Long experience has shown that there are numerous areas of instability following orthodontic treatment. The tendency for lower anterior teeth to develop crowding after treatment is widely known. Maxillary transverse changes during treatment frequently have a tendency toward later relapse, as does lower cuspid expansion. None of this excludes relapses due simply to poor treatment. Teeth are often placed in positions that are not in equilibrium with their functional environment and are therefore destined to relapse. On the other hand, even teeth that have been placed in a reasonably stable environment may show relapse tendencies due to environmental changes over a period of time.

Diastemas\(^1-3\) constitute a dilemma that has traditionally required frenectomies,\(^4\) circumferential fiberotomies, and/or permanent retention. Do we as orthodontists simply decide that permanent retention is the best solution to our problems of instability—or is it possible that we can first ask why our present “solutions” are not always successful? Although it is not unusual in orthodontic treatment to look for devices to overcome or prevent undesirable tooth movements, perhaps a greater effort to understand cause-and-effect relationships involved in relapse can lead to better solutions for instability, as well as overcoming the undesirable side effects we so often observe during treatment.\(^5\) Orthodontists must not depend entirely on devices to resolve orthodontic problems, but must also make an effort to better understand the nature of these problems.

**“Lifetime” Retention**

It is a concern of orthodontists and patients alike that diastemas be eliminated without depending on lifetime retention. Even with surgical procedures,\(^6\) diastemas often tend to recur and require some form of retention as a result. Obviously, retention with removable appliances will result in back-and-forth movement, since retainers are not worn for 24 hours every day—not to mention that no patient wants to wear a removable appliance for a lifetime. I have never seen an adult treated as a youngster, 10 to 20 years earlier, who was still wearing a removable retainer. A bonded retainer has the potential to loosen, usually at the most inopportune time, while at the same time not completely relieving the orthodontist from legal responsibilities as long as it remains in the mouth. It is not uncommon for a patient to believe that if a retainer is lost after having been worn for a considerable period of time, the teeth will no longer move. Of course, we know this is not the case, but as long as the patient thinks so, there will be disappoint-
ment in the treatment or in simply accepting the diastema as a fact of life.

Figure 1A shows a patient with a typical diastema. Power-chain elastics can rapidly close the space (Fig. 1B), which is usually impressive to the patient. The orthodontist hopes that upon full eruption of the permanent cuspids, there will be sufficient tooth contact to maintain the space closure. But we know this does not always occur, even when there is no evidence of a frenum problem.

Archwire Removal

It has been my strong opinion that the most reliable means of testing for post-treatment stability is to remove all archwires for a minimum of six weeks at some point during treatment. This does not mean that archwires must be removed following each procedure; many changes, including crossbites, overbites, open bites, diastemas, and rotations, may be checked for stability—or instability—at the same time.

Even in cases where the orthodontist knows with confidence that certain areas will be unstable, it is advantageous to point out the degree of instability to the parents and patients during treatment. When it is obvious that instability is unavoidable—as frequently occurs when considering facial profiles—the orthodontist can then allow the parents and patients to observe these changes rather than discovering them following treatment, when only “perfection” has been experienced. We all know the tendency for parents and patients to interpret explanations of later relapse as simply defensive postures on the part of orthodontists. This provides an opportunity to tell them of the importance of absolutely following post-treatment instructions regarding retention requirements. When they have seen and observed the problem during treatment, rather than following appliance removal, much greater cooperation and understanding are likely to occur. The orthodontist also has the opportunity to observe any changes that occur and to incorporate the patient’s functional environment into tooth-positioning decisions.

The Gedanken Experiment

This is a German expression that essentially refers to an experiment conducted in one’s mind, as was frequently done by Albert Einstein. The outcome is determined by considering known facts without actually performing the experiment. In this article, the Gedanken experiment will be applied to the discussion of diastemas.

The first question to be asked is, “Are there any analogous situations in orthodontics where maintaining space closure presents a retention problem?” The answer is, clearly, “Yes.” We know from experience that space closure after bicuspid extractions in adults is often difficult to maintain. Let’s suppose that instead of paralleling the roots following space closure, we were simply to tip the crowns together. Obviously, this would present periodontal problems, but as you will see, this analogy is only being made to predetermine the outcome of altering root inclinations following diastema closure. The question to be asked about tipping the crowns together in an adult case is, “Would this assist in maintaining space closure?” The answer, without performing the experiment, is, “Yes.”

