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Long-term follow-up of Class II adults treated with orthodontic camouflage: A comparison with orthognathic surgery outcomes

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Abstract

Thirty-one adults who had been treated with orthodontics alone for Class II malocclusions were recalled at least 5 years posttreatment to evaluate cephalometric and occlusal stability and also their satisfaction with treatment outcomes. The data were compared with similar data for long-term outcomes in patients with more severe Class II problems who had surgical correction with mandibular advancement, maxillary impaction, or a combination of those. In the camouflage patients, small mean changes in skeletal landmark positions occurred in the long term, but the changes were generally much smaller than in the surgery patients. The percentages of patients with a long-term increase in overbite were almost identical in the orthodontic and surgery groups, but the surgery patients were nearly twice as likely to have a long-term increase in overjet. The patients' perceptions of outcomes were highly positive in both the orthodontic and the surgical groups. The orthodontics-only (camouflage) patients reported fewer functional or temporomandibular joint problems than did the surgery patients and had similar reports of overall satisfaction with treatment, but patients who had their mandibles advanced were significantly more positive about their dentofacial images.

For nongrowing patients with skeletal Class II malocclusions, there are only 2 possible treatment approaches: (1) orthodontic camouflage, based on retraction of the protruding maxillary incisors to improve both dental occlusion and facial esthetics without correcting the underlying skeletal problem; or (2) orthognathic surgery to reposition the mandible or the maxilla. Skeletal Class II problems are due to mandibular deficiency or downward-backward rotation of the mandible caused by excessive vertical growth of the maxilla. Surgical treatment, therefore, consists of mandibular advancement, superior repositioning of the maxilla, or a combination. Mandibular deficiency is the problem in about two thirds of surgical patients; one third require maxillary surgery, either alone (15%) or combined with mandibular surgery (20%).¹

In one of the few published comparisons of orthodontic versus surgical correction of Class II problems in nongrowing patients, our research group noted that both orthodontic and surgical patients showed similar correction of the malocclusion, although the camouflage group had slightly greater overjet at 1 year posttreatment.² The surgical patients, as

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expected, had a more ideal skeletal relationship, with the mandible more anteriorly positioned and the mandibular incisors in a more ideal position relative to basal bone.

Better data exist for long-term outcomes for orthognathic surgery than for orthodontic camouflage, although many more Class II patients are treated orthodontically. Surgery patients have been followed carefully because of concerns about condylar remodeling or other skeletal changes that would produce relapse, but dental and skeletal stability in nonsurgical patients has not been evaluated in the same systematic way. Existing data show that during the first postsurgical year, both mandibular advancement and maxillary intrusion are quite stable in most surgical Class II patients. At 1 year, skeletal landmarks for both groups were within 2 mm of the immediate postsurgical position in more than 90% of the patients in the University of North Carolina (UNC) database, and similar results have been reported from other centers. Comparable stability for 2-jaw surgery requires rigid internal fixation, but, with it, more than 90% of the patients are stable during the first year.³

Skeletal changes occur in a surprising number of surgery patients between 1 and 5 years postsurgery, however. Long-term (5-year) recall of UNC patients who had mandibular advancement showed a small but statistically significant decrease in mean mandibular length (condylion-Point B) from 1 to 5 years. Usually after any type of treatment, a few patients have most of the changes, so that a better perspective is gained from noting that, at 5 years postsurgery, the mandible is within 2 mm of its immediate postsurgical position in 80% of the patients, and 5% have more than 4 mm shortening of mandiblar length (Co-Pg).^{4,5} These skeletal changes are not necessarily accompanied by occlusal relapse, because compensatory movement of the teeth often occurs.

To compare this with long-term skeletal changes in adults who did not have surgery, Schubert et al⁶ recalled 33 adults for whom cephalometric radiographs were available at the end of orthodontic treatment. Of these patients, 9 had refused recommendations for surgery (2 chose orthodontics), and 24 received orthodontic treatment that would have produced dental but not skeletal changes; ie, they had milder malocclusions and did not require surgery. Although evidence of skeletal remodeling over a 5-year period was observed in these orthodontic patients, surgery patients had larger changes in most landmark positions and were more likely to have a decrease in mandibular length. Because both the magnitude and the pattern of change in the nonsurgical adults were different from the surgery patients, the changes beyond 1 year postsurgery could not be attributed just to normal adult growth. There are no data for long-term changes in a sample of only adult Class II patients treated with orthodontics alone.

Both occlusal and skeletal stability are important in comparing treatment outcomes. The peer assessment rating (PAR) method developed in England provides a weighted measure of the occlusion that takes into account overjet, overbite, midlines, buccal occlusion, and maxillary and mandibular anterior alignment.⁷ Al Yami et al⁸ used PAR scores to evaluate the treatment outcomes 10 years after treatment in 564 adolescents (mean age, 12.0 years \pm 3.1 years at the start of treatment) with various orthodontic problems. Their results showed that about two thirds of the achieved orthodontic correction was still present 10 years after treatment. When PAR scores increased after treatment, about half of the change occurred within the first 2 years. Otuyemi and Jones⁹ used PAR scores to characterize the relative success of orthodontic treatment in adolescent Class II patients and found on recall that 60% remained in the same category at 1 year and 38% at 10 years; the major factors in higher scores were an increase in overjet and a deterioration of mandibular anterior alignment.

In evaluating treatment outcomes, not only the objective changes measured from radiographs and other records but also the patients' perceptions must be noted. A major

reason for seeking orthodontic or surgical correction of a Class II problem is to improve the quality of life, and this must be evaluated from the patient's point of view, not from what the doctor measures on physical records. Most published data on perceptions of treatment are for surgical patients. Although camouflage patients do not undergo orthognathic surgery, they still have teeth extracted, their dental and facial appearance changes, their jaw functions are affected, and the same methods used to study surgery patients can be applied.

