Predicting soft tissue changes in maxillary impaction surgery: A comparison of two video imaging systems

Glenn T. Sameshima, DDS, PhD; Ruth K. Kawakami, DDS, MS; Ronald M. Kaminishi, DDS, MS; Peter M. Sinclair, DDS, MSD

The rapid development of fast and affordable digital computers has revolutionized science and industry. This revolution has affected orthodontics in many ways; there are few practices today that do not rely on computers for communications, accounting, and other important tasks. The impact of computers on actual patient care, however, lags behind the business side, and for good reason—the practice of orthodontics remains as much art as science. The one clinical aspect of practice where computing has made inroads is in diagnosis and treatment planning; specifically, the forecasting of surgical outcomes. The old method of cutting and moving structures on matte acetate is gradually being replaced by sophisticated, computer-based systems.

Video imaging computer systems combine cephalometric landmark and structure data with a photographic or live video image.[1-4] A recent study showed that 89% of video-imaged patients felt that the predicted image was realistic and that the desired result was achieved, compared with 45% who viewed tracings only.[3] In another study, the actual postsurgical results were found to be more esthetically acceptable than the majority of the predicted images.[2] With video imaging, patients appear to better understand and accept both the proposed surgical procedure itself and the facial changes anticipated from surgical and nonsurgical treatment options.[5] Early fears of unrealistic patient expectations based on the images have not materialized.

Abstract

The purpose of this retrospective study was to investigate the accuracy of two video imaging systems, Orthognathic Treatment Planner (OTP) and Prescription Portrait (Portrait), in predicting soft tissue profile changes after maxillary impaction surgery. Computer-generated line drawing predictions were compared with actual postsurgical profiles. Neither program was very accurate with vertical measures and lower lip contour. Portrait was more accurate at pronasale, inferior labial sulcus, and pogonion in the y-axis direction ($P < 0.05$). Video image predictions produced from the presurgical photographs were rated by orthodontists, surgeons, and lay people, who compared the predictions with the actual postsurgical photographs using a visual analog scale. Portrait's prediction images were scored higher than OTP's for five of eight areas. Orthodontists were most critical of the lips and the overall appearance. Lay people were most critical of the chin and submental areas.

Key Words

Video imaging • Prediction • Orthognathic surgery

Submitted: July 1996 **Revised and accepted:** December 1996 Angle Orthod 1997;67(5):347-354.

Table 1
Horizontal axis differences between actual and predicted line drawings: soft tissue values

	OTP* x ± SD (mm)	Portrait** x ± S.D (mm)
Nose		
Nasal dorsum	1.18 ± 1.34	0.74 ± 0.97
Pronasale	1.02 ± 0.93	0.76 ± 0.65
Subnasale	1.72 ± 1.23	0.96 ± 0.89
Upper lip		
Superior labial sulcus	1.41 ± 1.30	1.08 ± 0.78
Upper lip	1.34 ± 1.14	0.95 ± 0.97
Stomion superior	0.27 ± 0.50	0.24 ± 1.06
Lower lip		
Stomion inferior	1.17 ± 1.56	0.33 ± .81
Lower lip	1.71 ± 1.37	1.45 ± 1.24
Inferior labial sulcus	1.33 ± 1.13	0.93 ± 0.95
Chin		
Pogonion	1.68 ± 1.13	1.19 ± 1.07
Gnathion	1.70 ± 1.55	0.91 ± 0.97
Menton	0.74 ± 1.10	0.12 ± 0.33

*Orthognathic Treatment Planner; **Prescription Portrait

Several video imaging software programs for orthodontic and orthognathic surgical treatment planning are commercially available. This study investigated two systems that use the IBM-PC architecture: Orthognathic Treatment Planner (OTP) from Pacific Coast Software (1994 version), a Windows program, and Prescription Portrait (Portrait) from RX Data (version 3.5), a DOS program.

The objective of this study was to evaluate the accuracy of these two programs when used to predict soft tissue changes associated with maxillary impaction surgery.