Now we will look into the reason behind this prediction. When roots are parallel, vertical forces of occlusion pass through and near the centers of resistance of the teeth. However, when the teeth are tipped, the vertical forces will produce “functional moments”. Since we know that moments are simply a result of forces acting perpendicular to the center of resistance, it can readily be seen that when teeth are tipped, the per-
perpendicular distances—not the forces—are increased, thereby resulting in larger moments. These moments are referred to as “functional moments” because they are produced as a result of forces occurring during function—unlike moments produced by archwires.

Without having performed the experiment, but having concluded what effect the tipping of teeth will have on stability, we can now consider the diastema. When we tip the crowns together for space closure, instability is frequently recognized. Once the space is closed, we can’t tip the crowns any more, but we can diverge the roots, thereby creating the change in inclination that has already been shown to produce higher functional moments (Fig. 2). It can be seen that when the roots are convergent, simply uprighting the roots results in increasing the moments. As we will see, further divergence of the roots will afford larger functional moments.

Only by removing the archwire will we determine the point of stability, which makes it necessary to do something that many orthodontists dread. I can assure you, however, that removing archwires on every patient, regardless of the degree of malocclusion, has been the greatest learning experience of my 41 years in practice. If all orthodontists did so, I think it highly likely that intra-arch mechanics would become much more routine in daily practice than the interarch mechanics so commonly used today. Midline elastics, Class II elastics, and the like result in tooth displacements leading to instability that will be quickly recognized when archwires are routinely removed.

Initial Patient Samples

To test the Gedanken experiment, I gathered patients whose parents were willing to have treatment initiated early, informing them that this was an attempt to discover the legitimacy of seeking stability for diastema space closure. The parents knew beforehand that this attempt could result in success or failure, but having trusted the practice as part of their families for a considerable period of time, they were most cooperative.

It was important to evaluate the x-rays closely, as some patients were beginning this experiment prior to the eruption of permanent cuspids, which would provide contact adjacent to the four incisors, and other patients had missing laterals, offering the opportunity to move the central incisors together with no lateral contact. Obviously, if stability could be achieved in these cases, further eruption of teeth would only add to the existing stability. Orthodontists would no longer have to pay special attention to the x-rays, as such treatment could simply be incorporated into normal treatment planning. Again, success could not be determined without archwire removal.

Producing the Moments

In Figure 3A, it can be seen that the use of an .016" anterior segment with no bends results
in equal and opposite moments, as a result of the wire/bracket relationship formed by the malocclusion. This particular relationship produces the same moments as a center bend, and is characterized by equal and opposite moments whenever there are equal and opposite angles between the wire and brackets.

As the roots upright, the bracket slots then become aligned, and a center bend is placed in the archwire (Fig. 3B). This is done intraorally with a Tweed loop plier and produces a 45° angle in the wire.

Next, the roots diverge as a result of the center bend, and the anterior segment is removed (Fig. 3C). If the space remains closed for a minimum of six weeks, the closure can be deemed stable. If it reopens, the same wire with the same original bend is placed in the bracket slots, and the root is permitted to undergo additional divergence.

Finally, the incisal edges can be reshaped using a diamond disk (Figs. 3D, 4). It is critically important not to reshape these incisors if the archwire has not been previously removed. Otherwise, any later relapse would result in an undesirable cant to the incisal edges.

Factors Regarding Inclination

The orthodontist will discover that the treatment time and amount of root movement required will vary from patient to patient, usually depending on the inclination of the incisors. Small diastemas will often exhibit a convergence of the roots (divergence of the crowns). Therefore, the original archwire will automatically produce moments at the brackets, and when the bracket slots become level and a center bend is placed, this will create the moments necessary for further divergence. In other cases, the tooth

---

**Fig. 3** A. Equal and opposite angles between .016" anterior segment and incisor brackets, producing equal and opposite moments. B. Center bend placed in archwire after roots have been uprighted and bracket slots aligned. C. After roots diverge due to center bend, anterior segment is removed for evaluation of stability. D. Incisal edges recontoured with diamond disk.

**Fig. 4** Recontouring of incisal edges with diamond disk.
inclinations may be parallel from the beginning, thus requiring less movement than previously described. And finally, some of the larger diastemas, following rapid space closure, have a head start on root divergence (crown convergence) and, surprisingly, will often require less time to achieve stability than some smaller diastemas.

