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A brief history of orthodontic retention

Piotr S. Fudalej*[1,2,3] and Anne-Marie Renkema[4]

Key points

- The history of orthodontic retention dates back to the nineteenth century.
- Initially, orthodontists used primarily removable retainers.
- The introduction of fixed wire retainers was a major change in orthodontic retention.

Abstract

The retention phase has become an accepted part of orthodontic therapy. Irrespective of the patient's age, underlying malocclusion or the type of mechanotherapy, an orthodontist will use some retention method in virtually every patient following completion of the active treatment. This article presents a short description of the history of orthodontic retention and highlights major developments in retention strategy.

Introduction

Orthodontic retention has become integral to orthodontic therapy. Irrespective of age, underlying malocclusion or the type of mechanotherapy, some retention method is relied upon in virtually every patient following completion of the active treatment. A necessity to retain corrected malocclusion relates chiefly to two factors: 1) an understanding that post-treatment changes in occlusion are likely if the dentition is unretained; and 2) growing demand to maintain a perfect aesthetic result indefinitely. Also, typically, the retention phase significantly exceeds the duration of the active treatment phase.

The history of orthodontic retention can be roughly divided into two periods: 1) before 1970, when the acid etch technique was not readily available within orthodontics; and 2) from the early 1970s, when enamel etching and modern adhesive systems facilitated the use of bonded retention as we know it. The initial description of the bonding procedure of a mandibular retainer wire in 1973 by Knierim[1] may, therefore, symbolise the beginning of the era of modern orthodontic retention.

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History of retention: 1800s to 1970

The requirement for retention is long-established, with Angell[2] suggesting in the nineteenth century that 'orthodontic retention is needed to stabilize the result of an orthodontic treatment.' Twenty years later, Norman Kingsley[3] cautioned that teeth 'could only be retained in the new position by constantly wearing fixtures. The wearing of retainers is undesirable in itself and objectionable [...] nevertheless, the fruits of a skilful and successful effort in regulating teeth must not be lost by neglecting to retain'. Although 140 years have passed since that statement, it remains relevant to this day.

Kingsley was a pioneering clinician who noticed that corrected malocclusions were frequently unstable. In order to counteract this, he introduced a removable retainer consisting of a rubber plate covering the mucosa with perforations to accommodate the teeth.[3] Unfortunately, little is known about its effectiveness or popularity among other dentists. After more than two decades, Edward H. Angle reconfirmed observations of Kingsley by stating that 'after malpositioned teeth have been moved into the desired position, they must be mechanically supported until all of the tissues involved in their support and maintenance in their new positions shall have become thoroughly modified, both in structure and in function to meet the new requirements'.[4]

Angle also proposed a new method of retention, which made use of the interproximal spaces between the teeth. The spurs coming out of a plate covering the removable palatal plate were designed to hold the sides of the necks of the crowns, preventing their rotation and mesio-distal and labiolingual movements. With time, the plate was replaced by the removable base wire for the retention of anterior teeth. The tendency for lingual movement of molars and premolars, however, was to be resisted by a neatly fitting vulcanite or metal palatal plate. In the case of severely rotated teeth, fixed retention was recommended by Angle. Specifically, he advocated that aligned, de-rotated teeth were fitted with a band from which spurs were projected towards adjacent teeth. The spurs were attached to the band by

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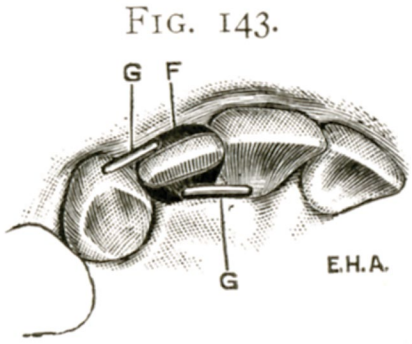


Fig. 1 Schematic presentation of a banded retainer. The banded tooth is prevented from returning to its former position with the spurs being placed in contact with the adjacent teeth. Reproduced from E. H. Angle, *Treatment of malocclusion of the teeth and fractures of the maxillae*, Philadelphia: The SS White Dental Manufacturing Company, 1900[4]

