

# Evolution of Pre-Adjusted Edgewise Appliance in Orthodontics

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## Abstract:

In the nineteenth century Dr. Edward Hartley Angle worked hard to establish orthodontics as a specialty in dentistry. He revolutionized the orthodontics treatment with the invention of first fixed appliance system, the edgewise appliance. Later, Andrews Straight Wire appliance was another breakthrough for the orthodontic practitioners. Various modifications and improvements in the pre-adjusted appliance have been made available since then. The purpose of this article is to review the various pre-adjusted appliance prescriptions in orthodontics starting from the Andrews Straight wire appliance, Roth, Ricketts Bio progressive therapy, Alexander's discipline, Bidimensional system, McLaughlin Bennett Trevisi, Viasis Bio efficient brackets, self-ligating system, Butterfly system, Sugiyama's Evidence-Based Asian prescription, Variable Prescription Orthodontics, and Lingual orthodontics followed by a look into the future with aligners and myobrases.

**Keywords:** Straight wire appliance, various pre-adjusted appliance prescriptions, aligners, mvobrases.

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## INTRODUCTION

Orthodontics has always strived to control tooth movements in all planes of space to obtain the ideal occlusion: the results of researches have led to the evolution of the edgewise appliance.<sup>[1]</sup>

In the last decades, orthodontists have tried to define the parameters of an ideal occlusion and to enhance and improve the straight wire appliance. A number of preadjusted edgewise appliance prescriptions have been made available since then like the Roth (1976), McLaughlin Bennett Trevisi(1993-1997), Rickett's Bio progressive therapy(1976), Alexander's discipline(1978), Viasis Bio efficient brackets(1995), Gianelly's Bidimensional system(1985), Butterfly system(2003), Sugiyama's Evidence Based Asian prescription, Self-ligating systems, etc. <sup>[2-5]</sup>. Moreover, advances in the field of diagnostics have led to change in the treatment philosophy of orthodontic treatment and development of the lingual systems. Also, with the increasing demand for aesthetics,

myobrases and aligners have brought about a complete evolution in the orthodontic treatment.<sup>[2-5]</sup>

The purpose of this article is to review the history of fixed appliances in orthodontics and compile a brief description of various new pre-adjusted edgewise appliance prescriptions.

## Various fixed appliance systems

### A) Straight wire appliance

Andrews is regarded as the father of the pre-adjusted bracket system. He developed the first pre-adjusted edgewise appliance system in 1972 called the Straight Wire Appliance. Straight wire appliance was a radically new appliance which employed traditionally heavy edgewise forces. Andrew based the bracket positioning on the center of clinical crown. He used the basal bone of the mandible as an arch form reference and also emphasized the 'wagon wheel effect' where tip is lost as torque is added. He developed multiple bracket system for extraction and non-

extraction cases. Also, he recommended the use of three different sets of incisor brackets, with varying degrees of torque for different clinical situations.<sup>[1,6-12]</sup>

#### b) Roth prescription

Roth saw in the original straight wire appliance, mainly the need to place compensating and reverse curves in the upper and lower arches. Therefore in 1976 he introduced the Roth prescription, the second generation bracket system. He also noticed that anchorage was a problem in some cases. He over-corrected the teeth and then let the teeth settle into the final position. His principle was to fill the slots with a full-size arch wire (0.022"x0.028") while Andrews used the maximum size 0.018"x0.025". Roth explained that if the arch wires were firmly tied into the bracket slot then it would remain there no matter how far the tooth was moved.<sup>[13-15]</sup> Several years of clinical evaluation led to the conclusion that he could treat the majority of cases with a single prescription with over-correction in all planes of space to meet the six keys of Andrews. He did this with full size arch wires, rarely placing offset bends, with the arch wires being flat to level the curve of Spee. Positioning was more incisal on the anterior teeth than recommended by Andrews to accomplish this. Hooks were added to the posterior brackets for the use of short Class II and III elastics.<sup>[13-15]</sup>

