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History of Orthodontics

The practice of orthodontics, as we know it today, is not just about correcting the position of misaligned teeth, but has a long history behind it. Teeth are important to us, and even in ancient times they were of interest. Archaeologists have found attempts to straighten teeth on human skulls, which had wire wrapped around the teeth in an attempt to realign them. It has taken the knowledge and written works of many dentists and orthodontists to reach the current state of the science.

1.1 Orthodontics before the Twenty-First Century

Modern orthodontics began developing around the eighteenth and nineteenth centuries, but was not known as a specialism until 1900. The appliances that were developed and used over that time were very different to the appliances we use today. A French dentist named Pierre Fauchard designed the first expansion appliance in 1723, which was known as the *Bandeau*. This consisted of a U-shaped metal strip to which the teeth were ligated. The ligation helped to create expansion. In the late eighteenth century, an American dentist, Norman W. Kingsley, started using an early form of headgear, a traction device to help move teeth distally. The very first type of headgear was created in 1840 and was known as the chin cup. Removable appliances were not used much at this time due to the retention making stability poor. It was not until 1949, when Adams clasps were introduced, that their use became more widespread. A Dwinelle's jack screw was a popular screw to use within removable appliances in the nineteenth century, quite similar to the screws we use on patients today.

Functional appliances only started to be developed in 1879 and again this was by Norman W. Kingsley. The functionals we know today work by posturing the mandible forward, whereas Kingsley designed one that would make the bite jump into the desired position. After this, many more functional appliances were produced, some removable and others fixed. Examples of removable functionals are the monobloc by Pierre Robin in 1902, the medium opening activator by Viggo Andresen in 1990 and the Frankel functional appliances FR-1, FR-2 and FR3, all designed by Rolf Frankel in 1957. An example of a fixed functional is the Herbst, produced in 1905 by Emil Herbst. Clark's twin block is a very popular functional appliance, still used today due to being well tolerated by most patients. This was developed by William Clark and has been used since the 1980s. Fixed appliances were employed very regularly by 1970, although they were slightly different from those we use today.

Edward Angle produced a number of appliances, including in 1904 Angle's E (expansion) arch, which consisted of molar bands with a labial archwire connecting from one molar band to the

other running across the labial aspect of the dentition. Teeth needing expansion were then ligated to the archwire. Around 1910 Angle realised that he needed more control of the teeth, so to gain this he developed the pin and tube appliance. Gold and platinum bands were used on all the teeth with a vertical tube soldered onto them, then a pin was used which passed through this tube, achieving tooth movement. The downside of this was that rotational movement and root parallelism were difficult to achieve due to the use of round archwires. The pins had to be removed and resoldered into a new position at every appointment. The ribbon arch was the next appliance that Angle developed in 1915. With this rotational movement was achievable due to the vertical bracket soldered onto each band. Raymond Begg was inspired by this appliance and went on to develop his lightwire technique from it. Five years before Angle died in 1930, his final invention was the edgewise appliance, which was a bracket with a horizontal slot that was identical for every tooth. Angle moved away from the vertical slot, since he found that using a horizontal slot meant rectangular archwires could be used and by placing bends this allowed three-dimensional control of the teeth. The preadjusted edgewise appliance used today is based on Angle's edgewise appliance.

During the twentieth century fixed appliances consisted of bands with brackets welded onto them. Bands were made chairside by using straight strips of stainless steel that were shaped for each individual tooth, but as you might imagine this was very time consuming. In 1930 these stainless steel bands began being sold ready made by the very first orthodontic supply company. The purpose of the bracket was to hold the archwire in place. Tooth movement was achieved by the orthodontist placing bends within the archwire. Again, this was very time consuming and it took hours to get fixed appliances onto a patient.

In 1970, Lawrence Andrews developed the preadjusted edgewise appliance which is still popular today, and this changed much in orthodontics. The difference with this appliance was that the brackets were made for each specific tooth and contained prescriptions such as in and out, tip and torque within the bracket. These prescriptions all helped with tooth movement and reduced the need for wire bending. Today these prescription brackets are available with different angulations, slot sizes and base types.

