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Pitts 21™ Brackets: Biomechanical Innovation and Aesthetic Integration in Orthodontics

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Abstract: Traditional orthodontic treatment has often prioritized dental occlusion over facial aesthetics, leading to suboptimal smile outcomes. The Pitts 21™ bracket system, developed by Dr. Thomas Pitts, integrates modern biomechanics with aesthetic goals through innovations such as square wire finishing, progressive slot depth, and Smile Arc Protection (SAP). This review explores the biomechanical advantages, aesthetic enhancements, and clinical protocols associated with the Pitts 21 system, with an emphasis on its role in achieving early 3D control and more predictable treatment outcomes. The Pitts 21 bracket system represents a significant advancement in aesthetic orthodontics. By merging biomechanical precision with facially driven treatment planning, it allows clinicians to achieve superior functional and visual outcomes in a more efficient manner.

Keywords: *Pitts 21, Self-Ligating Brackets, Smile Arc Protection, 3D Control, Orthodontic Aesthetics, Torque Expression.*

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I. INTRODUCTION

Orthodontic treatment has traditionally focused on achieving ideal dental occlusion, often with limited attention to facial aesthetics. However, in contemporary practice, the integration of smile design and facial harmony has become essential to successful outcomes. Advances in bracket systems have played a pivotal role in this shift, with self-ligating brackets offering significant improvements in efficiency, patient comfort, and control of tooth movement.

Among these, the Pitts 21™ bracket system, developed by Dr. Thomas R. Pitts, represents a major evolution in bracket design. Unlike conventional systems that prioritize mechanical correction alone, Pitts 21 incorporates aesthetic goals from the onset of treatment. Central to this philosophy is Smile Arc Protection (SAP), a protocol that enhances the natural curvature of the smile through strategic bracket positioning and biomechanical planning.

The Pitts 21 system features a unique 0.021" x 0.021" square slot, progressive slot architecture, and a workflow designed to initiate 3D control—torque, tip, and rotation—early in treatment. These innovations, combined with protocols such as ELSE (Early, Light, Short Elastics) and Active Early mechanics, allow clinicians to achieve more predictable, efficient, and aesthetically pleasing outcomes with fewer wires and shorter treatment duration.

This review aims to explore the biomechanical innovations, aesthetic strategies, clinical protocols, and scientific evidence supporting the Pitts 21 system, with emphasis on its practical application and advantages over traditional self-ligating bracket systems.

II. THE PHILOSOPHY OF DR. TOM PITTS

Dr. Thomas R. Pitts is internationally recognized for his contributions to aesthetic orthodontics and for redefining how clinicians approach case planning, bracket positioning, and smile design. His philosophy centers on achieving excellent facial aesthetics through biologically efficient, mechanically sound, and highly individualized treatment protocols. Rather than focusing solely on occlusion, Dr. Pitts advocates for a facially driven treatment approach where the final smile appearance is considered from the very beginning of treatment—an idea he famously termed *"Begin with the end in mind."*

A key concept in his philosophy is Smile Arc Protection (SAP), which involves deliberate bracket positioning to preserve or enhance the curvature of the upper incisal edges in harmony with the lower lip line. By controlling vertical tooth positioning, SAP improves incisor display, lip support, and overall smile attractiveness. This is especially relevant in today's aesthetically aware patient population.

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Dr. Pitts also emphasizes early control of 3D tooth movement—including torque, tip, and rotation—starting from the initial bonding stage. His Active Early protocol promotes early engagement using square wire mechanics and lighter forces, made possible by the Pitts 21 bracket's 0.021" × 0.021" slot and progressive slot design. Supporting tools such as ELSE (Early, Light, Short Elastics), bracket flipping, and disarticulation further enhance control and efficiency.

Importantly, Dr. Pitts integrates aesthetics, function, and biomechanics into a comprehensive system rather than relying on isolated techniques. This integrative mindset has helped redefine finishing standards in orthodontics, placing aesthetic outcomes on equal footing with traditional occlusal goals. His methods encourage clinicians to adopt a proactive, not reactive, approach—adjusting mechanics early rather than making aesthetic compromises at the end of treatment.

Through teaching, publications, and the development of the Pitts 21 system, Dr. Pitts has established a legacy centered on clinical excellence, efficiency, and the pursuit of the *"most stunning smiles"* in orthodontic care.[1]

III. DESIGN FEATURES OF PITTS 21 SYSTEM

As the first and only self-ligating system, the Pitts 21 bracket system seeks to offer 3D control both before and during treatment. Using 30–40% less power, revolutionary square wire finishing improves slide mechanics, comfort, and control. The goal of progressive slots is to offer an intelligent balance between control and mobility in order to produce efficient sliding mechanisms. Reliable completions with as little as four wires.

A. Torque Values of Pitts 21 bracket

Table 1 Showing Torque Values of Pitts 21 Brackets

Tooth	Upper Torque (Pitts 21)	Lower Torque (Pitts 21)
CI	12	-6
LI	6	-6
CN	9	9
PM1	-11	-17
PM2	-11	-17
M1	-27	-22
M2	-27	-22

Table 2 Showing low Torque Upper Brackets and high and low Torque Brackets

Torque	U1	U2	U3	U4	U5
Normal	+12	+8	+7	-11	-11
Low	-12	-8	-7		

Torque	L1	L2	L3	L4	L5
High	+6	+6			
Normal	-6	-6	+7	-12	-17
Low			-7		

B. Tip values of Pitts 21 brackets

Table 3 showing Tip values of Pitts21 brackets.

Tooth	Upper Tip (Pitts 21)	Lower Tip (Pitts 21)
CI	5	0
LI	9	0
CN	5	5
PM1	2	2
PM2	2	2
M1	9	0
M2	9	3

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➢ *Unique features*

- *Integrated Hooks*

There is a convenient, cost-free option on the 3's, 4's, and 5's.

- *Smooth, Rounded Edges*

Guarantees the best comfortable experience for your patients.

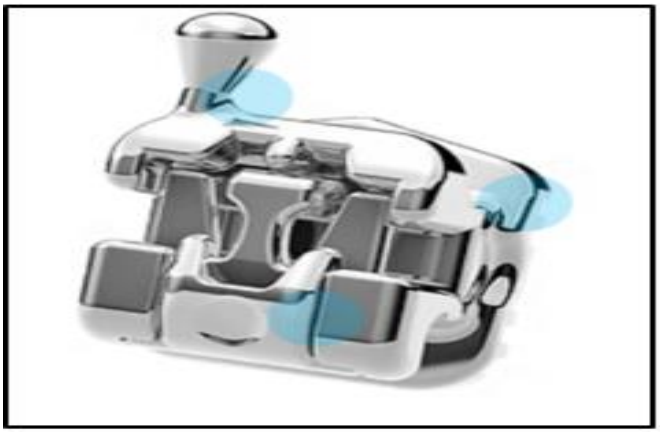

Fig 1 Pitts 21 bracket

- *Unique Door Design*

The distinctive sliding door's design aims to increase structural stability and improve torque and rotation control.

