Computer-Assisted Surgical Simulation for Concomitant Temporomandibular Joint Custom-Fitted Total Joint Reconstruction and Orthognathic Surgery

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KEY POINTS

- Temporomandibular joint conditions and dentofacial deformities commonly coexist.
- Combined orthognathic and total joint reconstruction cases can be predictably performed in one stage.
- The application of computer technology for concomitant temporomandibular joint total joint replacement and orthognathic surgery improves the accuracy of treatment outcomes.
- With the correct diagnosis and treatment plan, combined temporomandibular joint and orthognathic surgical approaches provide complete and comprehensive management of patients with coexisting temporomandibular joint conditions and dentofacial deformities.

Introduction

Patients with temporomandibular joint (TMJ) conditions and coexisting dentofacial deformities can have these conditions corrected with concomitant TMJ and orthognathic surgery (CTOS) in 1 surgical stage or separated into 2 surgical stages. The 2-stage approach requires the patient to undergo 2 separate operations (surgery to correct the TMJ condition and a second operation to perform the orthognathic surgery) and 2 general anesthetics, significantly lengthening the overall treatment time. Performing CTOS in a single operation significantly decreases treatment time and provides better outcomes but requires careful treatment planning and surgical proficiency in the 2 surgical areas. Some TMJ conditions require total joint prostheses for best results. The application of computer technology for TMJ and orthognathic surgical planning and implementation has significantly improved the accuracy and predictability of treatment outcomes.

This article presents the treatment planning and surgical protocol for the application of computer-assisted surgical simulation (CASS) for CTOS cases requiring TMJ reconstruction with patient-fitted total joint prostheses and orthognathic surgery. The CASS protocol decreases the preoperative workup time and increases the accuracy of model preparation and subsequent surgery.[1,2]

Indications for concomitant temporomandibular joint and orthognathic surgery

TMJ disorders or conditions and dentofacial deformities commonly coexist. The TMJ condition may be the causative factor of the jaw deformity or develop as a result of the jaw deformity, or the 2 entities may develop independent of each other. The most common TMJ conditions that can adversely affect jaw position, occlusion, and orthognathic surgical outcome stability include (1) articular disc dislocation, (2) adolescent internal condylar resorption, (3) reactive arthritis, (4) condylar hyperplasia, (5) ankylosis, (6) congenital deformation or absence of the TMJ, (7) tumors; (8) connective tissue and autoimmune diseases, (9) trauma, and (10) other end-stage TMJ pathologies.[3–5] These TMJ conditions can be associated with dentofacial deformities, malocclusion, TMJ pain, headaches, myofascial pain, TMJ and jaw functional impairment, ear symptoms, and sleep apnea. Patients with these conditions may benefit from corrective surgical intervention, including TMJ and orthognathic surgery. Some of the aforementioned TMJ conditions may have the best outcome prognosis using custom-fitted total joint prostheses for TMJ reconstruction.[3–5]

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Concomitant temporomandibular joint total joint replacement and orthognathic surgery

Treatment planning for concomitant TMJ total joint replacement and orthognathic surgery (C-TJR-OS) cases is based on cephalometric analysis, prediction tracing, clinical evaluation, and dental models, which provide the templates for movements of the upper and lower jaws to establish optimal treatment outcome in relation to function, facial harmony, occlusion, and oropharyngeal airway dimensions. For patients who require total joint prostheses, a medical-grade computed tomographic (CT) scan with 1-mm overlapping cuts is recommended for the maxillofacial region that includes the TMJs, maxilla, and mandible. The surgeon has 2 options for model preparation to aid in the construction of patient-fitted total joint prostheses using the TMJ Concepts System (Ventura, CA). We previously published the traditional protocol technique versus the CASS protocol. The CASS technique is also known as *virtual surgical planning*.[1,2] This article presents only the CASS technique.

Protocol for concomitant temporomandibular joint and orthognathic surgery using computer-assisted surgical simulation

For CTOS cases, the orthognathic surgery is planned using CASS technology and moving the maxilla and mandible into their final position in a computer-simulated environment (Fig. 1). Using the computer simulation, the antero-posterior and vertical positions, pitch, yaw, and roll are accurately finalized for the maxilla and mandible based on clinical evaluation, dental models, prediction tracing, and computer-simulation analysis.

