Review Article

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EVOLUTION OF ORTHODONTIC APPLIANCES-THEN AND NOW!!!

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ABSTRACT:

Aim: The aim of the review article is to give a detailed description of the evolution of orthodontic appliances from the ancient to modern era.

Materials and methods: Various orthodontic journals were electronically searched and the following data were collected.

CONCLUSION: Orthodontics had its beginnings in the time of the ancient Egyptians, who used crude metal bands and catgut, but it was not until the late 18th century that the first practical appliances came into use. These were fine-tuned during the early 1900s and today's mechanisms are merely refinements. Major changes in appliances occurred when practitioners, originally physicians, began turning their attention from cosmetic "regulating" to occlusion and stability. The purpose of this article is to review the evolution of various orthodontic applainces from ancient to the modern era.

Keywords: Orthodontic Appliance,Functional Appliance,Edgewise Appliance.

INTRODUCTION:

Man has been striving for generations to improve his looks, his appearance- what he calls the aesthetic value.The face and the teeth have also come to play a part in his presentation to the outside world. To enhance this desire, attention has been given to correct malformations of teeth keeping patient's considerations in mind.

The history of orthodontic appliances dates back to the time of the ancient Egyptians, who used crude metal bands and catgut, but it was not until the late 18th century that the first practical appliances came into use. From evidence found in human skulls, crooked teeth have been around since the time of Neanderthal man (about 50,000 bc), but it was not until about 3000 years ago that we had the first written record of attempts to correct crowded or protruding teeth. Long before braces, long before the word "orthodontics" was coined, it was known that teeth moved in response to pressure. Primitive orthodontic appliances have been found with Greek arts . Archaeologists have discovered Egyptian mummies with crude metal bands wrapped around individual teeth. It is speculated that catgut was used to close the gaps.[1,2]

According to the literature, Aristotle and Hippocrates first thought about methods for straightening teeth between 400 and 300 BC. The Etruscans, in what we now know as Italy, buried their dead with appliances that maintained spaces and prevented collapse of their teeth and jaws during life.Archaeologists have discovered mummified remains in

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various locations that have metal bands wrapped around the teeth. A Roman tomb has also been discovered in which the teeth were bound with gold wire, including documentation on the wire's use as a dental device.

HISTORY

DURING 18TH CENTURY

The French dentist Pierre Fauchard is acknowledged as the father of modern dentistry. In 1728 he published a book that described various methods for straightening teeth. Fauchard also used a device known as a "blandeau" to widen the upper palate.

Louis Bourdet was another French dentist who published a book in 1754 that discussed tooth alignment. Bourdet further refined the blandeau and was the first dentist to extract bicuspids, or the premolar teeth between canines and molars, for the purpose of reducing tooth crowding.[3]

DURING 19TH CENTURY

Orthodontics started to become a separate dental specialty during the early 19th century. The first wire crib was used in 1819, marking the beginning of modern orthodontics. During this period, gold, platinum, silver, steel, gum rubber, vulcanite, and occasionally wood, ivory, zinc, and copper were used — as was brass in the form of loops, hooks, spurs, and ligatures. Edward Maynard first used gum elastics in 1843 and E. J. Tucker began making rubber bands for braces in 1850.Norman W. Kingsley published the first paper on modern orthodontics in 1858 and J. N. Farrar was the first dentist to recommend the use of force over timed intervals to straighten teeth.[3]

DURING 20TH CENTURY

Edward Angle developed the first classification systems for malocclusions (misaligned teeth) during the early 20th century in the United States, and it is still in use today. Angle founded the American Society of Orthodontia in 1901, which was renamed the American Association of Orthodontists in the 1930s.

By the 1960s, gold was universally abandoned in favor of stainless steel.

Lingual braces were the "invisible" braces of choice until the early 1980s, when tooth-colored aesthetic brackets made from single-crystal sapphire and ceramics became popular.[3]

DURING 21ST CENTURY

As we enter the 21st century orthodontists around the world mainly focus on giving an appliance which gives excellent esthetics but at the same time produce optimum efficiency and shorter duration time.Invisalign,ceramic brackets,clear aligners,treatment using corticotomy procedures,accelerated osteogenic orthodontics are all part of this century.

