DR. CREEKMORE What are your goals of orthodontic treatment?

DR. ROTH I would divide my goals into five categories: facial esthetics, dental esthetics, functional occlusion, periodontal health, and stability. I'd like to explain each of these further.

Facial esthetic goals would differ with the racial or ethnic type and with the society in which the patient will be living. For instance, the facial esthetic goals for a Japanese patient are slightly different if that patient is living in Japan or in the United States. Also, the goal for a Japanese patient will vary from that of a Caucasian or black patient. But in the United States, the standards for facial esthetics have been tailored to the Caucasian "North American Ideal" or what has been termed the "Hollywood Profile". This is best exemplified by a study of soft-tissue profile preferences of the American public published by Dr. Nelson Powell. I have had students who have done a Japanese Powell Analysis and a Korean Powell Analysis.

For North American Caucasians, then, my facial and profile esthetic goals would be: harmony with the soft-tissue profile of the Powell Analysis, a nasolabial angle of 90-110º, a reasonably prominent chin, the ability to close the lips without strain, and a smile line in which the crowns of the upper centrals and 1-2mm of gingiva are visible, yet when the lips are relaxed there is about 3mm of upper central incisor below the vermillion border of the upper lip. Supporting the lip, there should be adequate torque of the upper incisors--approximately 110º to Frankfort horizontal or 103º to SN.

Under dental esthetic goals, all teeth should be unworn, and there should be adequate torque and tip of the upper anterior teeth. The upper central incisors should be 1mm longer than the laterals, with flat incisal edges; the laterals should have rounded incisal edges; and the canines should be 1mm longer than the laterals, with pointed cusp tips. The teeth should be positioned vertically in keeping with the lip-line esthetics I mentioned, and should converge toward the midline. The coloration of the teeth should be pleasing. The gingival margins should be gradually stepped down from canines to molars and should be symmetrical on the anterior teeth. There should be no rotations, crowding, or spacing. In general, the teeth should be arranged as described in the Andrews nonorthodontic normals.

Under functional occlusion, when the teeth are in maximum intercuspation, the condyles should be seated in centric relation. There should be equal contacts around the centric cusps of the posterior teeth. When the posterior teeth are held in occlusion,
there should be .0005” clearance of the anterior teeth. Upon movement in any
direction from full closure, the condyle-disc assembly should transverse the eminentia
in a gliding movement while the anterior teeth provide guidance to separate or
disclude the posterior teeth. To attain this, there must be a 4mm vertical overbite and
a 2-3mm horizontal overjet between the incisal edges of the upper centrals and the
facial surfaces of the lower incisors, with a 1mm overjet or less between the tips of the
upper cuspids and the lower cuspids and first bicuspids. There should be free
movement in all directions, with the condyle-disc assemblies gliding up and down the
eminentiae. To achieve these goals in the natural dentition, the teeth must be
arranged similar to those of the Andrews non-orthodontic normals--meaning Class I
buccal relationships whenever possible.

My periodontal goals include adequate alveolar bone support without dehiscences or
fenestrations, good gingival crest height, no pocketing or inflammation of the
attachment apparatus, adequate thickness of the attached gingiva, no frenum pulls,
and optimum crown-root ratios.

Finally, under stability I would list placement of the teeth to establish adequate centric
stops of the posteriors; archform in harmony with bone support, musculature, and
mandibular border movements; root paralleling; proper anterior and cuspid guidance
with posterior disclusion; clear nasal airway; elimination of undesirable neuromuscular
habits; fiberotomies on rotated teeth; reshaping of teeth as needed to provide proper
occlusal form; centric-related occlusion; elimination of all rotations so that teeth are
lined up contact point to contact point, which means the contacts must be reshaped in
some instances; spreading of the roots where teeth were crowded initially; and equal
artistic tip of the upper and lower incisors on either side of the midline.

Having ideal goals also makes one aware of the limitations of treatment. The degree to
which one decides to compromise is a value judgment and is based upon weighing
various factors in any given situation. Nevertheless, these factors must always be
considered in light of ideal goals; otherwise you run the risk of having your results
become your goals, which amounts to no goals at all!

DR. RICKETTS Traditionally, the objectives of orthodontic treatment, according to
Tweed, were to achieve the best function, the best esthetics, and the best stability.
While that was acceptable at the time, there are several more we could add today: to
save as many teeth as possible; to save the patient from surgery if possible; and to
treat with the best efficiency, with the best preservation of tissue and the best
achievement of a happy patient. Finally, the orthodontist is in a position to play a role
model for children, and one of my goals in orthodontic treatment is to enhance the
personality and the lifestyle of our patients, helping to channel children as well as
adults into a self-esteem and lifestyle away from chemical dependency and into a
natural life flow.

DR. CETLIN My goals include facial and dental esthetics, long-term stability, function,
periodontal health, conservation of tooth structure, detailed finishing procedures, and
normal relationship of centric occlusion to centric relation free of TMJ dysfunction.

DR. ROOT Mine would be similar. I would say a stable, long-lasting end result; facial
features and teeth that are esthetically pleasing; and excellent function, with CR and
CO the same and disclusion in excursions.

DR. CREEKMORE Would each of you describe your routine of treatment planning?

DR. RICKETTS Treatment planning starts with correct records. And today, this
means good lateral and frontal headfilms, together with a good panoral film and right
and left films, preferably tomograms, of the temporomandibular joint.
DR. ROTH My routine records also include FMX, hand-and-wrist film on growing patients, facial and intraoral photographs, mounted models with condylar position graphs, and diagnostic setups as needed. I perform centric-relation and centric-occclusion analyses, a Ricketts Summary Analysis, a Roth-Jarabak Analysis, a Powell Soft-Tissue Analysis, computerized growth forecasts (long- and short-term), and several VTOs or STOs. Examination by a periodontist is requested at the time of initial records, and the report is included in our records. The records and setups are gone over based on the treatment goals I mentioned earlier. As many setups--both diagnostic for tooth fit and potential surgical on the articulator--are made as necessary to come to an acceptable set of treatment options.

DR. CETLIN The focal points of my analysis of orthodontic records are the soft tissues as related to profile fullness, gummy smile, and nasolabial angle; and the skeletal pattern, principally the cant of the mandibular plane, the palatal plane orientation, and proportions of anterior facial height. The age of the patient is important, since the majority of malocclusions in the mixed dentition can be treated without the extraction of teeth.

DR. ROOT My patient examination includes the chief complaint and age of the patient; the facial profile and lip line; and intraoral examination for:

- Type of malocclusion
- Amount of crowding or spacing, missing teeth, rotations
- Amount of overjet, overbite, open bite
- Function, including TMJ
- Health of tissue, both soft and hard
- Tongue posture and habits

I then proceed to a records examination, checking the models for depth of curve of Spee; crowding or spacing, rotations, and missing teeth; and the relationship of the upper teeth to the lower teeth (overjet, overbite, or open bite). I check the headfilm and full-mouth x-rays for anomalies, posterior crowding, cavities, any blocked-out teeth, paths of eruption, periodontal problems, and overall appearance. Then I review the cephalometric tracing for denture-base discrepancy, prognathic or retrognathic maxilla or mandible, angulation and position of the upper and lower anterior teeth, and mandibular plane angle.

With this information, I choose a cephalometric goal, then use the Level Anchorage analysis chart to record the anchorage requirements to reach my goal:

- Depth of curve of Spee
- Discrepancy (spacing or crowding)
- Millimeters of space necessary or available to place the lower anterior teeth in their goal positions
- If an extraction case, the amount of anchorage loss in closing the extraction spaces
- The amount of anchorage needed to correct the denture base (1mm of space needed to reduce each degree of ANB)
- The amount of anchorage gained or lost if the case is a low or high mandibular angle

I then record what anchorage is available to reach my goal, taking into account:

- Any extractions (which teeth)
- If a bicuspid extraction case, the possibility of delaying extraction of the upper bicuspids
- Expansion in certain cases
- Use of a transpalatal bar
- Class III elastics to tip the lower buccal teeth distally (number of months)
Headgear (hours and months)

Finally, I record the treatment steps for the particular case.

