Multiple Extraction Patterns in Severe Discrepancy Cases

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Extraction has today become an accepted part of orthodontic treatment planning. The battles of earlier years over whether to remove bicuspids are now history and, except for the cultists, virtually all orthodontists realize that to achieve the accepted objectives a certain percent of patients will require reduction of tooth material. While because of varying objectives, different men extract in different proportions of their patients (perhaps ten to ninety percent), the principle of harmonizing tooth size with arch length is now a firm part of orthodontic practice. And the first bicuspids, with occasional exceptions, have been the overwhelming teeth of choice.

Only the most fortunate of us has not faced cases where four first bicuspids still did not appear to provide enough space to solve the discrepancy problems which presented themselves. In spite of careful anchorage conservation, who has not experienced the occasional case which is *still* a discrepancy problem at the point at which all bicuspid spaces have been "used up" and the case is still not completed? This seems to occur most frequently in 1) extreme Class II, Division 1, 2) skeletal problems, 3) nongrowing cases, 4) cooperation problems, 5) open bites, 6) extreme crowding cases, and 7) cases exhibiting some combination of the above factors.

If it is accepted that a certain percentage of cases require four bicuspid extraction to meet a practitioner's criteria of excellence, it is expected by projection along a distribution curve that a certain *small* portion of these extraction cases would have an even larger discrepancy than could be relieved by four bicuspid extractions. It is in the nature of a random sample that a tiny percentage would be outside even the four bicuspid category (and a practice is a random sample). Although the number of cases that appear to require more space than four bicuspids provide is a very small proportion of any orthodontic practice, it is these malocclusions that provide us with a great deal of our concern and frustrations and it was felt that an investigation of alternatives available to treat them would be of interest and value.

In several severe or nongrowing Class II cases in which the four first bicuspids were extracted and one upper first molar was missing, the author observed that treatment progressed toward normal with much less difficulty on the side with the missing molar. By moving the second molar and third molar into the places normally occupied by the maxillary first molar and second molar, a "normal" Class I molar relationship was achieved on that side. In several of these situations the other upper first molar was removed to attain a similarly successful Class II correction on both sides. From time to time the author had treated an additional case with more than the usual four bicuspid extractions, usually two additional maxillary teeth. Having a total of eight cases treated this way, it was decided to make this study in more detail.

To obtain a larger sample a number of colleagues were contacted and asked to check their files for cases in which removal of four bicuspids had not been adequate to solve treatment criteria and additional teeth had been extract-

ed, at least in the maxillary arch. Removal of upper third molars did not qualify a case to become part of the sample. Thoroughness of records, rather than perfection of finish, was requested. It was desired to determine both advantages and disadvantages of the treatment procedure. Seventeen men responded with twenty-seven additional cases making a sample of thirty-five. Because of the number of variables that presented, treatment plan, treatment time, cooperation, growth, appliance design, retraction method, headgear type and time, facial pattern, amount of discrepancy, and availability of treatment information, it was obvious that the study must be descriptive. The thirty-five cases fell into four categories: those in which four bicuspids had been removed plus upper second bicuspids (8), upper first molars (22), upper second molars (4) and miscellaneous (1). Six cases also had four teeth extracted in the mandibular arch, other than third molars.

There were twenty-nine Class II and six Class I malocclusions. The ages of the patients ranged from ten to twenty-nine years of age. Median age at the beginning of treatment was fourteen years, six months. Treatment times ranged from eighteen months to seventy-three months, with thirty-nine months as the average treatment time. Growth was absent in fifteen cases, unfavorable in nine, and relatively normal in nine. Eighteen cases presented with intermediate records made at the time of the second series of extractions. This was of real help since it was possible to segregate the effect of the additional extractions from that of the four first extractions. To provide some comparison with incisor movement in nonextraction cases headplates for a sample of ten nonextraction cases with major Class II corrections (averaging ANB reductions of four degrees) were traced.

Research Plan

Tracings were made of the cephalometric radiographs utilizing many of the standard landmarks, planes, angles and superimpositions with one additional tracing procedure. It was felt that to evaluate the effectiveness of the varying extraction patterns on incisor retraction, some form of superimposition close to the maxillary teeth would have to be chosen. SNA, Frankfort plane, pterygomaxillary fissure, etc., all had the disadvantage of mixing the effects of growth, bodily movement of the maxilla, growth retardation of the maxilla, etc. After discarding a number of tracing methods, the following satisfactory method was arrived at.