EVOLUTION OF ORTHODONTIC APPLIANCES

Teeth were regarded by the ancients as very precious to the extent that special penalties were given for knocking out the teeth of an individual. As early as 400 B.C , Hippocrates referenced in his writings the correction of tooth irregularities . And while Greece was in its Golden Age , the Etruscans (the precursors of the ROMANS) were burying their dead with appliances that were used to maintain space and prevent collapse of the dentition during life. Then in a roman tomb in Egypt Breccia an archaeologist found a number of teeth bound with a GOLD WIRE , and at the time of CHRIST , Aurelius Cornelius Celsus first recorded the treatment of teeth by FINGER PRESSURE. Thus , inherent malocclusions and the use of corrective force were recognized, the virtue of maintaining space was appreciated, and the first orthodontic material is documented “a gold ligature wire”.

The FRENCH and ENGLISH dominated the earliest contributions to the field of orthodontics , which as yet had not been formally named. Among these contributors is PIERRE FAUCHARD (1723) who Invents the expansion arch and gives the first comprehensive discussion of appliances .

In 1819 Delabarre introduces the wire crib,and this marks the BIRTH of CONTEMPORARY orthodontics. Later, Schange showed that the gold wire crib afforded adequate anchorage and formed a base for attachments. A century later, Lufkin stated that Schange made an invaluable contribution because it really marked the beginning of the EDGEWISE APPLIANCE.

As early as 1841, William Lintott introduced the use of screws. They were described in On the Teeth, in the chapter entitled “Irregularities of the Teeth”. A modification of the screw, called the crib, was introduced by the Frenchman J. M. A. Strange in 1841. Strange also introduced the use of the clamp band and for retention.[6,11]

In 1846 Tucker described the use of rubber elastics though no importance was given until Case & Baker used it to provide intermaxillary force & intermaxillary anchorage in 1893.

Edward H. Angle1855-1930 dominated orthodontic armamentarium, diagnosis and treatment planning for almost a half century until Charles Tweed successfully challenged his mentor’s nonextraction mantra.The ensuing diagnostic regimen used by Tweed, however, proved to have serious limitations and clearly resulted in the extraction of too many teeth. This caused a subsequent deterioration of soft tissue appearances of patients that neither they nor their doctors liked

The first decade of 21st century was an era of manufacture of standardized appliances. John. V. Mershon (1867-1953) introduced removable lingual arch based on the principle that teeth must

be free & unrestricted for adaptation to normal growth.

George Crozat in 1928 developed the Crozat appliance – a removable appliance fabricated entirely of precious metal with effective clasps for I molars modified from Jackson‟s designs from which Class II elastics wereemployed to treat Class II malocclusions. Spencer Atkinson introduced the Universal appliance which was a combination of ribbon arch appliance & edgewise appliance, using a flat wire & round wire in combination .During 1922 James. D. Mc Coy introduced open tube appliance.

In 1928 George Crozat developed Crozat appliance to treat Class II malocclusions

In 1940, Oren A. Oliver introduced the labiolingual appliance.

During 1941-1950 Charles Tweed (1895-1970) 1941 – introduced edgewise appliance based on basal bone concept.

DEVELOPMENT OF REMOVABLE APPLIANCES

In 1881, Coffin plate was introduced by Coffin with the spring that is still part of present appliances, butwas then made of piano wire .In 1902 Pierre Robin introduced the “Monobloc‟ named so since it was made of a single block of vulcanite.Though it repositioned the mandible forward it was originally designed to prevent glossoptosis in micromandible& cleft lip & palate patients (later known as Pierre-Robin Syndrome), and not as a functional appliance to stimulate mandibular growth.,

Charles Hawley introduced the Hawley's retainer appliance in 1908. But in the next 3 decades these plates were dominated by Angle's fixed appliances which dominated the orthodontic world. Only the Hawley retainer came to stay.

In 1911 J.H. Badcock introduced expansion plate with screws.

Two years later A.M. Schwarz published a textbook entirely devoted to treatment with plates, where designs of different split plates with various screws were shown. It was the book “Lehrgang der Gebissregulung‟whichbecame the Orthodontic bible in Europe.