Applying the Moments

The patient in Case 1 had an obvious diastema, but closer evaluation showed the diastema to involve root inclinations that were nearly parallel (Fig. 5). After removal of the archwire for six weeks, the space remained closed, so the archwire was reinserted and a diamond disk was used to contour the incisal edges (Fig. 6). With no further need for the archwire, it was removed, and the patient was placed on observation for several months while waiting for the permanent cuspids to erupt (Fig. 7). Two months later, additional cuspid eruption could be seen, but there was no recurrence of the diastema, despite the lack of tooth contact to maintain space closure (Fig. 8). This is a sure indication
that upon full eruption of the cuspids, the stability of the closure will be further enhanced.

**Missing Lateral Incisors**

The next patient also exhibited parallel root inclinations, but had missing lateral incisors (Fig. 9). This was an excellent opportunity to discover whether root divergence could permit stable space closure. Initially, an .016” anterior segment with a center bend was placed to provide the equal and opposite moments (Fig. 10). Power-chain elastics provided rapid space closure. Crown movement always precedes root movement, but once the space is closed, the crowns can no longer move and the roots move in the opposite direction. Anything that prevents crown movement in one direction results in root movement in the opposite direction.

Bracket angulations are not esthetically pleasing after root divergence, but it is important not to reposition these brackets until stability has been obtained, because any evidence of instability will require reinserting the same archwire segment. Once stability has been confirmed, if the patient is ready to resume full treatment, brackets can be placed ideally. In Case 2, improper bracket placement initially resulted in a slight vertical discrepancy between the two incisors (Fig. 11A). By sliding the wire slightly to the patient’s left, a long section and a short section were created (Fig. 11B). The long section always points in the direction of the force produced at the bracket engaged by the long section. These forces are produced by definition to maintain equilibrium whenever moments are not equal and opposite.
Nine months later, the cuspids were erupting, but there was no space opening whatsoever between the central incisors (Fig. 12). If space closure can be maintained without the presence of lateral incisors in contact with the distal surfaces of the central incisors, then stability will only increase with further treatment.

**Root Divergence**

In Case 3, the diastema was obvious to any observer, and a closer view showed an inclination that was predominantly parallel (Fig. 13). Six years later, the patient could smile with pride, having had no retention of any kind (Fig. 14). The root inclinations were divergent, but the exact amount of divergence required for stability cannot be known unless archwires are removed during treatment.

The next patient, Case 4, revealed a diastema similar to that of her sister in Case 3 (Fig. 15). Both sisters were treated at the same time, yet in one case the archwire was removed only once to determine stability, whereas the sibling required several archwire removals before stability was established. Keep in mind that similar diastemas do not necessarily require the same amount of treatment time or root movement. This is determined solely by archwire removal. Six years later, the patient had a beautiful smile without retention of any kind (Fig. 16). The root divergence was similar to that of her sister. Slight differences in inclination can make the difference between stability and instability.
Root Convergence

Case 5 shows a patient with a smaller diastema than any seen thus far (Fig. 17). When taking a closer look, however, it can readily be seen that the root inclinations were convergent, although not in equal amounts. The initial archwire leveled the bracket slots, followed by placement of the center bend (Fig. 18). More than a year and a half later, while waiting for cuspid eruption, the space closure remained stable (Fig. 19). Another several months later, the cuspids
were about to erupt, but the space closure remained stable with no tooth contact distal to the lateral incisors (Fig. 20). This assures stability following completion of treatment.

The next young lady also displayed a convergence of incisor roots (Fig. 21). After leveling of the bracket slots, a center bend was placed to produce further root divergence (Fig. 22). Three months later, there was only minor additional movement (Fig. 23), but archwire removal short-
ly thereafter indicated stability, and treatment was concluded with no retention (Fig. 24).

Another root convergence is evident in Case 7, but this time in combination with a rotation of the upper right central incisor (Fig. 25). Rather than remove an archwire for each individual problem, it only makes sense to diverge the roots, over-rotate the central incisor, and then remove the archwire so stability can be checked for both conditions at the same time (Fig. 26). In this case, stability was demonstrated after archwire removal (Fig. 27).

**Minor Cosmetic Adjustments**

If the contact area between the central incisors is a little greater than normal, very slight movements can be obtained with the center bend to produce some cosmetic improvement. In Case 8, the patient required only a minor amount of tooth movement (Fig. 28), so a center bend was placed as shown (Fig. 29). Although the movement was small, the patient’s appearance improved (Fig. 30).

