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Fixed retainers in Orthodontics

The College of Dentistry, University of Baghdad, Department of Orthodontics in Partial Fulfillment for the Bachelor of Dental Surgery

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Certification of the Supervisor

I certify that this project entitled "**Fixed retainers in Orthodontics**" was prepared by **Nawras Salam Adnan** under my Supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Date: /4/2022

Dedication

To the kindest hearts in my life my mother and my father… who give me all the support and care in my life…

Last but not least to all healthcare workers who fighting against covid -19 with great person risk…

Acknowledgements

First and foremost, praises and thanks to **Allah** Almighty for helping me fulfill my dream, for his blessings throughout my work to complete it successfully.

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VFR	Vacuum formed retainer
SS	Stainless steel
BR	Bonded retainer
NiTi	Nickel titanium
Al2O3	Aluminum oxide
GDPs	General Dental Practitioners
CAD CAM	Computer aided design Computer aided manufacturing
FRC	Fiber-reinforced composite retainers

Introduction

Orthodontic retention is the final stage of orthodontic treatment and aims to maintain the teeth in their corrected positions after the completion of orthodontic tooth movement. Teeth have a tendency to return towards their initial positions due to tension in periodontal fibers, particularly those around the necks of the teeth (inter-dental and dento-gingival fibers). The quality of the final occlusion will also affect the stability of the orthodontic outcome, with unwanted displacing occlusal contacts potentially leading to unfavorable changes in tooth position. Sound orthodontic treatment planning and the achievement of appropriate occlusal and soft tissue treatment goals can help to minimize orthodontic relapse. Nevertheless, some degree of relapse is almost inevitable unless a suitable retention protocol is put in place following removal of active appliances **(Johnston and Littlewood, 2015)**.

Fixed retainers are a type of invisible retainers which are bonded to the lingual surface of the teeth, hence it is not visible to the naked eye. It is indicated where prolonged retention is required and involves minimal or no patient cooperation. They are fixed to the teeth and hence cannot be removed by the patient **(Scheibe and Ruf, 2010)**.

Fixed retainers are easy and well tolerated by the patient and there is no tissue irritation unlike what may been seen in tissue bearing areas of Hawley's retainer and can be fabricated in the lab which saves chair side time. But they can cause Gingival/periodontal disease and caries may develop due to plaque accumulation, also may prevent settling of the occlusion **(Alassiry, 2019)**.

Aims of the study

To review the history of bonded (fixed) orthodontic retainers regarding the following aspects:

- Indications, advantages, Disadvantages
- Material types and designs of bonded retainers,
- Fixation method and bonding technique of fixed orthodontic retainers
- Failure and unintended effects of bonded orthodontic retainers on oral health

Chapter one: Review of literature

1.1 Retention

In orthodontics retention mean the stabilizing the occlusion achieved by means of orthodontic therapy is one of the main treatment goals **(Edman *et al*., 2013)**

Retention it is defined as phase of orthodontic treatment following completion of the desired tooth movement, focused solely on maintaining the finished treatment result and preventing relapse **(Alkadhimi and Sharif, 2019)**.

A number of factors can be cited as influencing long-term results, including gender, posttreatment growth, type of malocclusion, magnitude of the pretreatment irregularity, and quality of the orthodontic treatment **(Joondeph *et al*., 2017)**

Most orthodontic treatment results are potentially unstable, and therefore retention is necessary for three major reasons **(Proffit *et al*, 2019)**:

• The gingival and periodontal tissues are affected by orthodontic tooth movement and require time for reorganization when the appliances are removed.

• The teeth may be in an inherently unstable position after the treatment, so soft tissue pressures constantly produce a relapse tendency.

• Changes produced by growth may alter the orthodontic treatment result.

High percentage of clinicians choose different retention periods: “at least as active treatment”, “at least two times longer as active treatment”, or “at least a half of the active treatment”. According to scientific evidence on the stability of orthodontic alignment, ceasing retention at any time does not guarantee

stable orthodontic alignment **(Littlewood, 2018)**. Any malalignment of the anterior teeth may be esthetically unacceptable for the patient. On the other side, retention is associated with cost, discomfort, and potential iatrogenic effects, and it requires cooperation. **(Vagdouti *et al*., 2019)**.

1.1.1 Types of retainers

Retainers can be classified as either fixed or removable. Removable retainers can be removed by patients allowing them to clean fully around the teeth and to wear them on a part time basis if indicated. Fixed retainer is fixed to teeth and cannot removed by patient **(Wouters *et al*., 2019)**.

1.2 Fixed retainers

Fixed retainers are a type of invisible retainers which are either banded or bonded to the lingual surface of the teeth, so it's not visible to the naked eye. They are fixed to the teeth and hence cannot be removed by the patient **(Pravindevaprasad and Therese, 2013)**. A fixed retainer typically consists of a passively bonded wire to the lingual side of the tooth usually in mandibular incisor region **(Vignesh and Sumathi, 2015)**.

1.2.1 Indication of fixed retainers (Profit *et al*., 2019; Alkadhimi and Sharif, 2019).

1. Severe rotations which have been corrected or in case of lower incisors have been proclined by >2 mm. Also for teeth moved out of the zone of equilibrium and in combined periodontal/orthodontic treatment where the adequacy of support for the teeth is in doubt.

2. Diastemas or closure of generalized spacing or severely displaced teeth, particularly palatal canines, also in cases of non-surgically treated anterior open bite with incisor extrusion.