**DR. RICKETTS** Like Ron, we use the computer in conjunction with the comprehensive analysis to screen all the variables and uncover any unforeseen conditions. With the programs available today, we can ask for a long-range forecast to maturity without treatment so we can determine the natural characteristics of the forecast growth pattern. We can then determine the amount of skeletal change that would be desirable for the patient.

Our findings have shown that contrary to some people's opinions, a permanent change in the midface can be achieved. The change in the mandible brought on by mandibular posturing or sometimes with vigorous use of elastics is, however, a temporary bending. If iatrogenic damage has not been experienced on the condyle, the chin is likely to be in the same position with or without treatment.

Therefore, with the long-range forecast in hand, we begin the cybernetic cycle of treatment planning (Fig. 1). At each step in the cybernetic cycle, there is a feedback to all the other variables. Cybernetics is the process the mind goes through in the determination of such a plan. In the computer, it requires feedback loops, which were developed in 1970.

We then break down the four-position analysis (Fig. 2). In Position 1, the first issue is the probable position of the chin, to determine the position of pogonion. Position 2 suggests the intended location of the maxilla or Point A, which then establishes a new APo relationship and position. The next step is to work out the effects of incisor location on lower archform in Position 4, and thus the position of the lower molar. Once the lower incisor is positioned, we return to Position 3 to place the upper incisor and calculate its effect on upper arch length. The last tooth to be set up is the upper first molar.

The actual mechanical treatment plan, then, is the establishment of sequences for movements and anchorage regimes to bring about the changes drawn up in the treatment design. It would include orthopedic as well as orthodontic attention, with the application of the modalities available to the profession today.

**DR. ROTH** It is important to address all points on the problem list—even those that may be limitations for which no correction can be accomplished. The various treatment options that are feasible, with the pros and cons for each, are then presented to the patient and parents, and a risk vs. benefit assessment is explained. The patient and parents are then left to select the options that I believe are feasible or am willing to do from a treatment standpoint. If there are any doubts, or if there are several possible options, we do realistic trial treatments on the mounted models and the articulator, as well as on the computer with tracings and video imaging. The video imaging is not used as a sales tool, but only to get the patient or parent to tell us what they like or dislike.

**DR. CREEKMORE** All of you have mentioned facial esthetics and stability as two of your most important goals. Where should the teeth be positioned on the jaws to best achieve these goals?

**DR. ROOT** I use the patient's facial profile and a cephalometric tracing to determine the position of the anterior teeth for esthetics. The size of the nose and chin affect the lip line, but stability is probably more important than subjective esthetics. If the chin and nose are near average size, I like the facial profile of patients with an ANB angle (denture base) of 2–4°. For stability and function, when the ANB angle is 4°, the lower anterior teeth are at 5mm and 22° to the NB line. When the ANB angle is 2°, they are at 4mm and 20° to NB. The larger the ANB angle, the more tipped the lower anterior
teeth are. From an esthetic standpoint, if the patient has a large chin and nose, the teeth should be a little more protrusive, such as an ANB angle of 6° and the lower anterior teeth at 6mm and 25° to NB. I feel we start to sacrifice stability if the teeth are more protrusive than that, and the case might then require lifetime retention or surgical reduction of the nose or chin. If the patient has a small nose and chin, an ANB angle of 2°, with the upper anterior teeth at 4mm and 22° to NA and the lower anterior at 4mm and 20° to NB, is ideal for esthetics and stability. Another stability factor is that the cuspid width and buccal segments should not be expanded beyond their original normal positions.

**DR. RICKETTS** We all accept that Tweed was correct in building his plan around the lower anterior segment, but with the use of the APo plane, the ridge and Point B are ignored. Point B, however, is determined by the original position of the lower incisor. Our early findings suggested that the lower incisor should be 1mm ahead of the APo plane at 22°; this was the mean and the mode of a significant sample of normal patients. The upper incisors should be in a 2-2.5mm overbite and overjet, at a mean of 130°. The range of objectivity in planning the lower incisor position was ±2mm, which gave a range of -1 to +3mm as the usual goal. However, later studies of untreated patients at an average age of 55 with healthy teeth revealed that the mean was +2.5mm and the standard deviation ±3.5mm. This placed the lower incisor in a range of -1 to +6mm within only one standard deviation—or significantly more protrusive than proposed by Tweed, Steiner, or even myself.

In Tweed's preoccupation with maintaining the chin, he flattened the denture too much. Today, based on curves of distribution determined in 1988, three formulations of anterior tooth relationships have been developed with regard to bracket design—proversion, neutroversion, and retroversion—essentially altering the interincisal angle for the facial and denture type of the individual, which includes an appraisal of the oral musculature.

**DR. ROTH** I do not believe there is a "magic angle" for the lower incisors that will yield stability. The Ricketts range of normal relative to the projected APo plane is reasonable in positioning the dentition for stability, as long as factors such as alveolar bone support and muscular tonus are considered. Given that placement, most instability is due to airway problems, inadequate attention to detailing of tooth positions, or occlusal interferences. The tooth positioning and goals for a good functional occlusion that I outlined before are my guidelines for gaining stability.

**DR. RICKETTS** I agree that there is no one absolute position in which teeth must be placed where they will be stable for any individual. The old idea that teeth placed on the ridge would be more stable was a figment of the imagination. My findings in the 1950s, Frankel's in the 1970s, and Little's in the 1980s exploded that viewpoint altogether.

**DR. CETLIN** The cephalometric analysis can provide parameters for incisor position, but stability of the mandibular incisors is also achieved by various treatment procedures such as labial root torque, the alignment and divergence of the incisor roots in the trough, and mesial rotation of the mandibular canines. Anterior stability and esthetics are related to proper axial inclinations and labiolingual and vertical positioning of both maxillary and mandibular incisors. This relationship is often referred to as the "correct interincisal angle". The posterior teeth should be relatively upright, with a slight curve of Wilson, and when viewed from the occlusal, the gingival margins should be visible, buccally and lingually. With proper design and placement of the lip bumper and transpalatal bar, the stability of the vertical molar positions can be achieved or maintained. Esthetically, I prefer to treat growing patients to a fuller profile, since with age the slightly convex faces of teens tend to flatten.
DR. RICKETTS  There has been a subliminal change in the minds of orthodontists and of the public in the last 10 or 15 years with regard to fullness of the face, particularly in females. A fuller denture is the mark of youth, and too much flattening in the female has met with criticism. I feel that in the adult Caucasian female, as long as the lips are contained within a line from the nose to the chin, the upper lip is slightly posterior to the lower lip when related to that line, and the mouth can be closed with no strain, then the esthetic and functional objectives have been met. In the male, the lips are normally about 2mm more retrusive, due to the longer time for growth of the nose and development of the chin. However, in both sexes there is a range of esthetic variables. Jack Kennedy's smile was slightly protrusive by ordinary orthodontic standards, and this profile is not rejected in our society today. Perhaps in our American culture, because of the abundance of Hispanics, blacks, and orientals--all of whom have more protrusive dentures than is common in the Anglo-Saxon--the acceptance of protrusion is greater than we witnessed three decades ago.

DR. ROTH  In my opinion, the dentition can be positioned objectively for esthetics only by doing a VTO. The VTO is a projection of what is most likely to happen as a result of growth and the effects of certain treatment plans and mechanical approaches to correction of the malocclusion. A proper VTO is, in short, a clinically accurate trial treatment of the face. The assessment of the projected soft-tissue profile with the Powell Analysis will provide a relatively unbiased forecast of the proposed treatment plan. Certainly there is some art in this approach, but it is the most intelligent way we have to plan treatment for the face. Orthodontics is still part science and part art. I am not aware of any other approach that could be considered pure science, and many of the popular "formulas" are likely to lead to treatment errors that will result in poor facial esthetics.

DR. CREEKMORE  How accurate is growth prediction?

DR. CETLIN  Growth prediction is not a part of my usual treatment-planning procedure. I plan on average growth for each growing patient.