Philip Adams in Belfast modified the arrowhead clasp favored by Schwarz into Adams crib, which became the basis for removable appliances and is still the most effective clasp for orthodontic purposes.

EVOLUTION OF FUNCTIONAL APPLIANCES

Andresen developed a mobile, loose-fitting appliance modification that transferred functioning muscle stimuli to the jaws, teeth and supporting tissues. Haupl collaborated with Andresen and together wrote about their appliance & the interpretations of its actions. They named the technique as “Functional Jaw Orthopedics‟and Haupl gave the name “activator‟ to the apparatus introduced

by Andresen, based on its ability to activate muscle forces.[4]

The Bionator developed by Balters is the most frequently used activator modification today.The development of the unique and complex myodynamic appliance was due to the ingenuity of H.P. Bimler Stockfish originally a disciple of Bimler who modified the appliance and produced the Kinetor .

In 1934 Herbst & Schwarz presented a series of articles on their experiences with the appliance. In 1977 Hans Pancherz introduced the Herbst appliance, introduced by Emil Herbst. In 1977, Clark developed the twin-block appliance as a two-piece appliance

In 1912 Newell introduced vestibular screens

In 1950s Rolf Frankel developed the frankel appliances and subsequently its tyes for various malocclusions.

EVOLUTION OF FIXED APPLIANCES

At this point in time the world received another landmark contribution in the field of fixed appliance. It was the introduction of multiple-loop, lightforce wire appliance by P. R. Begg of Australia. In 1956 Begg introduced the concept of Differential force. As of now, the Begg technique has undergone manymodifications from the way it was practiced by Begg originally.It is known and practiced in its various forms as conventional / traditional begg, modified begg, refined begg. Peter Kesling modified the edgewise bracket to create Tip-Edge bracket in 1988.[7]

In 1972, Dr. Lawrence F. Andrews ushered in the preadjusted era with the introduction of the Straight WireAppliance (SWA) which was hailed as a revolutionary development with the dual advantage of less wire bendingand improved quality of finished cases.

Dr. Robert Murray Ricketts developed the bioprogressive therapy. He introduced utility arch,Rickett‟s Quad Helix made of 0.40 blue elgiloywire and the use of preformed bands in orthodontics.

In 1978 Alexander introduced his Vari-SimplexDiscipline to get high quality results in a large practiceusing a relatively simple appliance technique.

Charles Burstone is credited with introducing newer materials in orthodontics like - TMA, Chinese NiTi and Fibre reinforced composite and introducing newer approaches like Holography & use of Occlusograms.

Burstone also developed the surgical planning analysis – COGS ie. Cephalometrics for Orthognathic Surgery. He also devised the segmented arch technique

In 1976 –Ronald Roth published a report entitled “Five year clinical evaluation of the Andrews Straight WireAppliance.

To avoid the difficulties of a multiple bracket system, Roth recommended the

2nd generation of preadjusted brackets (roth prescription) which consisted of minimum extraction series brackets and could be used in both non-extraction and extraction cases. He came out with innovation self-ligating brackets.

Bennett, McLaughlin and Trevisi have modified Andrews's standard SWA bracket system to MBT bracket system. These third generation brackets retained the best in original design but introduced range of improvements and specifications to overcome the clinical shortcomings.[14]

MODIFICATIONS IN ORTHODONTIC APPLIANCES WITH TIME

1.SELF LIGATING BRACKETS

Self ligating brackets were introduced as an alternative to conventional ligation

The first patent for a self-ligating attachment, the Boyd band bracket, was filed by Charles. E. Boyd (1933).Later James. W. Ford filed a patent for the Ford lock design, which was manufactured by the Dee Gold company of Chicago, Illinois. Production was banned because it was expensive.This bracket was reintroduced by his son William F. Ford.(1951),but it was primarily marketed for Johnson twin wire technique.

The Edgelok bracket was the first self-ligating bracket designed to enjoy any sort of commercial success. (1971)Another design was found in 1980's called Mobil – Lock. Both were passive brackets that achieved limited acceptance in orthodontic community because of bulky design.[20]

In the mid 1970's an entirely new generation of self-ligating appliance began, one that was active not passive, G.H. Hanson's SPEED appliance was a revolutionary step in orthodontic bracket design.[20]

In (1986) the obsolete self ligating Activa bracket designed by E. Pletcher, also offered an alternative to passive ligation. Some deficiencies, such as the ease with which the patient could open the bracket, and the excessive mesiodistal width, led to its commertial demise.