Aesthetic brackets first become available in 1963, which are very popular today, as are lingual appliances, the first of which were developed in the 1980s. Since then a wide range of different systems have been developed by orthodontists, including the standard edgewise appliance, Begg appliance, tip edge appliance, preadjusted edgewise appliance, self-ligating appliance, and the lingual appliance system. We will look at each of these in turn.

1.2 Standard Edgewise Appliance

Edward Angle (1855–1930):

- Developed the standard edgewise appliance in 1925.
- Was an American dentist and was known as the 'Father of orthodontics'.
- Attended Pennsylvania College of Dental Surgery and qualified in 1878 as a dentist.
- Founded the Angle School of Orthodontia in 1890, where orthodontics become known as a specialism.
- Angle's classification of malocclusion that we use today was developed by him in 1890.
- Established many appliances within his lifetime, such as the E arch appliance (1907), the pin and tube appliance (1910), the ribbon arch appliance (1915) and the edgewise appliance (1925).
- In 1930 he died at the age of 75.



Figure 1.1 Standard edgewise bracket. The same bracket is used for every tooth which contains a passive bracket slot with no inbuilt prescription.

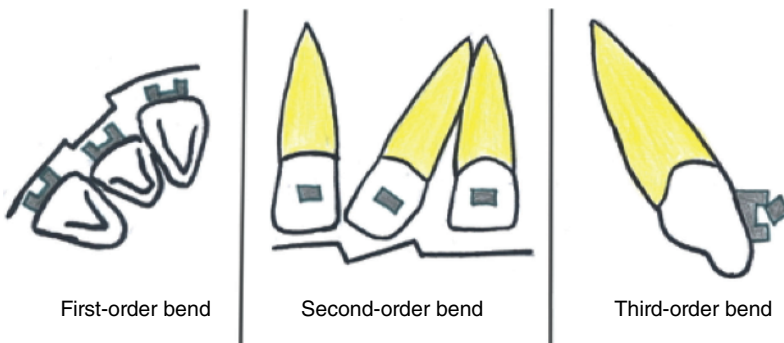


Figure 1.2 First-, second-, and third-order bends.

Standard edgewise appliance (Figure 1.1):

- The design of the bracket was the same for every tooth which had a passive bracket slot.
- All brackets were rectangular in shape.
- The size of the bracket was determined by the width of the bracket slot.
- The brackets came in two different sizes:
 - Width usually 0.018 or 0.022 in.
 - Depth usually 0.025 or 0.028 in.
- The appliance had three-dimensional control of the teeth.
- To aid tooth movement all archwires were dependent on bends being added. However, this was time consuming and difficult for the orthodontist, as it was required at every visit.
- The bends created were to achieve the following (Figure 1.2):
 - *First-order bend – in and out:*
 - To compensate for the different tooth widths, bends are placed in the horizontal plane of the archwire.
 - The bends correct the tooth widths in the bucco-lingual and labial-palatal direction (anterio-posterior [AP] plane – anterior/posterior movement, front to back).
 - For example: in modern-day orthodontics, central incisors are always slightly in front of the lateral incisors, which sit slightly back. Canines sit in the same antero-posterior position as the central incisors, which helps to create the canine eminence (corner of the mouth).

- *Second-order bend – tip:*
 - To compensate and correct the angulation of the teeth, bends are placed in the vertical plane to achieve the correct mesiodistal angulation of the teeth.
 - For example: distally angulated laterals would need bends to help upright the laterals mesially, which ensures that teeth gain the desired angulation.
- *Third-order bend – torque (rectangular wire only):*
 - This is achieved with rectangular archwires only.
 - Orthodontists would place a bend in the archwire to help correct the torque of the roots.
 - For example: buccal root torque is achieved by the archwire being twisted forwards; palatal root torque is achieved by the archwire being twisted backwards.
- Closing loops were placed within the archwire and used as a method of space closure.
- This system placed a high demand on anchorage.

