Over the last two decades, transparent removable orthodontic appliances have been developed to treat patients who desire a more aesthetic and comfortable treatment option compared to traditional metal braces. There have been many published journal articles declaring the effectiveness of clear appliances, and one of the major advantages of these appliances is the patient’s ability to remove them for eating, brushing, and other reasons.

The eCligner System is a clear plastic removable orthodontic appliance produced by a vacuum former. It is made of non-toxic and biologically acceptable PET-G material, similar to PET milk bottles and elastics. In crowding cases of 2–3 mm, orthodontic treatment with eCligner clear aligners can be as short as 4–5 months (Figs. 1–3).

Development of Clear Aligners and the eCligner System

In late autumn of 1998, the inspiration for moving teeth with transparent removable orthodontic appliances came to me while I was observing soap bubbles in my bathroom. I successfully started using these appliances to treat simple relapse cases and named them Clear Aligners. Although several appliance companies use the term ‘clear aligner’, it was the name I originally created for marketing this technology worldwide.

Making clear aligners in the laboratory requires precise tooth movement control in the model set-up. CAPRO (IV-Tech, Korea) software was used to overlap two digital photos for checking the range of move-
ment for each tooth. Using a heat-generated vacuum former and 0.5 mm, 0.62 mm, and 0.75 mm laminate foil, three thicknesses of aligners (soft, medium, and hard) were created for each movement or ‘step’ of treatment. Starting with the soft, then medium, and then hard, each aligner is worn for one week before moving on to the next step (Figs. 4 & 5).

As effective as handmade aligners are, there are limits in the clinical application. The quality of the aligner depends upon the expertise of the technician, even using technology like the CAPRO software. Some of the limitations include the tendency for tooth necrosis due to heavy orthodontic forces, as well as inefficiencies in tooth movement or misdirection. To overcome these challenges, it was necessary to de-

Fig. 6: 3-D eCligner programme enables precision digital tooth movement in full 3-D movement control. Each tooth segment is separated and patterned in hexahedron, controlled by adjustable CR (centre of rotation) point.

Fig. 7: eCligner diagnostic data for multitasking function, simulation for facial profile change.

Fig. 8: Multi-overlapping (superimposition) among each 3-D digital set-up model enables measuring the distance and angle directly on the monitor. Each tooth shows current torque and angulation as to progress. Also it is possible to make animation function to compare each movement pattern. Colour and tone change function is helpful to recognise complicated tooth movement among the steps.

Fig. 9: Doctor view (eCligner Dr Program).

Fig. 10: Various print function, photo galleries. Model analysis data is useful to determine the amount of stripping.

Fig. 11: eCligner diagnostic data, cephalo analysis (Tweed, Ricketts, Jarabak, Grummon), P-A view analysis.
Fig. 12

Fig. 13

Fig. 14

Fig. 15

Fig. 16a

Fig. 16b

Fig. 17

Fig. 18
velop new eCligner software utilising a 3-D CAD/CAM system. This system incorporates the same basic principles as handmade clear aligners with the added benefits of improved control over tooth movement, digital diagnosis and treatment planning, as well as consistency in estimating treatment times. It also allows for better patient communication and solutions for lost/broken aligners or relapses. By developing this advanced software in 2009, the eCligner System gained significant clinical enhancements (Figs. 6–11).

Mechanics of the eCligner

The eCligner System produces aligners from 3-D-printed resin models, which are created using the eCligner treatment planning software. Each model represents a step and is used to create three aligners of increasing thickness (soft, medium, and hard). The patient wears each aligner for 1 week until that step is complete and then moves on to the next step (3 weeks in total). eCligner aligners are worn for 17 hours a day and removed when eating or when drinking hot drinks. The Treatment Plan is a guide for the entire process and includes estimated treatment times, expected results, profile changes, and the amount and location of IPR (stripping) required. The Treatment Plan can also be used to evaluate extraction or non-extraction options in borderline cases. eCligner aligners are a comfortable fit and the increasing thickness helps promote gradual tooth movement, thus avoiding pain or irritation of the periodontal ligament tissue (Figs. 12–18).

Adult patients

For adult patients, aligners should be worn 17 hours every day except during mealtimes or when drinking hot drinks. Patients must wear the aligner each night and clean the aligner with a toothbrush daily. eCligner aligners can be used to create space for prosthetic implants or extrusion for periodontal purposes.
3-D simulations within the programme can enhance treatment acceptance by the patient (Fig. 19).

**Adolescent patients**

Treatment with eCligner aligners is possible with children under 14 years of age for the purpose of interceptive orthodontic treatment. The eCligner System can be used for space maintenance, space creation, eruption guidance, and growth control. Children wear eCligner aligners for only 8–10 hours daily and only at night. Thus, the eCligner System does not disrupt daily routines and takes advantage of peak growth hormone secretion during the midnight hours for maximum effectiveness (Figs. 20 & 21).