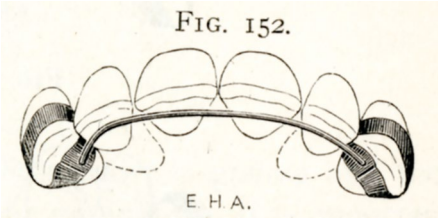


Fig. 2 A retainer consisting of two bands and a wire, reproduced from E. H. Angle, *Treatment of malocclusion of the teeth and fractures of the maxillae*, Philadelphia: The SS White Dental Manufacturing Company, 1900[4]

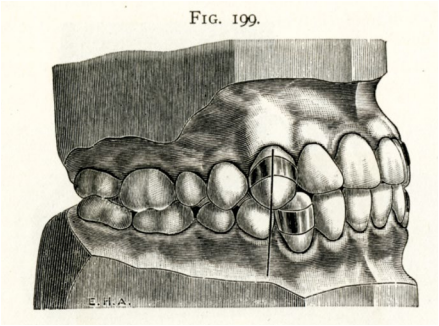


Fig. 3 A retainer consisting of two bands and a wire, reproduced from E. H. Angle, *Treatment of malocclusion of the teeth and fractures of the maxillae*, Philadelphia: The SS White Dental Manufacturing Company, 1900[4]

means of a small tube and key pin (Fig. 1). For retention of cuspids, two bands attached to the wire were proposed (Figures 2 and 3).[4]

In 1908, Calvin Case[5] suggested that the use of uncemented extensions or bars resting on teeth could promote development of caries and should be avoided. As an alternative, he

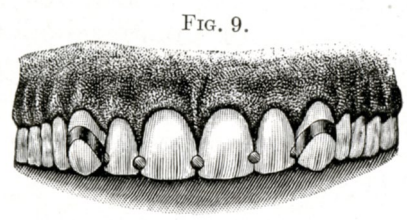
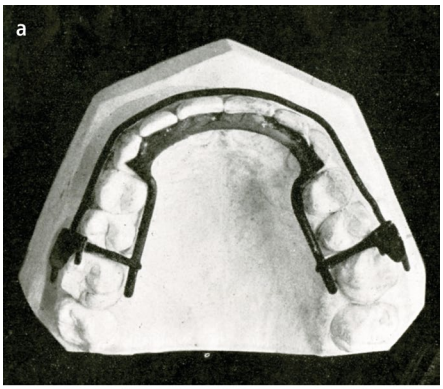


Fig. 4 A six-band labial retainer; initially the bands covered all six labial surfaces. 'After the appliance has been worn for a few months the extents of the laps may often be safely reduced, so that more appears than is often seen with proximal gold fillings'. Reproduced from C. S. Case, *A practical treatise on the techniques and principles of dental orthopedia*, USA: C. S. Case Company, 1908[5]

Fig. 5 Original design of Hawley's retainer, reproduced with permission from C. A. Hawley, 'A removable retainer', *International Journal of Orthodontia and Oral Surgery*, 1919, Elsevier[6]

proposed a removable retainer (Fig. 4) made of platinum-gold with joints on the lingual aspect made of nickel-silver intended to retain six anterior teeth in the maxilla. Several years later, in 1919, Dr Hawley reported on the retainer he had been using since 1914 (Fig. 5).[6] This was inspired by the retainer design of McBride from Dresden, Germany[7] (Figures 6a and 6b). Retainers used by Hawley and other clinicians were fabricated from vulcanite (that is, vulcanised rubber) and gold wire. Today, the Hawley retainer, which is very similar to the original concept, continues to be a frequently used removable retainer (Fig. 7).

In the second half of the 1930s, removable retainers with acrylic baseplates and steel wires were used extensively. In those days, patients were often finished to a point where minor corrections were necessary and settling would be required to produce the desired final result. In order to facilitate this, in the 1940s, Kesling designed an elastoplastic positioner,[8,9] which was particularly useful in extraction cases.



