Essix Appliance Revisited

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Abstracts: Patients now do not want the cumbersome fixed orthodontic appliances for the correction of misaligned teeth. The trend is towards invisible orthodontics were the patient expects minimal discomfort, maximum esthetics, easy maintenance of good oral hygiene and not compromising on the final outcome of the treatment. Essix appliance is the appliance of choice for this century. The materials available, design, fabrication, uses, instruments used have been discussed extensively. The modifications of the standard design of the appliance with the wide use of a variety of instruments for active tooth movements have been discussed. This appliance is not only used for active treatment but also for retention at the end of treatment..
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Introduction: Orthodontic **retainers** are used after removal of fixed appliances to hold teeth in their new position while surrounding gums and bone adjusts to this new position. Often a person will need to wear them only at night. The length of time one must wear a retainer varies, but an average teenager will usually be advised to wear it into their early 20s. [1,2,3,4,] Clear thermoplastic retainers are an alternative to fixed lingual retainers and removable Hawley appliances[5,6]. These are becoming more popular, but in most cases the traditional Hawley retainers are the best. Essix retainers do not allow the upper and lower teeth to touch because plastic covers the chewing surfaces of the teeth. It is important for the top and bottom chewing surfaces to meet to allow for favorable settling to occur. Essix retainers are less expensive to fabricate and unfortunately, that is what is driving their popularity among some orthodontists. They are also used for the asthetics of not having visible metal.Graber states that a good retaining device should hold each tooth in the desired position and allow function activity to act freely in addition to being self cleansing and inconspicuous. The mostcommon type is the **Hawley retainer.** Initially, 3 - 3 retainers were secured with cemented metal bands on the canines. Now, they are bonded onto the lingual surface. This type of retainer has dual benefits: it holds the esthetic presentation of the incisors while allowing the buccal section teeth to adapt to diet, lifestyle, age, and stress. However, hygiene maintenance is difficult, and flossing is impossible without the aid of a device to place the floss under the bonded wire then the Essix retainer was devised by Dr Sheridan. Many articles have compared the efficacy of hawleys and essix retainers.[5,6,7,8,9,10,11]

A Rationale for Removable Retainers (Tony Collett, JCO- 1998 Nov) One commonly cited advantage of fixed retainers over removable retainers is their elimination of the need for patient compliance. In most cases, however, a fixed mandibular retainer is combined with a removable maxillary retainer. If bonded maxillary retainers are used, they generally extend only from lateral incisor to lateral incisor or canine to canine. These appliances can retain corrections of incisor irregularity, but are of little use after treatment such as maxillary expansion—an inherently unstable procedure.

Non-compliant patients can be identified and managed accordingly. Removable retainers also have the advantage of allowing patients to resume flossing in both arches.Removable thermoplastic retainers such as Essix appliances have the drawback of not allowing full seating of the occlusion. They can be trimmed into a wraparound form, but this reduces their strength.

An Essix appliance also has the capability of correcting minor tooth discrepancies. Tooth positioners can serve the same function, but have the disadvantage of taking a permanent set after

deformation, which reduces the force exerted on any malposed teeth.

The ideal removable retainers should be:

- Able to allow for functional occlusion.
- Sturdy enough to withstand long-term use.
- Convenient for the orthodontist to provide and maintain.
- Patient-friendly in both comfort and wear routine.

Essix Retainer: Essix retainer, is a clear or transparent removable device that fits over entire teeth which for all practical purposes is not noticeable. Essix retainers were introduced in 1993 as an esthetic, comfortable, and inexpensive alternative to traditional fixed and removable orthodontic retainers. They are thermoformed from plastic, copolyester Essix sheet material and trimmed to fit over the anterior teeth from canine to canine.A conventional Essix retainer incorporates all the advantages of the canine-to-canine retainer such as simplicity, stability, accuracy, patients' acceptability for long term wear, splinting periodontally weak teeth, allows for concomitant periodontal therapy, non-invasive on dental tissue and also permits effective hygiene. An Essix retainer also is an excellent fluoride tray that, when used periodically, can make the teeth more resistant to decay and, in contrast to full-arch retainers, allows molar band space to close naturally and the buccal section occlusion to settle in after active treatment.

Material Used : Because of its outstanding durability C+ is the material choice for long-term retention. Its durability compensates for functionally induced appliance abrasion, especially during pernicious nocturnal bruxing. Another type of plastic to use warrants adding acrylic to it—for example or posterior bite planes or occlusal type A+ plastic (ethylene-co-terptholate) resin that is clear and resistant to stain and abrasion, that has outstanding resiliency), and that amplifies the light reflecting properties of whatever surface it covers. Acrylic can be added to Essix type A - plastic surface is prepared. However durable as C+ plastic and is not the acrylic does not have to be bonded framework. Comparison between A+ and C+ plastics:

	Essix A+	**Essix C+**
Description	Crystal clear, rugged plastic with excellent flex memory and a snap-in fit.	The most popular Essix plastic. Esthetic, but less brilliant than Essix A+. It is virtually indestructible and inexpensive.
Bond Acrylic	Yes	No
Divots & Windows	Both divots and windows can be created.	Not with divoter. Only with the Hilliard Thermopliers
Bite Planes	Can be created by added acrylic	Created using Hilliard Thermopliers
Average Retainer Life	6 months	2 years
Protective Film	Present	Absent
Abrasion resistance	Absent	Guaranteed
Full-Arch appliance	Only for special applications ie. splints made with acrylic, bite planes, MTM & indirect bonding tray fabrication.	Recommended as it is impervious to occlusally induced fracture. For orthodontics in bruxism patient.