Using the clearest and preferably the middle cephalometric radiograph in terms of treatment, a template of the maxillary sagittal section was constructed. This was drawn up to include details of internal bony anatomy, key ridge, incisive canal, etc. The alveolar process was not used due to the high prevalence of alveolar bending and elongation during treatment. This template proved to be easily superimposed on the earlier and later tracings of each case with a high degree of accuracy. Two intersects were arbitrarily constructed at right angles on the template and were transferred to each tracing to provide a stable reference for maxillary superimposition. Thus movement of the teeth within the maxilla could be isolated from other movements in the facial skeleton. Also, to measure mesial movement of the anchorage teeth a constant tooth was traced in each tracing of each case; this was usually the maxillary left second molar. When second molars had been removed, the maxillary left third molar was utilized as an indicator of mesial anchorage movement. Tracings were superposed on both SN at S and on the registration intersect. Either im-

plants[1] or laminagraphic cephalometrics[2] would have been more ideal for superimposition and measurement of closure of extraction spaces. However, these were not available.

The method described proved quite satisfactory. Several cases from the sample treated by different orthodontists are illustrated. Pretreatment tracings are shown by continuous lines, posttreatment by interrupted lines, and midpoint by dotted lines.

Case #1

Thirteen year old girl, Class II, Division 1, protrusive. Four first bicuspids and two upper midline supernumeraries were extracted. Following space closure, the case was still in Class II buccal relationship. A decision was made to remove two upper first molars rather than to use intermaxillary elastics. Posttreatment records show eruption of upper second and third molars and major facial change. Lower third molars were extracted. Final records made two years after removal of all retention.

Case #2

Eighteen year old male, Class II, Division 1, extreme skeletal pattern (FMA 51 degrees, ANB 13 degrees). Four first biscuspids were removed, also upper second bicuspids. Case treated to acceptable conclusion by removal of four maxillary teeth. The second set of records are of the patient six months following band removal.

Case #3

Girl, aged fifteen years, received as a transfer patient with four first bicuspids removed, spaces closed; considerable anterior crowding still present and molar relationship Class II. It was decided to remove the four second bicuspids rather than to expand. This obviously acceptable result is shown and also the closeup of the cephalometric relationship. The second records show the case three months after active treatment.

Case #4

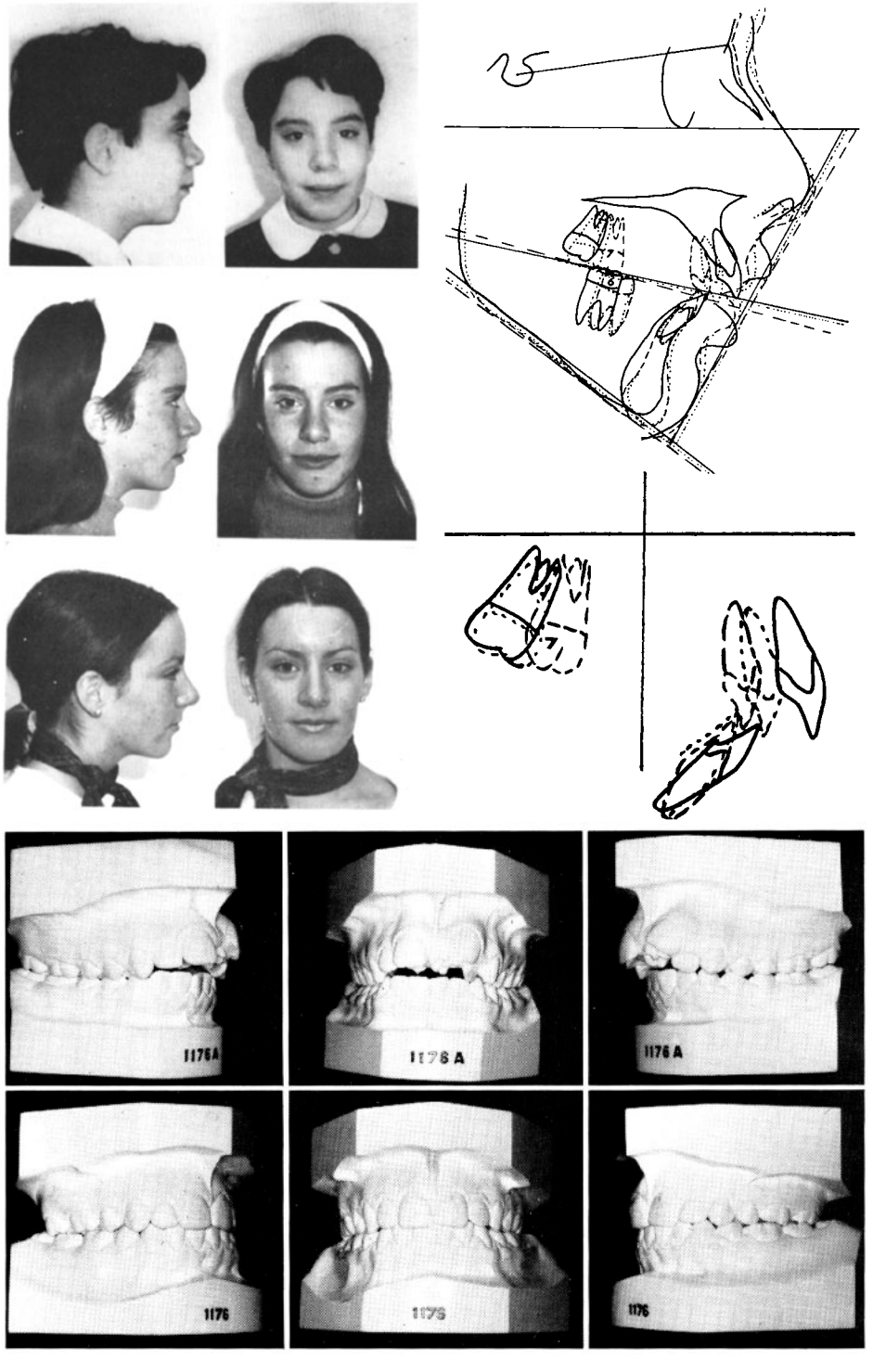
Female, aged sixteen, Class II, Division 1 crowding. After aligning teeth and retracting cuspids, it proved necessary to remove upper first molars to achieve orthodontic objectives. Upper third molars were thus saved and proved useful teeth. Lower third molars were removed. Final records made one month following band removal.

