Computer-Assisted Surgery
Applications in Dentistry and Oral and Maxillofacial Surgery

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KEYWORDS

• Computer-assisted navigation • Virtual surgical planning • Intraoperative navigation

KEY POINTS

- Computer-assisted surgery (CAS) has great utility in implant dentistry as well as craniomaxillofacial surgery.
- Computer-assisted surgery (CAS) allows the surgeon to precisely plan and execute complex surgical treatment in an efficient manner.
- The future and direction of CAS will allow the surgeon in the near future to complete more complex procedures, improving accuracy, and ultimately reducing patient time in the chair.

INTRODUCTION

Computer-assisted surgery (CAS) has evolved over time from its origins in the late 1800s as stereotaxy, which was used to obtain cerebral biopsies in neurosurgical procedures. A few years later, in the first decade of the twentieth century, Horsley and Clarke devised a method for using a head frame in combination with a stereotactic atlas. CAS has evolved from framed to frameless stereotaxy, to currently using optical tracking. The first navigation system based on an optical instrument presented in the early 1990s by Heilbrunn and colleagues.[1] Currently, computer navigation uses optical tracking, which can be categorized as active or passive optical systems. It has gained popularity in dentistry and craniomaxillofacial (CMF) surgery within the last 20 years. There is currently a positive role for CAS in implantology and oral and maxillofacial surgery (OMS), including orthognathic and temporomandibular joint (TMJ) surgery, facial trauma, maxillomandibular reconstruction.

Disclosure Statement: The authors have nothing to disclose.
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Dent Clin N Am 62 (2018) 403–420
https://doi.org/10.1016/j.cden.2018.03.009
dental.theclinics.com

The ability to visualize the patient in 3 dimensions is an important aspect of successful dental surgery. CAS allows the clinician to visualize the patient in the sagittal, coronal, and axial planes on a computer workstation, and to construct several virtual plans in conjunction with a design engineer. By using computerized technology, the clinician today has the capability of obtaining increasing accuracy in placement of dental implants, bone grafts, and hardware, as well as tumor excision, while concurrently reducing the risk of iatrogenic injury or suboptimal surgical outcomes.

Computer-aided design and computer-aided manufacturing (CAD/CAM) have historically been used in dentistry as a tool for dental implants and restorative prostheses. Digital impressions and restorations can be fabricated and delivered in a single visit. This eliminates the need for multiple visits and improves accuracy by reducing conventional errors. Digital impressions are particularly useful in patients with hyperactive gag reflexes and limited mouth opening that make conventional diagnostic impressions difficult to obtain.

CAS is currently used for virtual surgical planning (VSP), intraoperative navigation (static and dynamic), and intraoperative postsurgical computer tomography (CT) and/or MRI.[2] The intent of this article is to discuss the indications of CAS in dentistry and its subspecialties such as OMS, implantology, and prosthodontics. It highlights the process, benefits, and shortcomings of each modality; presents cases pertaining to each area of application; and explores the future of CAS.

PROCESS

The process of CAS begins with data acquisition (Fig. 1). A preoperative CT scan of the patient is obtained, which is then converted into a digital imaging and communications in medicine (DICOM) format. The DICOM data can be used in several ways, including creating 3-dimensional (3D) stereolithic (STL) models, performing virtual surgical simulations (with VSP), and navigating intraoperatively.

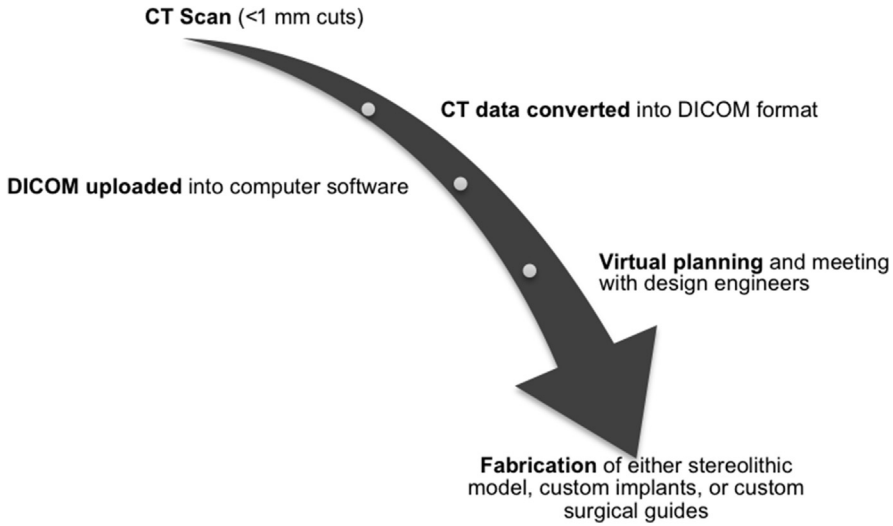

Fig. 1. The general process and order involved in CAS.