Essix ACE™ Plastic : Ideal for retention, Essix MTM (Minor Tooth Movement) & temporary bridges.

Brilliantly clear & rigid : Clearer than Essix A+® with strength comparable to the virtually indestructible Essix C+® Thermoplastic retainers have demonstrated poor wear resistance and durability after only a few months of use. So three thermoplastic products were evaluated:[13]

- C+ (Raintree Essix, New Orleans)
- 0.040-in Invisacryl C (Great Lakes Orthodontics, NY)
- 0.040-in TR sheet material (Bay Dental Direct, Mich).

Twenty specimens were fabricated for each group. The specimens were vacuum thermoformed

according to the manufacturers' recommendations and subjected to wear for 1000 cycles in a wear apparatus with steatite ceramic abraders.

Depth of wear was determined by surface profilometry. Mean wear in microns was as follows: C+, 5.9 (2.4); Invisacryl C, 6.1 (2.6); and TR, 1.6 (0.9).

TR material, a hard polyethylene terephthalate glycol copolymer (PETG), demonstrated greater resistance to wear than did the other 2 materials, which were softer, polypropylene-based thermoplastics whereas no evidence to suggest a difference in mean wear between the 2 polypropylene-based materials.

An "Essix box" is used for storing sturdy trays, precision impression material and dimensionally stable die stone. Steel trays with multiple retention holes are preferred because they are rigid enough to prevent flexing while taking the impression, which would distort the impression and consequently the appliance.

If disposable plastic trays are used to avoid the sterilization process, they should be thick enough to preclude flexing when the impression is taken. One should use tray adhesive with plastic trays for tenacious adhesion of the impression to the tray.
Hence the impression material of choice for canine-to- canine appliances is polyvinyl siloxane, which is easy to work with, has excellent elastic recovery does not distort, can be disinfected, and precisely registers interproximal morphology. Polyvinyl siloxane remains dimensionally stable for 6 months and can be repoured repeatedly without distortion.
It is more expensive than alginates, but more than compensated with fewer remakes and better fit of the appliance. The fit of an Essix appliance is directly related to the dimensional accuracy of the cast. Therefore dimensionally stable impression materials are mandatory

Clinically set material is close to being completely cured, so there is little residual polymerization to contribute to shrinkage. Obtaining the polyvinyl siloxane impression involves a combination of injectable (light-bodied) and putty (heavy-bodied) materials. The heavy-bodied material provides stability to the impression. The injectable light-bodied material ensures detail in the retentive interproximals.

Alginate is not the material of choice for Essix impressions. Alginate is not accurate or dimensionally stable enough to register consistently the precise anatomic detail of the retentive undercuts gingival to contact points.
If alginate is to be used, then a special quality extra fast set highly elastic material can used but an automatic vaccum alginate-mixer or a debubblizer (Turbo Max) is recommended to help eliminate air-bubble incorporation, user error and hand mixing. It takes less than 90 seconds to give a homogenous mix and effectively reduces chairside time by aiding in the making of bubble-free impressions.

But if alginate is used the impression should be poured immediately after removal from the mouth to avoid dimensional change associated with storage.

Die Stone: Pouring the impression with a quality die stone that has high compression strength with minimal setting expansion is essential. One should not use stone that has been in an open bin absorbing atmospheric humidity, for this will increase the setting expansion and in turn will cause the cast and the subsequent thermoformed appliance to be oversized. Quality die stone also eliminates the necessity of coating the cast with separating liquid before thermoforming because the gypsum particles in quality die stone are so fine that the stone will set to a silky finish. Omitting the minor thickness of separating medium allows a slightly better adaptation of the thermoformed plastic to the cast.

Essix Regular Die Stone

- Pink Powder
- Highest compression strength (17,000 psi)
- Lowest setting expansion
- Working time of 6-8 minutes
- Final setting time is 4 hrs

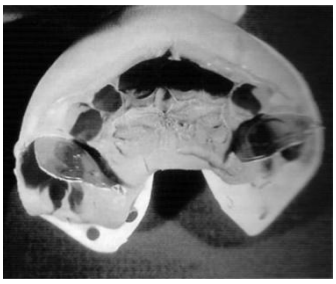
Essix Fast Cast Die Stone

- White Powder
- Compression strength of 14,000 psi
- Working time of only 60-90 seconds
- Initial setting time of 2 minutes.
- Final setting is just 30 mins

Earth Stone : Produces a model in a dust-free technique. Each unit contains 1 tub (90gm.) of stone and 1 bottle (1oz.) of activator.

