SmartClip™ Brackets offer the benefits of a passive self-ligating system with a familiar twin body design that is associated with positive treatment results. The presumed benefits of self-ligating systems include reduced friction, reduced overall treatment time, ease of use, and improved hygiene. Recent improvements to the SmartClip system include a redesigned clip and the incorporation of tie-wings on the first molar brackets. Extensive lab testing, in-vivo and in-vitro evaluations demonstrate that SmartClip™ SL3 Brackets, with an optimized clip design, exhibit lower large wire engagement and disengagement forces that can improve archwire changes without compromising treatment efficiency.

The advanced SmartClip SL3 appliances, along with the newly designed upper and lower first molar brackets, are examples of continuous improvements made to meet and exceed orthodontists’ needs.

Prior to the launch of the SmartClip SL3 system, in-vivo and in-vitro evaluations were conducted to validate design intents. From the in-vitro evaluation, it was learned that orthodontists and assistants were able to see a discernable difference between the existing and redesigned clips for the engagement and disengagement of the following archwires: .016 round Nitinol Classic, .016 × .025 Beta III Titanium, and a .019 × .025 Beta III Titanium archwires.

In the in-vivo evaluation, which lasted from initial bonding through progression to large rectangular archwires, there were no incidents reported of spontaneous disengagements or clip rotations for any of the archwires used in treatment. These results demonstrate that the new clips have enhanced engagement and disengagement forces without compromising treatment, and thus improving patient comfort.

The SmartClip bracket is comprised of three main components: a mesh base, a metal injection molded bracket body and a pair of nickel-titanium clips that open and close through elastic deformation during archwire insertion and removal. The clips’ nitinol material is a commonly used alloy in orthodontic archwires and other medical devices such as stents and orthopedic implants because of its biocompatibility and superelastic characteristics. The superelastic property allows engineers to pre-program the clip to open and release at predetermined force levels.
Recent developments have resulted in the SL3 clip, which has several key design features that include a leading ramp and narrower opening.

The new design allows the clip to flex more easily, making it more forgiving to archwire misalignment than a rigidly fixed clip. The leading ramp is designed to reduce the archwire disengagement force by gradually opening the clip as the archwire is removed. The angled slope replaces the instantaneous load with a gradual, more pleasant experience. However, because the ramp is required to reduce large archwire clip forces, the opening on the new clip is slightly narrower to maintain the proper level of retention for round archwires.

The design process begins with computer modeling of the clip geometry followed by analytical simulation known as finite element analysis. The models are used to solve problems that are too complex for conventional analytical methods and aid in the optimization of clip performance. Specifically, these models are used to tune the force and fatigue life properties of the clips by estimating the stress and strain of the material during archwire insertion, archwire removal and overall treatment. Figure 2 is an example of the simulation results of a clip during archwire insertion.

During development, the clips are cut with a high precision laser into the designed shape and assembled onto injection molded brackets and subjected to a rigorous set of laboratory tests. Archwires of various sizes are engaged and disengaged from the clips to determine the force exerted during archwire changes. Figure 3 depicts the standard archwire engagement and disengagement test setup. The brackets are mounted onto a fixture and the load cell measures the force response of the clips.

Mechanical testing confirms that the new SL3 clip generates less force than its predecessor during insertion and removal of large, rectangular stainless steel archwires. The data shows a decrease in the force required to engage and disengage a .019 × .025 Stainless Steel archwire for the new clips.

The same test shows that the round archwire retention force is maintained and comparable to that of the previous clip.
Additionally, a fatigue test is performed to ensure adequate life of the clip throughout treatment. The brackets are cycled repeatedly with rectangular stainless steel archwires. Above is a chart showing the fatigue life of the clip.

Another upgrade to the SmartClip™ Appliance System product line which merits mentioning is the addition of tie-wings to the first molar bracket. In order to maintain a lower profile, the initial version of the first upper and lower molars that was launched did not incorporate the tie-wings. However, through customer feedback it was indicated that there was a need for tie-wings in cases where ligation was desired. Maintaining the low profile, a key design feature of the first upper and lower molar brackets, tie-wings were added, compact in design, to minimize occlusal interference.

Although the tie-wings are compact, lab results demonstrate that the new tie-wings accommodate ligatures and chain in various ligation configurations (Figures 9 and 10).
To further improve the SmartClip™ first upper molar brackets, the new design has the distal offset built into the bracket base. Previously the upper first molars had the distal offset built into the archwire slot. Having the distal offset built into the bracket base allows the upper surface of the archwire to be flush with the clip retaining surface. This maximizes the holding surface between the clip and the archwire. This improves archwire retention and reduces the possibility of spontaneous archwire disengagement.

Although the new SmartClip first molar brackets have incorporated many design improvements, the desired design features found in earlier SmartClip first molar brackets were carried over to the new designs. Design features such as torque in base that allow for a compact occlusal gingival bracket body and micro etched mesh bonding base are still found in the redesigned SmartClip first molar brackets.

Customer satisfaction through product innovation and efficiency is always the primary focus with the development of new or existing products. The SmartClip appliance system product line is a state of the art orthodontic system that is efficient and easy to use. The optimization of the nitinol clips and the first molars' enhanced features exemplify how excellence in engineering is used for the development of new products.

Figure 11A-B: Previous design with distally offset archwire slot (left); New design with distal offset in bracket base (right). In the new design, the clip contact with the archwire is flush allowing improved archwire retention and reduced spontaneous disengagement.