Force + Space + Time = Tooth Movement

How to Achieve Minor Tooth Movements with Essix Aligners

By Larry W. White, D.D.S., M.S.D., F.A.C.D.

Patients and doctors alike have promoted the use of vacuum-formed clear plastic retainers since McNamara[1] suggested them in 1985. Subsequent articles by Sheridan[2-4] and others have continued to increase their popularity and use, but apparently Pointz[5] had first supplanted traditional methods of retention with clear plastic vacuumed appliances in 1971. The lack of commercially available instrumentation limited him and those who followed his lead, but by using clear vinyl plastic, a hot plate, a vacuum cleaner and a modified coffee can as a vacuum chamber, he successfully fabricated the first clear plastic retainers.

Figure 1: Stainless Steel Impression Tray

Figure 2: Hard Plastic Impression Trays

The use of clear plastic retainers to reposition teeth developed from the promotion of rubber tooth positioners by Kesling[6]. However, the use of clear, hard plastic retainers as tooth-moving appliances did not gain popularity until the suggestion of Air Rotor Stripping by Sheridan[2-4, 7-17]. This provided the space needed for the teeth to move and a technique that greatly facilitated the creation of space. The subsequent and recent introduction of the Invisalign[18] appliance has accentuated the current interest in invisible retainers that have the ability to straighten teeth.

Impression Technique

The fabrication of useful and flawless Essix appliances begins with flawless impressions.

This requires the use of rigid impression trays that will not distort when the clinician removes the impression (Figures 1 and 2).

It also demands dependable impression material and a consistent manner of preparing it. The gold standard of dental impressions is polyvinyl siloxane impressions, but the introduction of the TurboMax and ImprEssix alginate affords dentists with a technique that gives superior impressions at a fraction of the cost of more expensive elastic impression materials (Figures 3 and 4). The impressions gathered with ImprEssix mixed in the TurboMax will rival those obtained with polyvinyl siloxane.

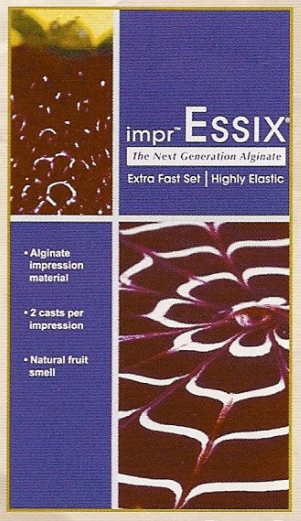


Figure 3: ImprEssix Alginate

Figure 4: TurboMix Alginate Mixing Machine

Laboratory Technique

Laboratory technicians need to fill the impressions with laboratory stone immediately since they will distort after a few minutes. Technicians should use a quality die-stone that has minimal setting expansion (<.015%) and

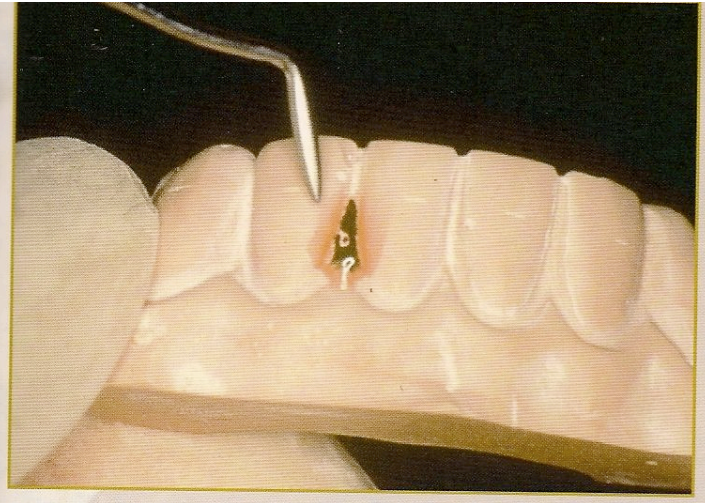


Figure 5: Block out Undercuts

Figure 6: Smooth Cast

maximum compressive strength (>15,000 psi). This dental stone should not have exposure to open air since it will absorb atmospheric moisture and the setting expansion will increase. Such treatment will cause oversized casts that will produce appliances that fit the casts but not the mouth.

Technicians should trim the casts taken from the impressions to heights of no more than three quarters of an inch and should not have the palate or bottom of the mouth displayed in stone. This will allow a better adaptation of the plastic to the models. The models need to have any defects filled in with block out compound, acrylic or stone. Trim any small knobs of stone to present a smooth surface (Figures 5 & 6).