Orthoboxes : Compactly designed and easy to assemble. Top-Loading Ortho Boxes (for finished cases) Drawer-Loading Ortho Boxes (for active cases)

i) FABRICATION:[7,8,9,10,11]Preparing the cast for receiving thermoformed plastic when the cast is removed from the impression, its height should be 2.0 cm from the incisal edges to the base of the cast. The height of the cast is correlated directly with the adaptation of the heated plastic, especially when thermoforming is done with a vacuum machine. The shorter the cast, the better the vacuum adaptation because the power of the vacuum is strongest on the base plate of the machine. A 2.0-cm high cast is closer to this power. The heels of the cast will be tapered from the base to the distal contact points of the canines because of the angulation of the blocking tabs placed in the impression before pouring. These tabs can be retrieved from opened beverage cans with a thin-bladed instrument. The edges of these tabs are sharp, the metal is rigid, and the tabs will slide into the polyvinyl siloxane impression and in effect block off the impression distal to the canines. The tabs should be placed at a slight angle so that the resultant cast will taper from the distal contact point of the terminal tooth in the impression to the base of the cast.



The only necessary cast modification is to the base. One should trim the base perpendicular to the long axis of the incisors. The incisal edges should be about in the middle of the cast when viewed from above. This configuration creates the least restrictive path of the heated plastic to thermoform over the cast.

The interproximal areas and gingival borders should be distinct. If they are not, one should emphasize them with a laboratory knife. One also must block out any air-bubble craters along the incisal edges with acrylic or plaster. If this task is not done, the subsequent thermoformed plastic appliance will not seat completely. One should not use wax for the blockout material because the hot plastic thermoforming over the working cast will melt the wax.

Excessive undercuts, such as the three-cornered spaces gingival to contact points and so often evident on older patients, should be filled in with a blockout compound to resemble normal interproximal morphology. Filling in of undercuts makes it easier for the patient to remove the seated appliance. One should use a bonding resin or, better yet, a light-cured composite gel to fill in deep undercuts, three-cornered spaces, or incisal-edge discrepancies quickly. However, adequate undercuts must remain gingival to contact points to ensure positive retention of the appliance. If the interproximal tissue is slightly swollen, it can be reduced judiciously on the cast to resemble normal morphology. On the working cast the interproximal tissue is represented in hard stone, but in the mouth it is compressible tissue that usually shrinks rapidly. If after altering the interproximal gingiva on the cast, the resultant Essix appliance does not fit precisely, the clinician can adjust it quickly at the chair.

ii) THERMOFORMING: The cast should be fully dry before thermoforming plastic over it. Essix A plastic will sag 1/2" in a vacuum machine when it is ready to be thermoformed. FDA recommends .040" thickness. Essix C+ plastic heats differently than the Essix A plastic. It will rise toward the heating element then return to a somewhat flat position when it is ready to be thermoformed. Essix C+ sag should not be let to sag ½" like the Essix A – it will be too thin.

The vacuum is run for approximately 30 seconds. When first learning the vacuum-forming technique – it is helpful to inspect the underside of the plastic encased cast to know if the thermoform was a good one or not.

When the plastic initially is vacuumed over the cast, it is still pliable enough for an accentuated

adaptation into the retentive undercuts gingival to contact points. To do this, one immediately pushes the heating element out of the way and forcefully pushes a tapered-tip instrument into the retentive undercuts gingival to facial contact points. This should take only a few seconds. Forced hand pressure using the small tip of the instrument generates an adaptation pressure of well over 100 psi exactly where it is needed—into the retentive undercuts that will stabilize the appliance.

Essix C+ has it's own thermoforming idiosyncracies, it does not thermoform like Essix A+ plastic. It is essential that the cast height be no higher than 3/4". The undercuts, gingival to the contact points can be emphasized with the Essix Accentuator. The plastic encased cast should be sprayed with Freeze Spray immediately after thermoforming. The vacuum machine should be fully heated prior to thermoforming. The Undercut Enhancing Thermoplier can be used to create a retentive bump in the Essix appliance, this will immediately improve retention. Because Essix C+ plastic takes longer to cool, Freeze Spray is essential to reducing any lift on the lingual or labial margins. An alternative, but less desirable method of cooling the plastic, is to place the thermoformed cast in ice water or to run cold water over it until it is at room temperature. Obviously, one should not use a refrigerant spray that has a flammable gas propellant.

The quality of the plastic adaptation to the cast can be appraised when the thermoformed appliance is removed from the fabricating machine. The clinician should examine the underside plastic to see whether there is a sharp line between the plastic and the cast. If a vacuum machine is used to fabricate the appliance, the vacuum holes should be well defined, and the machine marks on the metal baseplate should be evident in the plastic.

Plastic thermoforming machines : Two types of plastic thermoforming machines are available: pressure and vacuum types. Both types have the capability for Essix appliance construction.

Pressure machines such as the Biostar (Great Lakes Orthodontics) force heat-softened plastic over a cast with positive pressure within a chamber.