In a study of facial profiles after maxillary surgery, both orthodontists and lay people were found to perceive horizontal surgical changes more readily than vertical changes.[6] Soft tissue response to maxillary surgery has been evaluated and shown to be relatively predictable.[3,7-11] The nose usually undergoes minimal change, while the upper lip follows vertically, approximately 0.4 to 1 relative to the upper incisal edge.[12] Horizontally, the range is 0.5:1 to 0.7:1. The postsurgical position of the lower lip (and chin) in maxillary surgery roughly follows the movement of the mandible in a 1:1 ratio,[13] depending on the severity of the malocclusion. These predicted soft tissue changes associated with maxillary impaction have not been evaluated extensively with the video imaging techniques available today.

The research questions of this study were: (1) Are the OTP and Portrait software programs accurate in predicting both postsurgical line drawing profiles and postsurgical video images? (2) Are both software programs equally accurate? (3) Do orthodontists, surgeons, and lay people agree that the predicted video images sufficiently resemble the actual postsurgical result? (4) Do differences exist among orthodontists', surgeons', and lay persons' opinions of the accuracy of either software program in predicting soft tissue profile changes?

Materials and methods

The subjects of this retrospective study consisted of 32 Caucasian adult patients (21 female, 11 male) who were treated by one oral and maxillofacial surgeon. The sample population consisted of patients who had completed orthodontic treatment and maxillary LeFort I orthognathic surgery with the following restrictions: maxillary impaction of at least 3 mm and anteroposterior movement of between ±2 mm and -1 mm. Patient selection was based solely on the availability of diagnostic lateral cephalograms and clear profile photographic slides taken within 1 week presurgically and at least 6 months postsurgically using the same radiographic and photographic equipment. All records were taken in centric occlusion with natural head position and the lips in repose.

The presurgical and postsurgical cephalometric headfilms were traced and digitized into the imaging programs by one investigator (RK). Profile photographs were captured at a standardized distance with a color RGB video camera. The presurgical and postsurgical tracings were then superimposed on the line sella-nasion and point sella. The actual amounts of surgical change that had occurred were measured in millimeters at the following nine locations: upper incisor tip, upper incisor apex, A-point, PNS, lower incisor tip, lower incisor apex, B-point, pogonion, and menton. Using these calculations, the presurgical cephalometric images were moved the prescribed distances in both programs. Differences in millimeters between the predicted and actual final images were determined at 12 specific soft tissue areas: nasal dorsum, pronasale, subnasale, superior labial sulcus, upper lip, superior stomion, inferior stomion, lower lip, inferior labial sulcus, pogonion, gnathion, and menton.

In OTP, measurements were made directly within the program of vertical (y-axis) and horizontal (x-axis) differences between the superimposed actual and predicted images. Because a resident measurement tool was not available with Portrait, a digital caliper was used to make comparable measurements on printed line drawings. To ensure size compatibility between the two computer-generated line drawings, all Portrait measurements were corrected for magnification before any comparisons were made.

The data were analyzed using a repeated measures analysis of variance (ANOVA) with the two programs and 12 locations as main effects and interactions between program and point location as comparisons. Multiple comparisons of means were done using the Student-Newman-Kuels procedure with a significance level of $\alpha<0.05$. When interactions between the main effects were found to be significant, both programs were compared at each soft tissue point/area using a Bonferroni adjustment to determine where significant differences existed.

Method error was evaluated by double determinations of landmark locations made 1 week apart of 10 randomly selected cases. There were no significant differences found between replicate measurements.

The second part of this study was a subjective comparison of how well the predicted image resembled the actual surgical image. Video image predictions were created by each program for each patient from a combination of the presurgical image, the default hard-to-soft-tissue ratios, and the actual surgical movements of the maxilla, mandible, and dentition. The computer-generated images were then subjectively compared with the actual postsurgical images by a panel consisting of two orthodontists, two surgeons, and two lay people. A 10 cm visual analog scale (VAS) was used as the assessment tool. Each patient was evaluated at the following eight areas: nose, nasolabial angle, upper lip, lower lip, labiomental fold, chin, submental region, and overall image quality. Each mark on the VAS was measured in millimeters from the leftmost (zero) origin. VAS values are clearly not interval data, but it has been shown that the use of parametric statistics for VAS scores is appropriate and acceptable.[14] A two-way nested analysis of variance procedure was used to compare the scores among the orthodontists, surgeons, and lay people, and between the two software programs. Significant means were tested post-hoc with Tukey's LSD procedure.