Essentially all long-term studies show that most surgical patients are satisfied with their results and would recommend surgery to others. The major sources of information are a series of studies carried out in Seattle in the 1980s by Kiyak et al¹⁰ and studies at UNC in the 1990s by Phillips and Proffit.¹¹ In both centers, 75% to 80% of patients reported satisfaction with their treatment at 4 to 6 weeks postsurgery, and, by 2 years, nearly 90% were satisfied. Overall, patients were quite pleased with the esthetic results of treatment, and, even at 2 years postsurgery, many reported receiving positive comments about their appearance. In the UNC group, one fourth of the patients at 2 years postsurgery agreed that people whom they met for the first time reacted more positively than new acquaintances had before the surgery. However, 15% said they had expected more change in their appearance than achieved, even though they reported satisfaction with the results. No data exist to compare long-term perceptions and feelings of camouflage patients with surgical patients.

This project was based on long-term recall of adult Class II patients who had undergone orthodontic camouflage. It had 3 goals: (1) to compare long-term skeletal and soft tissue changes in these orthodontic patients with surgery patients; (2) to evaluate long-term changes in occlusal relationships after orthodontic camouflage and compare occlusal stability with surgery patients; and (3) to evaluate patient satisfaction after camouflage treatment by using a similar survey instrument to that previously used with surgery patients.

MATERIAL AND METHODS

Despite an underlying skeletal problem, orthodontic camouflage treatment, by definition, is based on tooth movement to correct only the dental occlusion. It typically requires premolar (occasionally other) extractions. For this study, we reviewed charts for all 135 patients in the UNC orthodontic clinic database who had orthodontic treatment between 1980 and 1995 for Class II malocclusion beginning when minimal growth would be expected (women, age 17 or over; men, age 19 or older) that involved dental extractions. Of this group, 100 completed orthodontic treatment at UNC (27 moved, transferred, or failed to complete treatment, and 8 had orthognathic surgery). Two of the 100 had died, and 24 did not have complete records including 1-year recall. The remaining 74 patients were selected for potential recall.

An extensive search (with Internet-based locating resources) was made to locate these patients, and 33 were found. The patients who could not be contacted had a mean age of 26.8 years (SD 8.00), 82% were female, and they had 5.7 mm mean overjet at the start of treatment (SD 2.68). The 31 who were recalled were very similar before treatment (Tables I and II). Once the patients were contacted, they were willing to return to participate in the study, especially if their travel costs were reimbursed. Only 2 patients declined, and both cited distance as a hindrance. Of the 31 recalled (42% of those originally selected), the average length of time since the end of orthodontic treatment was 12 years (range, 6.5 to 15.7 years). From the original sample of 74 patients, 85% were female, but 30 of the 31 recalled patients (97%) were female.

On recall, complete clinical records (impressions for study casts, intraoral and extraoral photographs, panoramic and lateral cephalometric radiographs, recall data forms) were

obtained, and the patients completed questionnaires on perception of current problems and satisfaction (described below).

The long-term cephalometric changes of interest were those between 1 year posttreatment and the long-term recall. For both cephalometric and perception data, these adult orthodontic camouflage patients were compared with 3 groups of Class II orthognathic surgical patients for whom long-term data had been previously published.³⁻⁵ Pretreatment characteristics of the 4 groups are summarized in Tables I and II. In addition, cephalometric changes were compared with the adult sample of Shubert et al⁶ with long-term follow-up after no treatment or orthodontic treatment for mild problems. All camouflage subjects were treated in the Department of Orthodontics at UNC, and all surgery patients had their surgeries at UNC. Approximately 25% of this group also had the orthodontic phase of their treatment at UNC; the others were treated in private practices.

As in previous studies at UNC, cephalometric radiographs for the Class II camouflage patients were digitized by using the UNC 139-point model.² A coordinate system was established, with a line through sella rotated 6° down anteriorly from the SN line as the horizontal axis, and a vertical line through sella perpendicular to it as the vertical axis. Angular measures and millimeter changes in landmark position were obtained as coordinate changes in this reference system. Thus, changes relative to the x, y-axis could be compared with previous studies at UNC of surgery and adult orthodontic patients. Cephalograms for all subjects in all treatment groups were obtained at UNC and digitized by the same research staff personnel.

In addition to descriptive statistics, analysis of covariance (ANCOVA) was used to estimate the average differences between the camouflage group and the surgically treated groups. Baseline values, age at the start of treatment, and the duration of follow-up were included as covariates, and adjusted mean change was compared among the 3 surgical groups and the Class II camouflage groups. ANCOVA was used to correct for the potential bias because of the differences in mean baseline value, age, and length of follow-up between the groups, and because of the possible relationships between the means of these covariates and the mean cephalometric changes in the treatment groups. ANCOVA removes this bias as far as possible statistically by comparing the mean change in the treatment groups at the same relative mean baseline value, age, and length of follow-up.

PAR scores were calculated from the dental casts for the camouflage patients at the end of treatment and on long-term recall, using both the English and the American weightings.

At the recall appointment, 27 of the 31 orthodontic Class II patients completed 3 questionnaires developed to evaluate perceptions in orthognathic surgery patients.¹¹ The facial-image (FI) scale is a 16-item questionnaire that asks the respondent to rate each facial feature from (1) have strong negative feelings to (5) have strong positive feelings. Two subscales are scored. The dentofacial subscale is sensitive to appearance changes that can be affected by different treatment approaches, and the cosmetic subscale includes facial features that are not affected by orthodontic or orthognathic treatment.

The second questionnaire, problems with occlusion and function (POF), consists of 21 statements and has a 1-to-5 agree or disagree format. Two subscales are scored: functional concerns and temporomandibular joint (TMJ) concerns. The third questionnaire, satisfaction (SAT), is a 16-item instrument on which 3 subscales are scored: (inter)personal outcome; functional outcome; and preparation/knowledge satisfaction. The item content for the preparation/knowledge subscale was modified slightly from that used for the surgery patients, because preparation for surgery did not apply to the orthodontic camouflage

patients. Each item was presented as a statement rated on a 7-point scale from “disagree strongly” to “agree strongly.”