A vacuum machine sucks the plastic around negative pressure. Pressure machines can be untidy because the casts are usually positioned in a bed of metal pellets. But this could be avoided by the use of adaptation unit attached. Biostar pressure machines require a code that is correlated with the type of plastic to be used.
A vacuum machine adapts heat-soft cast by negative pressure. Concentrating the vacuum by reducing the surface area to which it is applied amplifies the vacuum force and improves the subsequent adaptation of the plastic to the cast. To achieve this vacuum, one should block out the peripheral vacuum holes on the baseplate with a gasket thus condensing and amplifying the power of the vacuum. Because Essix retainer casts are small (usually canine-to- canine or terminal premolar- to-terminal premolar in extraction cases), two can be placed inside the gasket. Some manufacturers provide a gasket for this purpose, or the clinician can fabricate one independently from engine gasket or rubber dam material.

iii)**Removing the cast from the thermoformed plastic:** The intact cast can be removed from the plastic sheet with the following technique:

The excess plastic sheet is cut away with curved Mayo scissors, leaving anterior and posterior tabs.
The plastic covering heels of the cast is cut away with a sharp laboratory knife, acrylic bur, or plastic cutting disk, and the facial and lingual tabs are pulled 2 to 3 mm away from the cast. A thin-bladed instrument is inserted at various points between the plastic and the cast and the cast is gently pried out of the plastic

If cast is fractured beyond repair, the polyvinyl siloxane impression, because it does not distort over time, can be repoured for the duplicate appliance.

Trimming Appliances of the canine-to-canine retainer The curved Mayo scissors are used to establish the outline of the retainer by trimming away the excess plastic on the lingual and the labial (leaving tabs). Then using the Essix Lab knife or an electric knife trim away the distal ends.No matter which tool is used, the cutting is started from the incisal edge and cut toward the base.All the plastic

from the distal end is removed. Then, the lingual and labial tabs are pulled away simultaneously to allow the cast to drop out of the plastic.In order for the patient to remove the appliance, the distogingival should be trimmed away.

The borders of the appliance are trimmed to a gentle curve extending it 3 to 4 mm onto the facial and lingual gingiva. the gingival border should not be scalloped to conform to the cervical line. Scalloping not only would detract from the esthetic presentation of the appliance but more importantly would eliminate the retentive undercuts gingival to contact points.

Trim the lingual of the upper and lower appliances in a straight line from canine to canine, and if necessary notch the gingival edge of the plastic to accommodate labial and lingual frenums.

For canine-to-canine retainers, cut away the plastic at the distogingival margin of the canine. Because an Essix appliance cannot be sucked off the teeth (the negative pressure of suction causes the appliance to adhere more tenaciously), this modification establishes a fingernail purchase for the patient to remove the appliance.

Essix retainers delivered in duplicates because the clarity of Essix appliances allows them to be lost easily. Giving the patient two retainers cuts down on emergency visits and is negligible in time and cost.

Contra-Indication For Essix Retainer: If inter-proximal tissue is swollen and fibrous to the point that undercuts gingival to contact points cannot be identified, Essix retention is not indicated. This condition usually is associated with the adolescent patient. In these instances, an Essix appliance can be reserved as an “exit appliance”; that is, after conventional retention appliances (Hawley and bonded wires) have been discontinued. At that time, the gingiva usually has normal morphology and the patient may have matured enough to maintain acceptable levels of hygiene.

Disadvantage : One study of 430 patients wearing Essix retainers reported that 10 developed slight anterior open bites; this was attributed to their wearing the appliances longer than the prescribed time each day. (Sheridan JCO 1993)

Comparison of Essix and Hawley Retainers (Steven et al JCO 1998):28 patients were assigned to each group for observation during the first six months of active retention. The Essix retainers were instructed to wear their mandibular retainers full-time and their maxillary retainers half-time for the first four weeks, and both retainers only at night thereafter.

The Hawley retainers were made with lingual acrylic and canine-to-canine labial bows. Ball clasps or Adams clasps were used to hold the maxillary appliances, and occlusal rests were placed on the mandibular first molars. Patients wore the retainers full -time for the first three months and only at night for the remaining three months.

Results : The Hawley patients showed slightly more incisor irregularity in both arches than the Essix group did but the difference was significant only for the maxillary arch ($p < .05$). There were no significant differences between groups in the change in irregularity recorded for either arch over the six-month retention period.

No patient in either group developed anterior open bite. Various clinicians have reported individual cases of anterior open bite in patients wearing Essix retainers, probably because of the posterior disclusion caused by the anterior contact of the Essix material (Fig. 2). In the present study, with patients wearing the appliances only at night after the first four weeks, there were no such cases. It has also been claimed that Essix retainers are more easily lost than traditional appliances because they are transparent. However, one way to reduce the likelihood of an Essix retainer being lost is to add a colored stripe along the lingual edge of the appliance, making it more visible when out of the mouth. Another possible disadvantage of Essix retainers is that they may wear out and need to be replaced at least annually. When Essix retainers are used as recommended, they do not appear to be any less effective than Hawley retainers in maintaining orthodontic corrections.

Appliance Design: The appliance is U-shaped and does not cover the palate. But lateral stability in this

configuration is minimal. So to stabilize an expanded arch, a U-shaped 0.030-inch wire, positioned 2 to 3 mm from the cervical margins of the teeth, is bent to conform to the shape of the palate.

