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Comparative study of 2 software programs for predicting profile changes in Class III patients having double-jaw orthognathic surgery

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Introduction: Computer software can be used to predict orthognathic surgery outcomes. The aim of this study was to subjectively compare the soft-tissue surgical simulations of 2 software programs. **Methods:** Standard profile pictures were taken of 10 patients with a Class III malocclusion and a concave facial profile who were scheduled for double-jaw orthognathic surgery. The patients had horizontal maxillary deficiency or horizontal mandibular excess. Two software programs (Dentofacial Planner Plus [Dentofacial Software, Toronto, Ontario, Canada] and Dolphin Imaging [version 9.0, Dolphin Imaging Software, Canoga Park, Calif]) were used to predict the postsurgical profiles. The predictive images were compared with the actual final photographs. One hundred one orthodontists, oral-maxillofacial surgeons, and general dentists evaluated the images and were asked whether they would use either software program to plan treatment for, or to educate, their patients. **Results:** Statistical analyses showed differences between the groups when each point was judged. Dolphin Imaging software had better prediction of nasal tip, chin, and submandibular area. Dentofacial Planner Plus software was better in predicting nasolabial angle, and upper and lower lips. The total profile comparison showed no statistical difference between the softwares. **Conclusions:** The 2 types of software are similar for obtaining 2-dimensional predictive profile images of patients with Class III malocclusion treated with orthognathic surgery. (Am J Orthod Dentofacial Orthop 2010;137:452.e1-452.e5)

Over 70% of patients with a dentofacial deformity mention esthetics as the major factor motivating them to seek orthodontic or orthognathic treatment.[1,2] In view of this, prediction generated by computerized techniques has become a resource used by many professionals around the world.[3] However, a major concern regarding computer-assisted surgical prediction is its accuracy, and several studies have reached contrasting conclusions.[4-8]

It is difficult, if not impossible, to foresee the facial changes after orthognathic surgery without visual aids.[9] Manipulations of images with these programs influence a patient's expectations about the end result. In addition, it is virtually impossible, even with present technology, to predict variables, such as the thickness of the soft tissues and muscular tonicity in computerized predictions.[10,11]

Sarver et al[3] reported that 89% of a patient sample judged video images to be realistic and thought that the goal was achieved. In addition, 83% of patients said that it helped them to decide whether to have the treatment. Sinclair et al[12] analyzed the opinions of 2 experienced clinicians, using the prescribed plan, image software, and teleradiographs, and concluded that 60% to 80% of the simulated images were clinically accepted for the treatment plan. The areas evaluated were the lips, lip-mental sulcus, chin, and submental region. Although that study used only 2 clinicians to evaluate the images, it helped to guide other studies in the same area.

Since then, various computer programs have been released on the market: Dentofacial Planner Plus (Dentofacial Software, Toronto, Ontario, Canada) (DFP), Quick Ceph (Quick Ceph Systems, San Diego, Calif), Orthognathic Treatment Planner (GAC International,

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Table. Surgical movements in the vertical and horizontal directions for the maxillary incisors and molars (defining the spatial position of the maxilla) and the mandibular incisors (defining the spatial position of the mandible)

Movement (mm) / *Patient*	*Horizontal of the maxillary incisor*	*Vertical of the maxillary incisor*	*Horizontal of the maxillary first molar*	*Vertical of the maxillary first molar*	*Horizontal of the mandibular incisor*	*Vertical of the mandibular incisor*
1	2.9	–2.2	3.7	2.9	–3.2	–1.6
2	1.9	–3.3	2.3	–0.3	–4.0	–2.0
3	6.0	2.0	6.2	3.0	–4.0	4.8
4	4.4	2.0	5.0	4.6	–1.6	2.4
5	4.0	0.4	4.2	2.1	–0.4	2.4
6	4.0	–1.1	4.2	2.1	–4.8	1.6
7	10	4.0	10	4.0	–4.0	8.8
8	6.0	–0.4	5.9	–1.0	–6.4	0.0
9	7.0	–2.0	7.2	–0.4	–0.4	–3.6
10	9.2	–1.2	9.2	–1.2	–4.4	0.8

Negative numbers in horizontal movement mean bone retropositioning, and positive numbers mean bone advancement. Negative numbers in the vertical direction mean inferior repositioning (maxillary extrusion), and positive numbers show maxillary impaction.

Birmingham, Ala), and Dolphin Imaging (version 9.0, Dolphin Imaging Software, Canoga Park, Ca) (DI), among others.[2] Over the last few years, DI has gained popularity among professionals.[2,13] Therefore, the aim of this study was limited to comparing, through subjective evaluation, the soft-tissue surgical simulation (predictive profile) of DFP and DI in patients with a Class III occlusion and a concave face treated with double-jaw orthognathic surgery.

MATERIAL AND METHODS

Ten patients having orthognathic surgery participated in this study. The surgical movements were mandibular retropositioning and maxillary advancement, with linear movements of at least 4 mm in 1 bone segment or in the sum of maxillary advancement and mandibular retropositioning, and with minimal or no postsurgical orthodontic movement (Table).