The camouflage patients were compared with all UNC Class II surgical patients who had completed long-term perception survey instruments (who were not exactly the same groups for the cephalometric comparison).⁶ The long-term mean subscale responses of the surgery and the camouflage groups were compared with the Cochran-Mantel-Haenszel row mean score test.

RESULTS

Mean cephalometric changes for the camouflage patients during treatment and on long-term recall are shown in Figures 1 and 2, and tabulated data for changes from 1-year posttreatment to long-term recall are shown in Table III. As one would expect, the treatment changes were mainly retraction of the maxillary incisors. Long-term changes were quite small. Eruption of the mandibular incisors, leading to an average increase in overbite of 1.5 mm, was the largest mean change.

In clinical studies, a few patients usually show most of the change, so descriptive statistics based on the normal distribution can be misleading. For the camouflage patients, however, significant changes in skeletal landmarks were not observed. No patient had more than 2 mm change in Points A or B or pogonion. The cephalometric data for the camouflage patients showed almost no long-term relapse changes except for over-bite. Pearson correlation coefficients showed no relationship between the length of time to recall and the changes from end of treatment to follow-up.

PAR scores for the camouflage patients at the end of treatment and on long-term recall are shown in Tables IV, and PAR weightings in the 2 systems are given in Table V. The modest long-term increase indicates generally good stability of the occlusal result.

As Table III shows, the differences in mean long-term changes among the camouflage, general treatment, and surgical groups were small. Analysis of covariance showed, however, that there was a statistically significant difference in the change in mandibular landmark positions between the orthodontic and surgical groups. In all groups, if it changed at all, the mandible tended to come forward and downward, but there was a significantly greater chance of movement (growth?) in the nonsurgical groups.

This is clarified by Figures 3 through 5, showing the percentages of patients in each group with more than 2 mm change in landmark positions or dimensions. Note (Fig 3) that backward movement of the chin and Points A and B occurred only in the surgery groups, but forward movement of Point B and Pg also occurred in all 3 surgical groups, and forward movement of Pg was as likely as backward movement after mandibular advancement. Forward movement of all 3 landmarks and of the incisors occurred in 15% of the general treatment patients. In the camouflage patients, who were remarkably stable, the only change was backward movement of the mandibular incisors in 10%. What is not in Figure 3 is important: only for the mandibular incisor position did patients in the camouflage group have any long-term changes greater than 2 mm, and so they do not show up in the other sections of this figure, although the data were carefully examined for changes of this magnitude.

Long-term vertical changes occurred in more surgery than orthodontic patients (Fig 4), with one fourth of the patients who had maxillary surgery showing downward movement suggesting continued vertical growth. Incisor changes were smaller than skeletal changes. Overjet was stable in both orthodontic groups (Fig 5) and showed a long-term increase in

10% of the 2-jaw surgery patients, in 15% of the maxillary impaction group, and in 20% of the mandibular advancement patients. In contrast, overbite increased in 10% to 15% of the patients in both the orthodontic and the surgery groups. The percentage with overjet changes was much greater than the percentage with changes in the ANB angle; ie, this long-term change in the surgery groups was due more to tooth movement than skeletal change. The greater change in mandibular plane angles for the surgery patients is consistent with continued remodeling at gonion after surgery. Mandibular length, as measured from condyion to pogonion, decreased in 5% of the orthodontic patients and increased in 10%. The percentage of surgery patients with a decrease in length was greater, but nearly as many surgery patients had an increase in mandibular length as a decrease.

Results from the perception survey instruments are given in Tables VI through XI, which show the percentages of patients with a strongly positive response (5-7 on the 7-point scale of SAT, and 4-5 on the 5-point scales of POF and FI). Although the average subscale score is the best summary of patients' perceptions of a specific domain or construct, the percentage of positive responses for each item can illustrate differences in the pattern of responses that might result in the same average score. Surgery patients were asked about their perceptions of the surgical experience, but orthodontic patients obviously were not; thus all items on the 2 SAT versions could not be compared.

SAT scores for the camouflage patients were quite high (Table VI and VII). Perhaps the most sensitive indicator of satisfaction is reflected by willingness to undergo the same treatment again after knowing how it turned out; 92% of the camouflage group were strongly positive. Nearly all were pleased with the change in their appearance, but only one third agreed strongly that they could eat more easily.

Comparison with the surgery groups shows greater long-term satisfaction for the camouflage patients in almost every category, despite the positive numbers for satisfaction in the surgery groups. The only statistically significant difference, however, was that the maxillary impaction surgery group was less positive than the other groups for the interpersonal outcomes subscale (Cochran-Mantel-Haenszel statistics based on table scores, $P < .001$).

Only a few of the camouflage patients had functional or pain problems (Tables VIII and IX). Although 15% thought that their front teeth did not fit properly, no patients complained that they could not chew food well. Of the 18% of the camouflage patients who reported pain in their TMJs, over half reported pain in jaw muscles as well.

These numbers also compare favorably with those of the surgery patients. Scores for occlusion and function were similar, except that the maxillary surgery patients were more likely to feel that they could not chew food well. In all 3 surgery groups, reports of TMJ-related problems and pain or discomfort were 2 or 3 times more prevalent than in the camouflage group, and the difference between the surgery and camouflage patients was statistically significant ($P < .01$).

The facial image can be broken into 2 subcategories—cosmetic and dentofacial images (Tables X and XI). Half to two thirds of the camouflage patients responded quite positively to the cosmetic image items (that their orthodontic treatment would not have influenced), and the frequency of positive responses was only slightly greater for the dentofacial items that would have been affected. For the mouth, half (48%) of the camouflage group gave the highest score of 5 on the 5-point scale, and 41% scored their teeth at 5.

On the cosmetic scale, the camouflage patients' frequency of positive items (4 and 5 on a 1-5 scale) was scored at or slightly below the level for the surgery patients. Facial skin tone was rated most positively by the maxillary impaction group and least positively by the

camouflage group, although hard tissue support for the soft tissue facial mask would have been decreased by both types of treatment. Intermediate scores were reported by the patients who had mandibular advancement, which would increase soft tissue support and should have tightened the skin. Advancing a deficient mandible improves chin and neck contours, and the mandibular advancement patients reported higher positive feelings in this area.