Plastic Materials Available for Essix Appliances

Clinicians have several materials from which to choose for the construction of an Essix appliances. The most popular have been:

- A+ material that is a modified ethylene-coterepthalate resin.
- C+ material that is an amplified polypropylene resin combined with impact plastics.
- Ace material that is a copolymer.

Each of these materials has its advantages and disadvantages, but the A+ and Ace materials offer extremely clear but rigid materials that offer superb esthetics along with the ability to bond chemically with methyl methacrylate, which makes them excellent materials for fabricating TMD splints.

C+ material offers a more resilient material that will flex a bit and store elastic energy that will move the teeth. Unfortunately, clinicians cannot easily use it for splints since its chemical formula repels acrylic additions. For minor tooth movements, the C+ material offers the most versatile, durable and useful plastic now available, and it remains my favorite material for making aligners.

Aligner-Making Machines

Clinicians currently have two choices in plastic-forming machines with which to make aligners that will move teeth: vacuum machine or pressure machines.

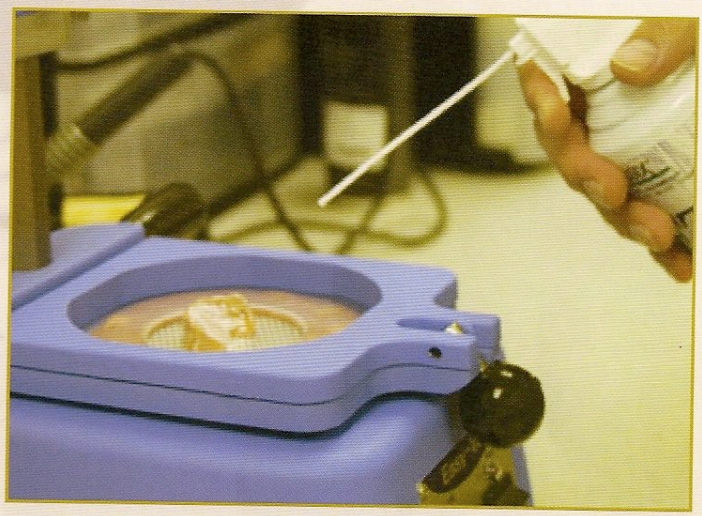


Figure 7: Freeze Spray with the Vacuum Machine

The Vacuum Machine is an inexpensive thermoforming instrument that will accept 5-inch plastic squares. It has built-in vacuum and heating features and does not require attachment to a compressor. It vacuums with less force than the available pressure machines and will not easily accommodate thick mouth protector plastics (Figure 7). But it makes accurate and useful aligners, especially when used with Freeze Spray.

Drufomat pressure machine has a vertical forming design that uses a safe two-handed operation, an electronic time and a release valve that eliminates back pressure. It delivers 6 bars/87 psi of pressure and easily handles all kinds of aligner materials (Figure 8).

Figure 8: Drufomat Machine

The Biostar and Ministar pressure machines are apparatuses that have non-vertical designs and pull with only 4.5 bars/65 psi of pressure, but they will also handle all available plastic aligners materials.

Possible Minor Tooth Movements

Essix tooth movement provides an excellent option for adults or adolescents with mild malocclusions who will not wear fixed appliances, but who will follow clinicians' instructions. Additionally, it offers a reasonable technique for recapturing relapsed anterior alignments. Nevertheless, three principles guide the successful use of clear plastic tooth movers:

- The appliances must exert enough force to move the teeth.
- Clinicians must provide enough space for the movements to occur.
- Patients must wear the appliances enough to achieve the movements.

These three criteria comprise Sheridan's First Law of Biomechanics: *Force + Space + Time = Tooth Movement.* Clinicians can provide the first two features of this formula, but only the patient can complete the task by wearing the appliances enough.

As bonding developed into a widely-used technique, the rationale of gaining space for orthodontic corrections through interproximal enamel reduction provided a reasonable alternative to the expansion of arches or the extraction of teeth. Several methods have developed for the provision of interproximal space.

