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Multi-View Stereo in the Operating Room Allows Prediction of Healing Complications in a Patient-Specific Model of Reconstructive Surgery

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Abstract

Excessive mechanical stress leads to wound healing complications following reconstructive surgery. However, this knowledge is not easily applicable in clinical scenarios due to the difficulty in measuring stress contours during complex tissue rearrangement procedures. Computational tools have been proposed as an alternative to address this need, but obtaining patient specific geometries with an affordable and flexible setup has remained a challenge. Here we present a methodology to determine the stress contours from a reconstructive procedure on a patient-specific finite element model based on multi-view stereo (MVS). MVS is a noninvasive technology that allows reconstruction of 3D geometries using a standard digital camera, making it ideal for the operating room. Finite element analysis can then be used on the patient-specific geometry to perform a virtual surgery and predict regions at risk of complications. We applied our approach to the case of a 7-year-old patient who was treated to correct a cranial contour deformity and resect two large areas of scalp scarring. The simulation showed several zones of high stress, particularly near the suture lines at the distal ends of the flaps. The patient did show delayed healing and partial flap tip necrosis at one of such predicted regions at the 30-day follow up visit. Our results further establish the application of computational tools in individualized medical scenarios to advance preoperative planing and anticipate regions of concern immediately after surgery.

Keywords: finite element analysis; multi-view stereo; virtual surgery; wound healing complications; local tissue rearrangement; patient-specific model

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