DR. ROTH  The issue is not whether incremental and total growth can be predicted to the nearest millimeter. The issue is the ability to predict where the chin will be in the face, so that we can plan where we would like to place the front of the maxilla and the dentition, and determine whether our treatment will enhance or detract from the face. Growth prediction in most patients is accurate enough to plan treatment. The amount of incremental growth--how much and when--seems to be the biggest problem. In forecasting growth for any given individual, the type and direction are reasonably predictable, but the exact amount of growth is predictable only within 2-3mm. Average growth figures, such as an enlargement of all structures based on averages, are not as good as an individualized forecast using average increments over the treatment period.

DR. ROOT  A two-year growth pattern of an individual would help in predicting subsequent growth, but the maturity factor will vary. So we don't know exactly when individual growth will occur or for how long.

DR. ROTH  I don't find the patient's previous two years of growth to be of any great value in predicting subsequent growth.

DR. RICKETTS  The computer can help in this regard. In 1970, I discovered that the mandible grows in an arc. By 1971 we had worked out the extension of the coronoid and condylloid processes and the drift of the angle, together with the sexual dimorphism that occurs in the chin and the gonial angle. Our success with that growth forecast and predicting the development of the lower arch was estimated to be at least 90% for 90% of the cases. The prediction of the behavior of the mandible in the face was not quite as good in the beginning. We were no better than average when it came to sella and the SN anterior cranial base. However, with research into the use of
basion-nasion and the Frankfort plane over the past 20 years, we have achieved a better than 90% reliability on the position of the chin relative to the cranium on a sensible clinical basis. Therefore, this is no longer just a prediction based on speculation from mandibular plane angles. Our computer program now has more than 200 bits of information with regard to sex, age, peculiarities of skeletal type, and biologic corrections.

**DR. CREEKMORE** How does growth of the jaws affect crowding in the deciduous dentition, mixed dentition, and permanent dentition?

**DR. RICKETTS** This question really pertains to arch length and natural growth. The findings of Moorrees on natural arch development are probably the best source of an answer. These findings suggest that once the lower first permanent molar erupts and makes contact and the upper molar fits into it, its width does not change thereafter. However, there is a width increase in the first premolar area in the transition from the deciduous to the permanent dentition. There is also an increase in canine width in the transverse dimension from the deciduous to the permanent dentition. An average loss of 1.7mm on each side can be calculated from the loss of the deciduous canines and both primary molars. But at the same time, an almost 2mm increase in the width of that first premolar area permits a shortening of arch depth without a crowding of the denture under normal growth circumstances.

One of the factors that has plagued the understanding of growth in the arch is the overall eruption of the lower teeth, and just where the adjustment of the leeway space as described by Nance takes place. If the mandibular plane is used together with the outline of the symphysis for superimposition, the impression may be gained that the lower molar erupts straight upward and the anterior teeth actually move backward. However, with the development of Xi point and Pm point, and the use of the corpus axis, the lower molar was seen to erupt straight upward at a 90° angle from the corpus axis, while the incisors move posteriorly to a lesser degree than when viewed from the mandibular plane. But the discovery of the arc of growth of the mandible presented a completely different picture. All the teeth in the lower arch erupt upward and forward (Fig. 3). If a tight lip or a lip habit contains the lower incisor segment and the upward and forward eruption of the buccal teeth continues, crowding will ensue.

Therefore, crowding of the dentition is dependent upon the containment by the lip musculature, together with its equilibrium with the tongue. In the final analysis, growth makes its statement depending upon the carriage of the chin and the carriage of the maxilla with the muscles of facial expression. To put it succinctly, patients with mandibular arcs with small radii, low oral gnomons, and wide faces tend to develop adequate arch lengths or even spacing. Patients with wider mandibular radii and longer and narrower faces, particularly those without convexity, tend to develop crowded arches or else have enough size to permit a slight posterior movement of the molar when compared to the normal. Thus, growth does have an expression in natural development, but it is much different from what has been conceived in the past.

**DR. ROOT** In the deciduous dentition, up to the time the first molars erupt, the jaws grow and provide space for the permanent upper and lower anterior teeth. In the mixed dentition, the space distal to the first molars increases to provide space for the second molars. When the primary first molars are lost, there should be adequate space for the first bicuspids to erupt. When the large primary second molars are lost, adequate space should be available for the cuspids and second bicuspids to erupt with space left over, especially in the lower arch, for mesial drift of the permanent first molars. Arch length decreases from the permanent first molar around the arch to the contralateral first molar. In the permanent dentition, space increases between the second molar and the ramus for third molar eruption. In the upper arch, this growth
occurs on the maxillary tuberosity. The posterior growth amounts to about 1.5mm per year per side up to about age 15 in females and 18 in males. To summarize, arch length does increase during all three periods, but only anteriorly in the deciduous dentition and only posteriorly thereafter.

**DR. ROTH** It has been my observation that growth of the jaws does not seem to substantially effect a change in arch length in most cases. It seems that in many instances, the lower permanent canines tend to erupt wider than the deciduous canines, thus increasing arch length to some degree. Growth of the jaws seems to produce increased arch length mostly distal to the terminal teeth, whether it is in the deciduous, mixed, or permanent dentition. In the final stages of mandibular growth, there is a tendency for the lips and buccinator mechanism to retract the entire dentition, thus producing some crowding or shortening of arch length.

**DR. CETLIN** I also find that crowding tends to increase in the conversion of the mixed to the permanent dentition. As Rick implied, if the pressures of the perioral musculature can be minimized, then dental arch development can be allowed to occur, concurrent with an increase in arch circumference and unraveling of crowded teeth.

**DR. CREEKMORE** *Is average growth favorable for the correction of all malocclusions?*

**DR. ROOT** No. In cases with a high mandibular angle and anterior open bite, the bite tends to open farther with many routine orthodontic mechanics. If the patient and orthodontist are willing to accept a long treatment time, then simple appliances that reduce the vertical growth of the face (an upper palatal bar and lower lingual), stop incorrect tongue posture (lower anterior spurs), and reduce the ANB angle (high-pull headgear) can be used while the patient is growing. These appliances are easily cared for and cause few problems while we wait for the end of growth. An excellent time to fully treat these cases is near the end of growth, when vertical facial growth has stopped but mandibular length continues to increase, or as an adult, when no vertical facial growth can occur. Class III malocclusions tend to become more Class III as mandibular growth outstrips horizontal maxillary growth. Again, the best time to orthodontically treat a Class III is at the completion of growth.

**DR. RICKETTS** Average growth may be unfavorable in the Class III, due to the fact that continued growth of the mandible carrying the lower molar forward might end up worsening the situation. Average growth of the mandible is a mean of almost precisely 2.5mm on the facial axis. A mean of 90° to the facial axis was found earlier, but more recently it was found that over a 10-year growth period, a slight closing of 1-2° on the facial axis occurs. When this is translated geometrically in the horizontal and vertical directions from the pterygoid vertical plane, the lower molar moves forward each year about 1mm in space, which is favorable for correction of a Class II. Under this analysis, if growth alone is used to correct a Class II, which is typically 6mm, it would take five to six years for growth alone to do the job, assuming the upper molar can be prevented from moving forward. If both the upper and lower molars can be held against growth in a Class I relationship, then normal growth would carry the remaining denture forward and space could be created for the crowded Class I condition.

**DR. ROTH** I would say that average growth is favorable for the correction of average malocclusions. If there is a large skeletal discrepancy or if the parts of the dentofacial complex relate to each other unfavorably, creating a disharmonious jaw relationship, then average growth would be inadequate to correct this relationship. In these cases, average growth either is inadequate or even makes the situation worse; for instance, in an asymmetry of the mandible, the more it grows the worse the asymmetry becomes.
DR. CETLIN I agree. If average growth refers to normal development and relationship of the dental arches or a mild skeletal discrepancy, correction of the malocclusion is feasible using current orthodontic procedures. If the patient has a severe skeletal discrepancy, average growth and orthodontics alone may not suffice, and orthognathic surgery may be necessary. If moderate-to-severe crowding is present where so-called "average" growth exists, the malocclusion can generally be corrected without the extraction of teeth.