Many clinicians employ interproximal discs, but this technique should never be used without a disc guard to protect the cheeks and tongue. Another limitation to discs is that they cut in only one plane and will leave a flat, unnatural tooth shape. Hand-pulled interproximal strips will provide the necessary space, but they offer a laborious task for the clinician and a discomforting experience for the patient. The KaVo interproximal reducing instrument or the Intensive Ortho Strip System both give clinicians mechanical methods of reducing interproximal enamel. But one of the least expensive and most efficacious way of reducing interproximal enamel is through air-rotor stripping, aka ARS by using thin diamond tips (55000)* (Figures 9 and 10) or carbide burs (699LC).*

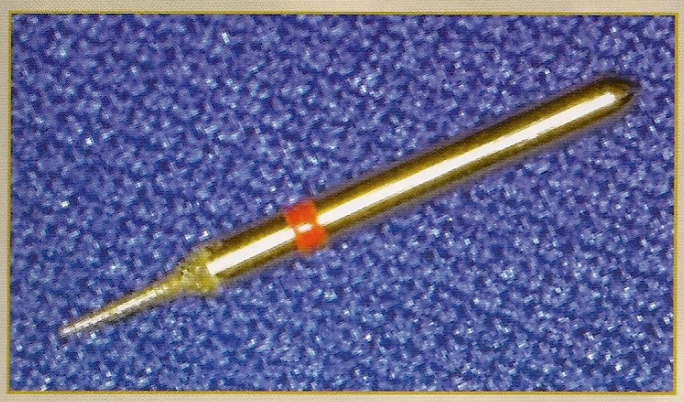


Figure 9: 55000 Diamond Bur

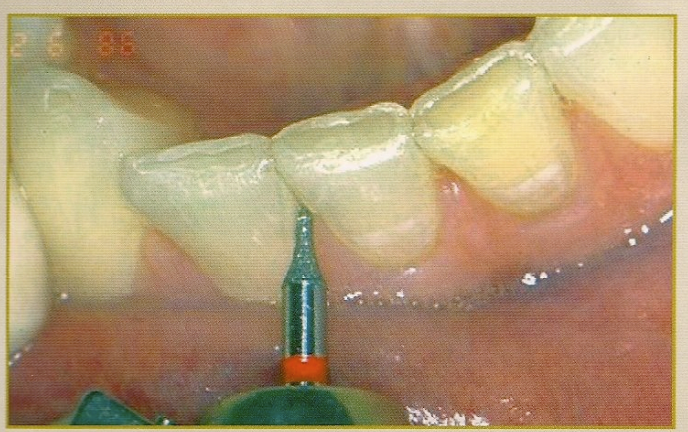


Figure 10: 55000 Diamond Bur Beginning ARS

Figure 11: Teeth Reset Prior to Essix Formation

Readers can discover more about interproximal enamel reduction by referring to the book by Dr. Jack Sheridan[12], *Essix Appliance Technology: Applications, Fabrication and Rationale.*

Essix appliances can accomplish several tooth movements such as torque, tip, rotations and lateral adjustments. These movements will depend upon where clinicians place pressure against the teeth via the plastic aligner. Vertical changes, however, require more sophisticated techniques as do the sagittal corrections between maxillary and mandibular arches, and they remain outside the purpose of this article.

Laboratory technicians can apply pressure against teeth by resetting the stone teeth before making the Essix or more easily by creating divots and areas of relief in the stone replicas of the teeth; e.g., the rotation of the distal surfaces of mandibular central incisors will require facial distal divots and simultaneously block-outs on the lingual

Figure 12: Divots and Block Out Material Added to Central Incisors

distal surfaces of those teeth. Make the block outs with acrylic, block out material or stone (Figures 11 and 12).

Adjustment of Essix Aligners

One large advantage an Essix Aligner has over other systems of clear plastic tooth movers is a system that employs specific pliers and other plastic-adjusting instruments along with precise measurements of heat,. This feature extends the usefulness of the aligners and averts the need to make new impressions and retainers on a continuing basis.

Dr. Keith Hilliard[12] has made a collection of instruments that will make bumps and/or spaces in clear plastic aligners. The adjustments need specific amounts of heat to keep the plastic from creeping away from the pliers-induced changes. Some of the more commonly-used pliers are:

- Maxillary thermoplier creates tooth-moving pressure by making bumps against the maxillary teeth (Figure 13).
- Mandibular thermoplier makes smaller pressure bumps against the mandibular teeth (Figure 14).
- Undercut thermoplier increases retention by reinforcing pressure in the gingival embrasures.
- Bite plane thermoplier forms a bite plane on the lingual of the maxillary incisors to open a deep bite.
- Mesial/distal thermoplier places pressure on the sides of the teeth to promote lateral movements.