- *0.021 Precision Slot Depth*

A closer paring between the wire and the bracket is intended to result from the reduced slot depth, which will enhance control, torque, and engagement early

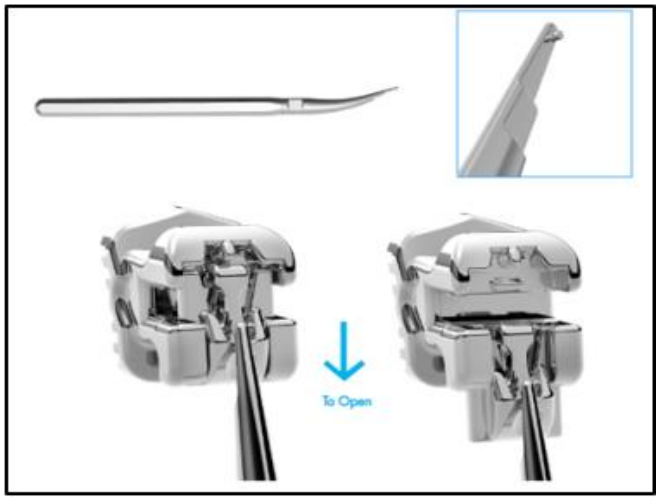

Fig 2 Unique sliding door design

- *Large Under Tie-Wing Clearance*

Supports early elastics, ligatures, metal ligatures, and power chain.

- *Base Lock Plus*

In order to reduce broken brackets and debonding issues, one-piece bases and brackets are designed to provide the best possible pad-to-tooth fit and bond strength.

- *Square Wire Finishing*

Offers unmatched 3D control both before and during treatment. Pitts21 reduces play by 70% and captures a couple 64% faster than a rectangular system. All of them have 30–40% less force, giving you accurate and pleasant 3D control both before and during treatment.

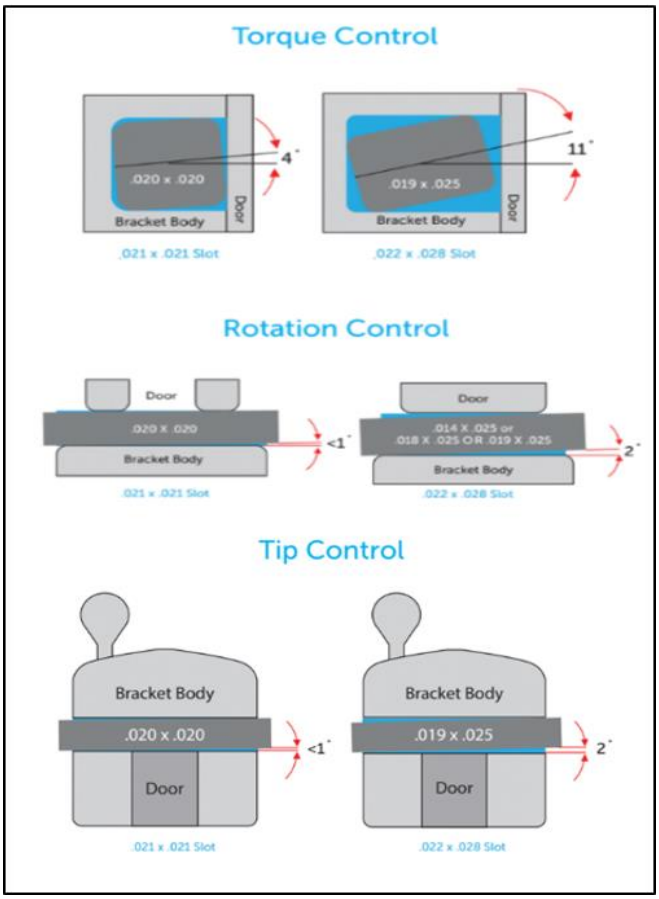

Fig 3 Torque, Rotation, and Tip Control in Pitts21

C. Progressive Slot Depth Delivers 3D Control

➢ Pitts21 system progressively varies the slot from square in the anterior to rectangular in the posterior portion of the arch.
➢ This aims to provide exceptional control of the anterior teeth while allowing for increased freedom of movement on the posterior teeth.

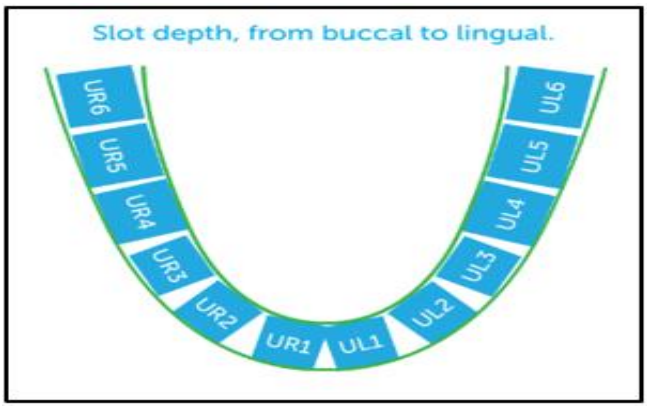

Fig 4 Slot Depth Variation

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➢ *Powerful Benefits*

- *Designed to Reduce Treatment Time*
  Improved early 3D control of torque, tip, and rotation aims to reduce treatment time. Remarkable.

- *Patient Comfort*
  Square wire finishing uses 30–40% lighter forces* with greater control than traditional rectangular wire.

- *Efficient Tooth Movement*
  True 3D control in as few as 4 wires promotes efficient tooth movement.

- *Stunning Smiles*
  Pitts active early protocols enable you to create the most stunning smiles.

➢ *Pitts21 Broad Archform*
The Pitts21 Broad Archwires have been meticulously designed to reduce extractions while achieving torsion even earlier, meaning you can finish cases faster.

➢ *As Few as Four Wires from Start to Finish*
Pitts21 system will use as few as four wire change appointments from start to finish. Fewer wires means fewer appointments for your patients, saving time and money.