Case #5

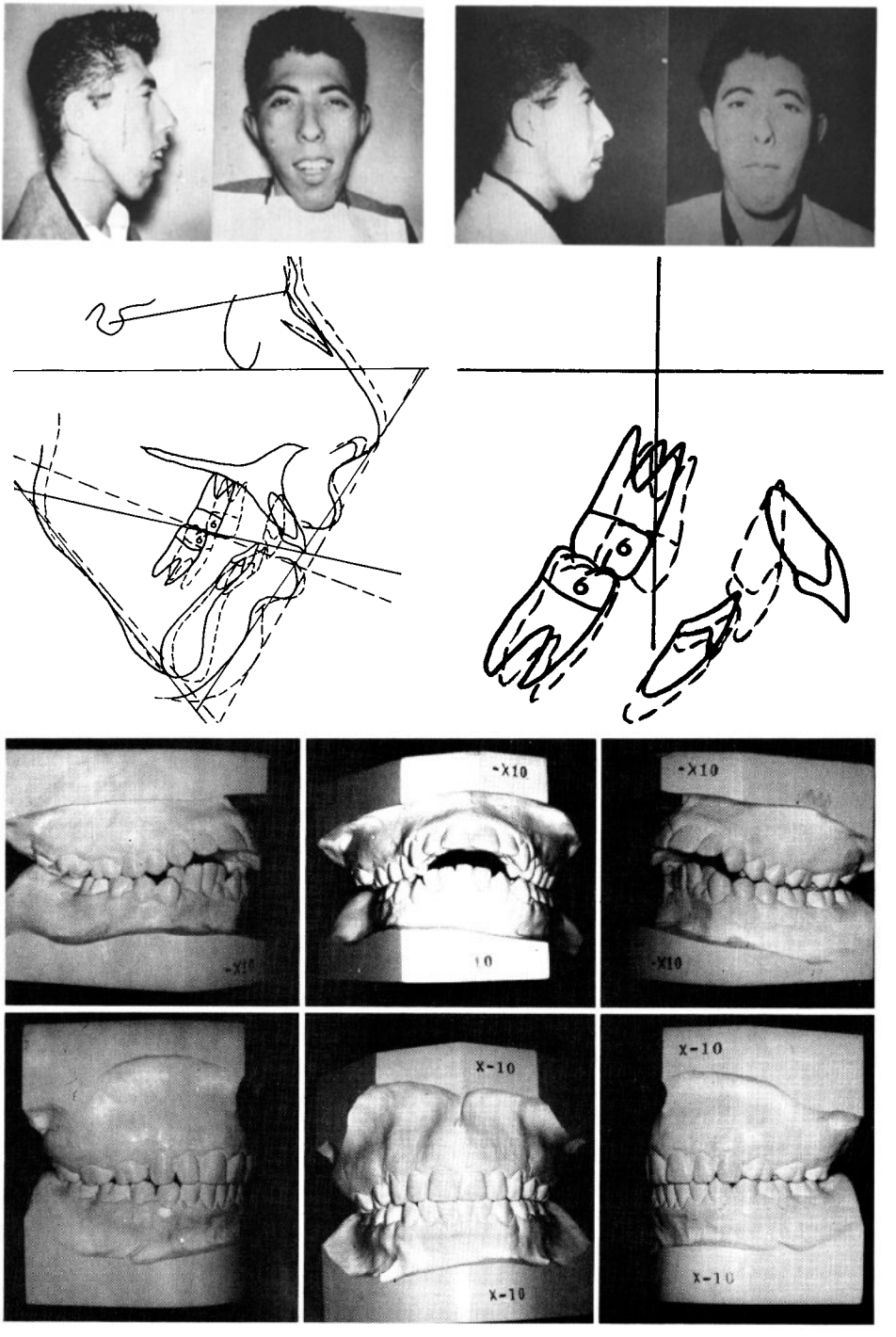
Male, Class II, Division 1, fourteen years, seven months; extreme facial, dental and skeletal discrepancies. Missing were the lower right first molar and lower left second bicuspid. Extracted were the upper first bicuspids followed by the upper first molars. The upper first molars were badly involved by caries and due to the anchorage requirements, it was decided not to salvage them. An excellent change was achieved which proved stable five years out of treatment, but an opening of FMA was seen, probably due to Class II elastic wear. Upper third molars erupted following the conclusion of appliance treatment. The second set of records depict the situation two months after active treatment.