#### C) McLaughlin Bennett Trevisi prescription

Richard McLaughlin, John Bennett, and Hugo Trevisi worked together in 1993-1997 to develop the third generation bracket system known as the MBT prescription. McLaughlin Bennett Trevisi is a version of the pre-adjusted bracket system specifically for the use of light, continuous forces, lace backs and bend backs, and it was designed to work ideally with sliding mechanics.<sup>[16,17]</sup>

The McLaughlin Bennett Trevisi measurements are based on Andrew's original research figures except it has for 10° less distal root tip in the upper anterior segment and 12° less distal root tip in the lower anterior segment. Hence, there is no compromise in the ideal static occlusion. And if

condyles are in centric relation, there is no compromise in the ideal functional occlusion as described by Roth.<sup>[16,17]</sup>

#### d) Ricketts Bio progressive Therapy

Dr. Robert Murray Ricketts introduced the concept of Bio progressive therapy in 1976. The biological concept of growth was applied in the manner that would help normalize the physiology and improve the aesthetics. The term "bio" is used to suggest the strong biologic implications to be constantly borne in mind with the technique, and the term "progressive" stands for the treatment sequence. He gave importance to growth and orthopaedic changes. In this technique; Dr. Ricketts used a .0185 x .030-inch slot bracket for ease of wire placement and use of overlaid arches. The concept of utility arch and sectional arches was first evolved by Ricketts.<sup>[18,19]</sup>

#### E) Alexander Discipline

R. G. Wick Alexander developed the Vari-simplex discipline in 1978. The 'vari' indicates the variety of brackets used, 'simplex' signifies the principle of 'Keep It Simple Sir', and 'discipline' is to reflect the idea that orthodontist must be knowledgeable in edgewise mechanics. He believed that the orthodontist must play an active role in the application of the appliance to the individual patients.<sup>[20]</sup>

#### F) Bidimensional systems

It is first bidimensional approach in which, 0.016-inch brackets are used on the anterior teeth (canine to canine), while 0.022-inch brackets on the posterior teeth. A 0.016"x0.022" stainless steel arch wire is engaged with a 90-degree twist made distal to the canines, so as to "full-sized" fill the anterior section as "edgewise," while the buccal sections are filled as "ribbon" with 0.022"x0.016" arch wire.<sup>[21]</sup>

Later the bidimensional technique was developed. In this system, pre-adjusted edgewise brackets with a 0.018-inch slot on incisors and a 0.022-inch slot on canines, premolars and molars are used. All the brackets have vertical slots that allow for an array of auxiliaries, such as up

righting springs. Smaller brackets (0.018x0.025-inch) on incisors provide three-dimensional control on incisors and "tight fit" as well as larger brackets (0.022x0.028-inch) on posterior teeth provide "loose fit" which facilitates sliding mechanism.<sup>[23]</sup>

Over the years after the bidimensional technique, certain modifications were done to enhance the efficiency of this technique. It is known as the dual-slot system. In this technique, 0.018-inch slot is used on anteriors and 0.022-inch slot used on posteriors. This allows the use of more stiffer wire (0.018-inch wire into 0.022-inch slot) preventing notching, deformation and increases the efficiency of retraction and greater torque control on anteriors with a 0.018-inch slot, since the 0.022"x0.028" wire is too stiff in the 0.022-inch slot.<sup>[24-28]</sup> Nowadays, only the bidimensional-slot technique is used, and the bidimensional wire technique is rarely used.<sup>[24]</sup>

#### G) Viasis Bio efficient therapy

Dr. Anthony D. Viasis in 1995 introduced the Bio efficient therapy. It is a patient-friendly and user-friendly system, designed to shorten the time-consuming initial phase of treatment. By proceeding more quickly to an individualized finishing stage, it reduces burnout for both patient and clinician and produces noticeable results early in treatment, improving patient cooperation and the quality of care.<sup>[29]</sup> Viasis developed a single multifunctional bracket providing optimal tooth movement. The triangular bracket design helps conformity to crown anatomy and gingival outline, allow easy placement, minimizes friction since the bracket slot is elevated from the horizontal member. In his new bracket design, as soon as a tooth begins to tip (as in space closure), the arch wire contacts the side elbows, and the single slot momentarily becomes a wide twin slot that produces root movement before any further crown movement. Thus, the tooth "walks" back in a zigzag fashion. High anterior torque was added to counteract any tipping effect produced by active mechanotherapy, especially during space closure.