Phase	Initial	Working		Finishing	Optional Archwires	
Wire	.014 Thermal Activated Nickel Titanium	.018 x .018 Ultra-Soft Thermal Activated Nickel Titanium	.020 x .020 (Upper) Thermal Activated Nickel Titanium .019 x .019 (Lower) Thermal Activated Nickel Titanium	.020 x .020 Beta Titanium (Upper) .019 x .019 Beta Titanium (Lower)	.019 x .019 Stainless Steel	.020 x .020 Stainless Steel
					Extraction Cases	Extra Width

Fig 5 Pitts 21 Archwires

D. Pitts21 Tooling Overview

➢ *H4/Pitts21 Tool*

- Excellent for opening and closing bracket doors on all Pitts21 brackets.
- Features a sloped tip that provides a comfortable angle for door manipulation.

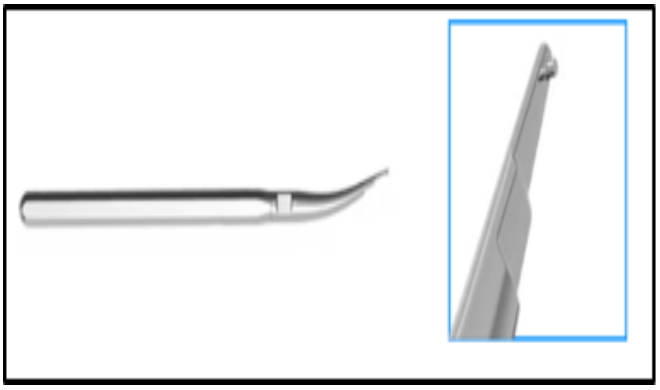

Fig 6 Pitts21 tool

➢ *Director Tool*

- Swiftly opens Pitts21 bracket doors.
- Also aids in directing wires for both removal and placement.[2]

Fig 7 Director tool

IV. "THE 14 KEYS TO PITTS CASE MANAGEMENT"

A. Active Early Concept

➢ To modify the vertical incisor location, use SAP bracket positioning.
➢ Invert bracket groups to turn on the device.
➢ To manage axial inclinations early, choose arch wire progressions.
➢ To create the arches' posterior portions, use arch forms.
➢ To control forces, use ELSE.
➢ Proper disarticulation to promote "wanted" tooth motions early

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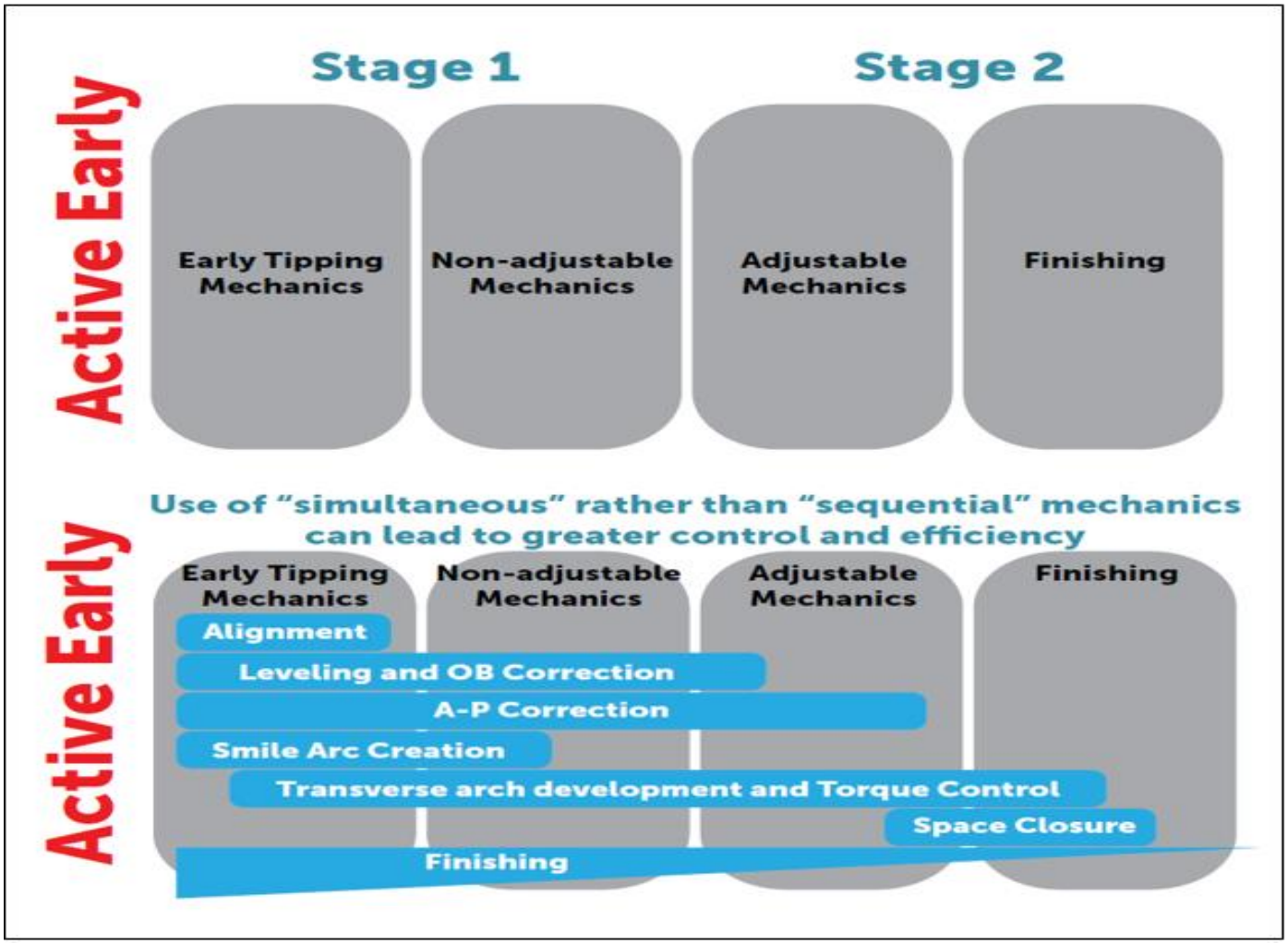

Fig 8 Simultaneous Mechanics Approach in Active Early Treatment Stages

B. Utilize PRACM to refine Aesthetic & occlusal goals

- Dr. Jim Morrish of Bradenton, Florida, refers to this as Panorex Reposition, Adjust Case Management (PRACM).
- At PRACM, disarticulation, ELSE, bracket torque (upright/flipped), bracket position modifications, the requirement for tooth re-approximation, or a change in mechanics (extraction choice, TAD placement, etc.)

