Intraoperative Use of CT Imaging

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KEYWORDS

• Computed tomography • Intraoperative imaging • Maxillofacial trauma
• Cone beam CT • Fan beam CT • Intraoperative CT • Facial fracture

KEY POINTS

- Intraoperative computed tomography likely has a role in complex congenital, traumatic, and/or oncologic facial deformities.
- There is low level support for this hypothesis in the literature.
- Although many surgeons think intraoperative imaging is beneficial in complex cases, high-quality prospective outcomes research will be required to determine the appropriate indications for the use of intraoperative computed tomography.

INTRODUCTION

In 1895 Wilhelm Rontgen discovered electron beam radiation and coined the term "x-ray." In 1903 William Coolidge developed the x-ray tube, which was further refined and is in clinical use today. Plain radiographs are the fundamental tools used for diagnosis and treatment of long bone fractures. Preoperative radiographs are used for diagnosis and treatment. Intraoperative and postoperative radiographs are routinely obtained to assure adequate reduction and appropriate implant positioning.

Before the advent of computed tomography (CT), plain radiographs were also the modality of choice for the diagnosis and treatment planning of maxillofacial injuries. However, intraoperative and postoperative radiographs were not routinely used. Studies evaluating the efficacy of postoperative plain radiographs have not found them to be beneficial,[1–4] most likely due to the limited resolution of plain radiographs in determining the accuracy of fracture reduction and implant placement, as well as the potential risk associated with radiation exposure to the vital structures of the head and neck.

The development of CT is credited to Godfrey Hounsfield and Allan Cormack in 1972. The specificity, sensitivity, and resolution of CT in midfacial fractures is

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significantly greater than plain radiographs[5,6] and greater than or equal to that of panorex images for the mandible.[7] Since its clinical introduction, CT has revolutionized head and neck diagnostic imaging and has become the gold standard for diagnosis and treatment planning of maxillofacial injuries.

With the increased availability of CT in the 1990s, some surgeons began to use CT for postoperative confirmation of fracture reduction and implant positioning. The more recent addition of portable scanners has brought the question of intraoperative imaging to the forefront. The few studies, which have looked at the efficacy of intraoperative CT scans for maxillofacial trauma, have been supportive of the technique.[8–11] However the question of efficacy remains unanswered. Is intraoperative and postoperative CT imaging beneficial for maxillofacial reconstructive surgery? Although currently there are no answers to this question, this article reviews the current literature, discusses the different CT modalities that are available, and presents the authors' clinical experience with the use of intraoperative CT for maxillofacial trauma and reconstruction.

TECHNOLOGY

X-ray CT can be divided into 2 different modalities, computed axial tomography (CAT) and digital volume tomography (DVT). Computed axial tomography scanners are also called "fan beam" scanners because of the "fan" shape of the x-ray photons that are emitted. These scanners are composed of an x-ray tube, a collimator to shape the beam, and a series of detector arrays opposite to the x-ray tube, all contained within a circular gantry. As the patient passes though the gantry, the x-ray tube moves in a circle around the patient. The x-ray beam is variably absorbed by the tissues, and the density differences are then recorded by a sensor array (**Fig. 1**). Information is then presented as a series of axial slices: one slice per sensor. Current CT scanners typically obtain between 64 and 256 slices per rotation. DVT scanners are also called "cone beam" scanners because of the "cone" shape of the x-ray photons that are emitted. Unlike fan beam scanners, there is no collimator, only a source and a sensor.

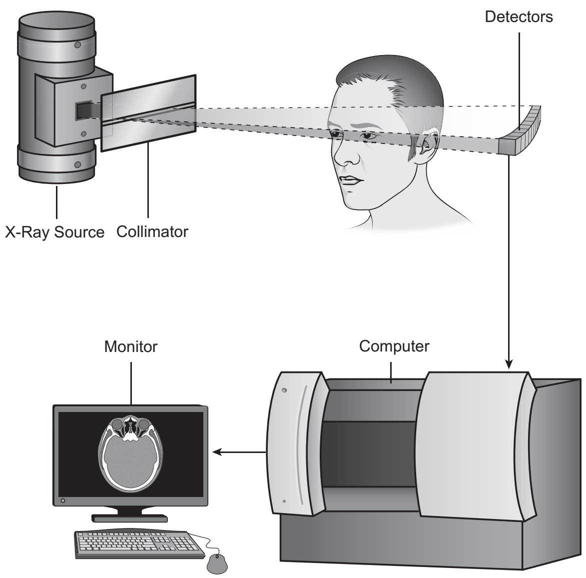

Fig. 1. The components of a fan beam CT scanner.