

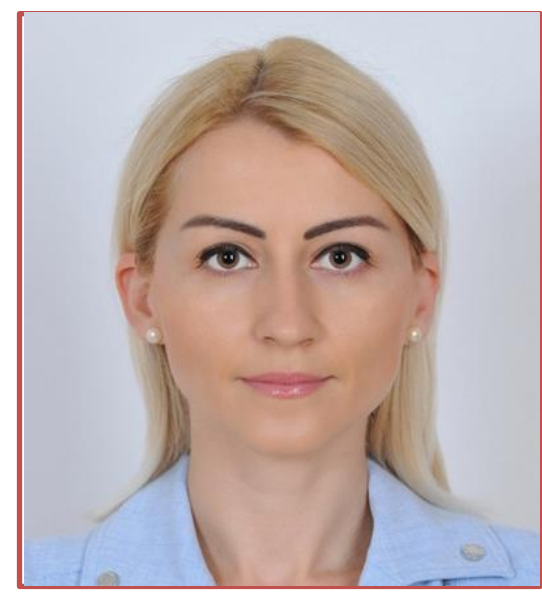


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COMPARISON BETWEEN THE X-GUIDE DYNAMIC NAVIGATION SYSTEM AND STATIC SURGICAL GUIDES- A LITERATURE REVIEW

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Highlights

- ❖ The vast majority of implants are placed freehand or without a conventional laboratory-made guide which can lead to significant errors and additional costs and chair time. Ideal dental implant positioning requires prosthetically planned implant placement (Panchal et al., 2019).
- ❖ Guided surgery allows the practitioner to place the implants accordingly. However, most dentists who use this technique, use static guides. Although static guides offer many advantages over the freehand technique or even the laboratory-made surgical guides conceived on models, they are also limited in terms of indications.
- ❖ Several studies state that more than half of the implants which are placed using static guides, are more superficially inserted in the bone than planned (Beretta et al., 2014; Zhao et al., 2014). Most errors regarding implant placement are due to asymmetric bone density which can be associated with deviation of the implant position when placed into dense bone (Emery et al., 2017). The model-based studies are ideal for the comparative assessment between guided systems (Emery et al., 2016).

Abstract

The aims of this study were (a) to compare the differences between the X-Guide dynamic navigation system (X-Nav Technologies, LLC, Lansdale, PA), static surgical guides and freehand dental implant placement in terms of advantages and disadvantages, (b) to assess whether the former is superior to the other two methods, (c) to establish the learning curve for the X-Guide system.

The X-Guide Surgical Navigation System (X-Nav Technologies, LLC, Lansdale, PA) represents a dynamic computer-assisted surgical (CAS) implant placement system based on optical triangulation tracking which allows real-time positioning and guidance of the dentist during the procedure. It uses 2 dynamic reference frames (DFRs), one attached to the surgical handpiece and the other one attached to the patient's dental arch and optical systems with passive tracking arrays which reflect a blue light captured by cameras. The computer generates a dynamic 3D representation displayed on the monitor.

X-Clip (X-Nav Technologies, LLC), a thermoplastic device with 3 radiopaque markers (fiducials) is adapted, after immersion into hot water bath at 140°F-160°F, according to the patient's teeth situated on the same jaw, opposite dental arch from where implant placement is considered. A CBCT scan is performed with the X-Clip in place, rigidly fixed on the patient's jaw and, then the arch and nerve mapping are created in the software. Prior to surgery the handpiece, the passive tracking arrays and the drills are calibrated, and the implant placement is virtually planned. After the surgery, a new CBCT scan is captured; the two are meshed and then the operator assesses the differences between the planned and the delivered treatment.

Materials and Methods

A Google Scholar literature review was performed using the MESH terms “X-Nav”, “X-Guide”, “dynamic navigation”, “static surgical guide” and “freehand implant surgery” and 8 scientific journal articles published between 2016 and 2020 were selected. The articles included both clinical case presentations and *in vitro* model-based studies.

Results

Among the advantages of X-Guide, the literature cites the following: it allows for same day scanning, planning and implant surgery and for real-time changes of the treatment plan and guidance regarding the implant size, shape, length and 3D intrabody position during the surgery. Because it does not use a surgical stent it provides the operator with complete visualization of the entire surgical field, it can be used in patients with limited mouth opening and in tight or reduced spaces where a surgical guide would be impossible to place due to the dimension of the metal tubes; it can be used for distal implants such as mandibular second molars; it can be used in patients with exaggerated gag reflex; it permits minimal invasive procedures by avoiding to raise a flap and it also can avoid anatomic structures (such as the IAN, maxillary sinus, nasal floor); it does not require special armamentarium for implant placement and it does not limit the diameter of the implant during the surgeries. By allowing the surgeon to look directly at the monitor it improves ergonomics; it also permits a double finger rest during the implant placement procedure which increases stability. It confers a 1mm “sphere of accuracy” due to high magnification which improves clinical skills. It does not display radiographic artifacts such as beam hardening, and it is associated with a reduced risk of complications. One of the most important advantages is that it allows prosthetically-driven implant placement and placement of multiple implants with appropriate angulation and intrabody positioning even for highly demanding esthetic cases. The disadvantages are a learning curve- to develop proficiency the practitioner must complete additional training and must learn to trust the dynamic navigation system (Block et al., 2017a). Also, the initial cost of the device is significantly higher compared to the financial investment required by freehand surgeries and static guided surgeries.