The wire was tacked away from the working cast. Then the Essix plastic is thermoformed over the wire incorporating it within the plastic Because the thermoformed plastic covering the buccal section teeth is so thin (<0.5 mm) removing all the plastic at the interference point may lead to perforation of the appliance which will in no way affect the structural integrity of Essix plastic.

While fabricating, the distal third of the terminating molar is cut away using the electric knife. Depending on the plastic being used, the Trim-Rite knife should be set properly. If the tool is too hot, the plastic will fray, leaving a very rough edge that will need to be trimmed again with scissors.

Equilibration : Full arch appliances should be equilibrated by making the patient bite on a double-sided articulating paper with the appliance fully seated. If there are some high spots, one can reduce them by grinding the spots with the Essix Trimming bur. This does not effect the efficiency or strength of the appliance. A trimming bur can be used to grind away the marked high spots.

Equilibration is a must after placement of full arch Essix plastic retainer as any thickness of plastic covering the terminal molar is closer to the hinge axis of the mandible and will induce proportionately larger opening in the incisor area leading to an anterior open bite.

The Appliance Remover Tool (ART): ART makes it easy for patients to remove the clear appliances Can be used from the cheek side and/or from the tongue side Provides for patient comfort & compliance Especially for men with large fingers Convenient to carry as it fits within existing appliance carrying case & Latex free so non allergic.

Polyethylene Ribbon Bonded Retainer Versus Removable Retainer For Orthodontic Retention
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Objectives: To compare the stability, durability, oral hygiene maintenance and periodontal status of a resin-bonded polyethylene ribbon retainer and a removable retainer.

Methods: 20 patients who have completed comprehensive orthodontic treatment were randomly assigned to either the 1mm resin-bonded polyethylene ribbon (Ribbond Orthodontic-THM) lingual retainer or the removable Essix retainer that served as the control. Irregularity Index, arch length and inter-canine width were measured from study casts taken at pre-treatment, post-treatment, 3 months and 6 months follow-up visits. Appliance durability, plaque scores, gingival bleeding incidence (BOP) and periodontal status were recorded clinically.

Results: There is a significant interaction between retainer type and time for Irregularity Index and inter-canine width. Essix showed significant increase in irregularity Index (0.4mm) and decrease in inter-canine width (0.5mm) throughout the study, compared to 0.06mm and 0.02mm respectively in the Ribbond group. Mean BOP was significantly higher in the bonded group (3.4 ± 0.37) compared to the control (1.9 ± 0.38).

Conclusions: These results suggest that removable retainers do not attain stability in retention as readily, but additional attention to oral hygiene is necessary with bonded retainers.

Tooth Movement With Plastic Appliances:

Indications for clear plastic appliance:

- Mild to moderate crowding
- Single arch alignment problems
- Adult patients and responsible adolescents who are reluctant to wear fixed appliances and who will follow the clinician's directions
- Absence of functional distress

Essix System: Essix tooth movement is a unique biomechanical system involving the use of a removable plastic appliance that is thin, durable, and practically invisible. The clinician constantly modifies the Essix appliance to realize treatment goals and when necessary to make in-course correction.

Advantages: Tooth movement is possible in all planes of space.The fabrication expense is a fraction of the cost of the Invisalign. The Essix system involves only one or two plastic appliances that can be fabricated in the office. Therefore the cost of fabricating the appliance is minimal.

Creating Space : Two types of space that must be evident for tooth movement with Essix appliances are space within the appliance and space within the dentition.

Creating Space within the Appliance

I. Blocking out the cast or cutting a window in the plastic : Space within the appliance can be obtained by blocking **out** the working cast or cutting a window in the thermoformed appliance. The clinician has the option of using the method that is most efficient for the particular circumstance. Blocking out the cast to create space for the target tooth to move into is achieved by placing a thickness of time-cured or light-cured composite on the working cast that is proportional to the amount of projected tooth movement (Figure 28-10).

The cast should be blocked out using special block out composite material (and not wax as it will melt during thermoforming). The blockout material will form a bulge in the thermoformed appliance. Bulge on the palatal aspect – in case`of normal overbite and overjet the bulge in the plastic can cause incisal interference. Bulge on the labial aspect – is unesthetic. The alternative method of space gaining is to cut a window into the thermoformed appliance with a plastic trimming bur in a slow-speed handpiece.

The frayed border of the window can be smoothened with a scalpel. The window must be of adequate size (even bigger) to allow unimpeded tooth movement. However, a 2- to 3-mm gingival border of plastic is necessary for adequate strength and resiliency. Hilliard Thermopliers enable the usage of one appliance for 3 months to produce 3mm of tooth movement.These pliers make it easy to use Essix appliances for multiple uses, including...

- Creating Space
- Increase retention
- Create bodily movement
- Rotate, tip and torque teeth
- Close diastemas and extraction space
- Create instant bite planes without acrylic

HILLIARD THERMOPLIERS

Creating space within the dental arches with interproximal reduction: Creating space within the dental arches usually involves expansion, extraction, or interdental reduction.

