Accuracy Using Static or Dynamic Navigation

Navigation is used for dental implant placement for several reasons: (i) to avoid important structures such as the inferior alveolar nerve, (ii) to minimize flap mobilization in order to achieve minimally invasive surgery, (iii) to accurately place multiple implants with proper spacing and angulation, (iv) to place single implants in exact locations when access is minimal and when the esthetic needs are high. Navigation allows prosthetic / surgical collaboration with precise planning and accurate orchestration of the plan to achieve ideal patient specific results. The following references provide evidence based information concerning accuracy of two navigation methods.

   Even with the aid of a laboratory-fabricated guide which is not true guidance, the error with the free-hand approach is greater in all measured parameters.

   Navigation surgery is known to have a learning curve associated with it. The learning curve of cardiothoracic and vascular surgical procedures (38) has been summarized in a total of 48 studies. Based on operating time, the learning curve for coronary artery bypass surgery ranged between 15 and 100 cases.

   Simulation of dynamic navigation has been used to decrease the learning curve for clinicians performing colonoscopy. Simulators improved training of novice endoscopists.

   Studies on models indicate that dynamic navigation systems have mean entry deviation approximating 0.4 mm and mean angular deviation error approximating 4 degrees. These studies, simulating dynamic navigation, indicate very accurate implant placement.

   Deviations from the predetermined plan can be seen in “real time” and changes to the plan can be made at the time of surgery. Surgeons are not forced to abandon a plan should they desire to make a change. Full guidance is possible as real-time visualization and adjustment of position can be made at any time.

   Tracking of the lower jaw using tooth retained fiducial markers, was found to be superior to indirect tracking. They concluded that a computerized navigation system using a teeth-mounted sensor frame and teeth-supported fiducial markers enables more accurate navigation for surgery of the lower jaw.

In two meta-analyses, with static guides, there was a mean deviation of 1.04 mm (up to 4.5 mm) at the entry point, and 1.4 mm (up to 3.75 mm) deviation at the implant’s apex. Analyses using free-hand methods were model based and showed less accuracy compared to navigation.

On porcine jaws, template guided implant placement was found to be more accurate than freehand methods.

There is a difference in accuracy between clinicians. Some clinicians are more accurate with CT guided implant placement than others, regarding the positions of the apex, depth, and angle. When inexperienced surgeons were supervised by experienced surgeons, there was no significant difference between inexperienced or experienced surgeons regarding implant placement accuracy when using CT-generated stents.