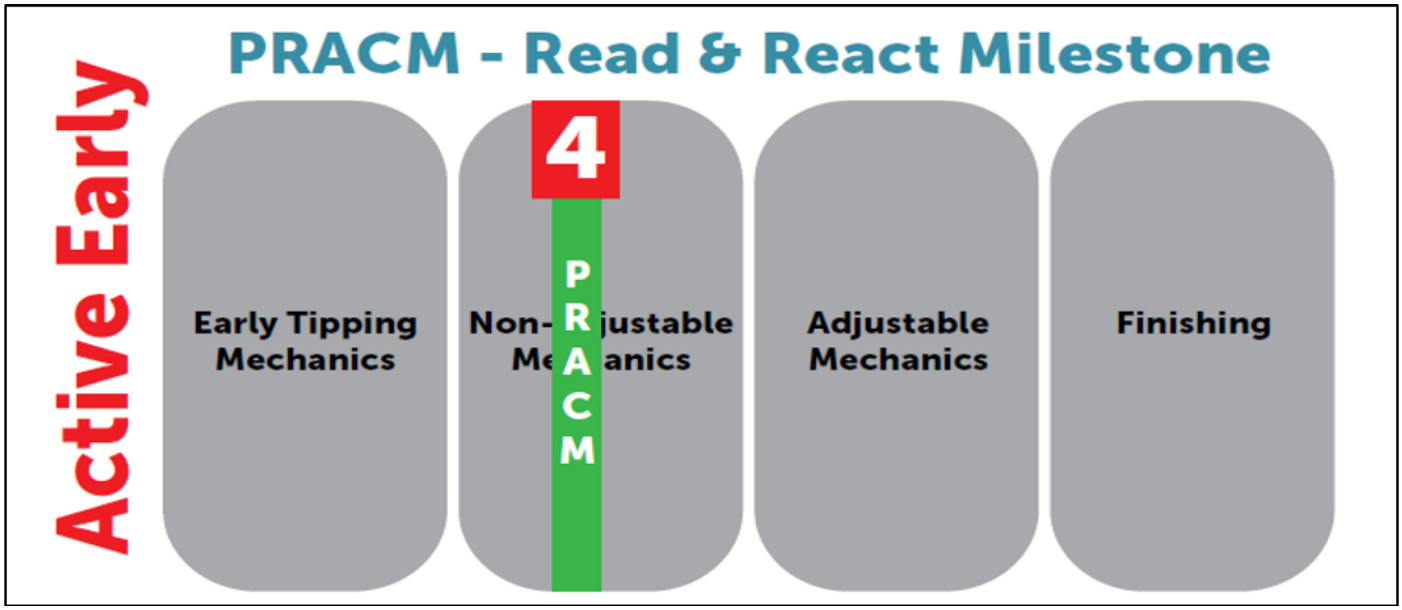

Fig 9 PRACM: Read & React Milestone in Active Early Treatment

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C. Stage 1: The 14 Keys to Case Management

- Positive and Negative Coronoplasty
- "SAP Bracket Position" as a tool in gaining optimal aesthetics
- "Bracket and Torque selection"
- "ELSE" – *Early, Light, Short, Elastics*
- "Disarticulation" – bite turbos or occlusal pads as a tool in increasing effectiveness of ELSE
- Arch Wire Selection and Progression – as a tool in controlling axial inclination early in treatment
- Patient Motivation – as a tool of controlling axial inclination early in treatment
- NMI – "neuromuscular intervention" as a tool in improving results
- "PRACM" – the critical "read and react" milestone

D. Stage 2 - Clinical Opportunities

- Arch Wire Adjustments – As a tool of controlling axial inclination, arch form, and transverse arch development
- "Overcorrection": as a tool of controlling rebound
- "CO=CR": as a tool in supporting long term joint health: treat cases to CR whenever possible
- "Micro-Aesthetic Detailing": as a tool in providing dental aesthetics
- "Tooth size refinement": as a tool in perfecting guidance systems

- *Positive and Negative Coronoplasty*

- Teeth need to be "optimized" for shape and contour.
- When done prior to bonding, aesthetic re-contouring:

- Improves bracket placement accuracy
- Maximizes the smile arc
- Optimizes axial inclination
- Controls 1st and 2nd order changes in tipping mechanics

- *Prior to bonding, it is recommended to:*

- Soften the cusp tips of the cuspids and first bicuspids
- Normalize facial irregularities
- Optimize length/width ratios of the upper anterior teeth
- Adjust contact point length
- Create appropriate embrasure spaces
- Delay slenderizing for tooth size discrepancies until after anterior alignment
- Use a white stone and black rubber tips in a high-speed handpiece for smoothing.[3]

- *Smile Arc*

- The smile arc is defined as the relationship between the curvature of the incisal edges of the maxillary incisors and canines and the curvature of the lower lip in the posed smile.
- The ideal smile arc has the maxillary incisal edge curvature parallel to the curvature of the lower lip.[6]

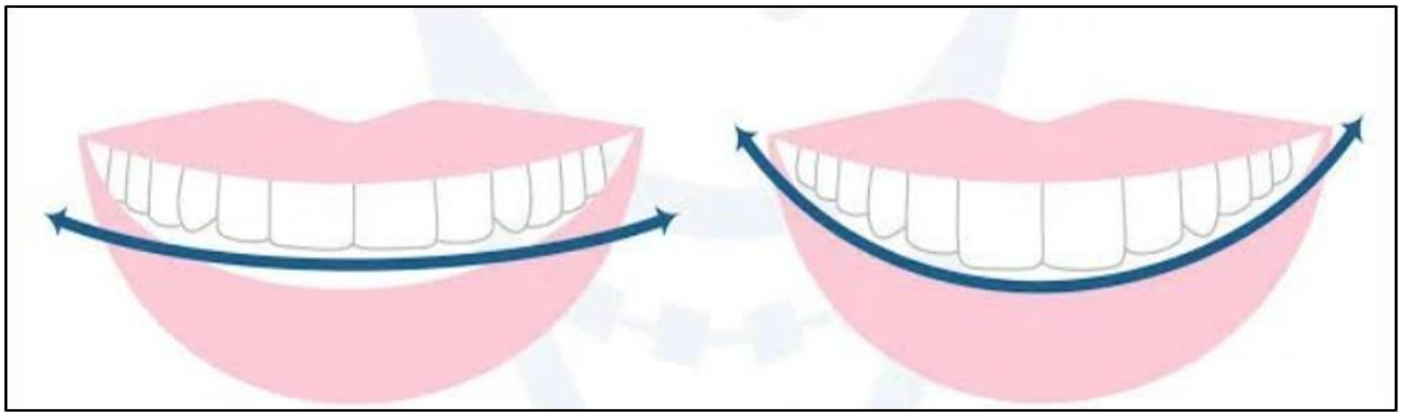

Fig 10 Smile Arc Comparison

- *SAP – Smile Arc Protection*

- Idealized inclination of the upper incisors and canines
- Idealized smile arc
- Proper incisal and gingival display
- Wide arch width, especially in the molars
- In deep bite cases, avoid over-leveling of lower incisors

- *Concept of Bracket Positioning – Maxillary Anteriors*

- The maxillary canine acts as a transition tooth between the anterior and posterior segments and helps define the smile arc.