Extraction is not a suitable option for gaining space with plastic appliances because it is difficult to upright roots and to close any remaining extraction space efficiently after the crowding is resolved.
Expansion with a clear plastic appliance is possible, but arch coordination is difficult, and because basically no potential exists for growth in the adult target population, one has the liability of moving the teeth past the limits of alveolar bone.

To avoid the complexities associated with extraction or expansion, the judicious removal of interproximal enamel is indicated.
It is best to move one tooth at a time. However, two teeth, that are not adjacent may be efficiently moved at one time. It's best not to try to align a whole section of teeth with a single appliance.

Airotor Stripping : Hand-pulled abrasive strips to reduce interproximal enamel is too laborious while interproximal reduction with disks mounted on a handpiece can be dangerous to the tongue and cheeks. Using a disk guard limits the ability to contour the proximal surface but obstructs vision while one appraises the quality of the reduction. The safest and most efficient system for ARS recommended by Essix and invasalign systems is the use of an air-turbine hand- piece.

The interproximal site Can be opened for ARS using coil-springs or separators, prior to interproximal reduction. This will greatly improve visual and mechanical access to the site.

Using coil springs is also the simplest, and most effective method, is to establish anterior anchorage to distalise buccal section teeth into the space created with Air-rotor stripping.

Only 1.0 mm of enamel is removed per contact point (0.5 mm/proximal surface). This amount will still leave an ample enamel covering (two-thirds of the original thickness) over the proximal surfaces. The purpose of ARS is to slightly reduce the bulk of buccal section proximal enamel, not to remove it all. The proximal surfaces are finished to an acceptable degree of smoothness after initial reduction with a 699L safe-tipped bur using medium, fine, and extra-fine safe-tipped finishing burs. The morphology of the stripped enamel wall should be contoured to resemble the original morphology of the proximal surfaces.

ARS makes reduced proximal enamel surfaces more resistant to caries than unaltered enamel by removing the outer layer of fully reacted enamel and thereby increasing the potential for remineralization

Closing an ARS site will reduce the interradicular distance. Actually, the interdental tissues, after ARS, may be better able to resist pathological insult. It appears, from controlled studies that narrower, rather than wider, interdental distances are more able to resist periodontal disease.

If a tooth is rotated then it is aligned with conventional mechanotherapy, and when the contact point is in acceptable position ARS can be done. This may involve some slight expansion of the arch, but this can be resolved with subsequent stripping and mechanics. It's a temporary inconvenience.

ARS will significantly reduce treatment times because space gained is directly proportional to the amount of crowding. There's no need for closing arches, and their attendant problems. Such as: loss of anchorage; headgear to protect anchorage; and intra-arch elastics to recover lost anchorage. Preemptive stripping to balance tooth mass ratios between arches should not be done.

The patient is advised on a fluoride rinse, or gel, to supplement the already powerful remineralization potential of reduced enamel surfaces to make the stripped proximal surfaces more resistant to carious insult. The Intensive Ortho Strip System is an alternative method of reducing interproximai enamel with a handpiece but without a rotating bur. This system involves the use of a handpiece-driven abrasive strips with different configurations and abrasive potentials. The instrument removes enamel with a 0.8-mm oscillation movement (back-and-forth shuttle action). This technique uses

handpiece-mounted metallic strips with different abrasive grain sizes 15- 90 microns for cutting and polishing proximal surfaces. Flexible blades (Proxyshape) also are available to contour and smooth the reduced proximal surface with abrasive grain sizes from 15 to 125 microns

Inducing Tooth-Moving Force In An Essix System : An Essix appliance permits force application on any area of any given surface. This force inturn determines the type of tooth movement. Two primary systems of creating a tooth-moving force are possible with an Essix appliance. Using Hilliard Thermopliers (Dr. Keith Hilliard) By "mounding"

These two basic systems can be used independently or jointly. For instance, the initial movement could be induced with Hilliard Thermopliers, and subsequently, additional force could be induced with mounding.

Inducing force by altering the appliance: A series of pliers is available to induce various types of tooth movement, create bite ramps, tighten an Essix appliance for a better fit, and create attachment hooks for Class II or III elastics. These pliers are capable of generating forces that can move teeth in all three planes of space and can move teeth that are adjacent to each other in different directions at the same time. Additionally, for additional tooth movement, adjustments to the appliance can be made at chairside during sequential appointments.

The force-inducing thermoformed projection created by the pliers is always made toward the tooth surface. The Thermopliers must be heated to the correct temperature depending on the plastic being used. For Essix Embrace and Essix A+ plastics the Thermopliers should be heated to 175^{o}F/70.4^{o}C and for Essix C+ the temperature is 200^{o}F/93.3^{o}C.

When the pliers reach this temperature, the clinician gently squeezes the handles of the thermopliers together to create a force-inducing projection within the plastic. However, during subsequent adjustments, this periodic stretching of the plastic will cause the projection to become thinner and decrease its force potential. Creating the first projection by making a 1.0-mm depression in the working cast allows the material to have a maximum thickness for future adjustments when the thermoformed plastic adapts to this depression. A heat source that will generate temperatures of 180 to 200° F is necessary to heat the Thermopliers tip for spot-thermoforming the plastic. However, because the Thermopliers usually are used at chairside, an open flame near the patient is a safety concern. The APT Burner is recommended for this reason. The burner has a "dead man's switch" that turns off automatically when the operator's hand is removed from the activation button Heat sources such as a butane flame or a bead sterilizer may be used in the laboratory, but caution would dictate that they should not be used at chairside.