DR. CREEKMORE Two patients have similar Class II, division 1 malocclusions. One is an 11-year-old with several years of growth remaining; the other is a 20-year-old with no growth remaining. Are their treatment plans similar?

DR. RICKETTS My answer would be no. A typical girl ceases her major growth activity at 14 years and 9 months. The male will continue to grow until a mean of 19 years. In effect, when growth is analyzed and reduced, it amounts to a difference of 2mm of arch length per year. Therefore, a two-year plan would be to reduce growth to 4mm of arch length in the lower arch, or 6mm in a three-year plan, everything else being equal. This is a very difficult phenomenon to teach, because most find it difficult to equate growth with an arch-length problem in the lower arch, particularly when it is combined with anchorage problems.

DR. CETLIN I would treat a mild, moderate, or severe Class II, division 1 malocclusion in either an 11- or a 20-year-old with nonextraction mechanics, although the correction of Class II malocclusion in the adult may be difficult without growth. However, in some Class II malocclusions where restrictions of the mandibular arch are present, coordinating the dental arches by relieving cuspal interference may contribute to sagittal correction. Nonextraction procedures are reversible, and the severe Class II, division 1 adult may have to be resolved with orthognathic surgery.

DR. ROOT My treatment plans would also be similar. In the growing patient, backward force on the upper arch slows forward growth of the maxilla while the mandible continues to grow forward. Orthodontic energy is used to stop forward growth of the maxilla. In an adult, we have no forward growth of the maxilla, so the orthodontic energy is used to move upper teeth distally. The adult case usually takes longer because the force of the mature musculature on the occlusion slows tooth movement.

DR. ROTH Whether the treatment plans are similar really depends on what the source of the Class II is and how to correct it to get the best facial esthetics. If it is a skeletal problem with a favorably growing mandible, it may be possible to reduce the jaw relationship with headgear on the 11-year-old, but not on the 20-year-old. The 20-year-old may require orthognathic surgery or dental compensation--for example, extraction of the upper bicuspids if facially appropriate. On the other hand, if the problem is only dentoalveolar--perhaps due primarily to mesially rotated upper molars, or a case in which loss of lower anchor age into extraction spaces was combined with retraction of upper anterior teeth into extraction spaces--the treatment plans could be quite similar, since only tooth movement is needed. So the answer depends on a thorough diagnosis and workup of the case at hand.

DR. CREEKMORE Can you selectively grow or inhibit growth of chins, without inhibiting maxillary growth, by appliance selection?

DR. RICKETTS As I said before, I think that on a short-term basis the chin can be brought forward by reposturing and also by a warping open of the mandible--even, perhaps, with vertical development and the increase in the arc of growth of the mandible. From another point of view, there is evidence that suggests that excessive rotation and opening of the mandible can inhibit the development of the mandible by a
secondary compression of the condyle. The amount of recovery that is possible after this insult has not as yet been determined.

DR. ROTH I do not believe that we can do much to the mandible other than displace it out of the socket with various appliances. I have seen nothing to make me think that anyone is doing much to either inhibit or enhance mandibular growth, but much is being done that creates false bites. My experience both in Europe and in the United States and with articulator mountings and splints gives me a little different insight into this area than most orthodontists have. I think we have to work within the limitations of the mandible on any given patient and, at best, diagnose how the particular patient's mandible will grow so we can treat effectively to a decent functional occlusion.

DR. CETLIN I have no evidence of selectively growing or inhibiting chins by appliance selection. Strangely, some chins seem to grow under genetic influence, but not as a result of appliances.

DR. ROOT Appliances such as the transpalatal bar can inhibit one-third of the total vertical growth of the face; therefore, the mandible will rotate one-third more closed than without the palatal bar. This will increase the prominence of the chin. An anterior bite plate appliance will encourage more posterior vertical growth of the teeth, thus rotating the mandible open and decreasing the prominence of the chin.

DR. CREEKMORE When is the optimum time to start treatment?

DR. RICKETTS If it is my child, I want to diagnose as early as age 4 or 5, and I like to start the treatment whenever the condition is sufficiently marked and the prognosis is one of little or no improvement with predicted growth and development.

DR. ROTH I don't believe that early treatment is necessarily an advantage. To me, whether a case is extraction or nonextraction is a diagnostic problem, not a treatment timing problem. Correction of skeletal discrepancies is a diagnostic and a treatment timing problem. Obviously, in certain cases correction by differential growth is an issue, and one must consider starting early enough to safely gain a correction while the patient is growing. In many instances, particularly in males, correction of most orthopedically correctable Class II malocclusions can be accomplished at 10 or 11, so why start at 7 or 8 unless the anterior teeth are in a position where fracture is likely?

DR. ROOT I agree that it depends on the case. If it is a Class I with no severe problems, start when the second molars have erupted. If it is a Class II with an average mandibular angle and a large ANB or denture-base problem, start in the mixed dentition with a headgear to partially correct the ANB angle, but finish after the second molars have erupted. If the denture base is close to normal (ANB of 2-6º), start when the second molars have erupted. If it is a Class II, division 2 with a low mandibular angle and closed bite, start when the second molars have erupted and the patient is still growing, so the posterior vertical dimension can be increased. For a Class III, start at the end of growth or when the patient is through growing. In a case with a high mandibular angle and anterior open bite, start in the mixed dentition with a transpalatal bar and lower lingual to slow vertical growth. Add tongue spurs lingual to the lower anterior teeth if the patient has incorrect tongue posture. Use a high-pull headgear if the ANB angle is large. When the case is Class I, wait until near the end of growth for full orthodontic treatment so the mandible does not rotate open.

DR. CETLIN I believe the optimum time for treatment is 10 to 11 years of age, for these reasons:

- Growth is available for the correction of Class II malocclusions.
- The "E" space can contribute to space gaining in both arches.
Rotation and distal movement of the maxillary molars is feasible, along with dentoalveolar lateral growth to increase arch length.

Cooperation is favorable because academic and social pressures are minimal.

Detailed finishing, including the alignment of second molars, can be completed in two to two and a half years.

With regard to the type of malocclusion, for moderate discrepancies the optimum time to start treatment is prior to the loss of the second primary molars. For severe Class II, division 1 malocclusions, treatment is usually started earlier to optimize growth of the mandible and to redirect or inhibit maxillary growth. True Class III malocclusions are started later to coordinate orthodontics with orthognathic surgery.

**DR. RICKETTS** We actually have four treatment phases: the preventive in the primary dentition, the interceptive in the 7-to-9-year period, the corrective from age 10 to as long as growth is available, and the rehabilitative when no growth is possible. The advantage of early preventive-phase treatment is the prevention of the malocclusion from ever involving the permanent teeth. This means a change in structure and function. The treatment of the second deciduous molars by one of many modalities is employed to produce a situation in which the first permanent molars would be guided into a normal relationship, and the incisors would have an opportunity to erupt into a normal overbite and overjet. This same aim extends into the interceptive phase, at which time the objective is to create a situation in which the permanent canines and premolars would erupt into normal positions and the 12-year molars would also be guided into normal development. When patients are delayed until the corrective stage, the capability of orthopedics is somewhat reduced, function has been more thoroughly established, and the risks of relapse appear to be greater.

It bothers me that so many orthodontists have chosen to default in the young patient. To leave crossbites and skeletal problems unattended, that to me is not to respect the child as a human being. Perhaps it is because the orthodontist is not sufficiently interested to learn how to treat young children with grace and efficiency.

**DR. ROOT** There are advantages to each of these age groups. At 7 or 8, the teeth move very easily, the posterior vertical dimension can be increased to open the closed bite of a Class II, division 2 case, and a Class II molar relationship is easy to correct. Patients who are 10 or 11 have the same advantages, but rotations of cuspids and bicuspids can also be easily corrected. At 14 or 15, the second molars have erupted, and therefore they can be controlled for bite opening, anchorage, and detailing. All the teeth except the third molars have erupted, so we have control over them and the end result can be perfected.