- For occluso-gingival (O-G) placement:

- The incisal edge of the canine bracket wings should be placed on a line drawn from the mesial to distal contact at the height of contour interproximally.
- This line is referred to as the mesiodistal (M-D) contact line.

- O-G (Occluso-Gingival) positioning for central and lateral incisors is determined using the canine bracket as the reference point.
- The central incisor bracket is positioned approximately 0.5 mm more gingivally than the canine bracket.

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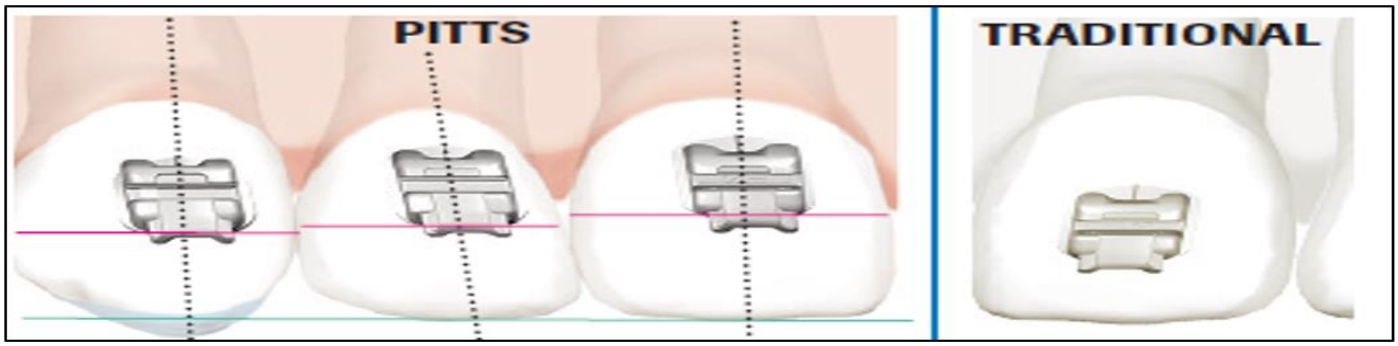

Fig 11 Bracket positioning Maxillary Anteriors

- The lateral incisor bracket is placed approximately 0.25 mm more incisal than the central incisor bracket.
- Placing brackets too incisal disrupts the smile arc and reduces torque control.

➢ *Bracket Positioning – Maxillary Premolars*

- Align the scribe line of the maxillary first and second premolar brackets with the crown-long axis at the height of contour, paralleling the central groove and the mesiodistal (M-D) buccal line angle
- The second premolar bracket may at times appear mesial to the height of contour.
- The occlusal edge of the bracket wings should align with the M-D contact line.

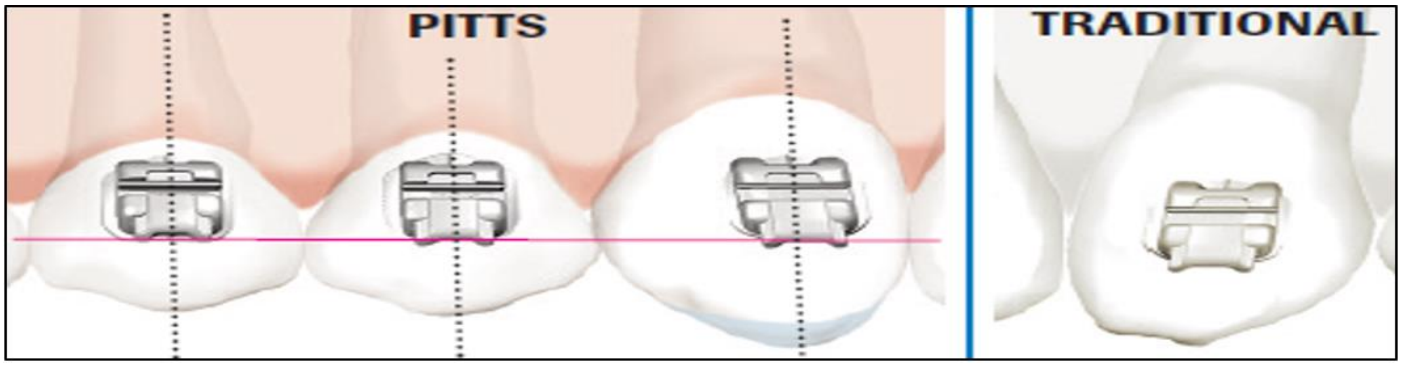

Fig 12 Bracket Positioning Maxillary Premolars

➢ *Bracket Positioning – Maxillary Molars*

- The mesial aspect of the bracket should be placed in the middle of the mesio-buccal cusp.
- For a smooth cusp height transition from the first molar to the second premolar, align the occlusal edge of the first molar tube with the mesiodistal (M-D) contact line.
- For O-G (occluso-gingival) positioning of the second molar tube: The bracket is positioned approximately 1.5 mm more occlusally than the first molar bracket.

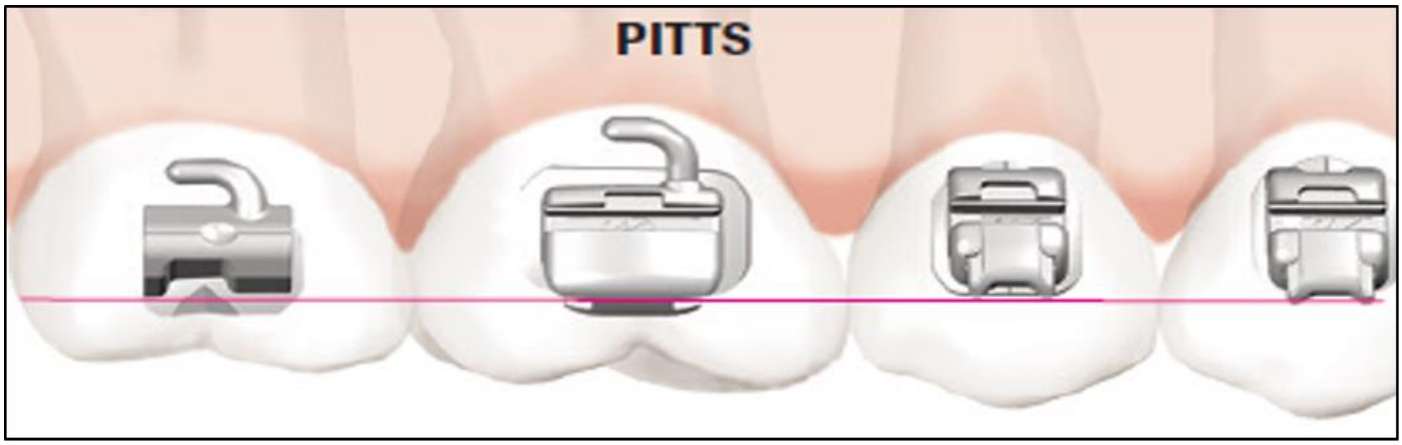

Fig 13 Bracket positioning Maxillary molars

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➢ *Bracket Positioning – Mandibular Incisors*