Measurement of the temperature of the Thermopliers tip before thermoforming is required. If the thermopliers temperature is below the thermoforming range, the plastic will only stretch, and the plastic will tend to revert back to its original sheet form, thereby compromising tooth movement. If the temperature is too hot, the pliers will burn through the plastic.

A HAKKO digital thermometer is used to measure the temperature of the thermoplier tip in Fahrenheit or centigrade. Thermoair allows the clinician to direct a small, precisely controlled jet of heated air onto the surface of a thermoplastic appliance. Both the air pressure and temperature are fully adjustable. thermoplastic appliance.

Once the material has been heated, the Thermoair Instruments (including pliers) are used to thermoform shapes in the appliance. As a standard 1mm nozzle is used regularly but 1-3 mm sizes are available. If using the Hilliard Thermopliers - two adjacent teeth can be moved using acrylic to build up the "window" instead of cutting out the window!

ThermoAire

Mounding : Mounding is the process of inducing force by placing composite on the tooth surface.A small mound of composite is placed on the enamel surface of the tooth to be moved. The unaltered resilient plastic resin against the mound induces tooth movement. Whether a thermoformed projection is in the plastic appliance or on the tooth surface no difference in force delivery.

Mounding is initiated after the Essix appliance has been thermoformed. For additional force generation and sequential tooth movement, additional composite layers can be added to the initial mound at subsequent patient visits.
The enamel is acid-etched to receive the mounding composite. .0-mm thick composite mound is bonded to the tooth. The height of the mound can be measured with a Boley gauge. The Essix appliance is inserted. At the subsequent visits 1.0-mm composite layers can be added to the original mound to create additional force and thus additional tooth movement.

If the patient feels force on the target tooth, the force is usually adequate. If the patient feels no force, the clinician should place a slight amount of additional composite on the established mound.
If the force is so great that it is difficult to seat the appliance, the clinician should decrease the height of the composite mound with a sandpaper disk or a fluted plastic trimming bur.

Types of tooth movement that can be achieved with Essix mechanics [29,30]

TIPPING: Tipping is accomplished by placing the force-inducing projection in the plastic or a composite mound on the enamel surface on the side from which the tooth is to tip away and by relieving the cast with blockout compound or a window cut into the plastic on the side toward which the tooth is to tip.

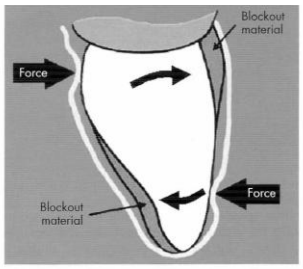
If for example an incisor is to tip lingually, a composite mound is placed on the enamel surface or a Hilliard Thermopliers projection in the plastic. Space for the tooth to move into is obtained with blockout relief or window cut into the plastic. Additionally, adequate interproximal space must be present or created with interproximal reduction. If the tooth is tipped too far, the composite mound or force-inducing projection can be reduced to allow the target tooth to rebound to the desired position.

LATERAL MOVEMENT: Blockout material is placed on the side of the tooth where the lateral movement is to be ccomplished. The blockout creates a channel within the thermoformed plastic into which the tooth can move.

For example, if a lower central incisor is to move to the mesial, the clinician would place blockout material in the mesial interproximal on the working cast. Space in the arch is obtained with interproximal reduction after the appliance is thermoformed. Additionally, the blockout relief must be slightly above the incisal edge of the target tooth; if not, the incisal edge will contact the inside of the Essix appliance and interfere with tooth movement.
Once space is obtained within the appliance and within the arch, the seated appliance induces initial movement. This force can be augmented during the patient's sequential visits for additional movement.

TORQUE: Essix-induced torque is more efficient than the conventional bracket-slot-wire system because the distance between the opposing moments is limited only by the length of the clinical crown measured in millimeters rather than the width of a rectangular bracket slot measured in thousandths of an inch as in the slot. Essix torque is accomplished by creating a force-inducing projection in the plastic with Hilliard Thermopliers or composite mounding simultaneously on the labial and lingual of the target tooth. In addition, the clinician places blockout material on the cast to allow tooth movement.

For instance, if incisor torque involves moving the incisal edge lingually and the root labially, the clinician prepares the working model by placing a force-inducing projection or composite mound on the incisal one third of the labial surface of the crown and on the lingual surface on the gingival one third of the crown. These forces induce a mechanical couple that will torque the incisor, moving the incisal edge lingually while moving the gingival section of the crown labially.

