Critically Appraised Topic (CAT)

Project Team:
8B-4
Project Team Participants:
Steven Krenzke (D4), Nichele Wada (D3), Jayson Wiernik (D2), Tyler Osterday (D1)
Clinical Question:
How is CAD/CAM and 3D printing used in implant planning?
PICO Format:
P:
People in need of an implant
I:
Fully guided placement
C:
Free handed placement
O:
Accuracy of implant placement
PICO Formatted Question:
For patients in need of an implant, what is the accuracy of fully guided implant placement compared to free handed implant placement?
Clinical Bottom Line:
Click here to enter text.
Date(s) of Search:
9/22/20, 9/23/20, 9/24/20
Database(s) Used:
PubMed
Search Strategy/Keywords:
Dental implants, guidance, implant template, computer-assisted surgery, free handed implantation
MESH terms used:
Dental implant, Accuracy, Surgery, Computer-assisted
Article(s) Cited:
▪ Chen S, Ou Q, Lin X, Wang Y. Comparison Between a Computer-Aided Surgical Template and the Free-Hand Method: A Systematic Review and Meta-Analysis. Implant Dent. 2019 Dec;28(6):578-589. doi: 10.1097/ID.0000000000000915. PMID: 31205270. ▪ Kühl S, Zürcher S, Mahid T, Müller-Gerbl M, Filippi A, Cattin P. Accuracy of full guided vs. half-guided implant surgery. Clin Oral Implants Res. 2013

Jul;24(7):763-9. doi: 10.1111/j.1600-0501.2012.02484.x. Epub 2012 May 3. PMID: 22551385.

- Varga E Jr, Antal M, Major L, Kiscsatári R, Braunitzer G, Piffkó J. Guidance means accuracy: A randomized clinical trial on freehand versus guided dental implantation. Clin Oral Implants Res. 2020 May;31(5):417-430. doi: 10.1111/clr.13578. Epub 2020 Jan 31. PMID: 31958166.

Study Design(s):

- Randomized Controlled Trial
- Meta-Analysis
- Systematic Review

Reason for Article Selection:

- **Article 1:** Accuracy is a primary variable outcome in this study which directly relates to my PICO question. It is also ranked as a high level of evidence.
- **Article 2:** This article looks at the accuracy of full guided implantation versus half guided implantation using five human cadaver mandibles. Although our patients implant is planned for the maxilla, the article offers useful data that relates directly to my PICO question with a moderately high level of evidence (RCT).
- **Article 3:** The article relates directly to my PICO question with a moderately high level of evidence (RCT). This article also compares all forms of implant guided surgery (pilot, partial, and full) to one another and against the free handed implant placement, which is slightly different from the first two articles.

Article(s) Synopsis:

- **Article 1:** The aim of this meta-analysis and systematic review was to assess the results of dental implantation using a surgical template versus the free handed method in regards to survival rate, accuracy, and other considerations. Of the 362 screened articles, 6 studies were used in the analysis including 2 clinical randomized control trials, 2 retrospective studies, 1 in vivo-in vitro study, and 1 in vitro study based on the laboratory jaw models. Four articles in the 5 clinical studies compared the survival rate between surgical guided and free handed operation of dental implantation, including 2 randomized control trials and 2 retrospective cohort studies. Three articles in the total 6 studies compared the accuracy between these 2 kinds of implantation methods. Accuracy of the template was defined by the deviation on the apical level, coronal level and angular deviation. Studies showed that the use of a surgical guide was more accurate than the free

handed method in regards to all three measurements. However, there are a variety of factors that influence angular and location deviation including movement of the patient, poor mouth opening, bone density, and presence of blood and saliva. Although various search strategies and databases were used to obtain the results, higher quality studies are needed for more comprehensive and reliable results.