**DR. ROTH** From my point of view, it is no advantage to start real early and have patients in appliances forever, so that they are burned out by the time of permanent-dentition treatment. There are not too many dentoalveolar, tooth-moving problems that cannot be corrected within two years, given a reasonable degree of cooperation. I don't believe functional occlusion goals can be reached unless the second molars are banded and properly positioned. I routinely delay Phase II treatment until the second molars are fully erupted, although on milder cases where I am confident the correction can be made in the permanent dentition, I will wait for the 12-year molars to erupt before starting treatment.

So unless there is some pressing reason, treatment at age 7 or 8 is not an advantage in a routine case. Cases that are not routine may require earlier treatment, but one should realistically assess whether they are truly correctable or destined for surgery before subjecting the patient to five or six years of appliance wear. Serial extraction or early enucleation may be indicated in cases with severe crowding. Sometimes mixed-dentition treatment is indicated to open space for eruption of the remaining permanent
teeth, as in a brachyfacial, deep-bite case that you want to treat nonextraction, but is crowded because of the deep bite.

**DR. CREEKMORE** What influence do Class I, Class II, and Class III dental occlusions have on jaw relationships and growth?

**DR. RICKETTS** There is very little evidence to support the contention that the type of malocclusion can affect the overall growth of the jaws. Yet more of the functional factors associated with each type may need attention in a given individual. It may be more than coincidence that Class II, division 2 is often associated with the square, brachyfacial pattern. There is also some suggestion that a Class III may feed on itself, as mandibular protrusion or prognathism may be associated with overclosure. Therefore, a lack of coupling of the anterior teeth could conceivably be a factor contributing to overgrowth of the mandible in these patients.

**DR. ROTH** I don't believe the molar relationship affects growth of the jaws to any clinically meaningful degree, either. Anterior crossbite can restrict the development of the anterior alveolus. A deep bite in a Class II case can affect the position of the lower dentition, but these are basically dentoalveolar changes. I don't believe that a deep-bite Class II stops the mandible from growing or that "unlocking the deep bite" allows the mandible to grow. The mandible will grow as it is going to grow, although the dentoalveolar relationships might be altered by unlocking the deep bite.

**DR. RICKETTS** Your question, Tom, is essentially whether there are Class I, Class II, and Class III skeletal patterns. Conceptually, small jaws with straight profiles might have Class I malocclusions. Conceptually, Class II might be present in patients with high convexity. And Class III may be present in patients with low convexity. Dramatic variations can be found. The so-called skeletal open bite simply means that the face is long and may be highly convex, but we have samples of patients with this pattern who have normal occlusions and yet closed bites. Contrariwise, the short, square face may be called a skeletal deep bite, but here again we have normal occlusions and even open bites in this type of face. Therefore, it would appear that malocclusions are generally produced by their oral environments, with the skeletal pattern being an overlay component. Clinically, it is my conclusion that breathing problems can restrict the width of the upper arch due to an alteration in the oral environment. In cases of bruxism and forward positioning of the condyle, we have seen vertical growth patterns result from flattening of the condyle.

**DR. ROTH** Although in a high percentage of cases the buccal segment relationship may be in harmony with the jaw relationship, there are many exceptions. Molar relationship, in many cases, just does not tell the story!

**DR. CETLIN** I would add that most dental malocclusions are relatively simple to correct, whereas skeletal problems may require compensations or surgery. Class I and Class II cases tend to remain stable even with growth. The severity of the Class III malocclusion depends on the influence of skeletal growth.

**DR. CREEKMORE** I would define orthopedic changes as changes in the relationship of the jaws to each other, and orthodontic changes as changes in the position of the teeth on the jaws. Do you agree?

**DR. ROTH** I agree with that definition.

**DR. RICKETTS** I define orthodontic changes as those induced from one or all of the seven classic malpositions of the teeth to the normal line of occlusion, as originally described by Angle. Orthopedic change is a change in the relationship of the basal structure of the jaws to each other in any of three dimensions--transverse, horizontal, or vertical--other than what would be produced by natural growth.
There can be three types of orthopedic change. One occurs as a disturbance of natural growth, by whatever process. This should include the concept of iatrogenics as well as of systemic disease. The second is that produced by orthodontic modalities. Palatal widening is a case in point in the transverse plane. Backward movement or tipping or forward movement of the palatal plane is also an orthopedic change; this may be dramatic with extraoral mechanisms and less so with intraoral regimens. A change in the corpus-condylar axis with redirected growth of the condyle is seen short-term and is also an orthopedic change. Bite opening by extrusion of posterior teeth and backward rotation of the mandible would be classified as an orthopedic change in the vertical dimension. Therefore, even simple orthodontic mechanics such as bite leveling and intermaxillary elastics can produce orthopedic changes. Also in the vertical plane, there is evidence from Baumrind in 1981 and my findings of 1960 that high-pull headgear off the upper molars may lead to condyle compression and produce an undergrowth of the condyle and thus significantly lesser growth of the mandible than in patients treated with cervical traction—much to the surprise of the whole profession. The third type of orthopedic change is surgical.

**DR. CREEKMORE** Is there a clinically significant difference in the correction of a Class II malocclusion in a growing patient between functional appliances and fixed appliances?

**DR. CETLIN** Correction with functional appliances assumes that treatment is directed mainly toward forward movement or growth of the mandible. The use of fixed appliances implies that distal pressure will be applied to the maxillary arch with headgears, removable appliances, or Class II elastics. With fixed appliances, the initial phase of Class II treatment should remove all restrictions or interferences with mandibular growth or repositioning. This may include maxillary expansion, elimination of crossbite, correction of deep overbite, and removal of cuspal interferences with the coordination of the dental arches. In the later phase, Class II correction is achieved through a combination of growth, molar rotation and expansion, coordination of increased arch width, and distal movement of the molars.

**DR. ROOT** Functional appliances can reduce the ANB angle of a growing patient, but not as effectively as fixed appliances can. Functional appliances tend to tip the upper teeth back and the lower teeth forward—which is orthodontic change—whereas a fixed appliance, with good torque control, can move teeth bodily. With a fixed appliance, the denture base can be corrected with both orthopedic and orthodontic control.

**DR. ROTH** It is my impression that correction of Class II malocclusion with fixed appliances can be documented and explained on the basis of serial headfilms and models. On the other hand, correction of Class II with functional appliances usually falls within the realm of clinical “black magic”, in which there seems to be no documentation of how the Class II was corrected, but somehow the appliance “just worked”. I do not believe that functional appliances make mandibles grow, so given two identical cases to be treated to the same goals, the same changes must occur regardless of the appliance used. If the mandible is deficient and has poor forward growth potential, the only clinical difference would be that the functional appliance would create a false bite, whereas the fixed appliance would either fail to correct the problem, over-retract the maxillary complex, or create a false bite due to prolonged use of Class II elastics. The problem is one of diagnosis and treatment planning, not of appliance selection.

**DR. RICKETTS** We now possess vivid composites to show the behavior of patients treated with a variety of functional appliances. It is quite clear that the mandible can be altered in the short range with mandibular posturing as the condyle-corpus axis opens up. There are actually four modalities for the correction of Class II. One is
mandibular activation with removable appliances. A second is with fixed Herbst appliances, and the results are not the same between the two. Another modality is extraoral traction, used mostly against the upper molar or employed against the whole upper arch, and applied from various directions. Finally, intermaxillary elastics can be used. Here again the result depends upon the anchorage preparation in the lower arch, whether or not the upper arch is segmented, and whether the forces are directed primarily against the upper molar as with the Wilson technique, or with a Ricketts push-coil utility section. There is a significant difference between all these modalities in the correction of Class II, and individual composites show the differences. Individual growth patterns have also been seen to correct Class II.

In general, the functional appliances—that is, the bionator, Frankel, Bimler, activator, and their variations—do open the corpus-condylar axis slightly. They move the lower arch forward slightly, they inhibit the eruption of the upper molar slightly, they tip the upper incisors backward slightly by changing the archform, and they sometimes alter the joint slightly. When all these are put in combination, they add up to an effective change in the Class II relationship.