**eCligner applications**

The eCligner System is effective for minor tooth movement, crowding and spacing, and for prosthodontic or periodontal treatment. It is also effective for retaining the arch after orthodontic treatment.

Examples of eCligner applications:

1. Minor crowding (Figs. 22–29)
2. Spacing (Figs. 30 & 31)
3. Intrusion (Figs. 32 & 33)
4. Extrusion for detailing & occlusal seating (Figs. 34 & 35)
Fig. 30: Spacing case (18/M) – Before and after.
Fig. 31: Spacing case (59/M) – Before and after 7 months treatment.
Fig. 32: Intrusion force vector is to improve overbite situation. Before and after.
Fig. 33: Figures show improved smile. Notice the upper and lower incisor relationship. Before and after.
Fig. 34: Before: Open bite case.
Fig. 35: After: Corrected by Cow-catch (extrusion movement for finishing and detailing)
Fig. 36: Before: Ectopic erupted canine (14/M). It deteriorated patient’s pronunciation.
Fig. 37: After: Night time wear corrected crowding as well as improved pronunciation.
Fig. 38: Before: Crowding case.
Fig. 39: After: Expansion procedure improved the anterior crowding.
Fig. 40: Before: Relapse case on extracted area both left and right side.
Fig. 41: After: 3 steps of eCligner corrected relapsed space and minor crowding.
Fig. 42: Insufficient space for prosthodontic implant on first bicuspid area. Anterior spacing was shown. Before and after.
Fig. 43: The spaces (first molars) have been regained by uprighting procedure for implant and anterior spacing problem, corrected. Before and after.
5. Children case (Figs. 36 & 37)
6. Expansion case (Figs. 38 & 39)
7. Relapse treatment (Figs. 40 & 41)
8. For prosthodontic needs (Figs. 42 & 43)
9. For aesthetic smile (Figs. 44–46)
10. Combination with whitening treatment (Fig. 47)

How to start
1. Register as a provider via the website
2. Upload patient info and photos
3. Submit PVS impressions or an intraoral scan
4. Receive and review the Treatment Plan
5. Consult with the patient using 3-D simulations
6. Accept the case
7. Receive the eCligner aligners and resin models (Figs. 48–50)

Patient management

Confirm the proper fit of the current aligner when the patient visits. If not fully fitting, the patient needs more time to wear the current aligner (Figs. 51 & 52).

Solution for lost/damaged aligners and relapse

The eCligner System provides all the aligners and resin models. If the patient has lost or damaged aligners, simply use the resin models to create replacement aligners. If the patient stops wearing the aligners, find the resin model that matches the current arch form and remake the required aligners to restart treatment. For relapses after treatment,
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Fig. 51: Check point: notice the transparency and eCligner fitting before and after. It depends on patient cooperation.

Fig. 52: High transparency and just fitting shows the sign, previous good cooperation. Upon patient wearing time every day, optimal progress leads to the final planned result.

Fig. 53: Check point: keep watching patient handling the eCligner. It is helpful to instruct the patient on how to insert or take out using the aligner tool.

Fig. 54: Resin models are useful to create aligners when troubleshooting.

Fig. 55: Removable eCligner retainer combined with fixed retainer. eCligner retainer does not always accompany the fixed retainer.

Retention

For the first year after orthodontic treatment, the patient must wear the retainer every night. After the first year, 3 nights per week is sufficient to prevent relapse. Thereafter, the patient must wear the retainer at least 1 night per week. The retainer should be replaced every year at the patient’s annual visit (Fig. 55).

about

Dr TaeWeon Kim DDS, MSD, PhD, graduated from the YonSei University Faculty of Dentistry in 1988, and completed his MSD and Doctorate in the same university in 1991. He served as a faculty member in the Tokyo Faculty of Dentistry in Japan between 1994 and 1995, and held office as the Head of the Department of Orthodontics in the Ewha Womans University between 1995 and 1996. Since 1996, he has had his own private practice and research centre.

In 2001, he received his PhD from the Showa University in Japan. Currently Dr Kim is the President of World Federation of Aligner Orthodontics (WFAO) and a honorary Professor in Binzou Medical College in China.

Dr Kim has been a pioneer in orthodontic treatment systems with transparent removable aligners known as Clear Aligners since 1998. He has made significant contributions to orthodontics with a new concept envisaging 3-D treatment planning and the digital production of clear aligners at three different levels of thickness using very sensitive technology. Dr Kim has presented at numerous conferences across the world on lingual orthodontics, micro implants and eCligner, and provides courses on these subjects at an international level. He is an author of numerous articles and books.

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