A reproducibility study of this section was done by replicate measures of 10 images for each program and each evaluator. Correlation coefficients of each area ranged from .456 to .893 for all evaluators.

Table 2
Vertical axis differences between actual and predicted line drawings: soft tissue values

	OTP $\bar{x} \pm SD$ (mm)	Portrait $\bar{x} \pm SD$ (mm)	
Nose			
Nasal dorsum	1.61 ± 1.99	0.43 ± 0.57	
Pronasale	1.89 ± 2.07	0.67 ± 1.24	*
Subnasale	2.03 ± 1.57	1.20 ± 1.11	
Upper lip			
Superior labial sulcus	1.44 ± 2.33	0.44 ± 0.90	
Upper lip	1.47 ± 1.77	0.80 ± 1.12	
Stomion superior	1.90 ± 1.73	1.38 ± 1.13	
Lower lip			
Stomion inferior	1.82 ± 1.50	2.88 ± 2.62	
Lower lip	2.76 ± 1.80	2.23 ± 2.50	
Inferior labial sulcus	2.54 ± 2.17	1.24 ± 1.66	*
Chin			
Pogonion	1.72 ± 1.65	0.40 ± 0.98	*
Gnathion	1.14 ± 1.19	0.95 ± 0.79	
Menton	1.86 ± 1.48	0.99 ± 0.92	

* $p < 0.05$

Results

Line drawing comparisons

Comparisons between the line drawings generated by the two programs are shown in Tables 1 and 2. Table 1 displays the mean and standard deviation of the differences along the x-axis of each measure to show accuracy in the horizontal plane. The smallest differences occurred at stomion superior for OTP (0.27 mm) and menton for Portrait (0.12 mm). The greatest differences occurred at subnasale for OTP (1.72 mm) and at lower lip for Portrait (1.45 mm). Table 2 shows the mean and standard deviation of the differences along the y-axis of each measure, thus demonstrating vertical accuracy. The differences are much larger in the y-axis than the x-axis. Portrait ranged from 0.40 mm at pogonion to 2.88 mm at stomion inferior. OTP ranged from 1.14 mm at gnathion to 2.76 mm at the lower lip. The two programs were significantly different ($p<.05$) at pronasale vertical, inferior labial sulcus vertical, and pogonion vertical. At all three locations the differences were less with the Portrait program. No significant differences were found among locations.

Tables 3 and 4 partition the results into three categories of frequency, based on what we considered clinically significant (differences ex-

Table 3
Frequency of differences (%) between actual and predicted line drawings (x-axis)

	Clinically insignificant <1.0 mm		Clinically questionable 1.0 - 2.0 mm		Clinically significant >2.0 mm	
	OTP	Portrait	OTP	Portrait	OTP	Portrait
Nose						
Nasal dorsum	59	88	19	6	21	6
Pronasale	56	72	34	25	10	3
Subnasale	31	69	38	16	31	15
Upper lip						
Superior labial sulcus	47	50	31	47	22	3
Upper lip	44	63	34	31	22	6
Stomion superior	88	94	12	3	0	3
Lower lip						
Stomion inferior	59	84	13	9	28	7
Lower lip	38	47	25	28	37	25
Inferior labial sulcus	44	66	28	22	28	12
Chin						
Pogonion	19	53	56	31	25	16
Gnathion	41	59	16	32	43	10
Menton	75	94	6	6	19	0

Table 4
Frequency of measured differences (%) between actual and predicted line drawings (y-axis)