Clinicians can apply and measure the heat to the pliers with the touch-activated burner and thermometer, and this guarantees the exact amount of heat that optimizes bump fabrication and subsequent tooth movement (Figures 15 & 16). *(Available from Raintree Essix 1-800-883 8733.)*

Clinical Results

To see some of the movements clinicians can expect with Essix aligners after a few weeks of use, follow Figures 17-20.

Technology, instrument and polymer developments have given rise to an entirely new method of aligning teeth for patients

Figure 13: Maxillary Thermoplier

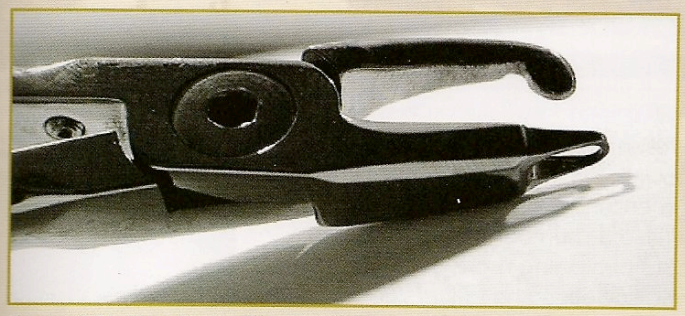


Figure 14: Mandibular Thermoplier

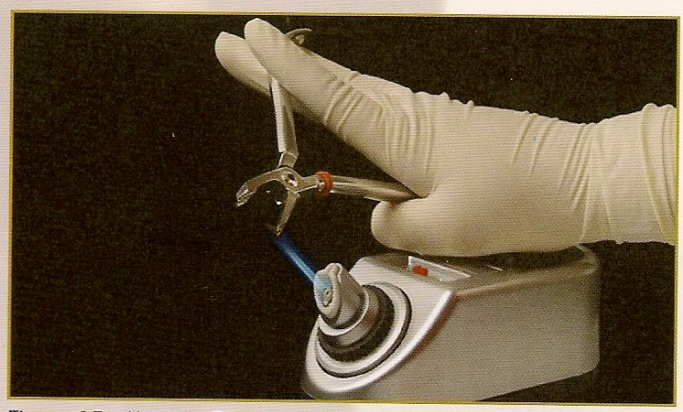


Figure 15: Heating Pliers with Thermoplier Burner

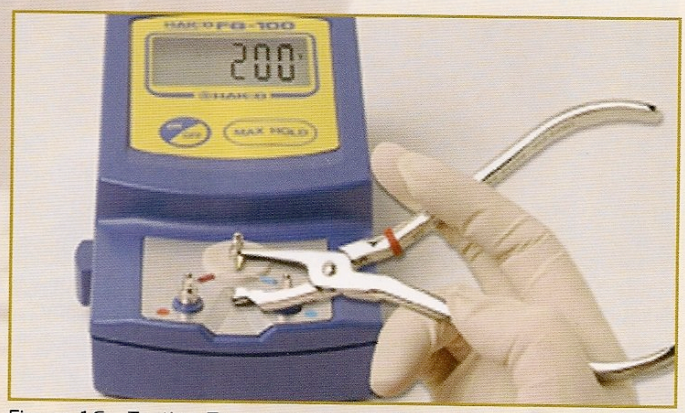


Figure 16: Testing Temperature with Thermometer

Figure 17a: Mixed Dentition Malocclusion

Figure 17b: Mixed Dentition Resolution

Figure 18a: Adult Malocclusion before Essix Therapy

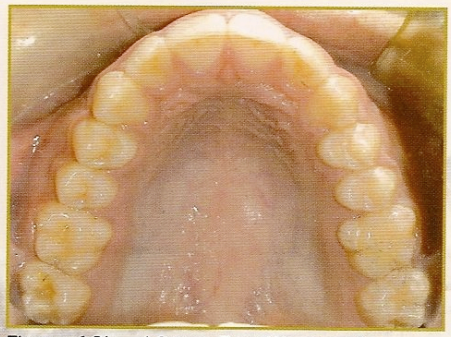


Figure 18b: After a Few Weeks of Essix Therapy

Figure 19a: More Difficult Adult Malocclusion

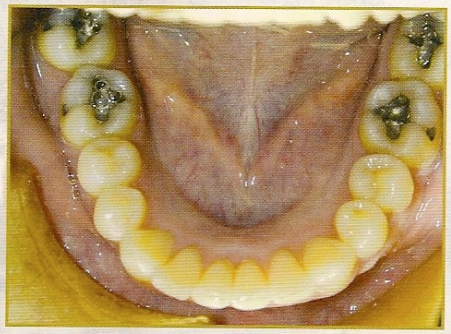


Figure 19b: After Interproximal Reduction & Essix Therapy

Figure 20a: Adult Diastema

Figure 20b: Diastema Closure after Essix Therapy

with mild malocclusions. For those patients with an aversion to wearing fixed appliances, Essix aligners offer them a reasonable and esthetic alternative to classical orthodontic therapy.