- M-D Positioning: Align the scribe line of the bracket with the crown-long axis at the height of contour.
- O-G (Occluso-Gingival) Positioning depends on the vertical bite relationship:

- *Deep Bite:*

✓ Brackets are placed more incisally, approx. 3.5 mm from the incisal edge.
✓ Aids in bite opening when used with maxillary anterior bite turbos.

- *Open Bite:*

✓ Brackets are placed more gingivally, approx. 5 mm from the incisal edge.
✓ Helps with extrusion to close the open bite.

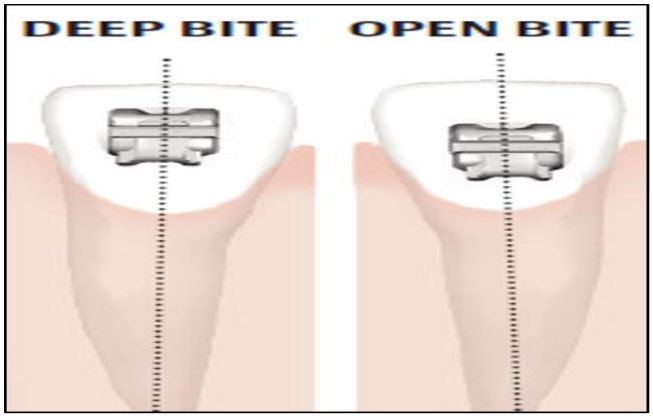

Fig 14 Bracket Positioning Mandibular Incisors

➢ *Bracket Positioning – Mandibular Canines*

- M-D (Mesio-Distal) Positioning: Align the scribe line of the bracket with the crown-long axis at the height of contour.
- O-G (Occluso-Gingival) Positioning: The incisal edge of the bracket wings should be placed on the mesio-distal contact line.

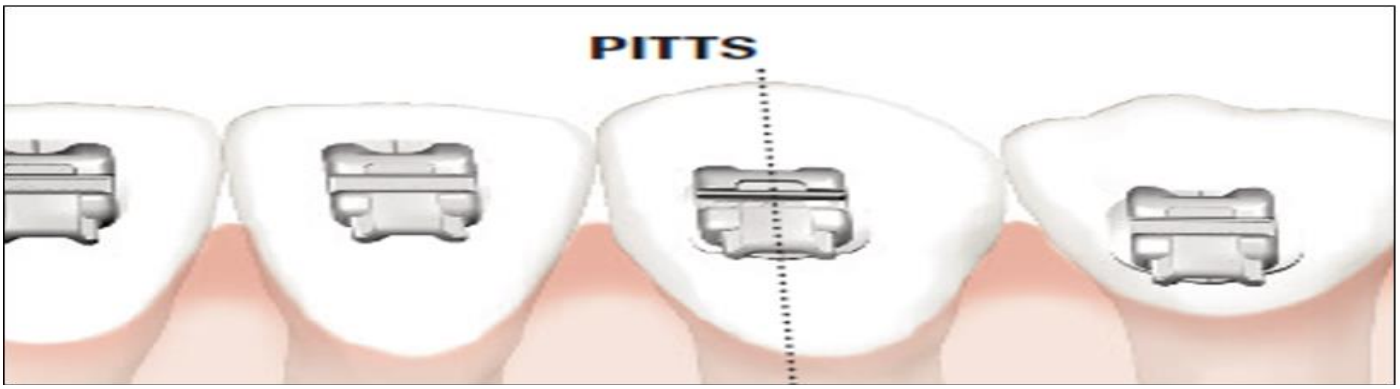

Fig 15 Bracket Positioning Mandibular Canines

➢ *Bracket Positioning – Mandibular Premolars*

- M-D (Mesio-Distal) Positioning: Align the scribe line of both mandibular first and second premolar brackets with the crown-long axis at the height of contour.
- O-G (Occluso-Gingival) Positioning: Place the occlusal edge of the bracket wings 0.5 mm gingival to the M-D contact line.

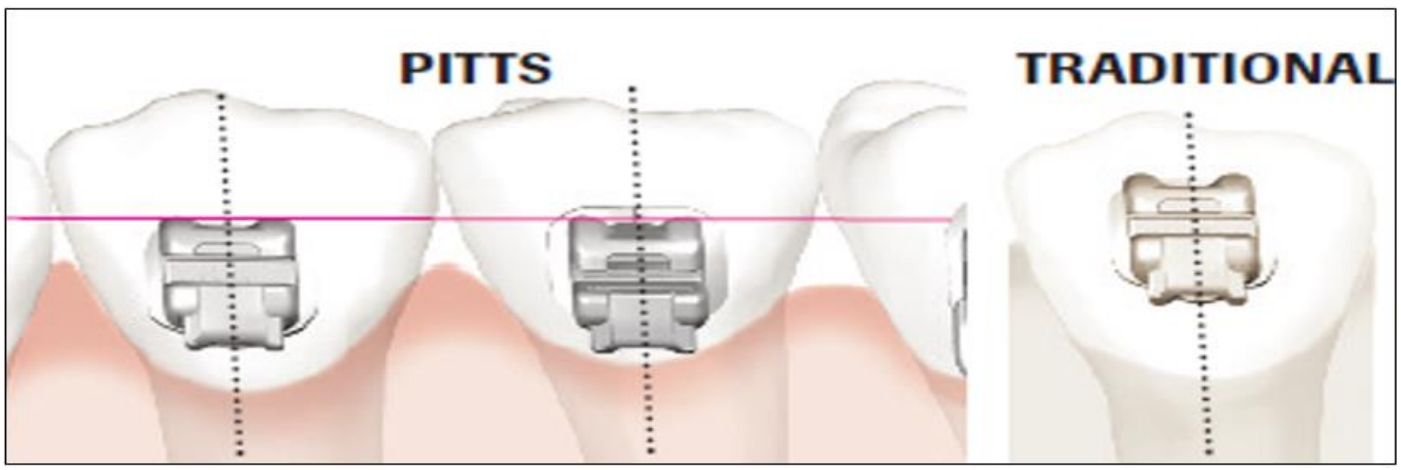

Fig 16 Bracket Positioning Mandibular Premolars

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➢ *Bracket Positioning – Mandibular Molars*

