Bone Perfusion Quantified by Intraoperative ICG-Based Dynamic Contrast-Enhanced Fluorescence Imaging Has the Potential to Predict Unplanned Reoperation and Infection After High-Energy Open Fracture

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Purpose: We believe that bone perfusion/bone viability in the setting of severe trauma is an important indicator of post-surgical complications. Because of this, thorough debridement is the cornerstone of treatment for severe open fractures. However, in the absence of intraoperative methods to assess bone perfusion, extent of debridement is subjective and depends on surgeon experience, which may put patients under unnecessarily high risk for infection. To address this issue, we have developed an indocyanine green (ICG)-based dynamic contrast-enhanced fluorescence imaging (DCE-FI) to provide surgeons with objective and quantitative data regarding bone perfusion. The aim of this study was to preliminarily evaluate whether bone perfusion, as reflected by post-debridement DCE-FI, is associated with risk of complication in the 12 months after surgery.

Methods: 26 patients who have completed 12-month follow-up visits were included in this preliminary assessment. Among these patients, 21 healed without complication, whereas 5 patients sustained a post-surgical infection. In each patient, after debridement 0.1 mg/kg of ICG was administered intravenously and DCE-FI was carried out by a fluorescence imaging system for 4.5 minutes. Bone perfusion-related parameters were calculated within the regions of interest (ROIs), after superficial blood artifact was removed. Based on the clinical outcomes, the patients have been divided into 2 groups of either non-infection or infection, and the parametric maps were analyzed by means of histograms and intensity thresholding in each group.

Results: The poor bone perfusion was characterized by low maximum intensity (Imax) and its area ratio (versus the entire ROI) was different between 2 groups of non-infection and infection. For cases with infected outcome, post-debridement ROIs were taken up by a larger ratio of poor bone perfusion areas, compared to those healed without complication. This ratio difference reached its peak at 18% for areas under the Imax threshold of 7.5 relative fluorescence units, and gradually diminished when Imax increased to the well-perfused range.

Conclusion: The results from this study demonstrate that bone perfusion quantified using ICG-based DCE-FI during the orthopaedic surgery has the potential to differentiate patients who will develop infection from those who will heal without complication.