**Producing Pure Moments on Four Incisors**

A continuous archwire with esthetic bends is incapable of producing pure moments on all of the incisors without vertical forces. These can be avoided by placing two separate anterior segments\(^\text{11}\) (Fig. 31). The segment connecting the two central incisors is an .016" stainless steel
wire, while the segment connecting the lateral incisors is .019” × .025”. The latter segment is rectangular simply to prevent any twisting of the wire in the slot. Each segment is activated 45° degrees as shown (Fig. 32). This activation is standard for all the wire bends discussed here.
Generalized Spacing in Deep Overbites

The young lady in Case 9 had not only a diastema, but a deep overbite (Fig. 33). The incisor roots can be diverged during overbite correction, but the archwire should not be removed until the overbite is corrected. Obviously, during overbite correction (Fig. 34), the anterior mesiodistal dimensions between the cuspids are reduced, so stability cannot be properly evaluated until the incisors are placed within these dimensions. In this case, the spaces were closed and remained so without retention (Fig. 35). A very slight space remained between the central incisors, but both the patient—a young adult—and her parents were unaware of it.

(continued on next page)
Problems of Morphology

Sometimes a patient will complain about a little space between the front teeth, when the problem is actually not a diastema, but rather crowns that taper toward the incisal edges (Fig. 36). A center bend can be placed to move the contact area incisally, thus reducing or eliminating the “space” that concerns the patient. Instead of referring the patient to the family dentist for a solution, a center bend can usually resolve the problem orthodontically.

Long-Term Rewards

The young man in Case 10 was treated in the original experimental group described above (Fig. 37). Seven years later, when he was driving his younger sister to the office for treatment, a chairside visit brought up a discussion of never having worn a retainer. He is now a handsome young man with a beautiful smile (Fig. 38), and he also has the satisfaction of knowing the diastema is not destined to reopen.

Contrast this with the case of a despondent young adult woman who visited the office wondering if anything could possibly be done for her front teeth (Fig. 39). She had been told to “leave them alone” and that she would be better off not having orthodontic treatment. She certainly had a need for cosmetic treatment, if nothing else.

The spaces were closed, but the incisors showed no root divergence (Fig. 40). The original space was simply consolidated into spaces between the lateral incisors and the cuspids. With no center bends having been placed or archwires removed to evaluate stability, we had no choice but to deliver a removable retainer, with its labial bow passing through the residual spaces. The patient was instructed to begin wearing the retainer at night only, which meant there would be continued movement of the teeth.

The patient’s stains were removed, and the final facial pictures showed a beautiful and happy adult. Although she stopped by the office periodically for about two years just to say thanks, she is no longer in the area. Is it possible...
Fig. 39 Case 11. Adult patient with diastema and need for cosmetic treatment (note stained teeth in occlusal view).

Fig. 40 Case 11. Diastema closed without root divergence, requiring retention. Original space was consolidated into spaces between lateral incisors and cuspids.
she might no longer be wearing her retainer? Is it possible the retainer was lost and treatment not reinstituted? If she is still wearing the retainer and still looks as beautiful as ever, is it possible that continued movement of the teeth might have resulted in some damage to the tissue? None of these questions would have to be asked if I had used center bends and archwire removal as a routine part of diastema treatment at that time.

The Black Triangle

Root divergence in the treatment of diastemas results in a greater mesiodistal width occupied by the incisors. With normal toothmass proportions, this divergence creates some overjet. By performing interproximal reduction with an .003" disk, however, the overjet can be reduced while minimizing or eliminating the “black triangle”. Keeping this in mind, even in the absence of diastemas, root divergence of the central incisors—or of all four incisors—presents the opportunity to eliminate generalized spacing in cases where tooth mass is deficient, as well as in situations where there is no tooth-mass deficiency, but a “black triangle”.

Conclusion

An approach to treating diastemas has been presented that requires no additional expense, but may even reduce costs as a result of eliminating retainers that would normally be required to maintain the space closure. It has been my experience that 90-95% of diastemas treated in this manner will not require retention. The orthodontist might decide on retainers for reasons other than treatment of the diastema, but should find this procedure to be highly successful in the majority of cases.

As difficult as some may find it to be, you can be assured that removing archwires in all orthodontic malocclusions—even those you know beforehand will not be stable—will be an extremely rewarding and educational experience. Greater respect will be gained for the normal functional and environmental positions of teeth and the need to avoid many of the interarch approaches to orthodontic mechanics that are prevalent today. Being able to let the patient observe the degree of stability or instability prior to termination of treatment is rewarding in itself.

REFERENCES