If extraoral traction is used to the upper arch in the manner I recommend, the maxilla, upper molars, and entire upper arch are moved posteriorly—sometimes even with lingual movement of the lower incisors. The lower molar can actually be intruded by extraoral traction to the upper arch in the young, growing patient. By opening the bite with utility arches and vigorous Class II elastics, some orthopedic alteration can be made in the maxilla, and the mandible can be bent open—similar to the results of mandibular posturing devices!

Therefore, much depends on the objectives of the modality and the long-range condition. Alteration of the mandible seems to be temporary and often gives the illusion that success has been achieved, only to witness a slight relapse.

**DR. CREEKMORE** How do you achieve orthopedic expansion of the jaws?

**DR. RICKETTS** Expansion means an increase in transverse width. Increases in horizontal arch depth are called "elongation". To my knowledge, elongation involves no orthopedics in either arch. Nor can there be orthopedic expansion in the lower arch. There can be in the upper arch because of the midmaxillary suture. We achieve this with a Quad Helix or extraoral therapy, or both. Either of these can be effective in the separation of the maxillary suture. We have not used jackscrew appliances in 20 years.

**DR. CETLIN** I use the transpalatal bar for orthopedic expansion of the maxillary arch, as evidenced by sutural opening. Since there are no patent sutures in the mandible, orthopedic expansion is not possible, but dentoalveolar widening is accomplished with proper design and placement of the lip bumper. Although the possibility of expanding the basal bone is doubtful, there may be lateral growth in the cortical and alveolar bone of the mandible.

**DR. ROTH** In the upper jaw, I use a Haas-type palatal appliance that is both tooth- and tissue-borne. I use the Lavin approach wherever possible. This involves rotating the molars properly and pulling them lingually to a buccolingual upright position with a lingual arch. The transpalatal appliance is then cemented in place, but not activated for three months. Activation is one-quarter turn per day until an overcorrected position of upper lingual cusp to lower buccal cusp is reached. This is held for three months by covering the jackscrew with acrylic.

I agree with Norm that dental expansion is possible in the lower arch, within the limits of the alveolus. It is possible to expand the lower arch in a number of ways, but none of these, in my opinion, affects the width of the mandible—only the width of the dental arch. If there is no inflammation of the attachment apparatus, the teeth can be moved...
out of the alveolus without gingival recession. Intraorally this may appear to have created bone growth, but such is not really the case, as we have seen when a tissue flap is retracted to evaluate for free gingival grafting. My appliance of choice for lower expansion is a lingual arch with recurved finger springs. It is predictable and dependable and reasonably quick. I do not believe, nor is there any evidence to support, that the way a lower arch is expanded makes it any more or less stable. Using the tongue to expand the lower arch by taking the pressure off the buccal segments is no more stable than expanding it mechanically.

**DR. CETLIN** In my experience, mechanical expansion of the dental arches through direct application of force to the teeth has proven unstable. However, expansion from redirecting the forces of the perioral musculature has been stable. This stability may be aided by a lower positioning of the tongue as the teeth move laterally. The aging dentition is constantly imperiled by a natural tendency of the arches to shorten and narrow. It remains to be documented whether a full dentition is more resistant to these natural forces.

**DR. CREEKMORE** *How has expansion of the dental arches now become acceptable in orthodontics?*

**DR. ROOT** I suppose it's "acceptable" because many orthodontists are doing it—probably because of financial and peer pressure from general dentists and other orthodontists.

**DR. ROTH** I think expansion of the dental arches was ushered in with the introduction of functional appliances to the United States. On top of this, pressure from the generalists to eliminate bicuspid extractions, the threat of lawsuits claiming that bicuspid extractions cause TMJ problems and ruin the face, and some underlying belief that if all the teeth are kept that somehow it makes it a better occlusion have all pushed orthodontists to try more cases nonextraction. If your goal becomes keeping all of the teeth at all costs, you do have to expand in a lot of cases. But from our studies of functional occlusion, keeping all the teeth does not necessarily make a better functional occlusion, and in many cases it creates occlusal problems.

The studies by Riedel at the University of Washington would suggest that universal expansion would lead to many relapse problems. Boley's study of extraction vs. nonextraction indicates that the current swing of the pendulum toward nonextraction is not justified on the basis of facial esthetics. It would seem that we have been down this road before, prior to Calvin Case and Charles Tweed. I guess history will just have to repeat itself once again.

**DR. RICKETTS** When I went to California in 1952, the Southern California Angle Society had such members as Cecil Steiner, Hayes Nance, and Charles Tweed, all of whom had categorically, without exception, thrown out expansion as a viable method in orthodontics. This was perhaps expressed most succinctly by Strang, who wrote the book on edgewise and who had done a 180° turnaround on expansion, writing an article in 1948 on "The Fallacy of Expansion". This came on the heels of the 1947 work by Nance describing the limitations of orthodontic expansion. It should be understood that the conclusions of these clinicians were based on their experiences with the edgewise appliance, in which expansion was gained in the permanent dentition with full banding, leveling, advancing the teeth from the molars, and often intermaxillary elastics. No doubt they reacted to their failures, but their attitude was conclusive and dogmatic. A young man, as I was, coming into orthodontics at the time was not even permitted to think of expansion as an alternative.

However, a series of observations started to take place. The first of these was perhaps an attempt to control the vertical development in the course of orthodontic treatment. We began to attempt to treat more slowly. We achieved methods for intrusion of
anterior teeth. The second was the advent of extraoral traction, with Kloehn's work first presented in 1948, when the extraction philosophy was at its height. A third change was the findings from the use of bumpers beginning in the 1950s. Distalization of the lower molar had been considered unthinkable prior to this time.

By 1960 the fourth shift occurred, as maxillary orthopedics was demonstrated with extraoral therapy. Later, palatal splinting became a popular and dramatic modality. These were combined with the results of the Quad Helix appliance, which also was shown to slightly correct the Class II condition. By this time, growth forecasting was having its effect as a fifth major factor. In these years a cultural shift was also starting to take place with regard to the flat profile. This produced a profound shift in the ideology of the orthodontist as the sixth factor.

In 1973, Frankel shocked the orthodontic world by showing dramatic lateral expansion of the arches simply by shielding the lips and pulling on the periosteum from the outside. This was a seventh movement. Reviewed years later, these cases appeared to be remarkable successes without severe protrusions. Americans, taking their cue from the European philosophy, started to attempt mandibular advancement and arch developments that would have been heretical before that time.

An eighth revelation was the findings of Little and colleagues at the University of Washington. Failures in two-thirds of extraction cases and crowding of lower arches would certainly seem to show that extraction of premolars was not the answer to crowding and permanency of results. Finally, the ninth factor was the discovery that long-range forecasts on the computer could be useful, and that we could begin with the end in mind and treat to the adult patient. Many clinicians began to take a stand against the advocates of extraction, and they made an impression on the profession.

DR. ROTH That's an excellent history, but I know of no studies that would support the contention that expansion is either stable or yields better results.

DR. ROOT I don't know of any scientific evidence that supports this procedure.

DR. RICKETTS There is abundant evidence that treatment without extraction has every bit as good or better long-range results than treatment with extraction. These were intimated in the findings of Gardiner in the 1970s and other clinicians. The dearth of long-range records in many practices makes it difficult to acquire data. My personal findings, however, indicate that extraction is not the answer or the salvation that it was purported to be 40 years ago. Quite the contrary: in specific cases it may worsen the odds of long-term stability. This does not mean that extraction is never indicated. Indeed, it is sometimes the most conservative procedure that can be offered a patient. But there has been a shift from 90% extraction by those in the Begg philosophy to 90% treatment without extraction of premolars in many philosophies today.

DR. CREEKMORE How do you predict where the teeth will be positioned on the jaws at the conclusion of nonextraction treatment vs. treatment with various extractions?

