Subjective evaluation of profile prediction using video imaging

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Video imaging has become a popular tool for predicting soft tissue profiles. However, it is important not to create false expectations with its use. The purpose of this study was to evaluate the clinical acceptability of video imaging for the prediction of soft tissue changes in mandibular advancement orthognathic surgery, and thus, to determine its suitability for patient presentation, education, and subsequent treatment planning.
Simulated mandibular advancements were performed on 30 patients (21 women and 9 men) using the Dentofacial Planner Plus v1.5 software program. Two separate panels consisting of 25 laypersons and 25 dental professionals (17 orthodontists and 8 oral and maxillofacial surgeons) compared prediction images to actual posttreatment images. Overall profile predictions were found to be clinically acceptable by orthodontists and oral and maxillofacial surgeons in 87.8% of the cases and by laypersons in 95.6% of the cases. No significant differences were found among the individual facial regions graded by the dental professional panel. The results of this study suggest that video imaging is an acceptable tool for profile prediction. (Int J Adult Orthod Orthognath Surg 1995;10:211–217)

Introduction

With the advent of refined surgical procedures, such as the Le Fort I osteotomy and the bilateral sagittal split osteotomy, a combined orthodontic/orthognathic surgical approach for the treatment of dentofacial deformities has become routine. Dental clinicians have become skilled at improving oral function and have developed techniques for predicting it. With the simple manipulation of models into a Class I occlusion, or the more skilled art of model surgery, one can readily predict function. Yet, if clinicians are to remain contemporary in the 1990s, then they must address the concerns of the 1990s patient.[1]

Today, more than 70% of prospective orthognathic surgical patients cite esthetics as a major motivating factor for seeking treatment.[2,3] With this knowledge, computer-generated prediction techniques involving video imaging have become popular tools in modern treatment planning. This process involves linking a still profile image from a video recorder to a cephalometric tracing. Manipulations of hard tissue (from a cephalometric tracing) are performed on a computer screen to simulate a proposed treatment. Soft tissue from the linked video image changes accordingly. The final outcome is a predicted facial image instead of a mere line drawing, as would occur with cephalometric predictions alone.

Esthetic and functional decisions can now be made by the oral surgeon, orthodontist, and the patient in a consensual manner.[4]

However, with the increased use of video imaging, the patient's expectations versus clinical treatment outcome must be considered. The issue is not the statistical summation of millimetric variability from prediction to prediction. It is virtually impossible, even with modern technology, to precisely predict soft tissue changes because of variables such as tissue thickness and tonicity.[5-8] The issue that needs to be addressed is whether or not the inherent inaccuracies of video predictions are clinically acceptable for use in treatment planning and presentation to patients. Subtle differences between video prediction and actual outcome may be clinically acceptable. It has been shown that changes of 2 to 4 mm in soft tissue profiles are often not recognizable, either by the layperson or the clinician.[9]

The question of the clinical acceptability of video imaging is just beginning to surface in the dental literature. Sarver et al[4] showed that 89% of surgically treated patients believed that their image predictions were realistic and the desired results were achieved. Sinclair et al[3] revealed that two experienced clinicians thought 60% to 83% (average of 70%) of the predicted image areas viewed were clinically acceptable for treatment planning (using the Prescription Planner/Portrait software program, Rx Data). The areas of the profile evaluated were the upper and lower lips, labiomental fold, chin, and submental region. Although the Sinclair et al study involved only two clinicians as a survey team, it has helped to guide researchers into further studies, such as the present one.

The purpose of this study is to evaluate the clinical acceptability of video imaging for soft tissue prediction in mandibular advancement orthognathic surgery, and thus, to determine the suitability of its use for patient presentation, education, and subsequent treatment planning.