For the dentofacial scale, both groups of patients who had mandibular advancement were much more positive about their chin and profile than were the camouflage patients, as one would think they should have been, and this difference was statistically significant ($P < .005$). There was no difference between the maxillary impaction and the camouflage patients.

DISCUSSION

Patients treated with orthodontic camouflage have, in general, less severe problems than those treated surgically. These data do not report outcomes of alternative treatment for comparable problems. As Table II shows, the camouflage patients that we studied had less severe malocclusions initially (overjet and overbite) and smaller jaw discrepancies than the surgery patients. Despite the initial differences, jaw relationships and dental occlusion were similar at the end of treatment, so both types of treatment largely met their treatment objectives. The amount of change produced by treatment was larger in the surgical groups, and they experienced a component of skeletal change that the orthodontic patients did not. The greater amount of treatment change in the surgery groups probably contributed to the greater prevalence of posttreatment change.

When only part of a group of treated patients can be recalled, those who cooperated with the recall might not truly represent all patients who underwent treatment. In this study, it was possible to recall 42% of the Class II camouflage patients with complete records that included the 1-year recall; they represented 31% of those who had appropriate treatment completed at UNC. Because all but 2 of the patients who were located agreed to return, willingness to participate probably did not bias the reported perceptions or physical outcomes. The recall percentages for long-term postsurgery patients are similar to those for the camouflage group. Although there is no way to be certain that patients who can be located are precisely comparable with those who cannot, we have found no reason to think that their perceptions or outcomes are systematically different.

Cephalometrically, the camouflage patients were quite stable in the long term, although 12% had an increase in overbite that could be attributed to the eruption of the mandibular incisors. Relapse of more than a 2-mm long-term increase in overjet was not observed. The amount of long-term change was not significantly related to the length of time to recall, which in any case was longer for the camouflage patients than for the groups to which they were compared.

The percentage of patients with an increase in overbite was almost identical in the surgery and camouflage groups, but an increase in overjet occurred in 10% to 20% of the surgery patients. Because for them skeletal change rather than tooth movement was the major factor in reducing overjet through treatment, it is surprising that the posttreatment changes were as likely to be due to tooth movement as skeletal relapse. Perhaps this reflects greater changes in relationships between the incisors and the facial soft tissue mask in the surgery group, but the surgery patients were stable during the first posttreatment year and showed changes after that, and soft tissue pressure changes would be expected to affect tooth position more quickly during the first year. Previous reports have noted that skeletal changes in surgery patients are not necessarily reflected in the occlusion,³⁻⁵ and changing dental and soft tissue

relationships probably contributes to dental compensation for skeletal change when it occurs.

Not all the skeletal changes in these adults were in a relapse direction. Continued growth of the facial skeleton has been appreciated for years now, but it still is surprising to see how much long-term change can occur in ways consistent with continued growth in patients who are expected to have little or no growth potential. Forward movement of facial landmarks was observed in 15% of the long-term camouflage group, and one fourth to one third of the surgery patients showed what appeared to be growth changes, ie, downward movement of the maxilla or forward movement of the mandible. Do the data suggest that late growth is more likely in patients with the severe problems that are selected for surgery, or is this another reflection of skeletal responses to greater soft tissue changes in surgery patients? We cannot be sure at present.

For occlusal stability, mandibular incisor alignment is the weak link, and retainer wear is obviously an important factor. This study showed that slightly over half of the camouflage patients had a long-term increase in incisor irregularity over time. Comparable data for the surgery patients were not available. Al Yami et al⁸ showed that the 11% of their large sample who had bonded lower retainers had better alignment at 5 and 10 years posttreatment even if their initial PAR scores were higher. In our camouflage sample, 10 of 31 patients (32%) with bonded lower retainers were present on long-term recall. Of these, 3 had minor slippages of 1 or 2 contacts, and the rest had no change in this component of the PAR score.

The extent to which removable retainer wear influenced changes in PAR scores is difficult to determine, but it seems likely that this would have an effect. Two camouflage patients specifically stated that they wore their removable retainers only for a few months and then stopped because of “the hassle,” but 3 patients were still wearing both upper and lower removable retainers every night, 10 years or more out of treatment.

In evaluating patients’ perceptions of treatment outcomes, it also is potentially important that the camouflage group was so overwhelmingly female. Most older Class II patients in the orthodontic clinic are women (relatively more women receive late Class II treatment than adolescent or preadolescent treatment), and all but 1 of those who were recalled were female. Most Class II surgery patients are also female, but the surgery groups were 25% to 30% male. In the surgery groups, no sex difference in response to the survey instruments has been detected. We do not know whether this also would be true for camouflage patients.

The camouflage group overall was very satisfied with their treatment and had fewer functional and TMJ problems than any surgical group. They were positive about aspects of facial appearance that were not affected by treatment as well as those that were; in most respects, they were as positive as the surgery patients, except that the mandibular advancement group had 20% to 25% more patients feeling positive about their chins. Similar findings were reported by Bell et al¹² in the 1980s, who noted that even though Class II camouflage patients were aware of differences in chin projection, most were pleased with the outcome of treatment.

From our perspective, these data show that properly selected patients for orthodontic camouflage treatment are as likely or more likely to be satisfied with the outcome of treatment as those who have surgery. Proper selection of patients, of course, is neither simple nor easy. When alternative treatment approaches are possible, the ratio of benefit to risk must be considered for each procedure. For orthodontic camouflage versus surgery, the important decision is whether the greater improvement in dentofacial image that is possible with surgery would be worth the increased cost and risk. The risks of surgery obviously can be much greater than those of a nonsurgical approach. The most common surgical risk is

decreased sensation of the lips, whereas the greatest risk for camouflage patients appears to be resorption of the maxillary incisor roots as they are retracted and torqued against the lingual cortical plate. The ideal patient for camouflage should have reasonably good facial esthetics initially, with overjet created more by maxillary incisor protrusion than mandibular retrusion. The more severe the mandibular deficiency and the greater the overjet, the greater the need for surgery to obtain satisfactory clinical correction.

