescence angiography revealed poor perfusion to hallux flap and distal digits 2-3. Postoperative plan was for surgical amputation vs auto-amputation. At 2 wk follow-up, digits 2-3 showed dry gangreneous changes with no acute infection. 1 month after injury, patient was taken to operating room for formal amputation of digits 2-3 with irrigation and debridement of hallux cap. Intraoperatively, hallux cap was removed after light sedation, digits 2 and 3 had previously auto-amputated. Patient presented to clinic nearly 1 month after final surgery (10 weeks from initial injury) and right foot had completely healed with auto-amputation noted to toes 2 and 3 at the level of the PIP.

Case #2: 13 yr M pt presented to the ER with a laceration to the 4th and 5th toes s/p dropping a meat cleaver on his foot. On exam the pedal pulses were palpable. Sensation was absent to the 4th and 5th digits. The laceration was found to be at the level of the 4th and 5th MTPJs. The laceration depth on the 4th toe was down to the flexor tendons, and on the 5th toe was found to be through the flexor tendons. On MMT, the pt could not extend the 4th and 5th toes, and also could not flex the 5th toe. CRT to the 4th toe was absent, CRT to the 4th toe was >5s. Skin to both 4th and 5th toes were dusky in appearance. X-ray showed open injury with fracture of the proximal phalanges of the 4th toe. The pt was consented for 4th blood supply, 5th repaired, and brought to OR for formal debridement where ICGA was used to assess tissue perfusion. Despite poor clinical appearance, ICGA imaging showed good perfusion to the 4th toe, which resulted in the decision to salvage the toe. The 5th toe had poor perfusion and was amputated.

Discussion

ICGA provides an assessment of soft tissue perfusion that may be correlated to tissue prognosis. It is safe for patient use, can be used at the bedside or intraoperatively, and allows for multiple repeat assessments within a short period.

In this series, ICGA altered or determined procedural management in both cases. Poor perfusion on ICGA was associated with negative clinical outcome, including progression to necrosis or amputation.

ICGA can assist in 1) guiding debridement in heavily contaminated traumatic wounds of the foot, 2) permitting rapid detection of vascular and/or microvascular compromise in acute soft tissue injuries of the foot 3) decreasing and possibly preventing perfusion-related complications in trauma (such as compartment syndrome), amputation closures, and reconstruction procedures of the foot and 4) aiding in improved outcomes in certain complex foot-related orthopedic and composite tissue injuries.

This technology holds promise for more widespread use in orthopaedic trauma, especially in controversial fields, such as defining the threshold for amputation versus reconstruction.

Conclusion

In cases of foot and ankle trauma, ICGA permits quick qualitative and non-invasive evaluation of tissue perfusion. The use of ICGA as an evaluation of tissue perfusion in cases of pediatric foot trauma has several implications: it helps direct surgical treatment for excision of devitalized tissue and aids in decision-making for major considerations such as compartment syndrome decompression and level of amputation.