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*Analysis and quantification of orbital fractures to aid surgical decision making: An artificial intelligence-based approach*

Trauma to the orbital region accounts for approximately 3% of all craniofacial injuries, with a mean hospitalization cost of $35,500 per case. Management of orbital fractures is challenging as a substantial amount of individual judgment is required to determine the need for surgery. The definitive indications for surgery include muscle entrapment, visible enophthalmos (sunken eye), diplopia (double vision) or hypoglobus (vertical asymmetry of the globes). Otherwise, the need for surgery is based on subjective factors such as the relative size of the fracture, which is used as a proxy for the risk of developing enophthalmos once healing has progressed. Other factors considered include calculating the change in orbital volume, presence, and extent of tissue herniation, etc. However, these methodologies lack robust sample sizes or controls for population-based variation. In addition, sophisticated systems to standardize orbital fracture surgical intervention are impractical for real-time clinical application, have low reproducibility and are not adequately validated against clinical outcomes. Complications arising from untreated orbital fractures pose a unique predictive analytics problem; an effective risk assessment tool to help determine the need for surgical intervention is highly desired.

The power of predictive analytics utilizing artificial intelligence (AI) provides a unique opportunity to address this issue. An innovative AI-based system will be developed to localize and quantify orbital fractures, and link these measurements to multiple factors contributing to change in volume associated with fracture injuries. Ultimately the analytical tools developed through this proposal will be used to create predictive models with the ability to link these characteristics to the likelihood of developing poor clinical outcomes such as, enophthalmos, hypoglobus and late-stage diplopia. This study will provide a proof-of-concept framework to automatically determine volume of the fracture and orbital contents, and predict deviation from the original volume of the orbit following a fracture. The long-term goal of this project is to utilize these analytical tools to link these fracture characteristics to the likelihood of developing complications such as late-stage enophthalmos. Surgeons will be able to use this tool in the future as an adjunct to their decisionmaking process, to both advise a patient on the risks of not treating an orbital fracture, as well as avoid unnecessary surgery when there is a low risk of complications. Unlike other automated orbit segmentation models, this AI-based approach calculates volume change due to hard tissue displacement caused by a fracture, as well as volume changes in critical soft tissue structures associated with the fracture.

Furthermore, this approach correlates these analytical findings with clinical, radiographic and demographic variables. This novel AI approach seeks to resemble the decision-making process of an oral and maxillofacial surgeon by combining information on fracture characteristics with individual patient-specific characteristics such as clinical and demographic factors. The success of this approach can also be adapted for other clinical challenges in oral & maxillofacial surgery diagnostics and decision-making utilizing AI.