How patients perceive the severity of their problems is a factor in the decision to have surgery rather than camouflage or no treatment. There is good evidence that the more the person perceives herself (or himself) as normal, the more likely he or she is to choose orthodontics alone and to be satisfied with the outcome. Conversely, patients who perceive themselves as outside the normal range are more likely to prefer surgery and to be dissatisfied with tooth movement alone.¹¹ Problem severity cannot be evaluated just from cephalometric radiographs, dental casts, and other physical records. Because of these perception effects, we cannot set physical characteristics as the sole definition of whether surgical correction is required or whether orthodontics alone would be satisfactory.

When alternative treatments are available, the doctor should provide the information a patient needs to make an informed decision. Use of computer image predictions of outcomes can help patients visualize the effect of surgery versus camouflage, and existing data now show that the benefits of this approach outweigh the risks of arousing patients' unrealistic expectations.^{12,13} This is an excellent way to involve the patient in the decision as to the preferred mode of treatment and to evaluate what the patient perceives—an essential part of proper selection of patients for camouflage or surgery.

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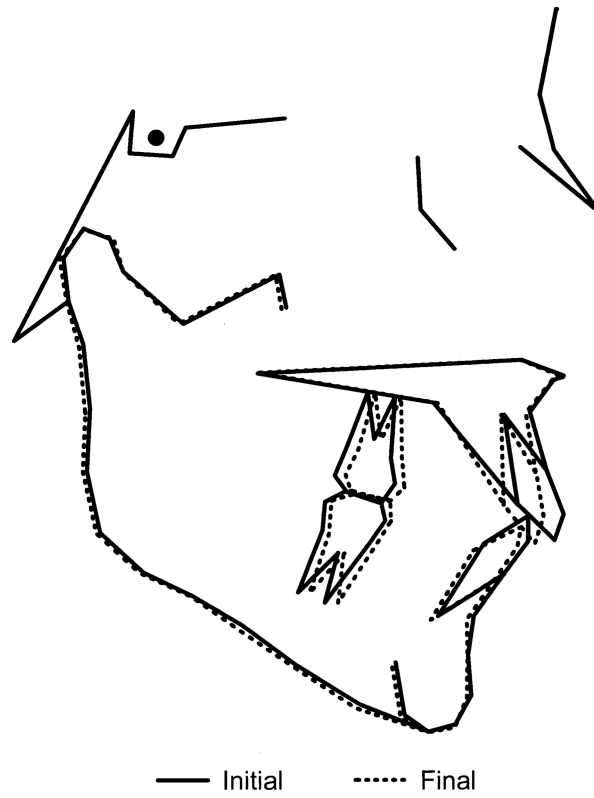


Fig 1. Mean cephalometric changes, camouflage group, during treatment.



Fig 2.
Mean cephalometric changes, camouflage group, end of treatment to long-term recall.

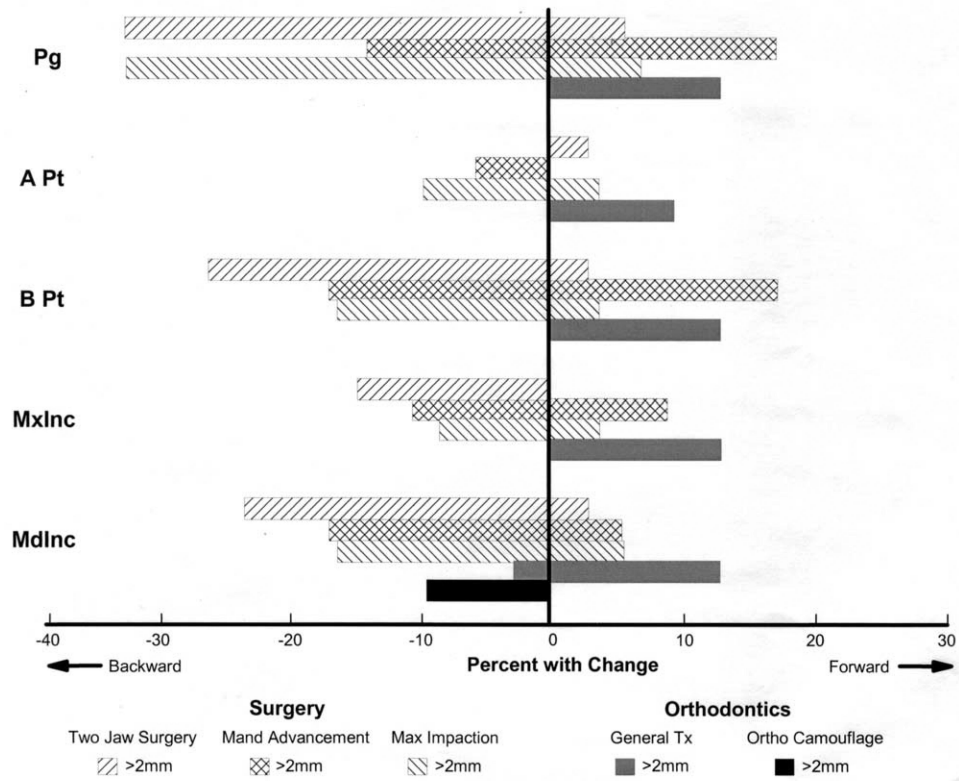


Fig 3. Percentage of patients in each group with >2 mm change in horizontal landmark positions from end of treatment to long-term recall. No camouflage patient had >2 mm change.