- **Article 2:** A randomized controlled trial was conducted to study the accuracy for full guided implant surgery compared to half guided surgery. Five formalin fixed human mandibles with different dentitions (Kennedy class II, Kennedy class III, and endentulous) were used to represent different clinical situations. Templates for each jaw were made and visually and manually fit onto the human jaw, followed by a CBCT being performed. The dataset of the CBCT's were transformed into digital imaging and virtual implant planning was done with the coDiagnostiX device. A total of 38 implants were planned. The templates were incorporated onto the jaws and soft tissue punches and cavity preparations were performed using the Straumann Guided Surgery kit. Implants were randomly inserted either manually without additional guidance (half-guided), or through sleeves using full guided implants. Both modalities were performed in each jaw. All implants were placed using a machine. Postoperative CBCT's were performed and the data set compared against the virtually planned implant positions at the implants base and tip. Overall, full guided implantation showed higher accuracy results than half guided implantation. Limitations of this study include a low number of implant measurements and the bone quality of the five jaws were not previously determined.
- **Article 3:** A randomized control trial was conducted to compare pilot, partial and full guided surgery with each other and against free handed surgery in terms of accuracy under the same conditions. A total of 207 implants of the same brand and type were placed in 101 partially edentulous volunteers in need of an implant in the mandible, maxilla, or both. Volunteers were randomly assigned to one of the study arms: Free hand surgery (Fr), pilot guide protocol (Pi), partial guide protocol (Pa), or fully guided surgery (Fu). CBCT images were acquired from each volunteer, and sent to the performing surgeon to virtually plan the implant placement using software (SMART Guide, dicomLAB). Surgical templates were 3D printed, and sent to the surgeon with case specific protocol. For free handed cases, no template was produced. All surgeries were performed by the same two surgeons with similar training and experience. Postoperative CBCT's were taken, and a comparison of the planned and actual implant placement positions were performed using a medical image analysis software with dedicated algorithms. Angular deviation (AD, degrees) was the primary outcome variable, with coronal global deviation (CGD, mm), apical global deviation (AGD, mm), and voxel overlap (VO, %) being second outcome variables. Results of this study showed that the highest mean AD was seen

with the free handed method, and the lowest with fully guided surgery. Second variable outcomes revealed that all guided surgeries were significant against free hand surgery, but were not significantly different from each other.

Levels of Evidence: (For Therapy/Prevention, Etiology/Harm)

See http://www.cebm.net/index.aspx?o=1025

☒ **1a** – Clinical Practice Guideline, Meta-Analysis, Systematic Review of Randomized Control Trials (RCTs)

☒ **1b** – Individual RCT

☐ **2a** – Systematic Review of Cohort Studies

☐ **2b** – Individual Cohort Study

☐ **3** – Cross-sectional Studies, Ecologic Studies, "Outcomes" Research

☐ **4a** – Systematic Review of Case Control Studies

☐ **4b** – Individual Case Control Study

☐ **5** – Case Series, Case Reports

☐ **6** – Expert Opinion without explicit critical appraisal, Narrative Review

☐ **7** – Animal Research

☐ **8** – In Vitro Research

Strength of Recommendation Taxonomy (SORT) For Guidelines and Systematic Reviews

See article **J Evid Base Dent Pract 2007;147-150**

☒ **A** – Consistent, good quality patient oriented evidence

☐ **B** – Inconsistent or limited quality patient oriented evidence

☐ **C** – Consensus, disease oriented evidence, usual practice, expert opinion, or case series for studies of diagnosis, treatment, prevention, or screening

Conclusion(s):

- **Article 1:** There is no significant evidence suggesting that computer guided surgical templates yield higher accuracy than the conventional free handed method in regards to each direction of placement. There is no statistically significant difference between the survival rate between the two implantation methods. Future studies of higher quality are suggested for more comprehensive and reliable conclusions.
- **Article 2:** The accuracy of half-guided implant surgery is comparable with full guided implant surgery.
- **Article 3:** Within the limitations of this study, it can be concluded that any degree of static guidance improves the accuracy of dental implant surgery as compared to free handed implantation. The most significant effect in terms of accuracy is seen in angular deviation.