Clinicians need to keep in mind, however, that although the doctor can provide the space and force for the alignment of teeth, only the patient can supplement these features with the time needed to make the desired changes. For this reason, only the most dedicated patients should enter this type of orthodontic treatment.

Once the teeth have achieved optimal positions, patients will cease using the aligners and will receive new passive retainers that will keep the teeth in their new positions.

Patients need to understand that teeth have remarkable memories for their previous malpositions, and this will require continued use of retainers, at least on a daily part-time basis. Ordinarily, night-time wear will suffice, but if patients notice unwanted changes occurring, they will need to wear them more.

Reference:

1 McNamara, J.A., Kramer, K.L., Juenker, J.P., Invisible retainers. J. Clin Orthod, 1985. 19(8): p. 570-578.

2 Moskowitz, E.M., Sheridan, J.J., Celenza, F., Munoz, A., Essix appliances: provisional anterior prosthesis for pre and post implant patients. New York State Dent J., 1997. April(April): p. 32-35.

3 Sheridan, J.J., Ledoux, W, McMinn, R., Essix retainers: Fabrication and supervision for permanent retention. J. Clin. Orthod., 1993. 27: p. 37-45.

4 Sheridan, J.J., Ledoux, W., McMinn, R., Essix technology for the fabrication of temporary bridges. J. Clin Orthod, 1994. 28(8): p. 482-486.

5 Ponitz, R.J., Invisible retainers. Am J. Orthod., 1971. 59(3): p. 266-272.

6 Kesling, H.D., The philosophy of the tooth positioning appliance. Am J Orthod Dento Fac Orthoped, 1943. 31: p. 297-304.

7 Sheridan, J.J., Air-rotor stripping. J. Clin. Orthod., 1985. 19: p. 43-59.

8 Sheridan, J.J., Air-rotor stripping update. J. Clin. Orthod., 1987. 21: p. 781-788.

9 Sheridan, J.J., Ledoux, P.M., Air-rotor stripping and proximal sealants: an SEM. J. Clin. Orthod., 1989. 23(790-794).

10 Sheridan, J.J., The three keys of retention. J. Clin. Orthod., 1991. 25: p. 717-718.

11 Sheridan, J.J., Hastings, J, Air-rotor stripping and lower incisor extractin treatment. J. Clin. Orthod., 1992. 26: p. 18-22.

12 Sheridan, J.J., Hilliard, K., Armbruster, P., Essix Appliance Technology: Applications, Fabrication, and Rationale. 1st ed. 2003, Bohemia: GAC International Inc. 130.

13 Sokolina, M.B., R., Air-rotor stripping for treatment of Class III malocclusion: case report. World J. Orthod, 2002. 3(3): p. 233-238.

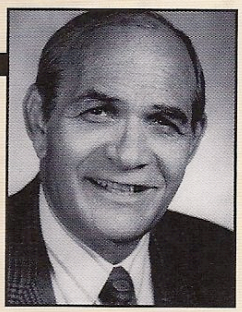
14 Twesme, D.A., etl, Air-rotor stripping and enamel demineralization in vitro. Am J Orthod Dento Fac Orthoped, 1994. 101(142-152).

15 Hanachi, F., the demineralization and remineralization potentials of striped enamel surfaces, in Department of Orthodontics. 1992, Louisiana State University School of Dentistry: New Orleans.

16 Stroud, J.L., English, J., Buschange, P. H., Enamel thickness of the posterior dentition: Its implications for nonextraction treatment. Angle Orthod, 1998. 68: p. 141-145.

17 Radlanski, R., Morpholog of interdentally stripped enamel one year after treatment. J. Clin. Orthod., 1989. 23: p. 748-750.

18 Tuncay, O.C., The Invisalign System. 1st ed, ed. O.C. Tuncay. Vol. 1. 2006, Chicago: Quintessence Publishing Co. 320.



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