A vertical slot feature was added to improve clinicians' efficiency.<sup>[29]</sup>

#### H) Butterfly system

It was developed by Dr. S Jay Bowman in 2003 as a hybrid, third-generation appliance, the Butterfly System. It is based on a new low-profile, twin-wing bracket. The bracket's reduced profile, its miniature twin-wing design and rounded tie wings, and the elimination of standard hooks are the main features of the appliance. It is thus, more comfortable, aesthetic, and hygienic appliance. It has several unique features, designed in response to the findings of the American Board of Orthodontics.<sup>[30-32]</sup>

Some important features of this system are the versatile vertical slot, reversible second premolar brackets, progressive posterior torque, progressive mandibular anterior tip, angulated first molar attachments, preventive mandibular anterior torque, conservative anterior torque and bonding pad enhancements.<sup>[30-32]</sup>

#### I) Sugiyama's Evidence-Based Asian prescription / protorque system

Dr. Raymond Sugiyama has researched the differences between various ethnic groups during 1990s. His findings showed statistically significant differences in the dental anatomy and cephalometric measurements between Caucasians and Asians. According to Sugiyama's research, Asian teeth are wider mesiodistally and have fewer angulations than Caucasian teeth. Also, the upper and lower incisors of Asian teeth are more proclined, in relation to basal bone, than Caucasian teeth, which results in a reduced interincisal angle. These evidence-based findings led to the development of the Sugiyama's Evidenced-Based Asian (SEBA) prescription. SEBA prescription has higher torque and lower angulation which keeps the teeth in the middle of the basal bone during orthodontic movement, thereby lessening the chance for root resorption. It offers patients the advantages over the Caucasian based straight wire systems.<sup>[33,34]</sup>

Later, Dr. Raymond Sugiyama and Dr. Mauricio Gonzalez Balut studied the Asian, Black, and Latin-Hispanic patients compared to the

Caucasian population and which led to the development of the protorque system.

#### J) Self-ligating system

The concept of self-ligating brackets is not new, having been described initially in 1935 with the Russell Lock edgewise attachment. The purported advantages of the early systems included a 50% improvement in operator efficiency. A resurgence in popularity of self-ligation occurred in the 1990s, reflecting further refinement, with many self-ligating systems having since been patented.<sup>[35-38]</sup>

A self-ligating bracket is a ligature-less system with a mechanical device built in to close off the edgewise slot. Secure engagement may be produced by a built-in metal labial face or by a clip mechanism replacing the stainless steel or elastomeric ligature. Both active and passive self-ligating brackets have been developed, referring to the bracket-arch wire interaction. The active type has a spring clip that presses against the arch wire. In the passive type, the clip or rigid door does not actively press against the arch wire. Active self-ligating appliances allow better torque control with undersize arch wires as compared to the passive appliances. The storage of potential energy in a spring clip of the active appliances also enhances the potential for labiolingual alignment. The resistance to sliding is thought to be lower for passive appliances.<sup>[35-38]</sup> Recent products include the Smart Clip 2, In-Ovation C,\* and Damon 3MX.<sup>[35-38]</sup>

#### K) Variable prescription orthodontics (VPO)

The evolution of orthodontics has introduced a new concept in treatment planning. Each malocclusion shows differences in the inclination of posterior and anterior teeth in both arches, so the information inside the bracket must be chosen considering the occlusal features before choosing the treatment and the biomechanics to achieve the final result. The different characteristics that could be found inside a malocclusion led to the development of different prescription of torque for the upper and lower six anterior teeth. This is known as 'Variable Prescription Orthodontics' (VPO). The aim of this individualization is to

achieve a better functional and aesthetic outcome, with less risk of orthodontic relapse.

