Orthognathic surgery is the surgery to treat disorders of skeletal malocclusion, that can not be corrected by orthodontics alone. Specifically, orthognathic surgery treats significant open bite malocclusions, class 2 and class 3 malocclusions. Mandibular orthognathic surgery has been performed since the 19th century, while maxillary osteotomies were not routinely performed until the 20th century. Orthognathic surgery is typically performed on young adults, uncommonly performed on older patients or patients who are partially or completely edentulous. The focus of this article is to review orthognathic surgery on the partially/fully edentulous patient and to identify differences in treatment and complications compared to surgery in dentate patients.

Introduction
Orthognathic surgery is mostly commonly performed on young adults with a full complement of teeth that have been orthodontically prepared prior to surgery. However, in some situations, the atypical orthognathic surgery patient may present with an old age or a patient that is partially or fully edentulous. These patients have the same basic desires as the typical orthognathic patient is to achieve as normal an occlusion as possible to treat the functional and aesthetics deficiencies that are associated with a skeletal malocclusion. As a major tertiary care university medical center for the State of New Jersey, our institution frequently treats these atypical patients. The goal of this paper is to share our experiences as well as pitfalls and recommendations for treating the partially edentulous orthognathic surgery patient.

The early orthognathic literature discusses treating the edentulous patient. Kazanjian, in 1951, reviewed his treatment of prognathism in four partially edentulous patients. His treatment included extraoral ramus osteotomies as well as utilizing splints attached to a head frame to ensure proper immobilization. In addition, intraosseous wiring was utilized. In 1953, Van Alstine and Dingman described treating prognathism in the edentulous patient via an ostectomy of the body of the mandible secured by intraosseous wiring. Acrylic splints wired circumferentially were utilized to place the mandible into a favorable position. In 1954, Caldwell and Letterman published the technique of the Extraoral Vertical Ramus Osteotomy to treat prognathism. This was later modified by Hebert, Kent, and Hinds in 1970 to an intraoral vertical ramus osteotomy (IVRO), a technique commonly used by today's surgeons. In addition, Obwegeser in 1952 started developing the sagittal split osteotomy to treat mandibular prognathism and retrognathia. What is most astounding about the development of the sagittal split is that Obwegeser notes the first 15 cases were done under local anesthesia in the dental chair!

Discussion
The work up for the partially edentulous orthognathic surgery patient is no different from that patient with a full complement of

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teeth. A full extraoral evaluation, noting facial symmetry and proportions, as well as standard radiographic evaluation (panoramic and cephalometric films). Of note on the radiographs-evaluation of the bone quality and height is needed in the long-standing edentulous patient as bone atrophy may occur. This especially important in the patient planned for sagittal splits-an atrophic mandible may not be amenable to a favorable split; in the prognathic patient with an atrophic mandible, the IVRO may be a superior procedure. In addition, an edentulous maxilla may lead to an extremely atrophic anterior maxillary wall, creating a very fragile Le Fort 1 osteotomy. A thorough intraoral exam should be performed - evaluating the arches in relation to one another from transverse, anterior-posterior, and vertical dimensions. If the patient has an existing prosthesis, evaluation should be performed both with and without the dental prosthesis in the mouth, with attention paid to any changes in vertical dimension with and without the prosthesis.

Once all the clinical and radiographic data has been collected, a standard surgical prediction tracing should be done as well to determine the required orthognathic movements and plan for the model surgery. The model surgery is performed in a standard fashion. Where the differences lie in the partially edentulous patient compared to the dentate patient is in the fabrication of the surgical splints. In most orthognathic surgeries, a surgical splint is an integral part of the surgery, guiding the surgeon to place the maxillofacial skeleton into the presurgically determined ideal position. In addition, tooth position and occlusion help guide the surgical movements. In the partially edentulous patient, these splints have even more of an importance, as there may not be teeth available to help guide the surgical movement of the maxilla and mandible. In our experience, fabricating splints to fit into the edentulous spaces has been useful in guiding the orthognathic surgery. In addition, to ensure appropriate maxillomandibular fixation (MMF), we have incorporated arch bars into splints in the edentulous areas (Figure 1a-1e)

![Figure 1a: Occlusal view of stent encompassing edentulous areas with arch bar attached](image1a)

![Figure 1b: Occlusal view of surgical splint in conjunction with stent](image1b)

![Figure 1c: Lateral view of splint/stent complex](image1c)

![Figure 1d: Frontal view](image1d)

![Figure 1e: Lateral view of final surgical splint with arch bar attached](image1e)

or utilized transosseous MMF screws to obtain adequate fixation (Figure 2). If the patient has an existing prosthesis, this is utilized as well as a guiding splint during surgery; an arch bar or MMF screws can be attached to the prosthesis to facilitate MMF.
The major surgical pitfall in treating partially edentulous patients is that there may be significant bone atrophy in the areas of missing dentition. As noted above, in the mandible this may lead to an unfavorable sagittal split or increase the risk of injury to the mandibular neurovascular bundle. In the maxilla, bone atrophy leads to an exceptionally thin anterior maxillary wall; if care is not taken, the process of completing the Lefort I osteotomy can result in fragmenting the anterior maxillary wall, making it difficult to secure rigid fixation or determine if the maxilla has moved into its planned position (Figure 3).

If this occurs, place the maxilla in its optimum surgically determined position, fixated it, and then bone graft to areas of bony defects. Often freeze-dried iliac crest will suffice, precluding the need for harvesting autogenous ileum. In addition, trying to minimize the amount of Periosteal stripping during surgery to maximize blood supply to the bone is preferred to ensure post surgical healing. Finally, as with any orthognathic procedure, ensuring that the bone segments are completely immobile once placed into their new position, and ensuring bone to bone contact are keys to avoiding relapse and facilitate optimal healing.

**Conclusion**

Orthognathic surgery in the edentulous and partially edentulous requires some minor modifications compared to surgery on a patient with a complete dentition. Edentulism in the maxilla often leads to maxillary atrophy, requiring extra care when completing Lefort Osteotomies. Additionally, sagittal split osteotomies in edentulous mandibles have a higher incidence of bad splits, requiring extra care and attention. Finally utilizing splint to encompass the edentulous segment can be beneficial to placing the jaw in the ideal presurgically determined position.

**Bibliography**