These cases, while far from perfect, illustrate the possibilities of multiple extraction treatment in difficult cases. Of particular interest is the amount of incisor retraction achieved.

Of primary interest to the researcher was the actual amount of space that could be expected to be available as a result of extraction of additional maxillary teeth, and which combination of extractions provided the best anchorage values. In other words, if additional maxillary teeth are removed, what percentage of the space can be expected to be lost to mesial movement of the anchorage teeth and what percent can be utilized as space available for cor-



Case 1



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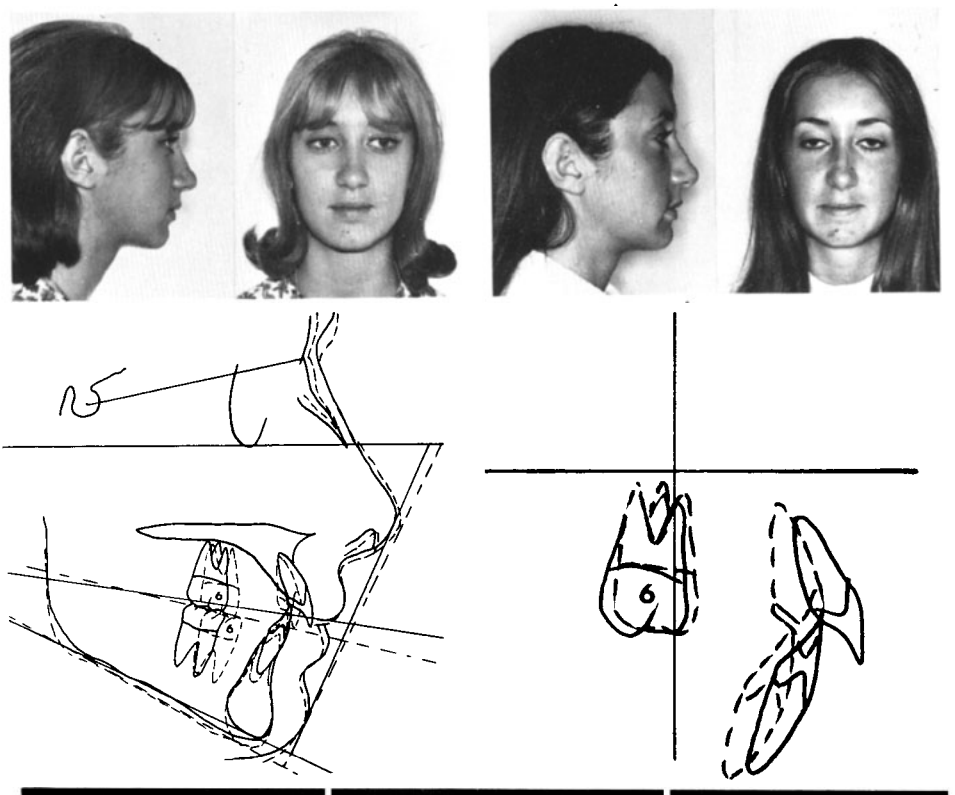

