The Impact of Design and Fabrication Technology to The Accuracy of Computer Guided Implant Surgery

Background and Significance

Placing dental implants with precision is critical for avoiding damage to vital structures, ensuring an optimal prosthesis, and achieving long-term success. Deviations from planned implant positions can result in significant challenges during prosthesis fabrication, underscoring the need for precise surgical placement. While various surgical guide techniques and CAD-CAM technologies have been developed to address these challenges, knowledge gaps remain regarding how specific manufacturing technologies and planning software influence the accuracy of implant placement.

Hypothesis

The design and manufacturing technologies used in creating CBCT-guided surgical templates significantly impact the accuracy of the templates and, consequently, the accuracy of implant placement.

Objectives

This study aims to evaluate the effects of design software and 3D-printing technologies on the accuracy of guided implant placement.

Specific Aims

Aim 1: Evaluate the Impact of Printer Type
Investigate how different 3D-printing technologies—digital light processing (DLP), stereolithography apparatus (SLA), and multijet printing (MJP)—affect the accuracy of CBCT-guided surgical templates and implant placement.

Aim 2: Assess Software Influence
Compare surgical guides designed using different planning software (3Shape Implant Studio vs. BlueSky Bio) to determine their influence on template fit and implant placement accuracy.

Methodology

1. **Study Design:**
    - Comparative in vitro study using CBCT scans and intraoral digital impressions.
2. **Sample Preparation:**

    - Fabricate CBCT-guided surgical templates using different combinations of printer technologies (DLP, SLA, MJP) and planning software (3Shape Implant Studio, BlueSky Bio).
3. **Accuracy Assessment:**
    - Quantify deviations between planned and placed implant positions using pre- and post-surgical CBCT scans.
    - Measure linear and angular discrepancies for depth, angle, and position.
4. **Statistical Analysis:**
    - Use ANOVA to compare outcomes among different printer types and software.
    - Post-hoc testing for pairwise comparisons.

Progress of Study

The pre-CBCTs have been taken. The Surgical guides have been designed based on CBCT scans and fabricated using different types of printers. The implants have been placed using the guide. The post-CBCT will be taken in this month or next based on facility schedule. The deviation between pre- and post- implant placement will be collected and compared.

Expected Outcomes

1. Identification of the most accurate 3D-printing technology for fabricating CBCT-guided surgical templates.
2. Insights into how software design influences surgical guide fit and implant placement.
3. Evidence-based recommendations for optimizing guided implant surgery workflows.