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Review Article

Navigation in Oral and Maxillofacial Surgery – Review of Novel Technology

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Abstract

Oral and Maxillofacial surgeons play an important role in the management of head and neck trauma, pathologies, and cosmetology. Like any surgical procedure, these require skill, technique, and resources. Advances in technology and resources have led to the introduction of 'Navigation systems' in the planning and execution of surgeries to improve visualization of the surgical field and the outcome of the procedure. The navigation systems find their applications in the field of craniofacial trauma, pathologies, orthognathic surgeries, impactions, implantology, and skull base surgeries. This review article attempts to widen our knowledge about this system, its applications, and shortcomings and thereby emphasize further research.

Keywords: *Navigation systems, Oral and Maxillofacial Surgery, 3D Visualization, Novel Technology*

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INTRODUCTION

The oral and maxillofacial region houses a complex distribution of arteries, veins, and nerves in addition to a variety of vital organs. Due to the presence of such important structures, there is also a chance for several pathologies and deformities to occur. Oral and maxillofacial surgery deals with the management of these to re-establish facial anatomy, aesthetics, and function. Before the surgical intervention, it is imperative to formulate a proper treatment plan based on computed tomography (CT) and/or magnetic resonance imaging (MRI) to minimize the risk of errors on the surgical table [1]. To overcome the shortcomings of conventional surgical procedures, technology has been put to its best use in surgery through the development of three-dimensional (3D) visualization for computer-assisted surgical procedures. Computer-assisted surgery comprises two components: Pre-surgical planning and Navigation [2]. While computer-assisted pre-surgical planning involves simulating the surgical work area with 3D images and models, Navigation enables the surgeon to determine and track the accurate position of the instruments in the surgical field in real-time with the help of the CT or MRI. This technology has been introduced in recent times to increase the efficiency and precision of the surgeon and reduce intraoperative flaws. This literature review attempts to provide an overview of navigation and its use in oral and maxillofacial surgery.

Basis of Navigation technology

Navigation technology aims to reduce surgical duration and errors and replicate the pre-planned surgery in the patient thereby restoring form, function, and aesthetics. It is composed of three components: a localizer, an instrument, and CT/MRI scan data [1]. The localizer or tracker is connected to the patient and is visualized on the monitor with the help of an emitter that locates the tracker. It marks the spatial position of the patient. This must coincide with the preoperative image taken and once calibrated, the procedure can be started [3]. Generally, there are two types of navigating systems used: Optical and electromagnetic. In the optical system, certain structures that emit light are attached to the patient and these are detected by the emitter. Whereas, the electromagnetic systems employ electromagnetic fields on a device placed on the patient [4].

Registration of points plays a pivotal role in navigation surgery. It can be either marker-based or marker-free. Marker-based are those that are located on the preoperative image and can be easily located intraoperatively, while marker-free depends on the anatomy of the patient [5]. These points help to orient the patient to the imaging data. The commonly used points of reference are the frontonasal junction, the medial and lateral rim of the orbit, the superior and inferior rim of the orbit, zygomatic prominence, the tip of the nose, the angle of the mandible, and the chin point [6]. Once oriented, the surgical procedure can be completed as planned.

Applications of Navigation technology

Over the past ten years, the clinical significance of navigation systems has drastically increased and there is still scope for further research and development. These systems have proven to improve the precision and effectiveness of various surgical procedures.

• Trauma management- Navigation systems help the surgeon simplify the reduction and fixation of any bone in the maxillofacial region. This is especially true in cases of orbital fractures, where management of the fracture is complicated due to the limited access and presence of vital structures. Virtual planning and navigation help to position the segments in the right position using a mirroring technique [7], thus achieving symmetry with the unaffected side.

• Removal of foreign body - Another such application is the use of the technique in the removal of foreign bodies as these can be difficult using the conventional methods due to accessibility issues and proximity to vital structures [8].

• Impacted teeth - Teeth completely impacted within the bone may pose as a challenge to the surgeon. These procedures are time-consuming and also may cause damage to adjacent anatomical structures like the inferior alveolar nerve, permanent tooth buds, maxillary sinus, etc, Navigation helps to accurately determine the position of these impacted teeth and thus makes their removal easier.

• Orthognathic surgeries - The benefits of employing navigation in orthognathic surgery are to locate the vital landmarks and integrate preoperative mock-up surgery with the surgical field. 3D planning helps to optimize results and navigation aids in transferring this plan onto the surgical table [9]. Navigation systems also help to evaluate anatomic points for verification of required changes in the bone.

• Implants - Based on the same principle, implant placement can also be simplified using navigation systems. The depth, angulation, and position of implants can be precisely determined and planned with these systems [10].

• Tumour resection - Similarly, the extent of deep lesions and tumors can be efficiently managed without encroaching on the anatomical landmarks and normal vital tissues and simultaneously removing the affected tissues [11]. It removes the need for excessive resection of bone.

Thus, it has come to the understanding that navigation systems have varied applications in the field of oral and maxillofacial surgery and thereby improve the execution and prognosis of a procedure.