- M-D (Mesio-Distal) Positioning: Center the buccal groove of the molar tube over the buccal groove of the tooth.
- O-G (Occluso-Gingival) Positioning: Position the occlusal edge of the bracket 0.5 mm gingivally to the M-D contact line

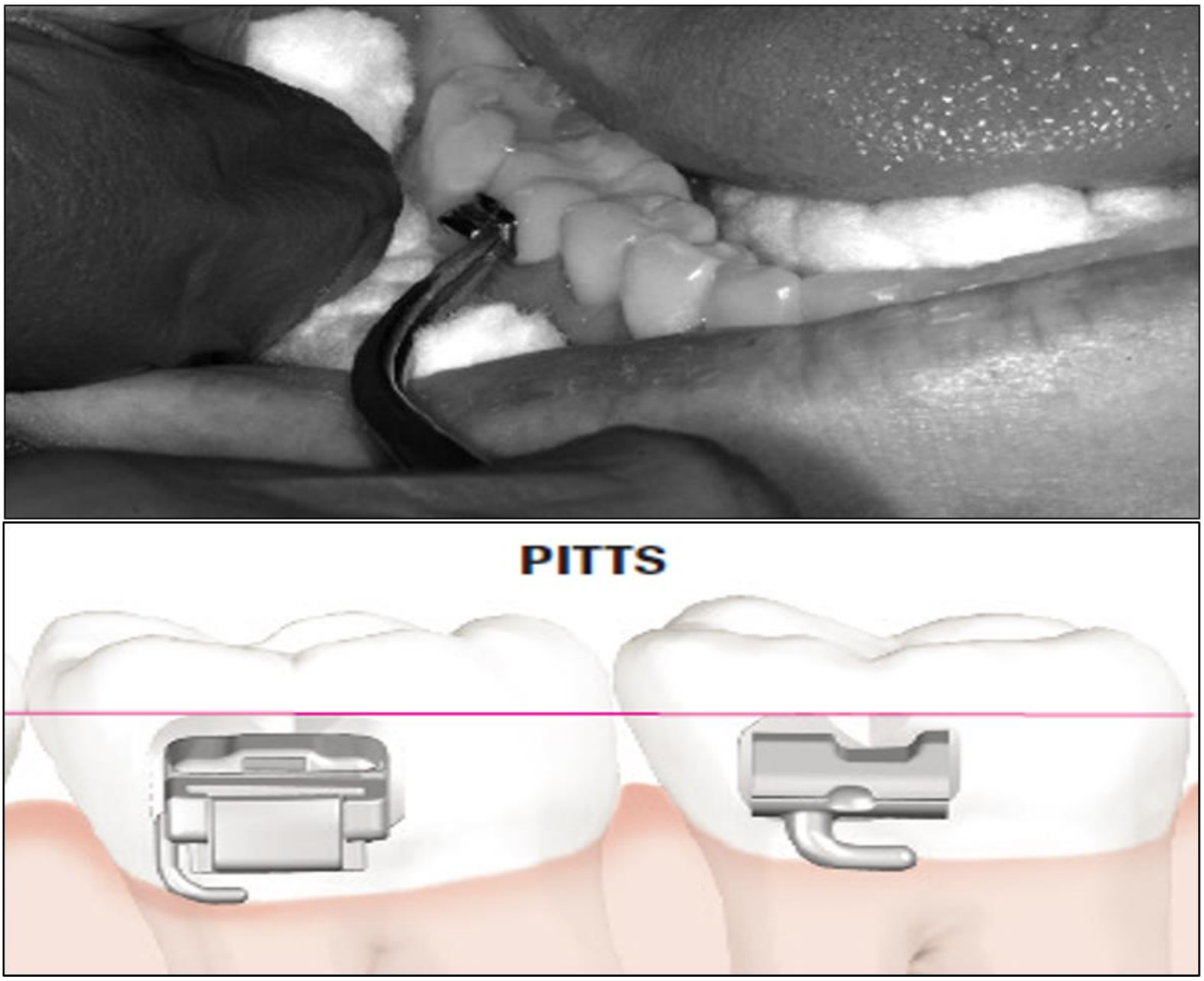

Fig 17 Bracket Positioning Mandibular Molars

➢ *Bracket and Torque Selection*

Factors Affecting Actual Torque Expression include; Bracket design, Wire/slot play (engagement angle), Mode of ligation, Bracket deformation on loading, Wire stiffness, Magnitude of wire torsion, Corner radius, Initial tooth position, Bracket position, Tooth anatomy

➢ *SAP – Smile Arc Protection Approach:*

- Bracket placement guided by aesthetic requirements.
- This enhances third-order control (torque control), offering clinical advantages.
- SAP Bracket Positions & Axial Inclination Control
- SAP bracket positioning reduces the angle of engagement between the wire and the bracket slot.[3]

➢ *"ELSE" – Early, Light, Short, Elastics*

Early Light Elastics Protect the Smile Arc by Correcting at the Same Time as Arch Leveling. The fundamental idea behind the Damon concept is to maintain optimal tooth mobility during all stages of treatment by applying appropriate forces in large passive bracket lumens. When Class II, Class III, deep bite, open bite, and even crossbite elastics are needed, their use enables a gradual progression.

➢ *Appropriate Disarticulation*

One significant "Active Early" component is the use of OGs (occlusal guides) to modify the occlusal plane and optimize desired and decrease undesired tooth movements. When teeth are disarticulated, they move easily and with little force. To enhance appearance and functionality, it is crucial that OGs are positioned carefully to erupt or intrude the proper teeth.

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➢ *Arch Width and Arch Form*

When Pitts Broad arch forms are used, arch width may be developed early in locations where it would have the biggest aesthetic impact. There is a significant degree of transverse development, according to research. Achieving the proper buccal segment inclination is crucial for both occlusal performance and aesthetics.