The profile prediction for this study were made 6 months after the surgery and used the real movements as the values of prediction. The real movements were obtained through the superimposition of the final cephalometry over the initial one of each patient. Then the soft-tissue images of preoperative, real predictive images of DFP and DI, and postoperative image were compared. All images were taken with the patient in centric relationship with the lips at rest.

The devices for creating the simulation of the postoperative profile were a Pentium 4 processor (Intel, Corporation, Santa Clara, Calif), a digitizer table (Numonics, Montgomeryville, Pa), a digital camera (EOS 10D, Canon, Lake Success, NY), DFP, DI, Photoshop (version 6.0, Adobe, San Jose, Calif), and PowerPoint software (Microsoft, Redmond, Wash).

The preoperative and postoperative profile images were digitized and standardized in the Photoshop program with regard to size, position, brightness, and contrast; they were cut a little behind the tragus and on the hairline. After this, they were exported to the Dentofacial Showcase (Dentofacial Software) and subsequently to the DFP and DI programs.

The postoperative lateral cephalometric radiographs for the DFP program were digitized by using the digitizer table; for the DI program, digitization was done with a scanner.

The maxillary and mandibular movements were made by using the real values in millimeters, previously obtained when comparing the preoperative and postoperative lateral cephalometric radiographs of the surgical movements in the vertical and horizontal directions for the maxillary incisors and molars and the mandibular incisors (Table).

To analyze the profile, we used the methods of Sinclair et al,[12] Magro-Érnica,[13] Giangreco et al[14] to compare the simulated and real images according to the points or areas of analysis (tip of the nose, nasolabial angle, upper lip, lower lip, menton region, base of the mandible, and complete profile) and the similarity among images (ranging from very similar to different). The PowerPoint program was used to create a comparative presentation between the images simulated by the programs and the real postoperative image. For each slide, there was a corresponding form to be filled out by the examiners. The form explained the scale for classifying the images.

One hundred one dentists, including orthodontists, maxillofacial surgeons, and general dentists, evaluated the images and filled out a form for each patient. The images of a patient are shown in Figure 1.

Fig 1. Profile images of a patient with Class III malocclusion, treated with orthognathic surgery: **A,** pretreatment; **B,** simulation from DFP; **C,** simulation from DI; **D,** actual postoperative photograph.

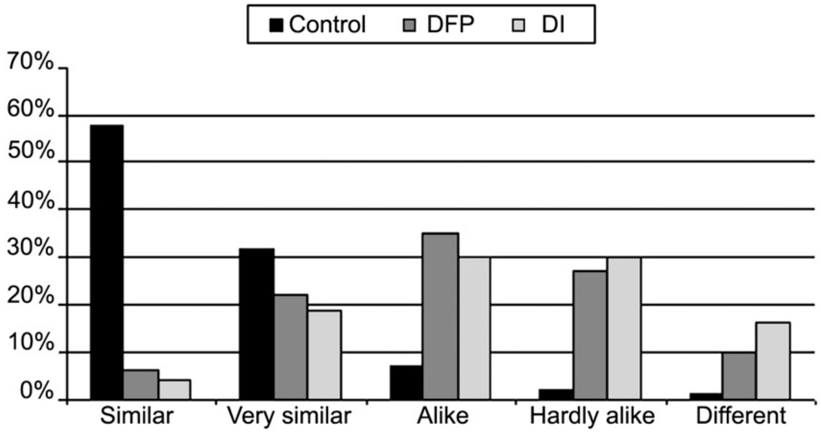

Fig 2. Comparative evaluation among the control, DFP, and DI groups relative to the total profile. There was no statistical difference ($P = 0.7945$) between the softwares.

The evaluators did not know which software they were judging. One patient was used as the control. The postoperative image for this patient was used in place of the prediction. To calibrate the evaluators, the control needed to receive more mentions of "similar" and "very similar," and, if "alike," "hardly alike," or "different" was selected for more than 1 item evaluated, the evaluator was disqualified.

The results were tabulated in absolute numbers and percentages. For comparisons between the cephalometric points of the soft tissues, the chi-square test was used. The same test was applied to compare the 2 programs and judge the criterions of similar, very similar, alike, hardly alike, and different. The nonpaired Student *t* test was used to detect differences between the criteria comparing the 2 programs. The significance level was 5%.

RESULTS

For possible comparison among the groups and to facilitate interpretation of the results by the reader, the data were transformed into percentages and presented in a graph (Fig 2). Analysis with the chi-square test showed statistical differences among the groups for each region analyzed. DI was better for predicting nasal tip ($P = 0.0145$), chin region ($P = 0.000000000000034$), and mandibular base ($P = 0.000055$), and DFP was better for predicting nasolabial angle ($P = 0.00006$), upper lip ($P = 0.000000007$), and lower lip ($P = 0.000000038$), and there was no difference among the groups in the evaluation of the complete profile ($P = 0.7945$).