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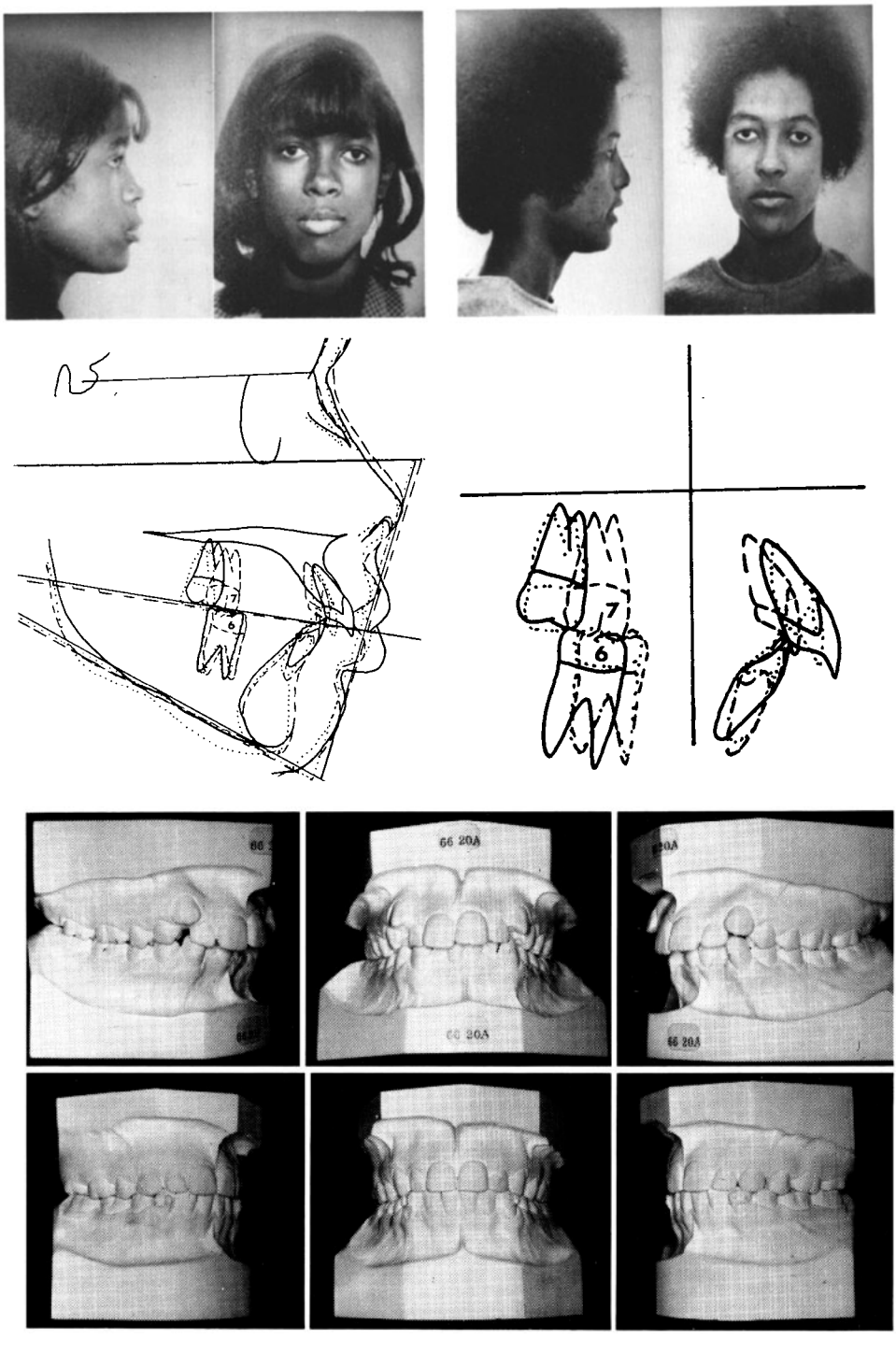

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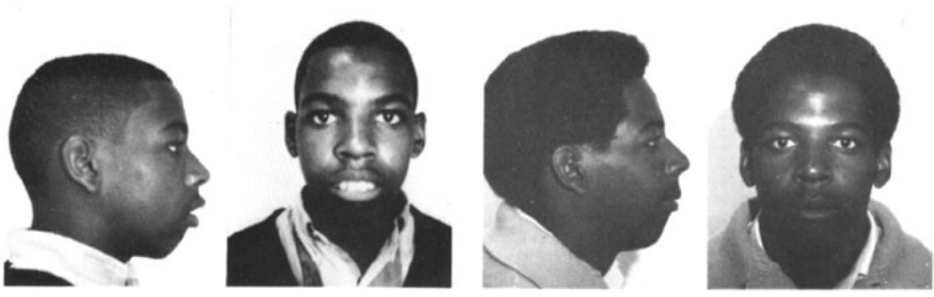