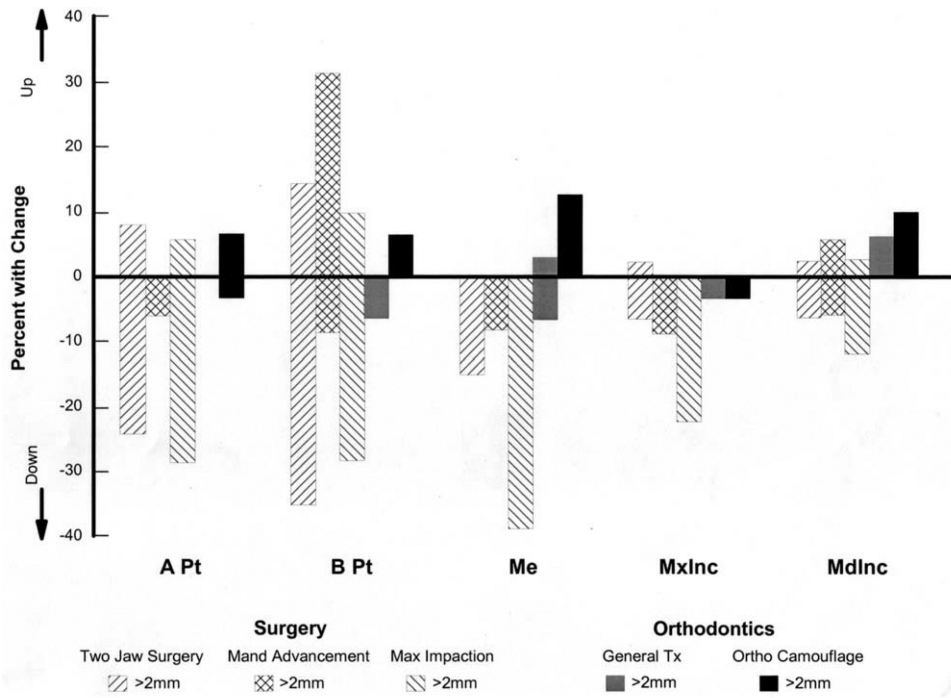


Fig 4. Percentage of patients with >2 mm change in vertical landmark positions from end of treatment to long-term recall.

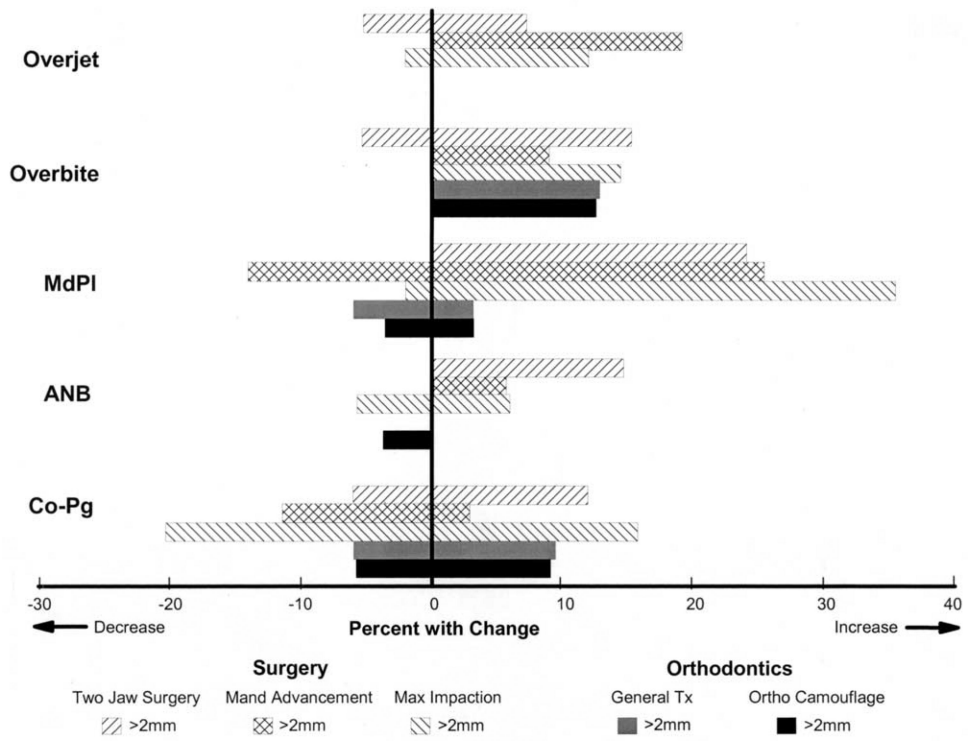


Fig 5. Percentage of patients with >2 mm change in dimensions from end of treatment to long-term recall.

Table I

Demographic comparison

	Orthodontics only		Surgery					
	Mean	Range	Maxillary impaction (n = 49)		Mandibular advancement (n = 35)		2-jaw surgery (n = 34)	
Initial age (y)	28.6	16-46	Mean	Range	Mean	Range	Mean	Range
Follow-up (y)	12	6-15	23.00	14-56	29	14-55	27	14-44
Sex: female (%)	97		7.30	3-13	5.9	4-9	6.5	4-13
			84		77		97	

Table II

Cephalometric comparison

	Orthodontics only			Surgery					
	Adult Class II camouflage (n = 31)			Mandibular advancement (n = 35)			2-jaw surgery (n = 34)		
	Mean	SD		Mean	SD		Mean	SD	
Overjet (mm)	5.82	2.20	6.03	3.44	7.90	2.44	8.97	3.27	
Overbite (mm)	4.30	1.80	0.25	3.22	9.34	2.80	2.87	2.66	
MxInc-SN (°)	105.07	9.27	102.02	8.30	103.97	7.84	100.11	8.43	
MdInc to MP (°)	103.48	8.02	96.18	6.47	100.35	7.83	94.20	8.23	
ANB (°)	5.59	1.88	3.92	2.55	6.57	2.39	7.45	2.60	
Palatal plane (°)	6.66	4.14	7.20	3.10	8.54	3.61	7.41	3.49	
Mandibular plane (°)	33.96	7.06	44.54	6.78	34.20	8.92	43.66	8.39	
TFH (mm)	116.20	8.00	132.35	6.19	120.51	6.83	126.41	6.95	
Ramus ht - Co-Go (mm)	55.31	5.06	59.02	6.17	59.91	7.04	55.6	5.76	
Mand length - Co-Pg (mm)	109.58	6.24	116.68	7.52	111.83	8.19	110.49	6.87	