	Clinically insignificant <1.0mm		Clinically questionable 1.0 - 2.0mm		Clinically significant >2.0mm	
	OTP	Portrait	OTP	Portrait	OTP	Portrait
Nose						
Nasal dorsum	53	91	9	6	38	3
Pronasale	38	72	16	16	46	12
Subnasale	31	59	28	22	41	19
Upper lip						
Superior labial sulcus	63	84	9	13	28	3
Upper lip	50	72	19	16	31	12
Stomion superior	44	41	19	31	37	28
Lower lip						
Stomion inferior	34	28	25	16	41	56
Lower lip	16	41	19	16	65	43
Inferior labial sulcus	31	59	19	16	50	25
Chin						
Pogonion	44	84	13	6	43	10
Gnathion	56	59	16	31	28	10
Menton	25	59	37	28	38	13

ceeding 2.0 mm), clinically questionable (differences between 1.0 and 2.0 mm), and clinically insignificant (less than 1.0 mm). In the horizontal direction, 70% of Portrait's predictions overall showed less than 1.0 mm of error and 8% had greater than 2 mm of error; for Orthognathic Treatment Planner, 50% of the predictions had less than 1.0 mm of error, while 24% showed clinically significant errors of greater than 2 mm. In the vertical plane, clinically insignificant differences for OTP ranged from a high of 63% at superior labial sulcus to a low of 16% at lower lip. For Portrait, the maximum vertical difference was registered at nasal dorsum (91%) and the low (41%) at lower lip.

Video image comparisons

The means and standard deviations of the evaluators' scores are shown in Tables 5 and 6. As a general guide, a score above 66.7 is considered good to excellent, and a score below 33.3 is considered poor and indicative of a predicted image that did not resemble the final outcome. OTP scores ranged from a minimum (worst) of 52.5 at lower lip to a maximum (best) 62.5 at nasolabial angle. Portrait scores ranged from 52.9 at lower lip to 70.6 at nasolabial angle. While the panel gave both programs similar overall scores, Portrait was scored significantly higher at the nasolabial angle, upper lip, chin, and submental areas ($p<0.001$). (The "overall" score was judged as a separate variable and is not an average of the other areas.) In general, the evaluations for both programs fell in the fair-to-good range, with several of Portrait's scores reaching the good-to-excellent category. By tests among the means when significant differences were found by ANOVA, Portrait was scored significantly better than OTP at three areas (nose, nasolabial angle, and submental), and significantly higher at two areas (upper lip and chin).

Table 7 shows the results of post-hoc mean comparisons among evaluators. Orthodontist evaluators were significantly more critical overall (51.1) ($p<0.001$) than lay people (62.6) or surgeons (61.6). This was also true for the upper and lower lip areas, where the orthodontists' scores were significantly lower ($p<0.05$) as well. The lay evaluators scored the chin (54.1) and submental areas (54.1) significantly lower ($p<0.001$) compared with both orthodontists (67.8, 69.3) and surgeons (65.6, 71.6). They also judged the nasolabial area more harshly than the surgeons (62.6 vs 70.1, $p<0.05$).

Discussion

The results of this study suggest that in maxillary impaction surgery, the accuracy of these two programs is fairly good—the computer line drawings generated were accurate to within 1.5 mm in the majority of measurements. This finding strongly supports the accuracy of video-imaging in diagnosis and treatment planning for this type of surgery. Both programs were more accurate in the horizontal axis; this would be expected since impaction surgery challenges the vertical algorithms more. The mean differences between the forecast line drawings and the actual outline measured at landmarks in the x-axis direction were 0.81 mm for Portrait and 1.28 mm for Orthognathic Treatment Planner. The mean differences of Portrait were less than that of OTP by less than 0.5 mm. In the y-axis direction, the mean differences were larger. Mean differences of 1.13 mm and 1.85 mm were observed for Portrait and OTP, respectively. The mean errors for both programs in the vertical plane were almost double the mean errors in the horizontal.

