VRIF: A Novel Preoperative Templating Software to Produce Patient-Specific, 3D-Printed Plate Templates for Pelvic Fractures

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Introduction

Three-dimensional (3D) printing allows for a novel method of preoperative planning by leveraging the widespread adoption of 3D imaging to build 3D models of fractures. Prior studies have shown that preoperative planning utilizing 3D printed models reduces surgical time, blood loss and radiation in the form of intraoperative fluoroscopy. However, the majority of these studies have relied on scale models of fracture patterns that aid in spatial understanding and serve as a patient-specific model to template proposed fixation. These applications are time and resource intensive in a way that is largely prohibitive for general practice or for utilization in an acute trauma setting.

There has also been much interest in 3D printing of custom, patient and fracture specific plates and implants. However, the time scale and resources required for these applications are functionally prohibitive for routine use.

In this study we introduce a novel preoperative planning software for pelvic and acetabular fractures which provides 3D visualization and preoperative templating along with the option to 3D print a pre-contoured plate template matched to the patient's anatomy. This study serves as a proof of concept for our software and workflow, and seeks to show that 3D preoperative templating can be conducted on a timescale appropriate for the fixation of pelvic fractures.

Methods

For this software, the Pelvis CT scan is saved and uploaded to the software which automatically creates a 3D model of the patient's pelvis. Then, the user can import pelvic recon plates of various sizes that are preloaded on the software and can place the plates on various locations on the pelvis model. The plates can be bent within the software to fit the uninjured contralateral anatomy on the patient's 3D pelvis model. By using the patient's own uninjured anatomy, a personalized pre-contoured plate can be constructed that should match the injured anatomy following anatomic reduction. After contouring these plates in virtual space, the plate model can be exported as a file for 3D printing which can be accomplished in roughly 1-2 hours. Using this 3D-printed, patient-specific contoured plate, a recon plate of similar size can be bent to match the contour and then sterilized and used for the surgery.

Results:

We detail a case in which the steps of this method were applied to show such a proof of concept. A 71 year-old female who sustained a posterior wall acetabular fracture was used to create a plate template as indicated in the method above. In this case, a second posterior wall plate was contoured during the case to match the implanted plate to provide a direct

comparison to the 3D printed template plate. The overall shape of the pre-contoured 3D printed templated plate matched very closely to the implanted posterior wall plate (Figure 1).

Discussion

We believe this software provides all of the already established benefits of 3D modeling for preoperative planning while ensuring the resources and time required allow it to be accessible for routine fracture care. It also provides a tangible output in the form of a patient-specific pre-contoured plate that can serve as a confirmation of anatomic reduction while also reducing intraoperative time utilized to contour a plate.

Further studies will consist of quantifying differences in operative time and fluoroscopy time with the utilization of these custom plate templates within pelvic fracture surgery. Further software functionality will allow for overlay of fracture lines on the contralateral uninjured side to allow for improved plate placement as well as functionality to automatically contour the plate to the region of interest on the pelvis.

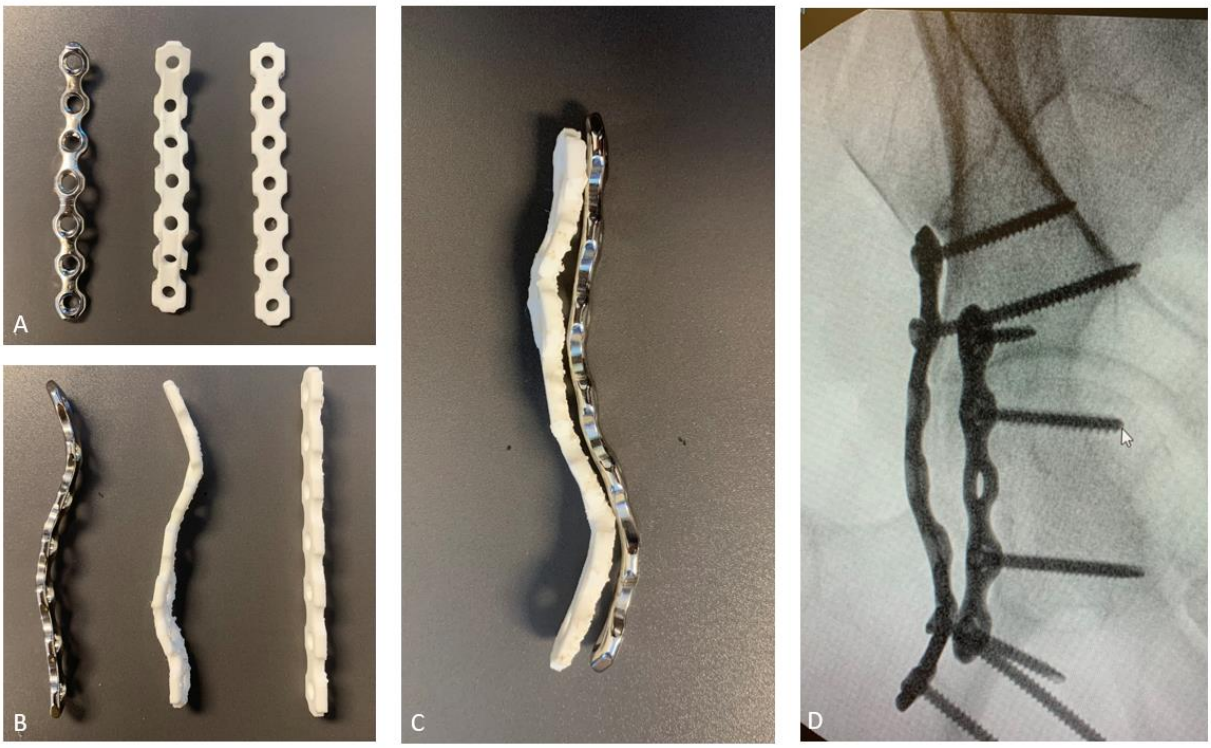

Figure 1: A and B) From left to right, contoured 7-hole recon plate bent to patient's anatomy in case, 3D printed pre-contoured 7-hole recon plate template created from software, 3D printed non-contoured 7-hole recon plate template. C) Side by side comparison of contoured 7-hole recon plate from operative case and 3D printed pre-contoured 7-hole recon plate from software D) Intraoperative fluoroscopic shots of the posterior wall plate that was utilized in surgery.