Tooth movement can be effected due to the inter-bracket span, the distance between the brackets:

 - Narrow brackets (more span): a greater span of the archwire between the brackets has the ability to make the archwire more flexible, which can achieve faster alignment.
 - Wider brackets (less span): a reduced span of the archwire between the brackets is more efficient for de-rotation and mesiodistal control of teeth.

1.3 Begg Appliance

P. Raymond Begg (1898–1983):

- Developed the Begg appliance in the 1950s.
- An Australian dentist.
- Attended the Angle School of Orthodontia in Pasadena, California in 1924 and was one of the first at the school to treat patients with the standard edgewise appliance.
- In 1925 he travelled back to Adelaide, South Australia to treat his own patients in orthodontics.
- Became a professor at the University of Adelaide.
- Was also known to develop the Australian orthodontic wires.
- In 1980 he retired and then died in 1983.

Begg appliance (Figure 1.3):

- This appliance was designed to overcome the high anchorage demand of the standard edgewise appliance and is a light anchorage appliance.
- Another name for the Begg appliance is the lightwire appliance.
- The components of the appliance are the bracket, pin, and archwire.

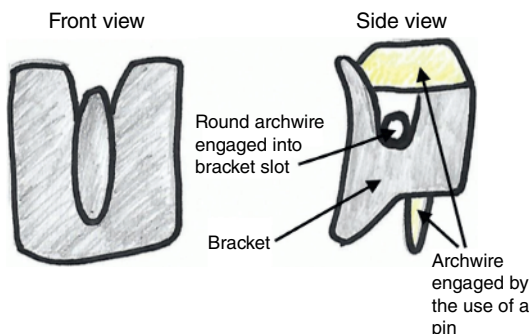


Figure 1.3 A Begg appliance. The components of the bracket are labelled.

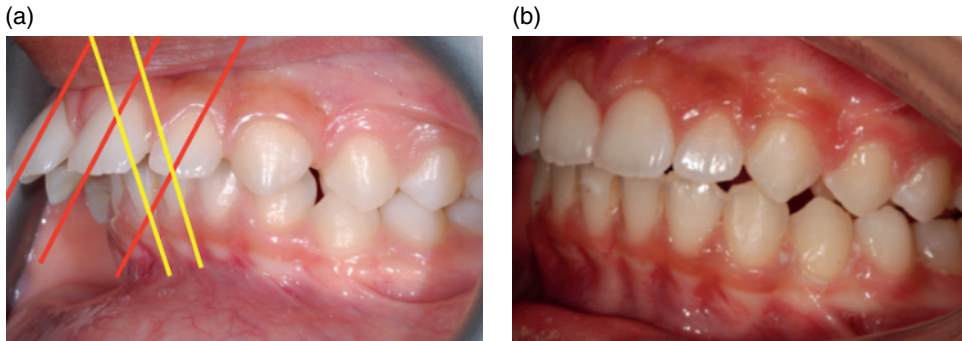


Figure 1.4 How the Begg appliance works. (a) The teeth are tipped into the desired position by the use of inter-maxillary elastics. The lines on the photograph show the inclination of how the upper and lower teeth sit. (b) The roots of these teeth are uprighted by the use of auxiliary springs.

- To ensure full engagement of the archwire, the pin is used to hold the archwire within the bracket slot.
- The appliance is dependent on round archwires only, which fit loosely into the bracket slot at the top of the bracket – this allows a lot of slop (play) within the bracket.
- Final detailing of teeth is difficult to achieve in this type of appliance.

The Begg appliance uses different methods to gain tooth movement (Figure 1.4):

- Round archwires and inter-maxillary elastics tip the teeth into the desired position.
- Auxiliary springs or loops are placed within the archwire to help upright the roots of the teeth and achieve rotational movement.
- To provide intra-oral anchorage, extractions can be considered, since intra-oral elastic wear would use the posterior segment as an anchor unit to help retract the anterior segment.
- Patient compliance is important throughout treatment with this appliance, as it is very dependent on intra-oral elastics.

