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## Accuracy of Orthopaedic Implant Contouring using a 3D Printed Template from Radiographs

In order to save time during orthopaedic surgical procedures, orthopaedic plates are often precontoured prior to surgery based on 2D radiographs. This involves the surgeon holding a template or a plate against a radiograph and “eyeballing” what the appropriate amount of contouring is until they match the plate to the bone contours on radiograph. With the increasing introduction of 3D printing, the option exists to print the entire bone and then use the 3D printed, patient specific bone as a template for plate contouring. Several studies have already identified that 3D printed bones based on 3D volumetric CT scans can provide the optimal mechanism for pre contouring plates. However, all of these studies utilized a pre-operative CT Scan. While this is commonly performed in human medicine, many veterinary patients continue to have 2D radiographs performed without 3D information provided. However, instead of “eyeballing” and holding up a plate to a computer screen or a 2D print out on a sheet of paper, we can 3D print the contour and use this 3D printed model as a template for our plates. Such a technique removes the need for an expensive CT scan and since the computer effort is minimal in terms of model creation, and 3D printing a simple contour would only take approximately one hour, the option exists to go from 2D radiographs to a benchtop model in a short (<4 hour) period of time. The aim of this study is therefore to determine if using a 3D printed contour results in greater accuracy in terms of implant alignment compared to a 2D computer image. We hypothesize that the fit of the plate to the bone will be improved using a 3D printed contour versus a 2D estimation. The outcome measure of evaluation will be the volume of space between the plate and the bone surface. To complete this, the student will collect data from the PACS archive of patients that have had both radiographs and a CT scan of a variety of canine bones. The CT Scan will be used to 3D print the actual test bone. The radiographs will be used to align an orthopaedic plate based off a screen image. In addition, the radiograph will be used to outline the shape of the bone, and based on the surface the plate is being applied, a 3D printed contour will be created and used for templating. In order to reduce expenditure, 3D printed 316L stainless steel implants will be used. For each bone, several sets will be created. The contouring will be performed by an experienced orthopedic surgeon (Stanley Kim), a resident in training (TBD) and the FVSP student, providing a range of expertise in the technique. To compare differences among users and techniques, a Two-way ANOVA will be used to compare two categorical variables (surgeon experience and 2D or 3D contouring) vary with the volume of space underneath the curve. To calculate this volume, after the plates are contoured, they will be positioned on the bone as appropriate, and a single screw will be placed at one end of the implant, thus causing a cantilever effect on the plate. Care will be taken not to move the plate around the screw to prevent error. Once the plate is positioned on the bone a CT scan will be performed using the single metal artifact reduction algorithm to reduce metallic spray artifact. Following this, the CT images will be segmented and the volume between the plate and the bone will be quantified. As such, the student will gain experience in experimental design, statistics, 3D modelling, 3D printing, contouring orthopaedic implants, drilling and screwing, presenting data and writing manuscripts.