In 1996,the Damon bracket was introduced, named the Damon SL I. This design was passive, and because of problems with the bulky slide and limited tooth control, its commercial life span was short.

The Twinlock bracket was A.J. Wildman's second endeavor, after Edgelok bracket in 1998.

One year later the Twin lock bracket was modified slightly and renamed as Damon II bracket. The bracket is now named as Damon 2 bracket.

In (2004) a passive, hibrid composite-metal bracket, the Damon 3 bracket was found.

The introduction of In - Ovation bracket in 2000 was an attemt, similar to the Damon design. The Elgiloy spring clip

renders the In – ovation an active self-ligating appliance.[17]

2.LINGUAL ORTHODONTICS

Since the earliest fixed lingual orthodontic appliances appeared in the mid- to late 1970s,there were subjected to significant vicissitudes.Beginning in 1979, an initial wave of popularity occurred when the first mass-manufactured lingual brackets were released in the United States. At that time, the media and public had been made aware, rather suddenly, of a new technique that would allow straightening of teeth, without the requirement for traditional labial “outside braces” .

The earliest consistently documented work on lingual appliances began around 1975,when 2 orthodontists working independently in Japan and the United States started developing their own systems to place braces on the inside surfaces of the teeth. The early prototypes were based on modified, traditional “outside” braces. Much credit has been given to the late Dr. Craven Kurz of California, who with co-workers developed the early Kurz/Ormco lingual bracket system. However, over the same period, significant development was made by Professor Kinya Fujita, of Kanagawa Dental University in Japan, who continued to make great advances in this clinical discipline.

Dr Craven kruz first appliance consisted of plastic Lee Fischer brackets bonded to the lingual aspect of the anterior dentition and metal brackets bonded to the lingual aspect of the posterior dentition.The plastic anterior brackets were selected because of the case of recontouring and reshaping them to avoid direct contact with the opposing teeth.[18]

Clinical protocols had not been fully elucidated in those early days, resulting in many clinicians feeling impelled to begin lingual orthodontic cases without being fully prepared. Orthodontists found that the new lingual technique required much more rigorous attention to detail, as well as a fundamentally different approach to treatment planning and biomechanics. Postural challenges associated with potential back pain and related discomfort may have discouraged many operators although these difficulties were overcome with practice and enhanced efficiency of clinical technique resulting in the abandonment of many early lingual orthodontic treatments, which were completed with labial appliances

ADVANTAGES

The main concern for the introduction of lingual appliance was esthetics

The inclined plane in the bracket design converted the shearing forces produced by the mandibular incisors to comprehensive forces applied in an intrusive and labial direction.These forces also produced a natural physiological bone resorption in the maxillary and mandibular incisor area, allowing the teeth to intrude at generally less than 100mg force each time the

patient swallows. (approx.: 2000 times per day)

DISADVANTAGES

Occlusal forces produced a shearing force on the maxillary incisor brackets, Creating a high bond failure rate.Additionally, the brackets were uncomfortable and irritating to the patient's tongue.

By the mid 1970s Dr. Kurz found that by smoothing the exposed surface of the brackets using a heat less stone, patient comfort and acceptance increased.

For even better results he introduced an "Anterior Inclined Plane" which became an integral part of the maxillary anterior brackets.[18]

3.BIOPROGRESSIVE SYSTEM

Its originators, Drs. Robert Ricketts and Ruel Bench, combined contemporary edgewise mechanics with solid diagnostic principles and an innovative approach to sectional mechanics. This was simplified by James .Hilgers in 1987

The main principle was the use of a systems approach to diagnosis and , treatment by the application of the Visual Treatment Objective (VTO) in planning treatment, evaluating anchorage and monitoring the results.[4]

4.**BIOEFFICIENT APPLIANCE**

Introduced by ANTHONY D. VIAZIS in 1995

The bracket prescription for the Bioefficient system was designed to overcorrect malocclusions and to make it possible to work with the largest possible wires from the start of treatment