➢ *Pitts Broad Archwire Progression*

- *Start with Light Thermal Activated NiTi:*

✓ 014 TA NiTi or .018 x .018 Ultra Soft TA NiTi
✓ Next Step: .020 x .020 TA NiTi
✓ From Here, Two Main Progressions:

- *Option A (Flexible):*

✓ 018 x .025 TA NiTi
✓ Then to:
✓ 021 x .025 TA NiTi
✓ Or .017 x .025 Beta Titanium (BT)
✓ Or .019 x .025 BT

- *Option B (Stiffer Early):*
  .020 x .020 Beta Titanium (BT)

➢ *Torquing Power Chains*

Early in treatment, axial inclination is controlled using i2, i3 torquing power chains to aid in early torque control. The use of incisal torquing elastomeric chain to reduce undesired tooth tilting during crowding relief is proving to be highly beneficial, particularly when the anterior brackets have not been "flipped."

➢ *Square Wire Early*

Developed a wire progression technique that enables the orthodontist to start controlling axial inclination through torsion that forms inside the slot far sooner in the course of therapy than was previously feasible. Early torsion within the slot can be started with 0.020X0.020 TA Niti wires, usually by the second or third visit. Often, "Square Wire" finishing offers a quick, easy, and effective way to achieve beautiful results.[5]

V. ADVANTAGES AND DISADVANTAGES

A. Advantages of the Pitts Self-Ligating System

➢ *3D Control Early & Throughout Treatment*

- The first and only system designed to achieve 3D control from the early stages.
- Enhances control over torque, angulation, and in-out positioning early on.

B. Square Wire Finishing

- Employs 30–40% lighter forces.
- Results in:

✓ Greater biological efficiency.
✓ Improved patient comfort.
✓ Better sliding mechanics.
✓ Enhanced control of final tooth position.

➢ *Progressive Slot Technology*

Combines Freedom of movement for early alignment and Control as treatment progresses. Allows smooth transition from passive to active control within the same bracket.

➢ *Single Prescription Inventory*

- Streamlined inventory system.
- Reduces clinical complexity and overhead.

➢ *Predictable Finishes in as Few as 4 Wires*

- Drastically simplifies treatment mechanics.
- Contributes to shorter treatment times and more consistent outcomes.

VI. DISADVANTAGES OF THE PITTS SELF-LIGATING SYSTEM

➢ *Bracket Slot "Slop"*

- Excessive play in the bracket slot can reduce precision.
- Leads to:

✓ Difficulty in expressing torque, especially in the anterior region.
✓ Inconsistent rotation control during initial phases of treatment.

➢ *Technique Sensitivity*

- Requires High degree of clinical experience and precision in bracket positioning—critical for expected outcomes.
- Mistakes in bracket placement may compromise control and finishing.

➢ *Time-Consuming Bracket Placement*

- Initial bonding process can be labor-intensive.
- Demands an experienced chairside assistant to maintain efficiency.

VII. FINITE ELEMENT ANALYSIS AND COMPARATIVE STUDIES

The biomechanical performance of the **Pitts 21™ self-ligating bracket system** has been evaluated in several **finite element analysis (FEA) studies**, offering valuable insight into its effectiveness in torque expression, stress distribution, and tooth movement compared to other popular bracket systems such as **Damon Q** and **MBT**. These comparative studies provide strong support for the clinical claims associated with the Pitts 21 system's efficiency and precision.

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A. Torque Expression at Varying Bracket Heights

A 2024 FEA study by **Bernisha et al.** evaluated torque expression in **Pitts 21 vs. Damon Q** brackets at different bracket bonding heights (5–8 mm), using a 0.020" × 0.020" TMA wire. The Pitts 21 system demonstrated:

- Higher torque moments at every bonding height
- Greater incisor movement with reduced wire slop
- More efficient third-order control

These findings were attributed to the square slot geometry (0.021" × 0.021") in the Pitts 21 system, which allows tighter engagement and earlier torque activation, even when brackets are placed more gingivally for aesthetic purposes (e.g., SAP protocol).[9]

B. Comparative Performance Across Different Incisor Inclinations

In another 2024 study by **Satapathy et al.**, FEA models were used to compare **torque efficiency** of Pitts 21 and Damon Q brackets at various incisor inclinations (0°, 5°, 10°, 15°, 20°). The results showed:

- Pitts 21 delivered **higher torque moments** and **greater tooth deformation** across all inclination angles
- **Von Mises stress** levels were higher with Pitts 21, indicating more effective energy transfer to the tooth
- *Reduced torsional play, improving the accuracy of root positioning*

The study concluded that Pitts 21 brackets offer more **consistent torque delivery**, particularly when managing highly proclined incisors, a common concern in adult orthodontics.[10]

C. Pitts 21 vs. MBT System

Another FEA investigation compared the torque behaviour of **Pitts 21 (square slot)** and **MBT (rectangular slot)** brackets using a 0.020" × 0.020" SS wire for Pitts and 0.019" × 0.025" SS for MBT. The results highlighted that:

- Pitts 21 exhibited **greater torque expression (13.8 N-mm)** compared to MBT (10.68 N-mm)
- **Less torsional play** was observed in Pitts (6.2°) vs. MBT (9.32°)
- Pitts 21 achieved **more precise root movement** in the labiolingual direction[13]

Despite higher stress concentrations in the cortical bone, the overall **biomechanical efficiency** of the Pitts 21 system was superior, making it a more effective option for aesthetically focused and torque-sensitive treatments.[11]

VIII. CLINICAL IMPLICATIONS

These FEA studies confirm that the **square-slot architecture** of the Pitts 21 bracket allows:

- Earlier and more effective torque control
- Reliable third-order movement even in aesthetic bracket positions
- Enhanced predictability in smile arc protection cases
- *Fewer mechanical compensations during finishing*

While in vitro and simulation data are promising, further **in vivo clinical trials** are encouraged to validate long-term outcomes, particularly in complex malocclusions and adult cases.[9,10,11]

IX. CONCLUSION

The Pitts 21™ bracket system represents a significant advancement in contemporary orthodontics by integrating biomechanical efficiency with aesthetic treatment goals. Through its unique 0.021" × 0.021" square slot, progressive slot architecture, and early 3D control capabilities, the system supports precise torque, tip, and rotational control from the initial stages of treatment.

When combined with protocols such as Smile Arc Protection (SAP), the Active Early concept, and strategic case management tools like ELSE and PRACM, Pitts 21 enables clinicians to deliver highly aesthetic, stable, and efficient outcomes. Its design supports fewer wire changes, reduced treatment time, and improved patient comfort, all while maintaining a strong emphasis on smile design and facial harmony.

As digital orthodontics and patient expectations continue to evolve, the Pitts 21 system offers a forward-thinking approach that prioritizes both function and aesthetics. Its application empowers orthodontists to plan with the end in mind and consistently achieve artistic and predictable results

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