Method and materials

A retrospective analysis was implemented on 30 patients previously treated with orthodontics and orthognathic surgery. The sample was gathered from the office of a practicing oral and maxillofacial surgeon in Chicago (RHK) and was limited to mandibular advancements of 4 mm or greater with little or no postsurgical orthodontic movement. The patient pool consisted of 21 white women and 9 white men. Presurgical and posttreatment lateral cephalograms and lateral facial slides (converted to video images) were used to create predictions. All images were taken with the patient in centric relation and the lips in repose. The analysis equipment and software used were Pentium Processor (Gateway 2000); digitizer (Numonics); Nikon Cool Scan (Nikon); CA Cricket Image (Computer Associates); Dentofacial Planner Plus v1.5 (Dentofacial Software); Adobe Photoshop v2.5 (Adobe Systems); and Epson Stylus Color ink-jet printer (Seiko Epson).

Presurgical (T1) and posttreatment (T2) lateral cephalograms were digitized on a Numonics digitizer. Presurgical acetate hand tracings were used as templates to duplicate unchanged landmarks on the posttreatment cephalograms. Video images were retrieved of T1 and T2 lateral facial slides using the Nikon Cool Scan. Scanned images were converted and resized to 320 pixels wide by 480 pixels high with 8 bits per pixel using the CA Cricket Image software. The final computer video image was linked to its corresponding cephalometric tracing using Dentofacial Planner Plus v1.5.

To eliminate potential surgical error, the exact surgical movements were computed using an analysis created specifically for this study in Tools, a program in Dentofacial Planner used to individualize measurements and analyses. Presurgical and posttreatment digitized cephalometric tracings were superimposed on sella-nasion at sella. The analysis displayed the change in position, horizontally and vertically from

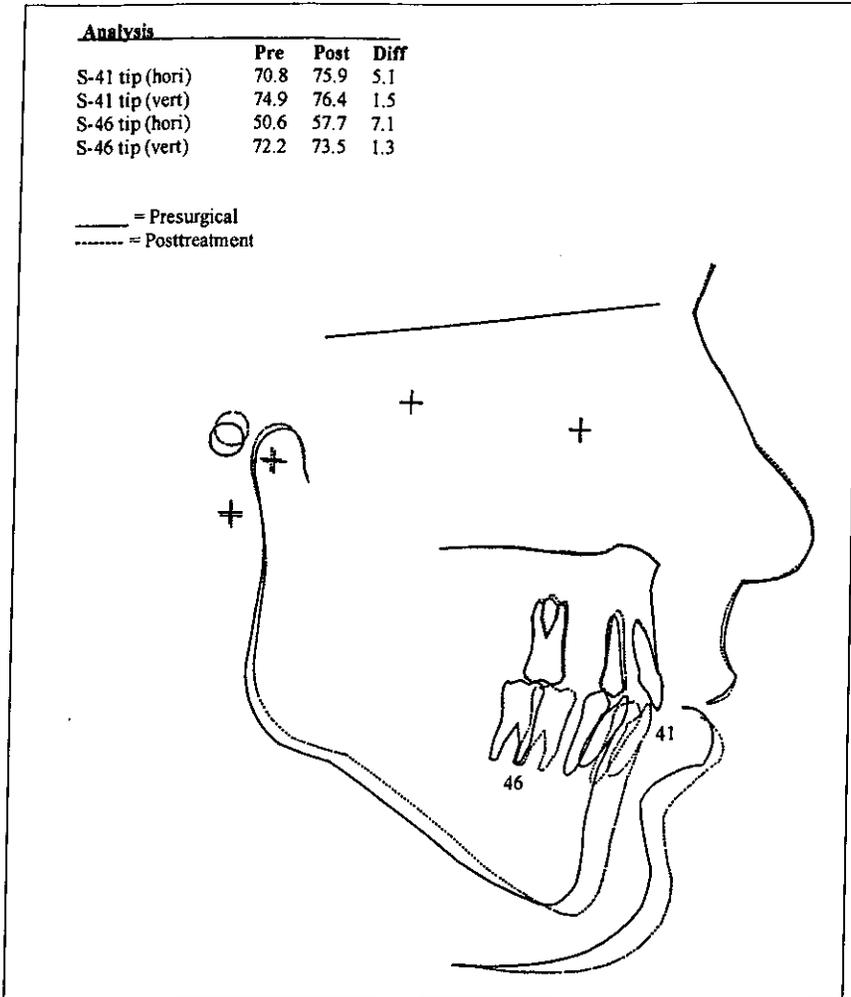| Analysis	Pre	Post	Diff
S-41 tip (hori)	70.8	75.9	5.1
S-41 tip (vert)	74.9	76.4	1.5
S-46 tip (hori)	50.6	57.7	7.1
S-46 tip (vert)	72.2	73.5	1.3