ADVANTAGES

- Reduces treatment time upto one half.
- Significantly less root resorption.
- 85% less friction.
- More patient comfort.
- This technique utilizes light biological forces through Super Elastic Arch Wires and a Unique New Triangular Brackets.
- The super elastic arch wires are different from stainless steel and NiTi wires and has shape memory and super elasticity controlled by temperature changes.[20]

5 INVISALIGN

Align Technology developed the Invisalign appliance for orthodontic tooth movement in the USA in 1998.This appliance was the first orthodontic treatment method to be based solely on three-dimensional (3D) digital technology. Through the use of computer programs that can manipulate 3D images of individual malocclusions, a series of algorithmic stages is produced which move the teeth in a series of precise movements (0.15-0.25mm).Stereolithographic

models are then constructed for each stage. Clear overlay appliances of 0.030-inch thickness are each worn sequentially by the patient for between 1 to approximately 2 weeks. Because this appliance is clear and removable, it provides an esthetic and hygienic appliance to correct malocclusion.[22]

Movement of teeth without the use of bands, brackets, or wires was described as early as 1945 by Dr Kesling, who reported on the use of a flexible tooth positioning appliance.

Later, Nahoum (Vacuum formed dental contour appliance, 1964) and others (Pontiz, 1971; McNamara, 1985) wrote about various types of overlay appliances such as invisible retainers.

Minor tooth movements have also been achieved with a technique developed by Raintree Essix (New Orleans, La).This technique uses clear aligners formed on plaster models of the teeth.The aligners are then modified with “divots,” which create a force to push on the individual teeth, and “windows,” which create the space for teeth to move into.This type of appliance can be effective in correcting mild discrepancies in the alignment of teeth.However, movements are limited to 2 to 3 mm; beyond this range, another impression and a new appliance are needed.

6.TEMPORARY ANCHORAGE DEVICES

The evolution of temporary anchorage devices was based on the development and improvement of traditional orthodontic anchorage, dental implants, and orthognathic fixation methods. Later, modifications of these techniques were unified with basic biologic and biomechanical principles of osseointegration into orthodontic mechanics that were finally improved based on experiences with interdisciplinary dentistry.

Orthodontists are accustomed to using teeth and auxiliary appliances, both intraoral and extraoral, to control anchorage. These methods are limited in that it is often difficult to achieve results commensurate with our idealistic goals. Recently, a number of case reports have appeared in the orthodontic literature documenting the possibility of overcoming anchorage limitations via the use of temporary anchorage devices—biocompatible devices fixed to bone for the purpose of moving teeth, with the devices being subsequently removed after treatment.[23]

ORTHODONTICS NOW!!

Orthodontic treatment is designed to result in improved aesthetics and/or function of the dentition and the face. Patients desire orthodontic treatment that is of short duration, effective and that does not negatively impact their appearance during treatment. Hence the introduction of lingual orthodontics,invisalign,ceramic brackets,clear brackets ,clear retainers have gone a long way in fulfilling the patients aesthetics requirements. [8,15]

A number of methods have been introduced to help reduce the duration of treatment. Surgical corticotomy assisted orthodontics.[14] and also accelerated osteogenic orthodontics with stem cells bone grafts and temporary anchorage devices.[22] for conservation of anchorage and efficient tooth movement. Most recently, a device called Acceledent has been developed that utilizes the concept of cyclic force application(A force propagating through a biological tissue, such as alveolar bone and the periodontal ligament, is transduced as a tissue-borne and cell-borne mechanical stress that in turn induces interstitial flow) to reduce treatment time by accelerating bone remodeling. Reducing the duration of treatment with effective and safe techniques, and improving aesthetics during treatment, increases the acceptability of orthodontic treatment for patients.[21]

CONCLUSION:

Orthodontics has achieved the status of a recognized specialty of dentistry because of a long period of craftsmanship and professional expertise. A great deal of development is still going on pertaining to aesthetics at the same time maintaining the efficiency and also shorter duration of treatment time

Orthodontics, and indeed all of dentistry if it is to survive as a profession must continually re-examine its history and find relevant and significant ideals to meet the crisis of today.

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