Limitations of Navigation technology

The advent of navigation technology has paved the way to improve surgical efficiency and accessibility thereby ensuring good quality of treatment to the patient. As it is a relatively new concept, it has its shortcomings. One such drawback is the inability to perform mandibular surgeries with the help of this technology because it cannot monitor dynamic movements continuously [12]. Thus, surgeons have to rely on their tactile sensation while working on the freely movable mandible. To overcome this, special sensors can be attached to the mandible to detect its position during the surgery [13]. In addition, soft tissue changes that occur during the period between imaging and surgery may complicate the usage of the technique in soft tissue surgeries. Structural image drift is a phenomenon in which the soft tissue landmarks change intra-operatively, in comparison to the preoperative images [12]. Another disadvantage is the need for a precise, preoperative image that forms the basis of the navigation. Instead, intra-operative CT can be taken to reduce preoperative imaging duration and also prevent volumetric tissue changes. Some navigation systems require immobilization of the head throughout the procedure and so such systems cannot be used during procedures like orthognathic surgery, which require mobilization. Other important aspects are the high cost of the equipment and the requirement of clinical expertise, but the advantages outweigh these drawbacks [14].

CONCLUSION

Navigation systems are believed to improve the functional and aesthetic results of any surgical procedure in patients with cranial- and orofacial diseases and disorders by locating the anatomy precisely and bridging the gap between the pre-surgical workup and the surgical field. Extensive research and usage of this technology are required to better understand the technique and limit its shortcomings about the cost and duration. This article is a brief outline of Navigation technology and we advocate further attempts to elaborate the technique.

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REFERENCES

1. Sukegawa S, Kanno T, Furuki Y. Application of computer-assisted navigation systems in oral and maxillofacial surgery. Japanese Dental Science Review. 2018 Aug 1;54(3):139-49.

2. Bobek SL. Applications of navigation for orthognathic surgery. Oral and Maxillofacial Surgery Clinics. 2014 Nov 1;26(4):587-98.

3. Demian N, Pearl C, Woernley TC, Wilson J, Seaman J. Surgical navigation for oral and maxillofacial surgery. Oral and Maxillofacial Surgery Clinics. 2019 Nov 1;31(4):531-8.

4. Samarakkody ZM, Abdullah B. The use of image guided navigational tracking systems for endoscopic sinus surgery and skull base surgery: a review. Egyptian Journal of Ear, Nose, Throat and Allied Sciences. 2016 Nov 1;17(3):133-7.

5. Habfeld S, Mühling J, Zöller J. Intraoperative navigation in oral and maxillofacial surgery. International journal of oral and maxillofacial surgery. 1995 Feb 1;24(1):111-9.

6. Anand M, Panwar S. Role of navigation in oral and maxillofacial surgery: a surgeon's perspectives. Clinical, Cosmetic and Investigational Dentistry. 2021;13:127.

7. Tarsitano A, Badiali G, Pizzigallo A, Marchetti C. Orbital reconstruction: patient-specific orbital floor reconstruction using a mirroring technique and a customized titanium mesh. Journal of Craniofacial Surgery. 2016 Oct 1;27(7):1822-5.

8. Lee TY, Zaid WS. Broken dental needle retrieval using a surgical navigation system: a case report and literature review. Oral surgery, oral medicine, oral pathology and oral radiology. 2015 Feb 1;119(2):e55-9.

9. Zinser MJ, Sailer HF, Ritter L, Braumann B, Maegele M, Zöller JE. A paradigm shift in orthognathic surgery? A comparison of navigation, computer-aided designed/computer-aided manufactured splints, and "classic" intermaxillary splints to surgical transfer of virtual orthognathic planning. Journal of oral and maxillofacial surgery. 2013 Dec 1;71(12):2151-e1.

10. Emery RW, Merritt SA, Lank K, Gibbs JD. Accuracy of dynamic navigation for dental implant placement–model-based evaluation. Journal of Oral Implantology. 2016 Oct;42(5):399-405.

11. Schmelzeisen R, Gellrich NC, Schramm A, Schön R, Otten JE. Navigation-guided resection of temporomandibular joint ankylosis promotes safety in skull base surgery. Journal of oral and maxillofacial surgery. 2002 Nov 1;60(11):1275-83.

12. Yu H, Shen SG, Wang X, Zhang L, Zhang S. The indication and application of computer-assisted navigation in oral and maxillofacial surgery—Shanghai's experience based on 104 cases. Journal of Cranio-Maxillofacial Surgery. 2013 Dec 1;41(8):770-4.

13. Panchal N, Mahmood L, Retana A, Emery R. Dynamic navigation for dental implant surgery. Oral and Maxillofacial Surgery Clinics. 2019 Nov 1;31(4):539-47.

14. Emery RW, Korj O, Agarwal R. A review of in-office dynamic image navigation for extraction of complex mandibular third molars. Journal of Oral and Maxillofacial Surgery. 2017 Aug 1;75(8):1591-600.

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