_____ = Presurgical
-------- = Posttreatment

Fig 1   Superimpositions of presurgical and posttreatment cephalometric tracings. Numbers are in millimeters from both horizontal and vertical references (from sella) to lower first molar (46) and lower central incisor (41). Difference (Diff) shows millimetric movement of teeth 46 and 41 as a result of mandibular advancement.

shots" of the computer screen within the Dentofacial Planner program. In Adobe Photoshop v2.5, all colored backgrounds were converted to white using the magic wand and paint bucket tools. Variability of image darkness, contrast, and color between predictions and posttreatment images were reduced using their corresponding tools. Images were then standardized in size and cropped anterior to the tragus of the ear and just above glabella to eliminate changes in hair style from the time of presurgery to posttreatment. Hard copies were retrieved via the Epson Stylus Color inkjet printer (a high-resolution printer of 720 x 720 dpi).

The prediction image and posttreatment hard copies were viewed by two separate panels consisting of 25 laypersons and 25 dental professionals (17 orthodontists and 8 oral and maxillofacial surgeons). Laypersons ranged from 20 to 40 years of age to correspond with the age group of the treated patients. The degree of similarity was evaluated using a grade scale of 0 to 4, with accompanying explanations for each grade. Laypersons judged the overall profile image, focusing on the lip and chin regions. Clinicians scored the upper lip, lower lip, labiomental fold, and chin areas (as in the Sinclair et al study[3]) in addition to grading the overall profile. The overall profile scores were used to determine clinical acceptability. The breakdown of the profile was structured to target greater differences in individual regions. The grade scale used for comparing overall profiles and individual facial areas was as follows (A = predicted; B = posttreatment):

sella, of the mandibular first molar and central incisor tip as a result of surgery (Fig 1). Surgical predictions were performed on all presurgical tracings and linked video images, duplicating the actual mandibular advancements found in the previous analyses. The "retouch" option was used in five cases to manually blend any gross distortions that occurred in the labiomental fold area. Image files (pcx files) of the prediction images were created by taking "snap-

0: Poor—profile (area) of image A has little agreement with profile (area) of image B.

1: Fair—profile (area) of image A only slightly similar to profile (area) of image B, with major differences between them.

2: Good—profile (area) of image A similar to profile (area) of image B, but with noticeable differences between them.