When analyzing all the points in a grouped manner for each criterion, there was no statistical difference among the groups (for "similar," $P = 0.9227$; for "very similar," $P = 0.2266$; for "alike," $P = 0.4359$; for "hardly alike," $P = 0.4182$; and for "different," $P = 0.5700$).

DISCUSSION

The precise evaluation of the surgical simulation images made by the computer is not easy. In this study, 1 patient was used the control, and that patient's image was repeated and compared. Not all examiners thought that the 2 images were identical, although they were. This shows a subjective aspect in this type of evaluation.

Five classification scales of similarity among the images were used, as was done by Giangreco et al.[14] Smith et al,[2] however, divided them into 6 levels. The more subdivisions have been adopted by the researchers, the greater is the level of technical knowledge of the area expected from the evaluator. Smith et al[2] worked with specialists in oral maxillofacial surgery and orthodontics, whereas, in the research by Giangreco et al[14] and in our study, the evaluators were dentists and specialists in orthodontics and oral maxillofacial surgery. The level of demand of an evaluation by laypersons in dentistry is lower than that of dental professionals.[3] In addition, Burcal et al[15] found that laypeople are less cognizant of differences between images along the horizontal plane than either orthodontists or oral maxillofacial surgeons.

Smith et al[2] and Magro-Érnica[13] also compared DI and DFP, but they evaluated long faced and retrognathic patients, respectively. The first authors retouched images, evaluated patients having bimaxillary surgery, and preferred DFP for these situations. The second author did not retouch the images, evaluated patients having mandibular advancement, and preferred the DI program. The differences observed by these authors can be related, among other factors, to the surgery types used for the patients in these studies. Chew et al[16] assessed the subjective accuracy of predictions generated by computer imaging software in Chinese patients who had orthognathic surgery and determined the influence of initial dysgnathia and complexity of the surgical procedure on prediction accuracy. These authors concluded that skeletal Class III patients managed by bimaxillary osteotomy were less accurately predicted by the computer program than were skeletal Class II patients. They attributed these findings to the fact that most skeletal Class II patients were treated with single-jaw osteotomies. In our study, the statistical results showed a certain similarity between the programs with regard to the evaluation of the profile prediction in 2 dimensions of Class III patients having bimaxillary surgery. Thus, the results obtained in this study might be influenced by the fact that the soft-tissue profile changes in our study were predicted through the use of the real movements as the prediction movement, 6 months after the surgery.

Schultes et al[17] noted that, with the DFP, the submental area and the lower lip were problematic when predicting changes from mandibular advancement. Recently, investigators in Germany came to the same conclusion.[9] In this study, differences between the 2 programs were found, favoring DFP for the nasolabial angle, and upper and lower lips, and favoring DI for the tip of the nose, chin region, and base of the mandible. Obviously, some differences between the simulations of the programs are explained by the type of surgical movement. When bimaxillary surgery is performed, new variables appear, making the simulation less accurately predicted.[16]

The companies disclose that the programs work on different bases. Whereas DFP was created in the DOS environment, DI runs in the Windows environment (both, Microsoft), and this generates a completely different basis of calculation for the programmers. This is perhaps the explanation for the differences between the 2 types of software for each point analyzed.

Therefore, this research brings up new aspects of comparison between the 2 best-known programs at the moment when one approaches orthodontic and surgical simulation of patients with dentofacial deformities, allowing persons that enter the area to have another parameter for choosing between the DI and DFP programs.

In a treatment plan for a patient with a dentofacial deformity, the orthodontist and the oral maxillofacial surgeon first should apply the facial evaluation based on clinical experience and use the computer programs in a coadjuvant role in the decisions to be made. No software performs numerical operations to determine what is the best surgical plan for each patient's psychological profile. The computer also does not perceive the limitations and difficulties of orthodontic treatment or when it is impossible to perform a certain surgical movement.

Prediction imaging programs have an enormous potential for advances. The company that created DI came out ahead with regard to orthognathic surgery planning by using tomographs in 3 dimensions, making it possible to follow up bone repair or even the change in aerial space easily. Furthermore, one cannot overlook that these programs allow us to organize information about patients.

It is obvious that the more information the program requires, the more training the operator needs. Although we did not evaluate this aspect in this study, we perceived that the time required to work with DI was longer than that for DFP. Smith et al[2] concluded that the performance and ease of use, cost, compatibility, and other features such as image and practice management tools are all important considerations, but users concerned with operating system compatibility and practice management integration might want to consider DI and Quick Ceph, the programs of the second tier.

As new programs are developed and old ones upgraded, dentists must remember that they must know and work with the programs for some time before buying them, because they are relatively expensive, and to abandon them for lack of adaptation would be wasteful.

CONCLUSIONS

Considering the methodologic conditions of this study, the 2 types of software were similar for obtaining a 2-dimensional profile for predicting the surgical images for Class III patients treated with orthognathic surgery.

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