Soft tissue algorithms for both programs were much less accurate in forecasting the lower lip and chin areas, with vertical predictions demonstrating a higher mean error than horizontal ones. Lower lip position was often found to be more anterior and inferior to the actual postsurgical result. These findings support the results of recent studies done by Syliangco[15] and Sinclair,[2] who found similar problems with the lower lip in mandibular advancement soft tissue prediction. Portrait and OTP are not unique in this respect in that other video imaging programs share this problem. Using another Windows orthognathic video imaging package (Dentofacial Planner), Kostantiantos[16] found similar horizontal accuracy problems in lower lip prediction. Hing[17] showed that the Macintosh program QuickCeph tended to overestimate the lower lip's horizontal position but underestimate its vertical position. Most recently, Upton[18] also found vertical and horizontal accuracy problems with the lower lip area with QuickCeph. However, Eales,[19] using Dentofacial Planner, found that lower face changes due to autorotation were generally predicted accurately in cases requiring maxillary anteroposterior correction.

In order to bring these findings into clinical perspective, the results were tabulated into three categories based on percentage of differences within certain ranges (see Tables 3 and 4). Portrait exhibited a higher frequency of clinically accurate predictions (less than 1.0 mm) in the horizontal dimension than OTP (70% versus 50%) and a lower percentage of clinically problematic (greater than 2.0 mm) differences than OTP (9% versus 24%). Vertical findings were similar—Portrait's predictions were accurate 62% of the time versus 40% for OTP. Portrait also demonstrated fewer clinically large prediction differences (20% versus 41%) than OTP. Using Portrait alone, Sinclair et al.[2] found more than 20% of the cases imaged showed clinically significant discrepancies of greater than 2 mm, primarily due to the difficulty the program had with lower lip prediction.

Image acceptability was investigated using the forecast video images. Orthodontists were found to consistently rate the overall video images lower than either the oral and maxillofa-

Table 5
VAS scores of quality of video image predictions between OTP and Portrait

	OTP	Portrait	
Nose	58.7 ± 20.1	69.9 ± 15.5	***
Nasolabial angle	62.5 ± 17.6	70.6 ± 14.6	***
Upper lip	54.8 ± 20.3	61.3 ± 19.1	*
Lower lip	52.5 ± 18.0	52.9 ± 22.7	NS
Labiomental fold	54.8 ± 17.0	55.9 ± 21.0	NS
Chin	59.6 ± 18.2	65.4 ± 18.1	*
Submental area	59.9 ± 18.0	69.8 ± 17.7	***
Overall	57.8 ± 18.0	59.0 ± 16.5	NS

Clinical acceptability:
0 to 33.3 poor to fair
33.4 to 66.6 fair to good
66.7 to 100 good to excellent

NS not significant
* $p < .05$
** $p < .01$
*** $p < .001$

Table 6
VAS scores of video image quality among orthodontists, surgeons, and lay people

	Orthodontists $\bar{x} \pm SD$	Surgeons $\bar{x} \pm SD$	Lay people $\bar{x} \pm SD$
Nose	61.3 ± 23.6	72.3 ± 14.6	69.3 ± 14.0
Nasolabial angle	66.9 ± 19.2	70.1 ± 26.8	62.6 ± 12.7
Upper lip	51.8 ± 22.8	63.0 ± 20.3	59.2 ± 14.4
Lower lip	47.5 ± 21.8	56.1 ± 22.3	54.5 ± 16.1
Labiomental fold	55.7 ± 20.5	55.9 ± 20.3	54.4 ± 16.5
Chin	67.8 ± 17.6	65.6 ± 18.9	54.1 ± 15.5
Submental	69.3 ± 18.9	71.1 ± 16.4	54.1 ± 15.3
Overall	51.1 ± 19.4	62.6 ± 17.8	61.6 ± 11.2

Clinical acceptability:
0 to 33.3 poor to fair
33.4 to 66.6 fair to good
66.7 to 100 good to excellent

Table 7
Statistical comparison of means among orthodontists, surgeons, and lay people

	Orthodontists vs surgeons	Orthodontists vs lay people	Surgeons vs lay people
Nose	NS	***	***
Nasolabial angle	NS	NS	**
Upper lip	*	**	NS
Lower lip	*	*	NS
Labiomental fold	NS	NS	NS
Chin	NS	***	***
Submental fold	NS	***	***
Overall	***	***	NS