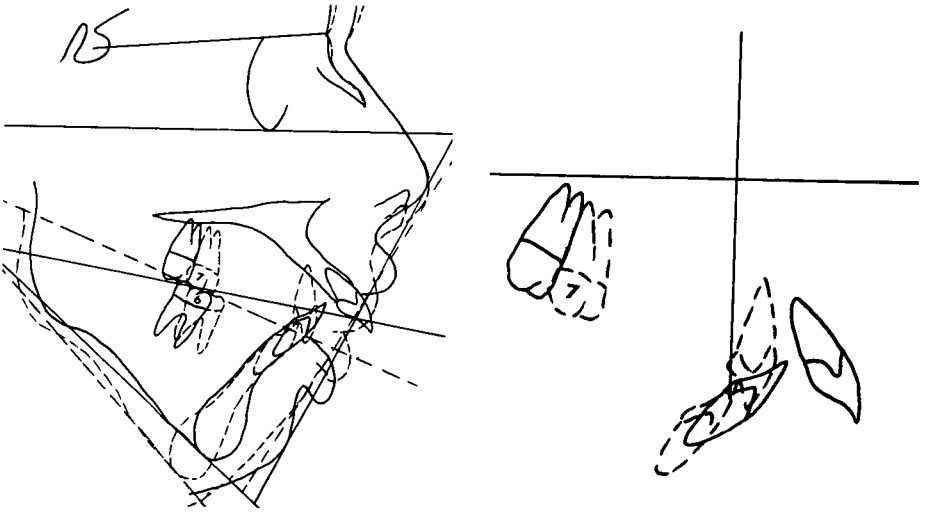

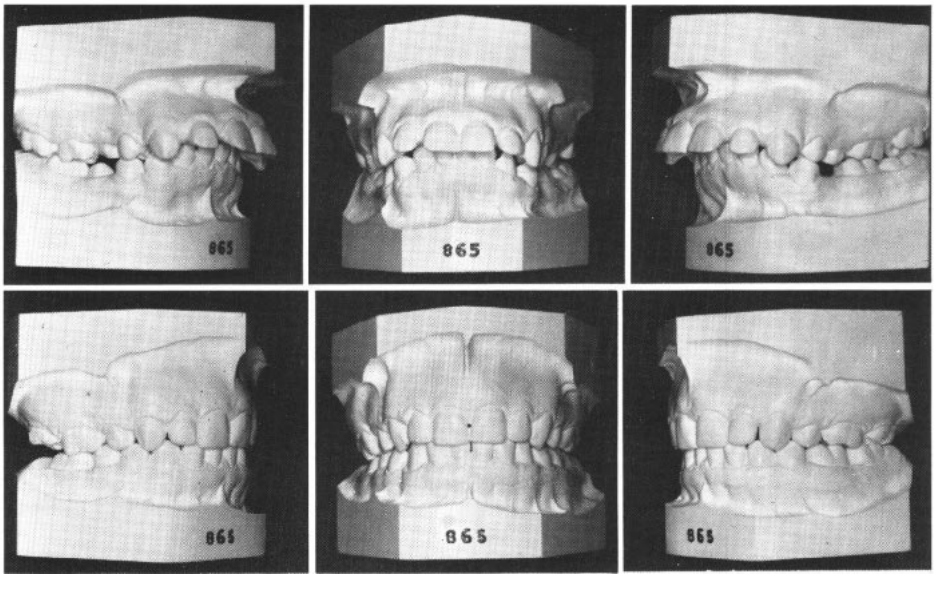

Case 5

CHART 1

Movement of Teeth—Total Treatment (mm)

	54/45	64/46	74/47	Control
Lingual movement 1 apex				
1. Total A & B phase**	2.87	3.82	2.75	.2
2. A phase	1.8	1.81	0*	NA
3. B phase	1.6	2.36	4*	NA
4. Lingual movement of 1 incisal edge	7.44	8.7	7	2.2
5. Lingual movement of 1 incisal edge corrected for crowding or spacing	9.93	10.72	9.5	—.2
6. Mesial movement of anchorage	4.93	9.45	9.12	NA
7. Effectiveness Lingual movement of 1 incisal edge expressed as percent of movement	67.55	50.1	51.1	NA

*One case

**Line 1 does not equal the total of lines 2 and 3 since it includes all cases including those not having midpoint records

rection of anterior crowding or overjet? Using the method described earlier of superimposition on the maxilla and its two coordinates, measurements were made of mesial movement of upper molars and the lingual movement of upper incisors (crown and apex). The molar tooth had to be one that was clearly identifiable and distal to any extractions. The incisor movement would be meaningless, of course, unless corrected for the amount of crowding and spacing present. So crowding and spacing were carefully measured from the model; if spacing was present, one half of this was subtracted from the crown movement; one half of crowding present was added to crown movement to produce net retraction, i.e., net space utilized by distal movement of anteriors. In the eighteen cases where midpoint records were obtained, the movement of the teeth was segregated into A and B phases; the effectiveness of the additional extractions was segregated from that of the first four extractions. All measurements were made along the occlusal plane. These measurements are shown in Charts 1 and 2. Lingual movement of the upper incisor apex was substantial in total treatment, phase A, and phase B. This was particularly significant when compared with the nonextraction sample where no net change of incisor relative to maxilla ever occurred. The Class II corrections observed were due to growth retardation or bodily movement of the maxilla.