1.4 Preadjusted Edgewise Appliance

Lawrence Andrews:

- Developed the preadjusted edgewise appliance in 1970.
- Also developed Andrews' six keys to occlusion.
- Is an American orthodontist who has now retired from patient care, although he still takes part in research and education.
- His son Will A. Andrews followed in his footsteps and joined the practice that Lawrence established in 1958 called Point Loma in San Diego, California.

Preadjusted edgewise appliance (Figure 1.5):

- Another name for this is the straight-wire appliance.
- It is used on patients for either their first stage of treatment or the second stage following removable or functional appliances.
- These brackets are called 'preadjusted' edgewise brackets because they are thicker in the horizontal dimension, and are also different from one another due to the inbuilt prescriptions designed specifically for each individual tooth.



Figure 1.5 Preadjusted edgewise brackets.

- The inbuilt prescriptions within the brackets are:
 - *In and out*: first-order bend
 - *Tip*: second-order bend
 - *Torque*: third-order bend.
- Because of the inbuilt prescriptions within the brackets they became very popular, as it meant wire bending was minimised and in some cases not needed at all.
- For the inbuilt prescriptions to be achieved on each tooth, the brackets are manufactured in a certain way:
 - *In and out (first-order bend)*: to achieve this, the base of the bracket is manufactured differently. For example, lateral incisors sit slightly back from the central incisors, therefore the base of this bracket will be thicker than the brackets for the central incisors.
 - *Tip (second-order bend)*: each bracket slot is cut at a certain angulation to help achieve the correct angulation for each individual tooth; this differs for each bracket.
 - *Torque (third-order bend)*: each bracket has different torque percentages within the bracket slot. The thicker the wire, the more torque is created. If the desired torque is not achieved, bends within archwires can be placed to help with this type of movement.
- Preformed archwires are used with this appliance, as this allows teeth to move gradually from their original position into their desired position.
- Brackets come in different slot sizes:
 - 0.018 × 0.025 in., with the working wire being used = 16 × 22 ss (stainless steel)
 - 0.022 × 0.028 in., with the working wire being used = 19 × 25 ss (more commonly used).
- Depending on the degree of crowding the patient presents with, the appliance can be used on non-extraction or extraction cases.
- Still in good use today, the preadjusted edgewise appliance has three common bracket prescriptions:
 - Andrews
 - Roth
 - MBT = McLaughlin, Bennett, Trevisi.
- Different orthodontists created these three common bracket prescriptions. It was known that each orthodontist had different views on how much torque should be built within the bracket slot. Therefore, each bracket prescription contains different values of torque, with MBT containing the highest value of torque out of the three.

Advantages of the edgewise appliance:

- Reduced chair time.
- Amount of wire bending is minimised.
- Sliding mechanics for tooth movement.
- Good finishing.

Disadvantages:

- Larger inventory of brackets is required, as each individual tooth has different requirements of in and out, tip and torque.
- Ignores individual biological variation.
- Increased friction has implications and increases anchorage considerations.

1.5 Tip Edge Appliance

Peter Kelsing:

- Developed the tip edge appliance in 1986.
- Is an American orthodontist, born in La Porte, Indiana, and is the son of Harold Kesling who was also an orthodontist.
- Peter also has one son called Chris Kesling who followed in both his father's and grandfather's footsteps and works as an orthodontist at the same practice in Westville, Indiana.

Tip edge appliance:

- Developed based on the best features of the Begg appliance (round wires, light forces) and the preadjusted edgewise appliance (detailed finishing).
- There are three stages of treatment when using this appliance:
 - *Stage 1*: Align teeth, correct incisor and molar relationship, crossbites and rotations.
 - *Stage 2*: Start space closure and maintain stage 1 corrections.
 - *Stage 3*: Correct inclination of teeth.
- Each bracket incorporates the inbuilt prescriptions (in and out, tip, torque).
- Round archwires are used for the initial tipping and aligning stage and the later stages have the use of the rectangular archwires, which gives more control over tooth movement and helps with the final detailing.
- To ensure full engagement, the archwire is engaged into the bracket slot by the use of elastomeric modules or metal ligatures.