Figs 2 and 3   Examples of images used in the study.   *(left)* Presurgical photo;   *(center)* Predicted photo;
(right) Actual posttreatment photo.
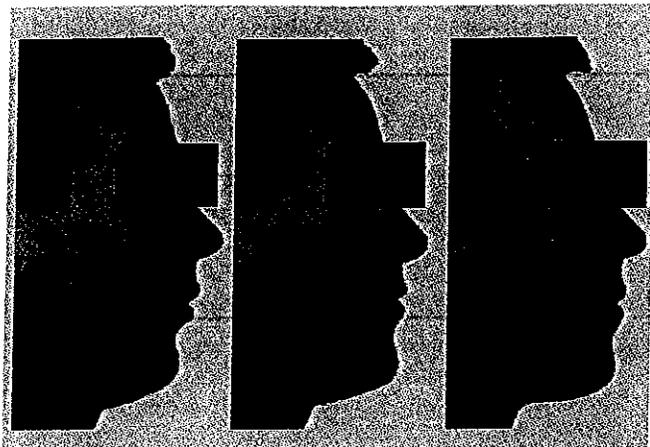
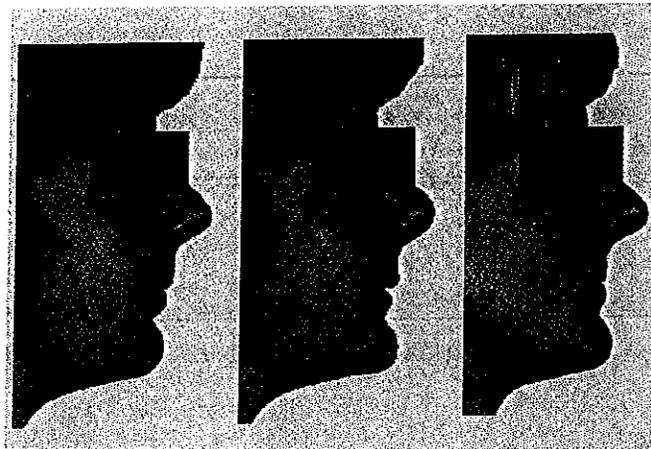*Fig 2*   *Fig 3*

3: *Very good*—profile (area) of image A very similar to profile (area) of image B, with only minor differences between them.

4: *Excellent*—profile (area) of image A not distinguishable from profile (area) of image B.

Figures 2 and 3 are examples of images used for this study.

Results

Evaluations of the overall profiles by laypersons and dental professionals are summarized in Table 1. Dental professionals found 11.5% of image pairs to be indistinguishable ("excellent" category). For the purpose of comparing studies and software packages, the "very good" and "excellent" categories were combined to form group A, similar to the Sinclair et al study using Prescription Planner/Portrait.[3] Orthodontists and oral surgeons judged 54.5% of the video image pairs to fall within group A when evaluating the overall profile. To evaluate clinical acceptability, the "good" or better categories were combined (group B), which raised the previous value to 87.8%.

When laypersons evaluated the overall facial profile, 21.5% of the image pairs were found to be indistinguishable from each other, and 69.2% of the video image predictions were ranked high enough to be in group A. This value increased to 95.6% for group B.

Grades for the individual facial regions were evaluated but were not found to be significantly different from each other or from the overall profile as determined by a one-way analysis of variance (see Table 2).

All evaluators thought that the actual profile image was more pleasing than the predicted image, as did those in the Sinclair et al study.[3]

Discussion

Evaluating the accuracy of video imaging is a very difficult task to perform. In this study, accuracy of the prediction has not been determined. What has been determined is the perception of similarities between video image predictions and actual posttreatment images. The way each evaluator perceived an image pair to be an acceptable match varied significantly. Because of the specific attention paid to details

Table 1 Distribution of evaluations of overall facial profiles (in percentages)

Scale	Laypersons		Clinicians	
	Mean	SD	Mean	SD
0: Poor	0.5	1.6	1.3	4.4
1: Fair	3.9	4.4	10.9	12.8
2: Good	26.4	15.6	33.3	13.6
3: Very good	47.7	12.7	43.0	15.5
4: Excellent	21.5	15.8	11.5	11.4
Group A[†] (3 and 4 combined)	69.2	17.4	54.5	23.1
Group B[‡] (2, 3, and 4 combined)	95.6*	5.1	87.8*	15.8

*t tests assessed that these values differed significantly from each other. P < .05; two-tailed test.
[†]Group A was used for comparison to previous study by Sinclair et al.[3]
[‡]Group B = clinically acceptable.