Chart 1 shows the over-all movement of incisors and anchorage. Lingual movement of the upper incisal edge is seen to be very substantial. Mesial movement of anchorage shows a significant difference if additional upper bicuspids or additional upper molars are removed, and the effectiveness of each extraction combination is expressed as a percentage, for example, in cases where four upper bicuspids were removed, 67.55% of total movement was distal as opposed to 32.45% mesial movement of the anchorage. The molar extractions are seen to be less efficient (50%) although the larger size of the molars would perhaps compensate for this.

Chart 2 shows the movements and effectiveness when only the B phase is considered, that portion of the movement that occurred after extraction of the *additional* maxillary teeth. Once again, there was a substantial difference between bicuspid and molar extractions. A general observation can be made that significant space was created

CHART 2

"B" Phase Only (after extraction of added *maxillary teeth)*

	54/45	64/46	74/47
Lingual movement of $\underline{1}$ incisal edge corrected for crowding and spacing	5.42	5.77	0*
Mesial movement of anchorage	4.25	7.40	9*
Effectiveness			
Lingual movement of $\underline{1}$ incisal edge expressed as percent of total movement	53.9	43.8	0*

*One case

for further incisor retraction by the removal of the additional teeth. The effectiveness of second molar extractions has not been illustrated adequately by this paper; the sample was too limited. For example, only one case had midpoint records which enabled segregation of A and B cases. This case, nineteen years of age, showed *no* anchorage gained by extraction of the second molar. All space was used by mesial movement of the upper third molar.

The behavior of the maxillary teeth following extraction should logically be related to the anchorage value of the teeth. Choice of which teeth to remove should relate to the amount of anchorage required. Salzmann stated, "Anchorage is directly proportional to root area, all other factors being equal." Four studies of root area were located in the literature.[3-6] Root areas were calculated for the various combinations of teeth used in this study. The efficiency factors observed were found to be closely correlated to the root surfaces and thus the anchorage values of the teeth.

There were slight increases in occlusal plane and Frankfort mandibular angle as might be expected in such a series of "difficult" cases. Other than substantial improvements in all values, nothing unusual was observed through cephalometrics. Favorable changes were seen in all measurements relating to lip and facial profile. In virtually all cases these movements were from protrusive toward normal rather than past normal to a retruded position.

Negative Factors

The cases were evaluated in terms of a number of other factors to determine whether additional upper extraction had any negative effects which might discourage its application in difficult cases. These will be briefly summarized.

Resorption

Observed and recorded, as in Vonder-Ahe,[7] the incidence was not considered unusual considering the age, treatment time, and amount of bodily movement of the upper teeth. Except for one case with severe generalized resorption, all other resorptions and blunting were confined to the upper incisors.

Molar rotations

A tendency for the molars to be rotated mesiolingually was observed. In many cases there was no such rotation indicating that it is not inherent to this type of case but is a technique deficiency. Also, in the cases with four upper bicuspids extracted, a Class II molar relationship existed which required some mesial rotation of the molar to achieve the best cusp approximation.

Closure of the extraction sites

As measured from the models, exactly 25% of the extraction sites in each category were found to be open. This was no higher than the percentage of the first bicuspid extraction sites which were found to be open. It was concluded again to be a technique rather than an inherent deficiency.

Root angulations

There was a frequently observed fail-

ure to parallel roots across the extraction sites. Particularly with upper first molar extraction sites was this noticed. Again, it was not a consistent factor since many cases showed good parallelism of the roots.

Contacts

Twelve of sixty-four possible maxillary extraction sites were found to have deficient contacts; in all twelve cases the distal tooth was contacting gingivally to the mesial tooth.

Supporting tissues

Using a screening-type millimetric measure of bone loss described by Dunning and Leach,[9] sixty-four possible maxillary extraction sites were evaluated for bone loss. Forty-four exhibited altered bony contour of one millimeter or more. This was not significantly different from the adjacent nonextraction areas, however. Whether more altered bony contour was observed in this group than in any other posttreatment group of orthodontic cases is not known. That these were severe cases and treated at a later than ideal age and involved extensive translatory movement would probably be relevant.

The curve of Spee was occasionally flat or "reversed"; this seemed to be a function of alignment and root paralleling.