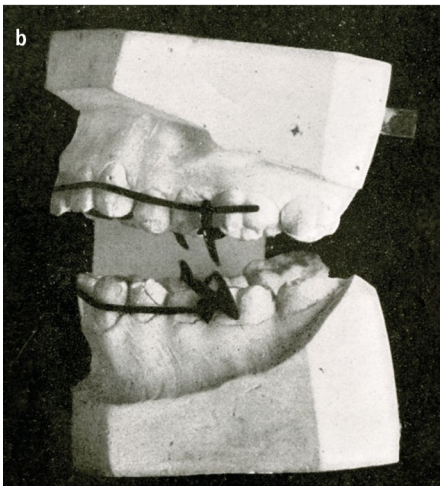


Fig. 6 a) Occlusal view of upper retainer: a very heavy wire bent to the lingual surface of the teeth with heavy flat bars of metal passing between the first molars and second premolars to the buccal surface. b) Lateral view: the bars on the buccal surface were fashioned into planes, which slid back of similar planes on the lower appliance to maintain a proper mesio-distal relation of the jaws

Fig. 7 A contemporary version of the Hawley retainer. This is similar to the original concept and remains one of the most frequently used removable retaining devices

Impressions were made at the time of fixed appliance removal, and teeth were cut out of the model and re-set in the ideal positions using wax. The positioner was fabricated

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based on this improved position (Fig. 8). While minor tooth movements could be accomplished with the positioner, the appliance also served as an orthodontic retainer or indeed as a mouthguard during contact sports.[10,11]

In the late 1950s, Nahoum[12] developed the concept of vacuum-formed retainers (VFRs) made of clear thermoplastic material, heated and formed on a patient's plaster model in a vacuum machine. The initial VFRs were prone to cracking and distortion due to the inferior quality of plastic used for their fabrication. With the introduction of durable, thin, clear polymers for intraoral use, VFRs became a reasonable alternative to conventional retention devices (Fig. 9). The advantages of VFRs over Hawley retainers included aesthetic superiority, ease of fabrication and decreased interference with speech.[13]

The duration of retention: a historical perspective

In the first decades of the development of orthodontics in the nineteenth century, there was little consensus regarding retention, not only about the type of retainer but also on the duration of retention. For example, Kingsley[2] suggested two to three years of retention, although he suggested that this should be tailored based on the subjective judgement of an orthodontist: '[...] with each case to be governed by judgement of the operator, bearing in mind a few general principles. The number of teeth moved, the distance, the occlusion, the age of the patient, and the cause of the malposition, whether hereditary or otherwise, all are factors in forming an opinion'. Angle,[4] in turn, implied that the time required for mechanical retention could vary from a few days to two years (or often longer). This depended on the 'age of the patient, occlusion gained, causes overcome, tooth movements accomplished, length of cusps, health of tissues etc. In the case of unconquered lip or tongue habits, retention may be required for an indefinite period'. Angle also suggested that the period of retention in adult patients should be substantially longer than in children. Hawley recommended full-time wear of the retainer for two to six months, followed by night-time wear only. Once the retainer had been worn at night for about a year, it was felt that it could be left out for several days or a week before being tried in again.[6] Recommendations that

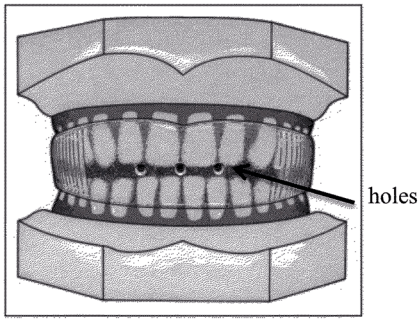

Fig. 8 A Kesling setup and positioner, reproduced with permission from H. D. Kesling, 'The philosophy of the tooth positioning appliance', *American Journal of Orthodontics and Oral Surgery*, 1945, Elsevier[8]

Fig. 9 Contemporary vacuum-formed retainer

retention should not be necessary were rather exceptional. However, Hovell[14] remarked that if treatment was carried out correctly and the teeth were in a position of stability within muscle balance, retention should not be required. Certainly, in modern day orthodontics, this tenet does not hold with an acceptance that retention is required in most cases to mitigate against both true relapse and maturational change, should maintenance of an optimal outcome be sought.

