Int. J. Oral Maxillofac. Surg. 2014; 43: 572–576
http://dx.doi.org/10.1016/j.ijom.2013.10.018, available online at http://www.sciencedirect.com

International Journal of
Oral & Maxillofacial Surgery

Clinical Paper
Orthognathic Surgery

Does computer-aided surgical simulation improve efficiency in bimaxillary orthognathic surgery?

H. C. Schwartz*
Department of Maxillofacial Surgery, Southern California Permanente Medical Group, Los Angeles, CA, USA

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Abstract. The purpose of this study was to compare the efficiency of bimaxillary orthognathic surgery using computer-aided surgical simulation (CASS), with cases planned using traditional methods. Total doctor time was used to measure efficiency. While costs vary widely in different localities and in different health schemes, time is a valuable and limited resource everywhere. For this reason, total doctor time is a more useful measure of efficiency than is cost. Even though we use CASS primarily for planning more complex cases at the present time, this study showed an average saving of 60 min for each case. In the context of a department that performs 200 bimaxillary cases each year, this would represent a saving of 25 days of doctor time, if applied to every case. It is concluded that CASS offers great potential for improving efficiency when used in the planning of bimaxillary orthognathic surgery. It saves significant doctor time that can be applied to additional surgical work.

Key words: orthognathic surgery; surgical efficiency; computers in medicine; computer-aided surgical simulation.

Accepted for publication 3 October 2013
Available online 11 December 2013

In the past 50 years, orthognathic surgery has evolved as a safe and successful method for the treatment of dentofacial deformities. Clinical examination, radiographs, and anatomically articulated models of the teeth are used to plan skeletal movements and to fabricate splints, which will be used to replicate those movements during surgery. Planning skeletal movements in double-jaw surgery can be difficult and time-consuming.

Orthognathic surgery is inherently inefficient when compared to most other types of surgery. There are numerous preoperative and postoperative patient appointments. Interaction with the patient and orthodontist, treatment planning, and laboratory work for splint construction are all far more time-consuming than the surgery itself. Although the jaws are anatomically complex structures that must be moved precisely in all three planes of space, planning for single-jaw surgery is simplified by the fact that the unoperated jaw serves as the target for the operated jaw. Treatment planning for double-jaw surgery is far more complex, since both jaws will be repositioned. A new three-dimensional position must be determined for the first jaw to be moved. After it has been precisely repositioned and rigidly fixated, it becomes the target for the second jaw. Planning these movements in double-jaw surgery can be one of the most difficult, challenging, and time-consuming aspects of orthognathic surgery. Computer technology has long been recognized for its potential in simplifying this process.[1–3] Several practical systems are widely available, and the cost of using these systems is gradually decreasing. The system we currently use costs US$800–2000 per case, depending on the number of cases performed annually.

Computer-aided surgical simulation (CASS) provides the surgeon with a composite computerized three-dimensional representation of the facial skeleton, soft tissues, and dentition. It permits diagnosis and virtual surgery to be performed on the computer, which then generates surgical splints using computer-aided design and computer-aided manufacturing (CAD/CAM) technology. CASS has been shown to be highly accurate in planning double-jaw orthognathic surgery.[4] The assumption of its advocates has also been that CASS is more efficient than traditional orthognathic workup and splint preparation, but this has never been clearly demonstrated.

There is ever-increasing pressure on health care budgets, and it is important to demonstrate efficiency in complex treatments like orthognathic surgery. However, surgical efficiency can be difficult to objectify.[5] Some authors have looked at cost as a measure of efficiency.[6] Costs vary greatly among different health plans and in different geographic regions. In addition, there are many hidden costs in complex types of surgery. These factors make cost a poor measure of efficiency. Time is a valuable and limited resource in surgical practice. There is a limit to the number of hours a doctor can work. Consequently, it was decided that total doctor time is a more useful way to measure surgical efficiency. The present study was designed to measure the overall time a surgeon devotes to planning and carrying out bimaxillary orthognathic surgery, and to determine whether there is a significant difference between cases managed with CASS versus traditional orthognathic workup.

Patients and methods

Patients who underwent bimaxillary orthognathic surgery by one of four surgeons in a large teaching hospital were studied. They were eligible for inclusion after their final postoperative appointment. This appointment followed orthodontic debanding, generally 6–12 months after surgery. The patients were divided into two groups. The CASS group consisted of 30 patients whose final appointment took place by January 2013, and who had undergone CASS diagnosis, treatment planning, and splint preparation (Table 1). There were 19 males and 11 females. The average age was 28.3 years (range 16–54 years). The traditional group consisted of 30 patients whose final appointment took place by January 2013, and who had undergone traditional orthognathic diagnosis, treatment planning, and splint preparation (Table 2). There were 15 males and 15 females. The average age was 25.6 years (range 16–49 years). We currently use CASS for about 10% of our patients, generally the more difficult cases, such as severe asymmetries. About 90% of our patients are currently managed in the traditional fashion.

Our hospital has utilized an electronic medical record (EMR) for the past 6 years. The EMR simplifies calculation of total doctor time for each patient (Table 3). Initial appointments are all allotted

Table 1. The CASS group.[a]

Age, years	Sex	Surgical procedures	Preoperative appointments, *n*	Surgical time, min	Postoperative appointments, *n*
31	M	MMO, genioplasty, lower border reduction	3	374	4
23	F	MMO, malar and angle implants	4	370	4
23	F	MMO	6	220	6
40	F	MMO	5	258	6
27	M	MMO, malar implants	4	232	6
31	F	MMO, genioplasty	4	230	6
28	F	MMO, genioglossus advancement	3	232	7
38	F	MMO, genioplasty	6	271	7
21	M	MMO	5	270	6
20	F	MMO	4	204	5
22	F	MMO, genioplasty	4	298	5
16	F	MMO	3	252	6
22	M	MMO, chin implant	5	243	6
25	F	MMO	4	242	6
28	M	MMO	5	226	8
52	M	MMO	4	210	7
18	M	MMO, genioplasty	3	228	7
31	F	MMO	5	300	7
54	M	MMO	4	249	5
17	M	MMO	5	320	5
54	M	MMO (MMA for OSAS)	4	249	5
21	M	MMO	5	216	5
23	M	MMO, genioplasty	5	320	6
18	M	MMO	3	275	5
23	M	MMO, genioplasty	3	213	5
39	M	MMO	6	285	6
20	M	MMO, chin implant	3	337	6
31	M	MMO, genioplasty	5	283	4
23	M	MMO	5	233	4
29	M	MMO	5	276	6

M, male; F, female; MMO, maxillary and mandibular osteotomies; MMA, maxillomandibular advancement; OSAS, obstructive sleep apnea syndrome.

[a] The CASS group consisted of 30 patients, who underwent MMO and adjunctive procedures. Each case was planned using computer-aided surgical simulation. Splints were fabricated using CAD/CAM technology.