Table 2 Distribution of evaluations of facial regions by oral surgeons and orthodontists (in percentages)

Scale	Facial region evaluated							
	Upper lip		Lower lip		Labiomental fold		Chin	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
0: Poor	2.3	6.1	0.5	1.6	1.1	2.1	3.7	7.3
1: Fair	13.0	14.0	7.3	9.1	8.9	12.7	12.1	11.2
2: Good	36.9	17.0	28.8	14.9	30.5	11.9	32.8	13.4
3: Very good	35.1	16.3	46.2	15.4	47.2	17.6	38.9	16.2
4: Excellent	12.7	18.4	17.2	18.3	12.3	16.1	12.5	15.0
Group A[†] (3 and 4 combined)	47.8	27.0	63.4	22.0	59.5	22.5	51.4	23.9
Group B[‡] (2, 3, and 4 combined)	84.7	17.7	92.2	10.0	90.0	13.3	84.2	15.8

[†]Group A was used for comparison to previous study by Sinclair et al.[3]
[‡]Group B = clinically acceptable.

of the facial profile within the professional group, clinicians were apt to be more critical in their evaluations than were laypersons.

Evaluations ranking good or better (no major differences) were deemed clinically acceptable. This range of grades was used because each grade fell within the confines of acceptable as defined by Webster's New Collegiate Dictionary. The percentage of image pairs falling within this group was 95.6% for laypersons and 87.8% for clinicians. These values give confidence in using the imaging tool for patient presentation and education.

Tentative comparisons can be made between this study and that of Sinclair et al,[3] by evaluating a similar category (group A). In the Sinclair et al study,

70% of predicted images received the grade of very good or better. However, in that study, only two clinicians evaluated image pairs, whereas 25 clinicians evaluated image pairs in this study. The results of this study showed that dental professionals judged a mean of 54.5% (range of 23.3% to 83.3% with standard deviation of 23.1%) of predicted images to be in group A. The broad range suggests that the opinions of evaluators vary considerably, and that a large panel is necessary for a study such as this.

Because of the low percentage of indistinguishable image pairs (excellent category), the fact must be stressed that the image is for treatment simulation only. Although the prediction will not be a perfect match of the end result, a general esthetic outcome of a proposed treatment option can be achieved.

It was expected that the least accurate area would be the lower lip, as was determined in previous studies on computer-generated predictions.[5-8] However, the results for this area were the same as all other facial regions. This finding supports the improvements that have been made by Dentofacial Software as suggested by such researchers as Jacobson.[6]

In this study, the original image used for prediction purposes was reduced in resolution to 85 pixels per square inch as required for use in Dentofacial Planner Plus v1.5. Thus, the actual posttreatment image, having better resolution of 200 pixels per inch, produced a higher quality picture. Improvement of resolution of images within Dentofacial Planner should be considered by its manufacturer. In addition, it appeared that there were problems in the linking capabilities of the program, which used a point-to-point system to create curves. This process often "cuts off" tissue in the rounded areas of the profile. The problems in resolution and linking may have led to the overall opinion that the actual posttreatment image was more pleasing than the predicted image.

Difference in head positions (both in Frankfort orientation and in rotation) was a limiting factor in the selection of images for this study. During the linking process, the cephalometric tracing is altered to fit the head position of the video image. Future developments in video-linking software should include a tool to achieve consistent head position of the captured images. Until such improvements are made, the operator must attempt to eliminate differences in Frankfort orientation from presurgery to posttreatment when linking images of a patient.

Although this study makes some comparisons of Dentofacial Planner Plus v1.5 to Prescription Portrait Planner, a definitive statement cannot be made. A future study is needed to compare various programs on the same group of treated patients. In addition, similar studies need to be performed to test the clinical acceptability of predicting different types of surgery involving the mandible and the maxilla.

Conclusions

1. Profile predictions of mandibular advancements via video imaging were ranked clinically acceptable by orthodontists and oral and maxillofacial surgeons in 87.8% of the cases, and by laypersons in 95.6% of the cases.
2. No significant differences were found among percentages of acceptably graded individual facial regions.
3. Video imaging is a suitable tool for use in patient presentation, education, and subsequent treatment planning.
4. There is a need for improvement in the resolution of images and in the linking process in Dentofacial Planner Plus v1.5. The possible development of a head repositioning tool within the program should also be considered.

Acknowledgment

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