DR. ROOT For nonextraction, measure the amount of crowding or spacing and the depth of the curve of Spee. You need 1mm of space to level 1mm of curve. Class III elastics in conjunction with lower tipback bends will provide up to 5-6mm of space. The molar relation should be corrected with headgear or very light Class II elastics. The Level Anchorage preadjusted appliance, in conjunction with full-size edgewise archwires, controls torque. Further torque adjustments can be made. It is now a mathematical problem of measuring the total discrepancy, knowing where the teeth are to begin with, and then using available anchorage--headgear, palatal bar, Class m elastics, space, expansion, stripping--to move teeth into the predicted, goal area.

Four-first-bicuspid extraction provides a net of 12mm of anchorage space; four-second-bicuspid extraction provides a net of 9mm of anchorage space. Second-molar
extraction does not increase anchorage unless third molars are available; it merely provides additional space to move the teeth distally that are anterior to the second molars. Four-cuspid extraction provides a net of 15mm of anchorage space (10mm in the lower arch, 5mm in the upper). Four-lateral-incisor extraction provides a net of 6mm in the upper arch, plus the width of the lower laterals (approximately 6mm each), for a total of 18mm. Four-central-incisor extraction provides 10mm in the upper arch, plus the width of the lower centrals (approximately 5.5mm each), for a total of 21mm. Using these anchorage values and knowing how much anchorage is provided by headgears, Class III elastics, palatal bars, etc., the position of where anterior teeth end up can be predicted mathematically.

**DR. CETLIN** As I said earlier, my prediction is based on the best estimate of lower incisor position as evaluated from cephalometric evidence, soft-tissue appraisal, and changes due to growth and profile flattening.

**DR. RICKETTS** In most situations, there is a prediction or an estimation of growth, together with skeletal change that can be induced by the clinician. Once this forecast is made and the designs are drawn, the mechanics are arranged to bring about the desired changes. The success of a prediction, therefore, is determined by the ability of the operator to achieve anchorage goals and execute the treatment.

**DR. ROTH** Prediction of where the dentition will be positioned on the jaws requires the same process no matter what teeth are extracted. It requires a combination of diagnostic setups and VTOs, and in our practice we routinely do both. The VTO requires that you estimate the chin position based on a growth forecast and the autorotation desired or caused by your mechanics. Once the chin position has been estimated, the position of the front of the maxilla is estimated, based on your facial goal and your ability to elicit the desired maxillary change. Once the position of both maxilla and chin are projected in the face both vertically and anteroposteriorly, the lower incisor position is established relative to the projected position of the APo plane. After establishing the lower incisors, the lower molar position is located by calculating arch-length requirements, arch shape, etc. The position of the upper teeth can be set relative to the lowers, and any adjustments in the positions of either upper or lower teeth can then be estimated according to anchorage requirements, which teeth are extracted, and so on. Once the dentition has been "set", the soft tissue is projected and evaluated for acceptability. This process can be repeated as often as necessary to arrive at the acceptable treatment options and the achievable optimum. Once a plan has been established, treatment steps are sequenced and mechanics chosen appropriately to accomplish the goals. Progress headfilms can be taken and tracings compared to the final VTO to monitor progress and make any necessary midcourse corrections. This method may not be infallible, but it is the best method we have, and if used judiciously and realistically it will usually lead you to your treatment goal or quite close.

**DR. CREEKMORE** *Is air-rotor stripping a better treatment option than extraction?*

**DR. RICKETTS** The answer is very simple: yes. With stripping, the teeth do not need to be moved over as great a distance. Extraction of teeth has not proven to be the final answer as a solution for crowding.

**DR. CETLIN** I believe that air-rotor stripping, which is an advanced and extended form of reproximation, is better suited for the adult patient where a minimum of biomechanics and treatment time is desired. Since my procedures in mechanotherapy maximize space gaining and minimize the extraction of teeth, I do not resort to air-rotor stripping in growing patients.

**DR. ROOT** If I needed so much space that extraction would solve the anchorage problem, I would not strip the teeth. I would personally prefer extraction rather than
stripping if that much anchorage space were needed. A little anchorage problem can be solved by stripping.

**DR. ROTH** There certainly is a place for air-rotor stripping, but that is a case-by-case judgment call. One must look carefully at the pros and cons in each instance. Extreme stripping creates a situation in which there is a severe narrowing of interseptal bone, putting the patient at periodontal risk. It all gets back to treatment goals, in my opinion.

**DR. CREEKMORE** Would you be more specific about how you correct mild crowding, moderate crowding, or severe crowding?

**DR. ROOT** The answer depends to a certain extent on the type of case--high or low mandibular angle--and whether the patient is growing or an adult. Generally, I treat mild crowding by moving the lower buccal segments distally with Class III elastics, and with headgear to the upper arch. Adequate posterior space has to be available. With medium crowding, I would extract upper first bicuspid only, or if a little more crowded, I would extract all four second bicusps or upper first and lower second bicusps, and limit the amount of other anchorage used such as headgear, palatal bar, Class II elastics, tipback bends in the lower arch, etc. In severe crowding cases, I would extract all four first bicusps and gain additional anchorage as needed with these appliances or by delaying extraction of the upper bicusps while I use their anchorage. In extremely severe cases, I would extract upper first molars, if healthy third molars are present, as well as first bicusps.

**DR. ROTH** As a general rule, I would say that in mild crowding I am prone to nonextraction and would gain space by slight stripping and/or expansion. In borderline situations I would lean more toward extraction, and in severe crowding (with some exceptions) I would lean heavily toward extraction. There is no reason that a good functional occlusion cannot be obtained with extractions. I am not impressed with the fact that someone gets all the teeth into alignment at the expense of the periodontium, facial esthetics, condylar position, anterior guidance, or stability. You need to reassess your goals, in my opinion, if you are willing to sacrifice all that just to keep all the teeth.

**DR. RICKETTS** I handle crowding in the upper arch with the Quad Helix appliance, and with intermaxillary elastics to sectional arches or with extraoral traction. Sometimes these are done with utility arches, as in the case of blocked-out canines in the upper arch. In the lower, crowding situations are managed usually with utility arches, either the "Z" type, the opening utility, or sometimes the push-coil utility. When lateral expansion is desired, we would go to the Crickett appliance, which is a modification of the Crozet, or some sort of a lingual widening device. In all cases, however, it should be borne in mind that arch-length increases are conceived three-dimensionally, and that closed bites, open bites, and placement of the dentures are also profound factors in the selection of a modality.

**DR. CETLIN** To quantify your question, Tom, I would define mild crowding as 2-3mm, medium as 4-6mm, and severe as 7+mm. The biomechanics--growth and mechanotherapy--are similar in most crowded conditions, but the procedures, appliances, and time involved will vary with the severity of the malocclusion.

In the maxillary arch, an objective in crowded cases is to gain rotational and distal movement of the maxillary molars. Overcorrection of molars is a critical procedure in gaining anchorage for retraction of the mandibular incisors and use of Class III elastics in the later stages of therapy. Initially, this correction is accomplished with palatal bars, either unilateral or bilateral. In mild crowding, the rotation and distal movement achieved with the transpalatal bars will be adequate for the first phase. In moderate and severe crowding, the combination of a "two-force system" of headgear (to control
root movement and the vertical) and removable appliances (to control crown movement) replaces the transpalatal bar on the first molar. Thus, overcorrection and space gaining can be maximized. Concurrently, an increase in arch width and distal movement occur in the cuspid and premolar areas. Modifying the archform relieves the forces of restriction inherent in the tapered arch.

In the mandibular arch, a bumper is usually placed against the most posterior molars. Proper design and positioning will deliver controlled reaction, as opposed to the often-reported distal tipping and extrusion of molars and forward movement of the mandibular incisors. Time and force application will vary with the severity of the malocclusion. Also, the use of Class III mechanics against the bumper is an important adjunct of treatment.

**DR. CREEKMORE** What do lip bumpers really do?

**DR. CETLIN** Lip bumpers, with appropriate buccal clearance, remove the constrictive force of the cheeks and perioral musculature against the buccal segments, allowing lateral dentoalveolar growth and thereby increasing the circumference of the mandibular arch and gaining space. When viewed occlusally after lip-bumper therapy, the pericoronal gingiva are visible both lingually and buccally, indicating appropriate uprighting. Occlusal forces are thus directed along the long axes of teeth, reinforcing the stability of the posterior segments. With selective horizontal and vertical adjustment of the lip bumper, controlled labial or lingual positioning of the mandibular incisors is feasible. Where lip and thumb habits have resulted in incisor flattening and extrusion, the lip bumper can effectively intercept these forces and permit the incisors to move forward to an upright posture. When the incisors are procumbent in space, the pressure of the lip may be augmented by an elastic from the lip bumper across the labial surfaces to retract the mandibular incisors.