1.6 Self-ligating Appliance

Self-ligating appliance (Figure 1.6):

- Developed in 1990.
- Became very popular among non-extraction orthodontists and was initially used on non-extraction cases.
- Self-ligating brackets incorporate a door/clip which ensures full engagement, and holds the archwire in place within the bracket slot.



Figure 1.6 Self-ligating appliance.

- There are two types of self-ligating bracket:
 - *Passive*: has a slide mechanism which is passive and places no active force on the archwire.
 - *Active*: Places an active force on the archwire.
- Once engagement of the archwire has been made by the door/clip, the archwire is free to move in brackets, making the appliance free-sliding.
- The circumference of the arch is increased, due to space being created on expansion to align teeth, leading to the wide smiles we see today.
- Inter-arch elastics are used in conjunction with self-ligating appliances to help improve the patient's occlusion.
- Self-ligating appliances are known to reduce chairside time as adjustments are quicker.
- Different types of torque are available within the brackets, such as standard/high/low torque.
- Manufacturers claim that self-ligating appliances produce lower friction.

Examples of self-ligating systems:

- Damon® – 3, 3mx, Q, Clear (Ormco Corporation, Orange, CA, USA).
- Clarity™ SL (3M, St Paul, MN, USA).
- Harmony (ASO International, Tokyo, Japan).
- SmartClip™ (3M).
- SPEED System™ (Haspeler Orthodontics, Cambridge, ON, Canada).
- In-Ovation C® (Dentsply Sirona, Woodbridge, ON, Canada).

Advantages:

- Provides low friction.
- Achieves full archwire engagement.
- Quick and easy to use.
- No elastomeric modules, which makes oral hygiene easier to control.
- Patient can go for longer intervals between appointments.

Disadvantages:

- If there is a fault in the door/clip, it means the whole bracket is faulty, therefore a new bracket would be needed.
- Appliance can be harder to ligate wire; it is important to make sure the wire is fully engaged in the bracket slot for the door to close.
- Higher cost in brackets.
- Difficulty in finishing due to the incomplete expression of the archwires.

1.7 Advantages and Disadvantages of all Types of Buccal Appliances

Advantages:

- Appliances allow good working access.
- Once the clinician is experienced they are easy to work on.
- Chairside working time is reduced.

- Can achieve excellent finishing and detailing – archwire bending is easier.
- Aesthetic brackets and archwires, which are popular with patients.
- Quicker treatment time as opposed to lingual appliances.

Disadvantages:

- Poor aesthetics as they are on the labial/buccal surface of teeth.
- Any decalcification occurring from treatment will be visible.
- Aesthetic brackets can fracture during debonding.

1.8 Lingual Appliances

Lingual appliances (Figure 1.7):

- First developed in the 1970s in the USA.
- The brackets are bonded onto the palatal/lingual surface of the upper and lower arches.
- Lingual appliances use preadjusted ribbonwise brackets, which are thicker vertically than horizontally.
- All brackets and archwires are custom made to reduce speech problems and tongue irritation and to help improve finishing.
- Custom-made brackets are good as they can be rebonded directly back on if they debond during treatment; however, if a bracket is lost, new ones have to be specially ordered.
- Brackets come in a jig and are all bonded together at once (indirect bonding). It is important to keep the bracket in the jig, because there can be undesired tooth movement if it comes out or is bonded directly to the tooth without a jig.
- Lingual appliances can also come in a self-ligating form.

Advantages:

- Good aesthetics.
- Decalcification less likely to occur with lingual appliances compared to labial appliances; however, if present it will not be visible.
- Upper anterior brackets can act as a bite plane, which is good for treating overbites (flat anterior bite plane or FABP).

Disadvantages:

- Can affect patient's speech.
- Much more ulceration can appear.
- Discomfort to patient's tongue.
- Clinically demanding on clinicians.
- Inter-bracket span is reduced.
- Increased chairside time.
- Finishing and detailing are difficult to achieve due to the reduced inter-bracket span, and archwire bending can be made difficult.
- Indirect bonding of brackets or debonding of brackets can result in poor positioning if not bonded back in the correct position.
- Increased cost.
- Longer treatment time.



Figure 1.7 Typhodont showing Harmony lingual appliance.