NS not significant
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

cial surgeons (p<0.001) or lay people (p<0.001). This finding is in partial agreement with Bell,[20] who stated that lay people were more likely than orthodontists and surgeons to assign normal ratings to profile drawings. Prahl-Anderson[21] found that orthodontists rated a greater number of line drawings of facial profiles as abnormal than the parents of the children participating in the study. However, the similarities of the lay persons' and surgeons' evaluations of the overall images was in disagreement with Burcal's[22] study, which found that lay people were not as critical as the surgeons and often failed to notice surgically corrected malformations. In our study, lay people were found to be more critical of the chin and submental areas than either the orthodontists (p<0.001) or surgeons (p<0.001), findings in agreement with Romani[23] and Syliangco.[15] On the other hand, orthodontists were more critical of the upper and lower lips than were the surgeons (p<0.001) or lay people (p<0.001). This may be due to the tendency of orthodontists to focus on lip and incisor position. In one study at least, orthodontists were found to prefer less facial protrusion.[24]

Several factors should be noted that underlie the difficulty both programs had in forecasting and accurately depicting the lower lip area. Because a substantial majority of patients in this study were lip incompetent (i.e., interlabial gap >3 mm) the surgical procedure resulted in large vertical lower lip change not only of landmarks, but of lip contour as well. Also, the lower lip position may also have been altered by the change in support provided by the maxillary incisor following surgery.[18] Initial lip thickness is another important variable that affects lip competence.[7] Other factors that affect both horizontal and vertical components of the lower lip include soft tissue thickness of the investing tissue surrounding the perioral musculature, underlying muscle attachments, and lower incisor position.[8]

Postsurgical edema and weight gain or loss also affect the appearance of the final outcome. All these factors are taken into consideration by clinicians on the basis of experience; it is probably safe to say, then, that the experienced surgeon or orthodontist using these programs in treatment planning vertical maxillary excess cases would alter the default ratios for soft tissue movements. They would also make extensive use of the "paint" features of the programs, such as "cut and paste" and "blending," to modify the predicted soft tissue contours based on previous cases with similar diagnostic features.

Other factors affecting the quality and accuracy of the predicted images are special characteristics of the computer programs themselves. A high-quality original image, i.e., a 35 mm color transparency, was critical to the accurate input into the programs. One of the keys to obtaining quality images in the computer is the background behind the patient's profile. The clearer the outline of the soft tissue, the better the rendering by the computer. For example, Portrait was found to be very sensitive to the color of the background. If the flesh tones of the outline were not contrasted with a white or light colored background, the program's "Profile" subroutine was unable to outline the profile. When this occurred, the operator was forced to adjust the color of the face so the image could be properly "captured." This often resulted in a poor image on the screen. The problem of a nonwhite background also caused problems for OTP, although not as serious or as frequent as for Portrait. Figures 1 and 4 show the initial pretreatment and postsurgical profile photographs of a subject from this study. The OTP and Portrait predictions shown in Figures 2 and 3 were rated high by the panel. The roughness and lack of blending of the lower lip, submandibular, and chin contours are clearly evident, but the general conformation matches the actual outcome fairly well.

The input of landmark and structure data is handled differently by the two programs. Our version of OTP was set up such that the cephalometric radiograph was captured by the video camera and the operator digitized the points by moving the mouse pointer on the screen. Although the image contrast and depth could be manipulated, the loss of resolution and readability was notable. (This problem was experimentally confirmed by Forsyth et al.[25]) For Portrait, the cephalometric data were digitized directly on a clear (lighted) digitizing tablet. Line output of the profile in OTP was also dependent upon curve-fitting algorithms rather than being streamed in directly, as in Portrait.