**DR. RICKETTS** I developed the lip bumper in the 1950s with the idea of releasing the tension of the lip and creating space for relief of crowding in the lower incisor area. To our amazement, however, we discovered that the function of the lip, particularly when the bumper was placed near the lower sulcus, was great enough to move the molars distally. Yes, the result is stable in many cases. In fact, after distalizing the lower molars and, indeed, the entire lower arch with the bumper, we were unsuccessful in moving them forward again. Many factors are involved with stability, as in any other situation. I must add, though, that since the discovery that utility arches could also move the lower molars posteriorly and at the same time intrude the lower incisors, it is a very rare situation today where we would use the bumper in our treatment.

**DR. ROOT** I find the movement achieved with a lip bumper is stable if the relation to the upper arch is corrected, adequate posterior space is available, and space is closed. The buccal expansion is not stable, however, because the musculature eventually moves the teeth in the buccal segment back to the original normal arch width.

**DR. ROTH** The lip bumper takes the lips and cheeks off the dentition, and the tongue then expands the dental arch. It acts much like a buccal shield. As I mentioned earlier, the result is no more or less stable, in my opinion, than expansion with any other appliance. Just because you did not physically touch the teeth with an appliance, it doesn't make the case more stable than if you moved the teeth directly with an appliance.

**DR. CREEKMORE** How do you resolve maxillary-mandibular anterior tooth-size discrepancies?

**DR. RICKETTS** There are only three ways. One is to adjust the remainder of the occlusion in accordance with the tooth-size discrepancy. For instance, in a patient with moderately small upper laterals, the buccal occlusion in the upper may be held very
slightly forward to the limits of the functional occlusion. Oversize teeth can be interproximally reduced, and in rare cases--and I should insist, very rare--we might remove a lower central incisor if the lower incisors were too wide. However, short of that we would interproximally reduce a significant number of teeth in the lower arch to achieve a harmonious relationship.

**DR. CETLIN** I also resolve slight-to-moderate excesses of anterior tooth structure in either arch by proximal stripping or reproximation of the teeth. When a marked deficiency of tooth structure is present in the maxillary arch, two options are available--proximal bonding of maxillary teeth or extraction of a mandibular incisor. I would extract in cases of severe discrepancy where some irregularity is present in the mandibular arch.

**DR. ROOT** I agree, and I also agree with Rick that I would accept a little more overbite if the excess is in the upper arch. The arch length between upper cuspids can be increased slightly by increasing mesial inclination and labial crown torque.

**DR. ROTH** We will do one or more diagnostic setups. Sometimes tooth positioning--for example, more artistic tipping to make the teeth occupy more space--will make up for the tooth-size discrepancy. Other times stripping is the best answer. Occasionally, dissimilar extraction will solve the problem. Other situations require composite buildups of the undersize teeth. The factors to consider are esthetics and occlusal function. Therefore, our trial treatments are done on the articulated models to insure that we are able to get adequate centric contacts and a proper anterior and cuspid guidance.

**DR. CREEKMORE** *What is the clinically acceptable relationship between centric occlusion and centric relation, and how do you establish this relationship prior to appliance removal?*

**DR. RICKETTS** There is no absolute relationship between centric occlusion and centric relation, particularly if one is determined by muscle and the other by the stretch of the ligament. It has been my policy since 1955 to slightly overtreat the buccal segments in Class II, to seat the condyle in its "A" position in juxtaposition with the eminence through the medium of the normal disc. But we also insist that interincisal angles be properly reduced to the range of 125° by the time of appliance removal, and further that canines and premolars do not interfere with the freedom of the excursive movements of the mandible. When this is achieved symmetrically--and perhaps overachieved in treatment of asymmetry--we rely on nature to do the rest of the adjustment.

**DR. ROOT** Ideally CO and CR should be the same, but it is clinically acceptable for CO to be 1-2mm forward of CR. This acceptable difference may be present before treatment. To check, I have the patient relax, and with gentle backward thumb and finger pressure, I rotate the mandible and feel for CR. Sometimes I have the patient place the tip of the tongue far back in the throat, and then carefully observe where the teeth occlude as the patient closes in CR. If CR is behind CO, additional Class II correction is needed.

**DR. ROTH** The clinically acceptable relationship in terms of condylar position is ±1mm anteroposteriorly, slightly more than 1mm vertically, and .3mm transversely. These are findings from mountings of different samples of several hundred pre- and post-orthodontic cases that, for the most part, were free of any occlusion-related symptomatology. One such study was done by my partner, Dr. Brian Wong. Even though this is an acceptable range for a high percentage of cases, however, treatment goals should be ideal. The ideal goal of no occlusal interferences implies no discrepancy between centric occlusion and centric relation. Also, the Wong study and a master's thesis by Utt showed that 15-17% of the patients exceeded this range of clinical acceptability before treatment.
Patients who have an anteroposterior discrepancy of 2mm or more begin to show symptoms or signs of TMD, occlusal wear, sensitive teeth, or shifting occlusion. Patients with a transverse discrepancy—a transverse displacement of the condyles from a centered position when closing into maximum intercuspation—of greater than .5mm tend to have a greater incidence of symptoms, particularly of TMD. The greater the discrepancy, the greater the tendency to develop some symptoms, although this is not a straight-line correlation; habits, stress, and general tolerance level do play a role.

In order to treat to a centrically related occlusion, the case must be diagnosed from centric relation position. This definitely means pretreatment mounting and possibly deprogramming with a splint. One thing that experience over the last 30 years has taught me is that one cannot accurately assess centric by jiggling the mandible at the chair. The diagnosis as to which plane or planes of space the discrepancy is in and, therefore, where to direct your treatment mechanics to eliminate the discrepancy or at least reduce it to clinically acceptable limits requires constant monitoring of condylar position throughout treatment—not just before appliance removal. Prior to appliance removal it may be necessary to deprogram the patient with a splint and then do a mounting to determine the condylar position.

DR. CREEKMORE We've talked a lot about mechanotherapy. What role does patient cooperation play in your treatment planning?

DR. ROOT Patients do not like to wear headgear, so I use many mechanical techniques to increase anchorage and thus reduce the amount of time that headgear needs to be worn. It is still extremely important that patients keep appointments, are careful not to break their appliances, maintain excellent oral hygiene, and follow directions regarding elastic wear and headgear.

DR. ROTH In our practice, patient cooperation is most required in the mixed dentition, in cases where headgear is necessary for correction of a skeletal Class II relationship. We use very little headgear to move teeth in the permanent dentition. The use of various mechanical principles that conserve anchorage, an appliance that prepares and conserves anchorage, minimization of sliding mechanics where anchorage is critical, routinely starting Phase II treatment after the 12-year molars erupt and then banding these molars and using them for anchorage, the use of transpalatal bars, and minimization of interarch elastics through better treatment sequencing and appropriate diagnosis and treatment planning all go a long way toward more efficient treatment. They can virtually eliminate the need to "throw headgear at everything" when one goes to move teeth. All these factors minimize the need for patient cooperation in my practice.

DR. CETLIN I agree that the maximum use of fixed appliances can minimize the effects of poor cooperation, but I still find that without any patient cooperation, a satisfactory result is usually unattainable. Two of my major space gainers are the transpalatal bar and the lip bumper. Both of these appliances can be placed so that compliance is not much of a factor.

DR. RICKETTS Without cooperation, I know of no orthodontic treatment plan that can be consummated. There are two simple words with regard to patient cooperation: analysis and communication. The whole first day of our advanced courses consists of understanding patients' needs and methods of achieving compliance from our patients.

DR. CREEKMORE My thanks to all of you.