The role of the upper third molars is, of course, crucial when four other maxillary teeth are to be extracted. Chipman outlined conditions for removal of upper second molars which will result in normal eruption of upper third molars.[10] Primary, of course, is the *presence* of upper third molars. In three cases the maxillary third molars had been extracted or were congenitally missing. However, in no other case was there observed any failure with the eruption of these teeth. In several cases their size was somewhat small to provide ideal function with the lower second molars and in other incidents the upper third molar was observed in lingual tendency. One disadvantage of the procedure described is that the upper third molars frequently erupted *after* treatment completion. This made it impossible to band and align these teeth. The results of this study show that this is well-worth doing where possible, both from occlusion and anchorage standpoints. If there is any possibility, when starting a severe anchorage problem, that additional teeth may be required to be extracted, it would seem wise to delay removal of the third molars since they may prove to be the "ace in the hole."

Discussion

The author does not attempt to justify removal of more than four teeth; it is the purpose of this paper only to describe it as an option. Let us assume a Class II, Division 1 crowding with no growth remaining, all extraction spaces closed, and a Class II occlusion still present. Among the alternatives are:

a) Class II intermaxillary elastics. This course of treatment in severe cases so often results in a sacrifice of orthodontic objectives, movement of lower incisors labially, occlusal plane tipping, opening of Frankfort mandibular angle with resultant backward movement of the chin, and undesirable lengthening of the maxilla. Frequently, removal of additional maxillary teeth will avoid these factors.

b) Headgear. The author is a firm believer in headgear to the extent of using fixed headgear when desirable and possible. But many of these cases were past their growth period, unwilling to wear the headgear adequately, or too extreme for achievement of the goals even with major headgear wear.

c) Surgical orthodontics would have been an alternative in a portion of this sample, but in the majority of the cases presented surgery would have been in-

appropriate or would have required removal of the same teeth that were here removed. Surgery also has its own advantages and disadvantages.

d) Probably the most common result of failure to remove sufficient maxillary tooth material is the inability to achieve true Class I relationship when the patient is in terminal hinge position. Gnathologically expressed, this is a failure to have centric occlusion and centric relation coincide. The resultant shift, slide, or dual bite is extremely destructive, as anyone attempting to equilibrate finished cases can observe. Roth lists "failure to achieve a true correction of jaw relation" as one of four causes of TMJ pain dysfunction syndrome.[11]

e) Expansion. In some extremely crowded cases this would have been an alternative and the same rules apply here that apply when one is considering the original removal of first bicuspids. Will the expansion be tolerated by the periodontium, will it be stable, and will it affect the facial pattern in a desirable way?

f) Additional tooth removal. This may be the best of the options in some cases. While most orthodontists are understandably reluctant to request two additional extractions, this may be clearly more desirable than the other alternatives mentioned above. Maximum treatment ideals may only be achieved by the occasional removal of additional upper teeth. While, for example, the author hesitates at removal of more than four teeth, it is questionable whether saving them would balance the damage done by a mesial slide, an occlusion that hinges open, an occlusal plane that is badly tipped, or an arch overexpanded. This would be especially questionable if their retention was followed by the extraction of well-formed upper third molars.

Those starting a severe discrepancy case should remove no more than four teeth until it becomes apparent that the case is still a discrepancy case following closure of the extraction spaces. This will result in better anchorage conservation; the maximum number of upper teeth are retained to provide anchorage during cuspid retraction. Additional extractions are no panacea; in the author's own practice only .003 of cases to date have been treated by this alternative and we made every attempt to avoid this by inducing cooperation, early treatment, and maximum anchorage conservation. But it may be helpful in a small number of extreme cases.

Summary

Thirty-five cases have been collected from colleagues which illustrate that removal of additional maxillary teeth, following first bicuspid extractions, can allow the successful resolution of difficult discrepancy and anchorage cases. Charts 1 and 2 describe the amounts of space that might be expected by removal of additional upper bicuspids, upper first molars, and upper second molars. The findings on upper second molars are admittedly limited. Anchorage values as expressed by an efficiency percentage were approximately what would be expected from a study of anchorage values of the roots of teeth. The removal of upper second bicuspids has a better anchorage efficiency potential than the upper first molar, but this may be overcome somewhat by the greater size of the molar. Clear guidance cannot be given as to which teeth to remove in a specific case, but it is the observation of the author that for cases that are still in full Class II following four bicuspid space closure, upper second bicuspid removal would be more helpful from an anchorage perspective, whereas for cases that are in end-to-end molar relationship or require only a few millimeters to move into Class I, the upper first molar might be the tooth of choice. Also, the

upper first molar removal allows for a more "normal" appearing arch assuming normal alignment and size of the upper second and third molars.

The comparison with the nonextraction control group showed an enormous difference in the amount of incisor retraction that extractions provide when related to the maxilla. The nonextraction control group, though experiencing dramatic correction of Class II relationships, showed *no* incisor movement within the maxilla.

Some problems which appeared in the sample were described. Removal of upper teeth in addition to the four first bicuspids can be a solution to an occasional anchorage, skeletal, growth or cooperation problem.

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