Watermark-text

Watermark-text

Watermark-text

Table III

Comparison of changes from posttreatment to long-term recall

	Orthodontics only						Surgery				
	Adult Class II camouflage (n = 31) [†]			Adult general treatment (n = 33) [†]			Mandibular advancement (n = 35) [†]				
	Mean	SD		Mean	SD		Mean	SD			
Vertical changes (mm)											
Point A [*]	0.12	0.99		0.02	0.55	0.73	2.03	0.12	1.48	0.74	1.61
ANS [*]	0.11	0.80		-0.10	0.61	0.64	1.68	0.08	0.74	0.37	1.01
PNS	0.04	0.58		0.18	0.53	0.60	1.13	0.12	1.48	0.39	0.76
Point B [*]	-0.13	1.12		0.35	1.03	0.81	2.50	-0.74	2.51	0.91	2.76
Me [*]	-0.09	1.42		0.50	0.97	1.39	1.45	0.24	1.32	0.96	1.25
Pg [*]	0.25	1.54		0.42	1.07	0.88	2.29	-0.03	1.71	1.17	1.34
Go [*]	0.03	1.47		0.70	1.42	-0.98	3.03	-0.42	3.17	0.06	2.48
Co	-0.24	1.63		0.29	0.93	-0.02	1.64	-0.05	1.86	-0.42	1.76
MxInc [*]	0.48	0.95		0.37	0.94	1.06	1.22	0.28	1.04	0.79	0.94
MxMol [*]	0.06	1.39		0.17	0.91	1.23	1.13	0.94	1.34	0.93	1.32
MdInc [*]	-0.52	0.92		-0.14	1.16	0.55	1.50	-0.45	1.39	0.28	1.58
MdMol	0.05	1.58		0.14	0.97	0.59	1.36	0.42	1.47	0.49	1.37
Horizontal changes (mm)											
ANS [*]	-0.05	0.59		0.47	0.95	-0.14	2.05	0.07	1.11	0.40	1.56
PNS [*]	0.04	0.61		0.23	0.82	-0.97	2.97	0.32	0.96	-1.57	1.97
Point A [*]	0.01	0.95		0.48	0.80	-0.12	1.19	-0.10	0.90	-0.04	0.92
Point B [*]	-0.04	1.00		0.46	1.23	-0.67	1.71	-0.12	1.88	-1.11	1.93
Pg [*]	-0.04	1.13		0.62	1.24	-0.89	2.09	-0.21	2.07	-1.48	2.18
Go [*]	0.06	1.53		0.27	1.06	-1.69	2.28	-0.45	2.68	-0.56	2.58
Me [*]	-0.09	1.45		0.54	1.25	-1.45	2.52	-0.21	2.30	-1.72	2.38

	Orthodontics only						Surgery								
	Adult Class II camouflage (n = 31) [‡]			Adult general treatment (n = 33) [‡]			Maxillary impaction (n = 49) [‡]			Mandibular advancement (n = 35) [‡]			2-jaw surgery (n = 34) [‡]		
	Mean	SD		Mean	SD		Mean	SD		Mean	SD		Mean	SD	
Co	-0.16	1.69		-0.06	0.89		0.47	2.04		0.45	1.39		0.99	2.41	
MxInc	0.17	0.89		0.50	1.21		-0.08	1.32		0.05	1.33		0.49	1.36	
MdInc *	-0.38	1.11		0.26	1.23		-0.47	1.75		-0.51	1.60		-1.10	1.36	
MxMol *	0.06	1.35		0.91	1.82		0.20	2.46		0.71	2.35		-0.47	2.15	
MdMol *	-0.07	1.3		0.67	1.68		-0.47	2.48		0.06	2.42		-0.73	1.76	
Dimensional changes															
Overjet (mm) *	0.78	0.65		0.17	0.69		0.33	1.15		0.26	1.03		0.41	1.32	
Overbite (mm)	1.53	0.96		0.54	1.07		0.50	1.29		1.05	1.29		0.51	1.44	
SNA (°)	-0.04	0.98		0.10	0.68		-0.01	1.24		0.12	1.07		0.04	0.96	
SNB (°)	-0.08	0.76		0.19	0.82		-0.31	0.92		-0.22	1.00		-0.51	0.99	
ANB (°)	0.04	1.07		0.09	0.58		0.25	1.34		0.42	0.94		0.39	1.12	
PalPl (°)	0.09	0.7		-0.28	0.85		0.01	2.20		0.02	1.16		-0.08	1.46	
MdPl (°) *	0.07	1.36		-0.31	1.00		1.41	1.95		0.27	2.10		1.23	1.65	
TFH (mm) *	-0.05	1.58		0.56	1.01		1.66	1.63		0.35	1.41		1.27	1.32	
Ar-B (mm) *	-0.25	1.14		0.62	1.33		0.03	1.73		-1.06	1.55		-0.16	1.68	
Co-B (mm)	0.08	1.43		0.47	0.98		-0.14	1.84		-0.89	1.95		-0.31	2.08	
Co-Go (mm) *	0.23	1.64		0.44	1.34		-1.11	2.05		-0.41	3.42		0.37	3.03	
Co-Pg (mm)	0.30	1.59		0.59	0.91		-0.05	2.02		-0.36	2.06		-0.13	1.51	

Vertical changes: negative value indicates superior movement; positive value indicates inferior movement.

Horizontal changes: negative value indicates posterior movement; positive value indicates anterior movement.

Dimensional changes: Negative value indicates decrease; positive value indicates increase.

Mean follow-up length in years: camouflage 12.0 ± 2.8; orthodontics 6.9 ± 3.7; maxillary impaction 6.8 ± 2.3; mandibular advancement 5.9 ± 1.1; 2-jaw 6.5 ± 2.1.

Posttreatment for surgical patients begins at 1 year post surgery.

[‡]Data obtained from Schubert et al.⁶

* Statistically significant difference among groups $P < .05$.