Nowadays, the authors that most emphasized the VPO concepts are Anup Sondhi and D. Damon. They suggest that the correct torque value has to be selected considering the patient malocclusion and periodontal characteristics, the inter- and intra-arch variables and the class correction biomechanics. All the possible clinical combinations lead to high-, standard and low-torque prescriptions for upper and lower anterior teeth: the high torque values are taken by Hilgers, the standard torque correspond to the MBT values, whereas the low torque values are the Roth values.<sup>[39]</sup>

#### L) Lingual Orthodontics

During 1970s, a Japanese orthodontist, Dr. Kinja Fujita, developed a lingual orthodontic appliance, not primarily for aesthetic reasons but rather to protect the soft tissues (lips and cheeks) of his orthodontic patients who practiced martial arts. Independently, in the United States of America, Dr. Craven Kurtz worked to develop a lingual appliance at this time. Lingual orthodontics since then has advanced to a highly sophisticated level where CAD/CAM (computer-aided design/computer-aided manufacture) technology is employed to manufacture both the brackets and arch wires for each patient individually.<sup>[40-42]</sup> The bracket design for lingual orthodontics is given special considerations like the brackets are made as narrow as possible to increase inter-bracket distance. Vertical slots for auxiliaries are added for better mesiodistal root control. Indirect-bonding procedures are employed with pre-angulated and pre-torqued brackets and also considerations are made for ease of insertion, ligation and removal of arch wires.<sup>[40-42]</sup>

The present seventh generation of lingual appliances has a heart-shaped maxillary anterior inclined plane and large anterior inclined plane for lower anterior brackets with short hooks. The mesiodistal width of premolar brackets is increased to allow for better angulation and rotation control and molar brackets come with either a hinge cap or a terminal sheath.<sup>[43]</sup>

## Recent advances

### A) Aligners

One of the major challenges in orthodontics is the ability of achieving an excellent result with appliances that are both aesthetic and comfortable. There is currently enormous interest in the 'invisible orthodontics'; this is contributed by the intensive marketing campaigns run by the manufacturers of various removable clear aligner systems.<sup>[42]</sup>

Clear plastic appliances have gained tremendous popularity and acclaim within the public and the clinician. This invention is primarily due to the advancement in clear durable materials, sensitive technique, the population of teens with 'cool factor' and adults who wish for appealing smile and dentition without metal braces and fixed appliance.<sup>[44]</sup>

INVISALIGN emerges to be the one among clear plastic appliance. Invisalign is a trademark held by the developers of the system "ALIGN TECHNOLOGY INC." introduced in June 1999 in the USA. This appliance was the first orthodontic treatment method to be based solely on three-dimensional (3D) digital technology. The company claims that more than 2, 50,000 patients are being treated using this system. Invisalign provides a unique way to align teeth and give excellent results with minimum efforts. Though, treatment with clear aligner does not produce as perfect results as traditional braces. However, when used appropriately, Invisalign can replace antiquated braces.<sup>[44]</sup>

### B) Myobracess

Over the last 20 years, myofunctional research cooperation (MRC) has developed orthodontic appliances to improve the dental and facial development of children from years of age, using myofunctional orthodontic techniques instead of traditional orthodontics. The treatment using MRC's appliance system can avoid the limitations of fixed appliances while achieving better results and improved case stability all with less chair side time.<sup>[45]</sup>

Myobracess, introduced in 2004, are preformed orthodontics devices, designed for the treatment

of malocclusion in the late mixed dentition (8-12 years). It can also be used in adult patients, non-extraction cases, and mild or moderate malocclusions. It works by promoting the balance of facial and masticatory muscles, and improves the posture of the tongue to get a myofunctional effect, together with a dental alignment and mandibular development.<sup>[45]</sup>

### Conclusion:

A variety of pre-adjusted edgewise appliances have been made available since Straight wire appliance. Some comparative studies done between the McLaughlin Bennett Trevisi and Roth prescription showed that the bracket prescription had no effect on the subjective and aesthetic judgments of post-treatment study models.<sup>[46]</sup> Also the differences in torque values between the two prescriptions do not lead to any clinically significant detectable differences in the final inclination of teeth.<sup>[47]</sup>

However, there are few studies in the literature comparing other pre-adjusted edgewise prescriptions. Therefore, more studies are needed to specify the use of a particular prescription in specific malocclusions like Class II division 1, Class II division 2, or Class III, whether involving or not involving extractions.

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