Using Digital Imaging and Communications in Medicine data, the stereolithic model is produced with the maxilla and mandible in the final position and provided to the surgeon for removal of the condyle and recontouring of the lateral rami and fossae if indicated The stereolithic model is sent to TMJ Concepts for the design, blueprint, and wax-up of the prostheses. Using the Internet, the design is sent to the surgeon for approval. Then, the custom-fitted total joint prostheses are
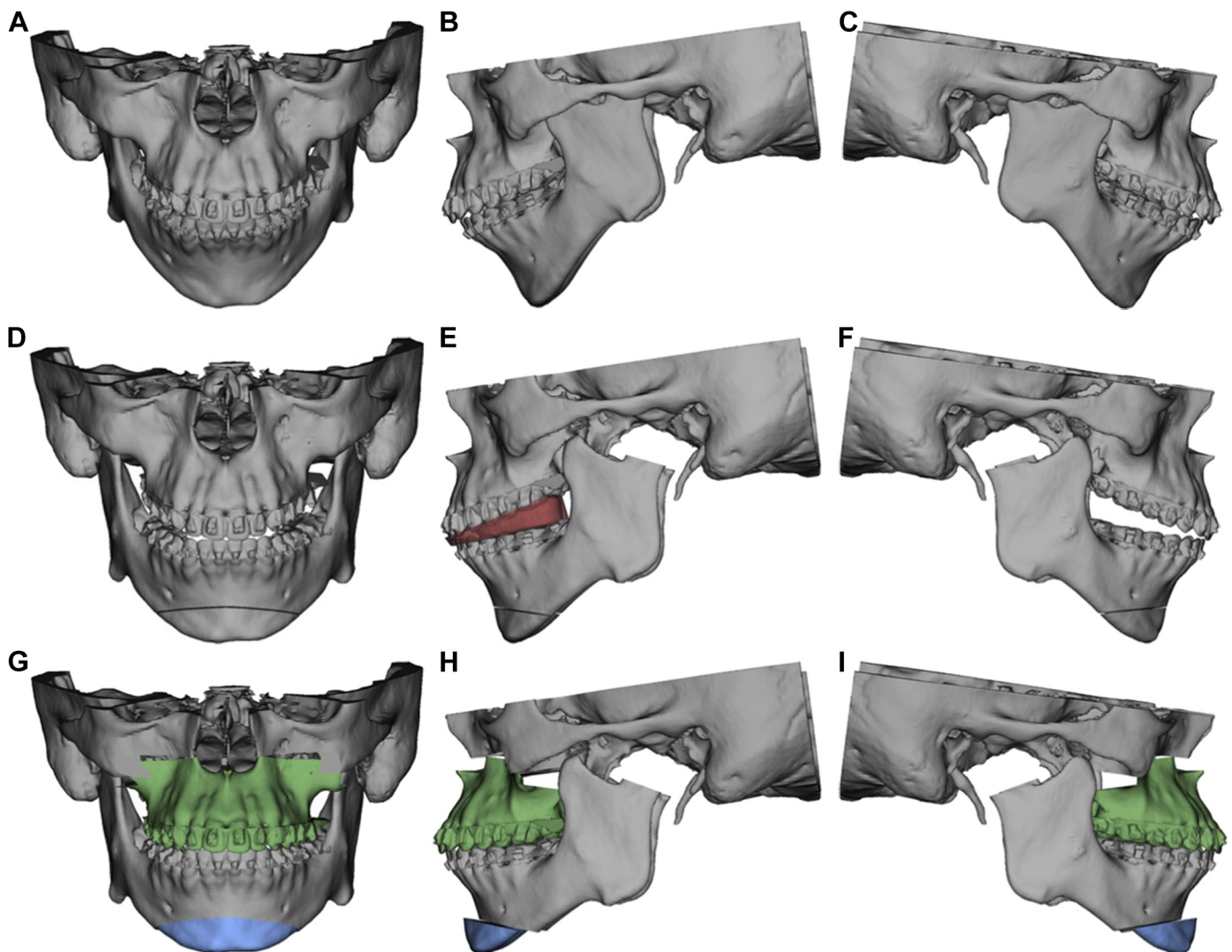

Fig. 1 CASS. (*A–C*) Simulated preoperative position of the maxilla and mandible. (*D–F*) The maxilla and mandible in the simulated intermediate position, with the maxilla in its original position but mandible in its final position with the mandibular surgery performed first for fabrication of the intermediate splint (*red simulated splint*). (*G–I*) The final position of maxilla and mandible, after counter-clockwise rotation-advancement of the mandible and segmented maxilla, for the production of a palatal splint.