Since their introduction a few years ago, video imaging techniques have improved dramatically and are becoming increasingly important to clinicians and patients for communication and visualization during treatment planning sessions.[26,27] Investigators have found that video imaging has not been directly linked to the decision to undergo surgery, but instead has contributed to a better understanding of treatment goals by the patient.[28] Most practitioners who regularly use video imaging would likely state that the primary role of these systems is to establish better communication with the patient. However, in order for this feature to be worthwhile, the forecasts must be accurate. This study and others in the recent literature have found the accuracy to be good. Both OTP and Portrait undergo regular revision; these upgrades are released throughout the year and include significant improvements in all areas. For this reason, many of the problems and limitations noted in this study will have been resolved or addressed by the programmers of these products by the time of publication of this article.

Conclusions

1. Both Orthognathic Treatment Planner and Prescription Portrait produced reasonably accurate line drawing and video image predictions of the results of maxillary impaction surgery, although both programs had particular difficulty in predicting lower lip position.

2. Prescription Portrait was significantly more accurate in the x-axis direction, with 70% of its predictions having less than 1.0 mm of error and only 8% having greater than 2.0 mm of error. In contrast, 50% of Orthognathic Treatment Planner predictions showed less than 1.0 mm of error, while 24% presented with clinically significant differences greater than 2.0 mm.

3. In the y-axis direction, Prescription Portrait was more accurate than Orthognathic Treatment Planner at pronasale, inferior labial sulcus, and pogonion. The mean vertical errors, however, for both programs were nearly twice those of the horizontal errors.

4. The video image evaluations for both programs fell in the fair-to-good range. Several of Portrait's scores achieved a good-to-excellent classification. Orthodontists were significantly more critical of the lips and overall video images when compared with surgeons and lay people. The lay people however, in scoring the nose, chin, and submental areas lower, disagreed significantly with both the orthodontists and surgeons.

5. Both programs are relatively fast and produce high-quality color images on the screen. However, although the programs are close in forecasting the postsurgical soft tissue contours, there is room for improvement in the rendering of the lips and other important areas. If, as we presume, the software engineers of these systems rely on movement ratios provided by the literature, then there is clearly a need for improved and more comprehensive studies to determine more accurate ratios and mathematical relationships among the many variables that account for the final postsurgical positions of the hard and soft tissues of the face.

6. Finally, because these programs are undergoing constant improvement in both image handling and ease of use, the results of this study may be different with current versions.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 1
Presurgical profile photograph.

Figure 2
Predicted surgical outcome using Orthognathic Treatment Planner.

Figure 3
Predicted surgical outcome using Prescription Portrait.

Figure 4
Actual postsurgical profile photograph.

Author Address
Glenn T. Sameshima
Dept. of Orthodontics
925 W. 34th St.
USC School of Dentistry
Los Angeles, CA 90089-0641
Email: Sameshima@hsc.usc.edu

G.T. Sameshima, assistant professor, Dept. of Orthodontics, University of Southern California.

R.K. Kawakami, private practice, San Pedro, Calif.

R.M. Kaminishi, clinical professor, Dept. of Oral and Maxillofacial Surgery, University of Southern California

P.M. Sinclair, professor and chairman, Dept. of Orthodontics, University of Southern California.