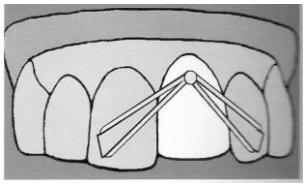


If incisor torque involves holding the incisal edge stationary and obtaining exclusive root movement, the Essix appliance is constructed to have 2.0 mm of the incisal edge of the target tooth covered with plastic and therefore is locked within the appliance. This incisal edge plastic cap will hold the incisal edge in place while the root rotates under it because of the induced gingival force. The torquing couple moves the incisal edge lingually while the root moves labially.

ROTATION: To rotate an incisor about a central axis, the clinician must induce a rotational force on diagonally opposed tooth surfaces and block out the appropriate space on the working cast to allow rotational movement.

For example, if an incisor is to rotate lingually on one side and labially on the other side, the force-inducing projections would be distolingual and mesiolabial and the relief would be distolabial and mesiolingual. Additionally, rotation can be induced in an out-of- line proximal surface while maintaining the proximal surface that is acceptable. To rotate the tooth on the mesial while holding the acceptable distal contact point the clinician does not block out the distolingual aspect of the tooth but obtains space for movement of the out-of- line contact point with blockout compound. This absence of relief on the distal of the tooth holds the acceptable contact point in place, and the target tooth pivots mesiolingually like a door on a hinge. A guideline for the amount of tooth to be held within in the appliance is 10% of the acceptable proximal surface.

EXTRUSION: The Essix appliance is an effective anchor for the elastics used to extrude the targeted teeth into created space. After thermoforming and removing the appliance from the cast, a complete window is cut into the plastic to create the space into which the target tooth can extrude and to allow the bonding of a clear plastic button, for esthetic reasons, to the facial enamel of the targeted tooth.



ATTACHMENTS : The elastic attachment tabs can be constructed by cutting two horizontal slits 3 to 4 mm apart into the appliance with a scalpel and extending them 2-3 mm from the center of the facial surface towards the interproximal. Then the horizontal slits are joined with a vertical scalpel cut then the tab is flexed to the facial, to attach the Class II or III elastics. Hilliard Therrnopliers also can be used to form elastic attachment buttons on Essix C+ at the desired location using gentle pressure for 15 seconds producing “lipped” edge around the base and the tab oriented up to 30 degrees to hold the elastics.

INTRUSION OF SUPRA ERUPTED TEETH: Resolving excessively erupted teeth with fixed appliances is biomechanically frustrating because the simultaneous extrusion of adjacent teeth is more evident than intrusion of the targeted teeth. This imbalance inevitably induces orthodontic complexities that can be avoided when intrusion, with minimal if any effect on adjacent teeth, is achieved with an Essix appliance. When intrusion or extrusion is indicated, an initial stage with an Essix appliance can reduce the complexities associated with trying to resolve the condition with fixed appliances. When the intrusion or extrusion phase is complete, a second phase with fixed appliances can be initiated.

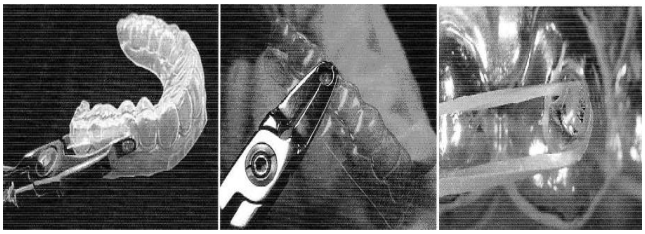
When constructing the intrusion appliance, the plastic covering the crown of the tooth to be intruded at the cervical line is cut away.

The elastic attachment tabs are placed into the facial and lingual of the plastic that is gingival to the extruded tooth on Essix A+ plastic using acrylic monomer or bonding composite primer over the roughened area and allowing it to dry for 1 minute.

A small rubber band (1/s inch, 4.5 oz) to the facial and lingual tabs is secured such that it crosses the crown of the extruded tooth. The rubber band is rotated to form an "X." When the appliance is seated, the rubber band will not slide into the interproximal area because of its configuration.

The reciprocal force of the stretched elastic tends to unseat the appliance. Therefore ensuring that the plastic is well adapted to all retentive undercuts gingival to contact points is critical. Additionally, small composite mounds can be placed on the facial of selected teeth before taking the impression. When the appliance is seated, it will snap over these.

The initial heated pliers thermoform a cylinder into the appliance. The second heated pliers crimp the base of the cylinder to form an elastic attachment.
An elastic can be attached to the thermoformed button.



The intrusion appliance directs the force to the target tooth. The "X" configuration of the elastic prevents it from slipping into the interproximal area.
Composite mounds and consequently form a mechanical lock that will resist displacement. The retention potential of the appliance can be increased further by emphasizing the retentive undercuts gingival to contact points with a Hilliard Thermopliers specifically designed for that purpose. The elastic should induce no more than 50 to 75 g of force. as the target tooth starts to intrude, occlusion on the rubber band will be eliminated, and the tendency for it to break because of occlusal shearing forces will be reduced.

Conclusion: The ideal would be if all teeth could be completely free of retention to naturally adapt to functional demands appreciably from their corrected position is beyond current technology. In lieu of amount of retention, consistent with seem to be indicated. Essix canine-to-c stabilize one third of the teeth one third of the time (at night only). Current retainers to be as close as orthodontists can come no retention whatsoever.

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