The advantages of static surgical guide are that it allows for flapless surgeries and for the creation of provisionals using the lab analog mounts in the static guide prior to the surgery. The disadvantages are a learning curve in terms of learning how to use the software to create the static guide and the fact it may need a collaboration with a dental laboratory to design it. Due to its presence over the surgical field, it limits the visualization in terms of the implant's crest depth location and the ability to irrigate during drilling. It cannot be used in limited spaces due to the bulkiness of the metal tubes which also make it impossible to use for distal implants placement and limit the diameter of the implant. The position of the surgeon during the procedure is limited by the presence of the static guide.

Freehand implant placement may seem to be more affordable, but in many situations, it may require additional prosthetic components with higher costs and more chair time due to the inaccuracies in regard to placement .The disadvantages are the inherent level of variability of positioning of the hand piece and maintaining proper angulation and positioning throughout the drilling and placement process.

In various branches of medicine, the learning curve for dynamic navigation use in surgical specialties varies between 15-125 cases (Koch et al., 2015; Arora et al., 2015). For dental implant placement with the X-Guide system learning curve was established to be between 11 (Emery et al., 2019) and 20 cases (Block et al., 2017a).



Fig. 1 X-Guide dynamic navigation system.



Fig. 2 Static surgical guide.

Conclusions

When compared to freehand implant placement, the X-guide dynamic navigation system was found to be superior (Emery et al., 2016; Block et al., 2017a; Block et al., 2017b; Panchal et al., 2019). The X-Guide dynamic navigation system was found to be similar to static surgical guides (Emery et al., 2016; Block et al., 2017b) but promising particularly for the training of inexperienced.

References

1. Arora KS, Khan N, Abboudi H, Khan MS, Dasgupta P, Ahmed Kamran. Learning curves for cardiothoracic and vascular surgical procedures—A systematic review. *Postgrad Med* 2015;127(2):202–214.
2. Beretta M, Poli PP, Maiorana C. Accuracy of computer-aided template-guided oral implant placement: A prospective clinical study. *J Periodontal Implant Sci*. 2014; 44(4):184-193.
3. Block MS, Emery RW. Static or dynamic navigation for implant placement-choosing the method of guidance. *J Oral Maxillofac Surg*. 2016;74(2):269-277.
4. Block MS, Emery RW, Lank K, Ryan J. Implant placement accuracy using dynamic navigation. *Int J Oral Maxillofac Implants*. 2017a; 32(1):92-99.
5. Block MS, Emery RW, Cullum DR, Sheikh A. Implant placement is more accurate using dynamic navigation. *Int J Oral Maxillofac Implants*. 2017b;32(1):92-99.
6. Cullum D, Lucas M. Minimally invasive extraction site management with dehydrated amnion/chorion membrane: immediate implant placement with dynamic navigation. *Compend Contin Educ Dent*. 2019;40(10):646-651.
7. Emery RW, Merritt SA, Lank K, Gibbs JD. Accuracy of dynamic navigation for dental implant placement-model-based evaluation. *J Oral Implantol*. 2016; 42(5):399-405.
8. Emery RW, Progebin K. The use of dynamic navigation to prevent implant complications-every patient, every time. *Implant Practice US*. 2017, April 22, Accessed at: <https://www.ccomfs.com/wp-content/uploads/2018/04/The-use-of-dynamic-navigation-to-prevent-every-time-implant-practice-US.pdf> on September 7, 2020.
9. Emery RW, Dala-Rosa-Silva RV, Tavares BM, Sheikh A, Camara-Puppin AA. Accuracy analysis of free-handed implant placement compared to a dynamic navigation system. *J Clin Dent Res*. 2019; 16(2): 24-39.
10. Panchal N, Mahmood L, Retana A, Emery R 3rd. Dynamic navigation for dental implant surgery. *Oral Maxillofac Surg Clin North Am*. 2019;31(4):539-547.
11. Koch AD, Ekkelenkamp VE, Haringsma J, Schoon EJ, de Man RA, Kuipers EJ. Simulated colonoscopy training leads to improved performance during patient-based assessment. *Gastrointest Endosc* 2015; 81(3): 630-636.
12. Zhao XZ, Xu WH, Tang ZH, Wu MJ, Zhu J, Chen S. Accuracy of computer-guided implant surgery by a CAD/CAM and laser scanning technique. *Chin J Dent Res* 2014; 17(1): 31-36.



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