Table IV

Mean PAR scores in Class II camouflage group

	End treatment	SD	Long term	SD
Weighted total:				
English	6.14	4.39	9.55	6.10
American	8.55	5.21	10.97	6.64
English weighted components:				
UA	0.27	0.53	0.80	1.00
LA	0.48	0.69	1.30	1.60
RB	1.48	0.95	1.45	0.95
LB	1.62	0.82	1.48	1.06
OJ	1.86	2.82	3.31	4.12
OB	0.30	0.90	0.83	1.14
ML	0.10	0.70	0.40	1.20

UA, Upper arch; *LA*, lower arch; *RB*, right buccal; *LB*, left buccal; *OJ*, overjet; *OB*, overbite; *ML*, midline.

Table V

PAR weighting

	English	American
UA	×1	×1
LA	×1	not scored
RB	×1	×2
LB	×1	×2
OJ	×6	×5
OB	×2	×3
ML	×4	×3

UA, Upper arch; *LA*, lower arch; *RB*, right buccal; *LB*, left buccal; *OJ*, overjet; *OB*, overbite; *ML*, midline.

Table VI

Selected questionnaire items from SAT index, percent at extreme (strongly positive)

	Orthodontics only	Surgery		
	Adult Class II camouflage (n = 27)	Maxillary impaction (n = 24)	Mandibular advancement (n = 103)	2-jaw surgery (n = 66)
Interpersonal outcomes				
Receive positive comments since treatment	69	46	52	67
Pleased with change in appearance	85	63	77	83
Treatment change was exactly what I expected	88	46	63	46
People react more positively at initial meeting	50	29	30	33
Delighted how much better I look	88	42	69	69
Like what I see in the mirror	88	50	76	75
Functional outcomes				
Eating is much easier	35	46	57	53
Can Chew Better	35	54	62	50
Other				
Recommend treatment to others	100	75	87	83
Undergo treatment again	92	79	85	76
Treatment was a positive experience	100	84	87	88

Table VII

Subscale scores from SAT index, percent at extreme (strongly positive)

	Orthodontics only			Surgery								
	Mean	SD	Median	Adult Class II camouflage (n = 27)		Maxillary impaction (n = 24)		Mandibular advancement (n = 103)		2-jaw surgery (n = 66)		
				Mean	SD	Mean	SD	Mean	SD	Mean	SD	Median
Interpersonal outcomes*	5.8	0.9	6.0	4.5	1.4	4.3	1.1	5.2	1.1	5.3	1.1	5.4
Functional outcomes	4.6	1.3	4.3	4.8	2.0	5.0	1.5	5.2	1.5	5.1	1.4	5.0

* Statistically significant difference among groups $P < .05$.

Table VIII

Questionnaire items from PSPOF index, percent at extreme (strongly positive)

	Orthodontics only		Surgery	
	Adult Class II camouflage (n = 28)	Maxillary impaction (n = 24)	Mandibular advancement (n = 106)	2-jaw surgery (n = 70)
Occlusion and function				
Front teeth stick out too much	7	21	8	6
Have deep bite	15	8	10	6
Have open bite	11	25	21	21
Front teeth do not fit properly	15	33	13	13
Cannot chew properly	15	13	11	10
Posterior open bite	11	9	12	14
Back teeth do not fit properly	7	9	17	13
Cannot chew food well	0	25	7	22
TMJ related problems				
Jaw hurts when mouth open wide	4	21	28	27
Jaw moves sideways when opening	4	13	8	9
Jaw makes grating/grinding noise	4	17	17	9
Cannot open mouth wide	11	21	19	19
Jaw pops/clicks	14	25	28	19
Pain, discomfort, soreness				
Pain in temples	4	13	8	4
Pain in jaw joints	18	46	27	34
Pain in jaw muscles	11	38	23	25
Pain in ears	7	21	11	10

Table IX

Subscale scores from POF index, percent at extreme (strongly positive)

	Orthodontics only						Surgery					
	Adult Class II camouflage (n = 28)			Maxillary impaction (n = 20)			Mandibular advancement (n = 106)			2-jaw surgery (n = 55)		
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
TMJ related problems*	1.5	0.9	1.0	2.1	0.8	1.8	2.1	0.9	2.0	2.0	0.8	1.9
Function/occlusion problems	1.9	0.7	1.7	2.0	0.9	1.8	1.8	0.6	1.7	1.8	0.8	1.6

* Statistically significant difference among groups $P < .05$.

Table X

Questionnaire items from FI index, percent at extreme (strong positive feelings)

	Orthodontics only		Surgery	
	Adult Class II camouflage (n = 28)	Maxillary impaction (n = 20)	Mandibular advancement (n = 82)	2-jaw surgery (n = 55)
Cosmetic image				
Hair	70	85	83	78
Ears	59	65	78	75
Forehead	57	60	78	65
Eyes	74	85	87	78
Nose	52	58	66	64
Lips	70	65	76	60
Facial Complexion	59	70	66	64
Neck	48	55	71	69
Eyebrows	52	75	79	65
Cheeks/Cheekbones	70	65	86	65
Facial skin tone	56	80	71	65
Dentofacial image				
Mouth	76	60	79	62
Teeth	74	65	82	67
Chin	48	45	76	57
Profile	52	55	73	64
Smile	74	52	69	63

*Statistically significant difference among groups $P < .05$.

Table XI

Subscale scores from FI index, percent at extreme (strong positive feelings)

	Orthodontics only						Surgery					
	Adult Class II camouflage (n = 28)			Maxillary impaction (n = 20)			Mandibular advancement (n = 82)			2-jaw surgery (n = 55)		
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
Total Facial Image scale*	3.8	0.7	3.8	3.8	0.7	3.9	4.1	0.6	4.0	3.8	0.7	3.9
Dentofacial Image*	3.9	0.8	4.0	3.5	1.0	3.7	4.1	0.6	4.0	3.8	0.8	3.8
Cosmetic Image	3.8	0.7	3.7	4.0	0.6	4.0	4.1	0.7	4.0	3.9	0.8	3.9

* Statistically significant difference among groups $P < .05$.