History of retention: 1970s onwards

The introduction of retainers bonded with modern adhesive systems brought about improved clinical effectiveness and comfort for patients. In the past, the chief disadvantage of removable retention was the problem with compliance. The primary limitation associated with the lingual bar banded on cuspids was the visibility of metal bands on the lower teeth, with patients complaining about the poor aesthetics of this type of retention. In addition, decalcification may be risked if bands are kept in place for prolonged periods.[15]

Early bonded fixed retainers were made with plain round or rectangular wires.[16,17,18,19,20]

Fig. 10 Plain rectangular wire with eyelets (0.0215" x 0.027" stainless steel) bonded to the mandibular canines only

Fig. 11 Thick multi-stranded wire (0.032" stainless steel) bonded to the mandibular canines only

Fig. 12 Thin multi-stranded wire (0.0195", three-stranded and heat-treated) bonded to all six mandibular anterior teeth

In 1977, Zachrisson[21] presented the results of mandibular direct-bonded canine-and-canine retainers up to 2.5 years after placement. He used 0.9 mm (0.036 inch) or 0.8 mm (0.032 inch) plain blue Elgiloy wire (Fig. 10), which was heat-treated and polished. The study demonstrated that directly bonded canine-and-canine retainers might be useful for routine retention in orthodontics. The main advantage of the bonded retainer as compared to the banded retainer was its aesthetic superiority.

Some years later, Årtun and Zachrisson[22] proposed the use of a thick multi-stranded wire without retention loops, also bonded only to the canines (Fig. 11). They listed an increased mechanical retention of the composite adhesive as a potential advantage of this wire material. The first report on the retainer made of thin multi-stranded flexible wire bonded to all six anterior teeth (Fig. 12) was presented by Zachrisson.[23] The flexibility of the thin multi-stranded wire was thought to allow physiologic movement of the teeth. The major difference between retainers made

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of thin multi-stranded wire and thick plain or thick multi-stranded wire was the number of teeth attached to the retainer – all six front teeth in the former wire retainer and canines only in the latter wire retainers.

Soon afterwards, other types of bonded retainers with thin multi-stranded flexible wires were suggested.[24,25] In 1975, Zachrisson[26] described an alternative method of retention in which the contact points of the teeth were splinted without the use of a wire. This method was unsuccessful because the splinted teeth rapidly broke up into segments of one or two teeth. In 1987, Diamond[27] described clinical experience with resin-reinforced fibreglass bonded retainers. Specifically, patients appreciated the tooth-coloured material and its comfort. Other authors, however, reported unacceptably high failure rates related to the excessive rigidity of this type of retainer.[28]

An interesting approach to increasing stability of tooth alignment was presented in 1988 by Edwards.[29] He evaluated the effects of circumferential supracrestal fiberotomy (CSF) 15 years after the procedure had been performed. In the long term, CSF was more successful in reducing relapse in the maxillary anterior segment than in the mandibular anterior segment. Its use, however, remains relatively limited and typically confined to the maintenance of severe rotational correction. Other more recent approaches include the use of selective interproximal reduction as well as pharmacological methods. While many of these show promise, the mainstay of retention continues to reside in mechanical approaches, including both removable and fixed approaches.

History of retention: the last decade (2010–2020)

Rigorous assessment of different retention strategies is a distinctive feature of the last years. In this time, several clinical trials of high methodological quality were carried out in which effectiveness of bonded versus removable retention,[30,31,32] direct versus indirect bonding,[33] or round twisted versus rectangular braided wire for mandibular retainers[34] were compared. The last decade also brought attempts to use CAD/CAM technology to improve accuracy of fabricated retainers[35] or to replace metal wire with alternative materials.[36]

Conclusions

The twentieth century witnessed the evolution of orthodontic retention, with an increasing recognition of the centrality of retention to preserving optimal intra-arch alignment. Furthermore, the past century has been marked by a shift from the use of removable to fixed retention. In recent years, numerous developments have occurred including the application of new materials in relation to both fixed and removable retainers, while lifelong use of fixed retainers in the mandibular arch has become increasingly more popular.[37,38] There is a long and rich history associated with orthodontic retention; this evolution is likely to continue, with mechanical approaches being continually refined in order to develop more predictable approaches to realising the goal of indefinite stability.

Conflict of interest

The authors declare no conflicts of interest.

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