References

1. Laney TJ, Kuhn BS. Computer imaging in orthognathic and facial cosmetic surgery. Oral Maxillofac Clinics North Am 1990;2(4):659-668.
2. Sinclair PM, Kilpelainen P, Phillips C, White RP, Rogers L, Sarver DM. The accuracy of video imaging in orthognathic surgery. Am J Orthod Dentofac Orthop 1995;107(2):177-185.
3. Sarver DM, Johnston MW, Matukas VJ. Video imaging for planning and counseling in orthognathic surgery. J Oral Maxillofac Surg 1988;46:939-945.
4. Sarver DM, Johnston MW. Video imaging: techniques for superimposition of cephalometric radiography and profile images. Int J Adult Orthod Orthognath Surg 1990;5(4):241-248.
5. Ackerman JL, Proffit WR. Communication in orthodontic treatment planning: bioethical and informed consent issues. Angle Orthod 1995;65(4):253-262.
6. Radney LJ, Jacobs JD. Soft-tissue changes associated with surgical total maxillary intrusion. Am J Orthod 1981;80(2):191-212.
7. Sakima T, Sachdeva R. Soft tissue response to LeFort I maxillary impaction surgery. Int J Adult Orthod Orthognath Surg 1987;2(4):221-231.
8. Stella JP, Streater MR, Epker BN, Sinn DP. Predictability of upper soft tissue changes with maxillary advancement. J Oral Maxillofac Surg 1989;47(7): 697-703.
9. Ayoub AF, Mostafa YA, Mofty SE. Soft tissue response to anterior maxillary osteotomy. Int J Adult Orthod Orthognath Surg 1991;6(3):182-190.
10. Sarver DM, Weissman SM. Long-term soft tissue response to Le Fort I maxillary superior repositioning. Angle Orthod 1991;61(4):267-276.
11. Hack GA, de Mol van Otterloo JJ, Nanda R. Long-term stability and prediction of soft tissue changes after LeFort I surgery. Am J Orthod Dentofac Orthop 1993; 104(6):544-555.
12. Schendel SA, Eisenfeld JH, Bell WH, Epker BN. Superior repositioning of the maxilla: stability and soft tissue osseous relations. Am J Orthod 1976; 70(6):663-74.
13. Jensen AC, Sinclair PM, Wolford LM. Soft tissue changes associated with double jaw surgery. Am J Orthod Dentofac Orthop 1992; 101(3):266-275.
14. Dexter F, Chestnut DH. Analysis of statistical tests to compare analog scale measurements among groups. Anesthesiology 1995;82:896-902.
15. Syliangco SM, Sinclair PM, Sameshima GT, Kaminishi RM. The accuracy of video imaging in the prediction of mandibular advancement surgery. Angle Orthod (in press).
16. Konstantiantos KA, O'Reilly MT, Close J. The validity of the prediction of soft tissue profile changes after LeFort I osteotomy using the Dentofacial Planner (computer software). Am J Orthod Dentofac Orthop 1994; 105(3): 241-249.
17. Hing NR. The accuracy of computer generated prediction tracings. Int J Oral Maxillofac Surg 1989;18:148-151.
18. Upton PM. Evaluation of video imaging prediction in combined maxillary and mandibular orthognathic surgery (abstract). Am J Orthod Dentofac Orthop 1994; 106(4):451.
19. Eales EA, Newton C, Jones ML, Sugar A. The accuracy of computerized prediction of the soft tissue profile: a study of 25 patients treated by means of the LeFort I osteotomy. Int J Adult Orthod Orthognath Surg 1994;9(2):141-152.
20. Bell R, Kiyak HA, Joondeph DR. Perceptions of facial profile and their influence on the decision to undergo orthognathic surgery. Am J Orthod Dentofac Orthop 1985;88:323.
21. Prahl-Anderson B, Boarsma H, Van der Linden FPGM. Perceptions of dentofacial morphology by lay persons, general dentists and orthodontists. J Am Dent Assoc 1979;98:209.
22. Burcal RG, Laskin DM, Sperry TP. Recognition of profile changes after simulated orthognathic surgery. J Oral Maxillofac Surg 1987;45:666.
23. Romani KL, Agahi F, Nanda R, Zernik JH. Evaluation of horizontal and vertical differences in facial profiles by orthodontists and lay people. Angle Orthod 1993; 63(3):175-182.
24. Pogrel AM. What are normal esthetic values? J Oral Maxillofac Surg 1991;49(9):963-969.
25. Forsyth DB, Shaw WC, Richmond S, Roberts CT. Digital imaging of cephalometric radiographs, part 2: image quality. Angle Orthod 1996;66(1):43-50.
26. Sarver DM, Johnston MW. Orthognathic surgery and esthetics: planning treatment to achieve functional and esthetic goals. Brit J Orthod 1993;20:93-100.
27. Phillips C, Hill BJ, Cannac C. The influence of video imaging on patients' perceptions and expectations. Angle Orthod 1995;65(4):263-270.
28. Sarver DM. Video imaging: a computer facilitated approach to communication and planning in orthognathic surgery. Brit J Orthod 1993;20:187-191.