3. Impacted teeth which have been individually extruded and aligned or teeth with no opposing tooth (to prevent over eruption). Also in cleft Lip/Palate patients. In these cases bonded retainer is combined with removable appliance to maintain transverse relationship, also in cases of extraction space closure in adults.

1.2.2 Advantages of fixed retainers (Luther and Moon, 2013; Alkadhimi and Sharif., 2019).

1. Easy and well tolerated by the patient, also unlikely to compromise on aesthetics, unlikely to interfere with speech and less compliance dependent. Also it may reduce the risk of development of late lower labial segment crowding, also allow some physiological movement of the teeth

2. Can be fabricated indirectly in the lab therefore reducing chair side time and complexity of fabrication. Also no evidence of increased periodontal or enamel damage, can be used for permanent and semi-permanent retention, also no tissue irritation unlike what may been seen in tissue bearing areas of Hawley's retainer.

1.2.3 Disadvantages of fixed retainers (Patel and Sandler, 2010; Alkadhimi and Sharif, 2019).

1. Expensive, their placement is time-consuming, technique-sensitive, also interference with the occlusion, especially in cases with increased overbite

2. Gingival/periodontal disease and caries may develop due to plaque accumulation, also may prevent settling of the occlusion.

3. Fixed retainers are associated with a significant long-term failure rate. One study reported that a third of patients experienced retainer failure within 30 months. In addition, there are reports of occasional, severe, unwanted tooth

movements caused by different types of failed fixed retainers **(Johnston and Littlewood, 2015; Littlewood *et al*., 2017)**.

Fixed retainers are most commonly used in the orthodontic retention phase as they have a number of advantages, such as better aesthetics, no need for patient cooperation, effectiveness, and suitability for lifelong retention **(Chinvipas *et al*., 2014)**. However, their need for precise bonding technique, fragility, and tendency to cause periodontal problems by weakening oral hygiene are some of their disadvantages

In 1965, Newman presented the direct bonding technique of orthodontic attachments. Later, in 1973, Kneirim introduced the use of fixed retainers for orthodontic retention purposes for the first time. The wires that are used in the manufacturing of fixed retainers are categorized into generations since they have been introduced **(Degirmenci and Ozsoy, 2009)**. These are the following:

• 1st generation: These are 0.025–0.036 inch blue elgiloy or stainless steel round wires. These are bonded only to lingual surfaces of canines, and loops are bended at each end to increase retention.

• 2nd generation: These are 0.032 inch triple-stranded wires and can be bonded to lingual surfaces of all anterior teeth. These multi-stranded wires substituted plain wires as they have higher elasticity that allows physiological movement of the teeth **(Årtun, 1984)**.

• 3rd generation: These are 0.032 inch stainless steel or 0.030 inch gold-coated plain wires. Their ends are sandblasted with aluminum oxide to increase mechanic retention. They are bonded to canines only **(Zachrisson, 1995)**.

• 4th generation: These are 0.0215 inch 5-stranded wires that can be bonded to all anterior teeth.

• 5th generation: These are 0.032 inch, blue elgiloy plain wires that are sandblasted at the ends and bonded to canines only.

At the beginning, plain round or rectangular orthodontic wires were used as fixed retainers (1). In 1977, Zachrisson presented the advantages of using multi-stranded wires as bonded retainers. Then, in 1982, Artun and Zachrisson introduced the technique of bonding multi-stranded wires to canines only. Later, Zachrisson (2015) applied triple-stranded wires to all anterior teeth in his studies. However, in his paper where he discussed his experience with fixed retainers for 20 years, he reported that 0.0215 inch 5-stranded wires serve better results based on failure rates observed in follow-up sessions **(Zachrisson, 2015)** (Figure 1)

Figure 1: 5-stranded wire retainer bonded to all anterior teeth from canine to canine (Kaya *et al*., 2019)

1.3 Types of fixed retainers

1.3.1 Bonded lingual retainers

They are normally used in situations where stability is questionable and prolonged retention is planned, especially the mandibular incisor region **(vignesh and sumathi, 2015)**. The two most generally used retainers stay the

thick (0.025 to 0.032 inch) spherical stainless-steel wire bonded solely to the canines and also the thin (0.0195 or 0.0215 inch) multistranded wire bonded to the incisors and canines. The most preferred bonded retainer is the thin multi stranded wire retainers as it is bonded to every tooth in lingual segment using acid etch composite bonding (Figure 2) **(Malandkar *et al*., 2019)**.

The preference to this retainer is attributed to the assumed extra mechanical retention to the composite resin due to the strands, and the wire flexibility that permits physiological tooth mobility. Bonding on all anterior teeth is also effective in preventing relapse of the incisors **(Kaya *et al*., 2019)**.

The primary problem of multistranded lingual wires is their high failure rate. Clinical studies indicate that 23%to 58% of maxillary retainers and 5% to 37% of mandibular retainers fail during retention in some form, either bond failure or wire breakage **(Kravitz *et al*., 2017)**. Other disadvantages include difficulty flossing, plaque accumulation, stretching of the wire causing misalignment or spacing **(Wouters *et al*, 2019)**.

Figure 2: Multi-strand wire lower bonded retainer (Johnston and Littlewood, 2015)

1.3.2 Development, advantages and disadvantages

Bonded retainers were first described in the early 1970s, which was more than 50 years after the Hawley retainer and 20 years before the vacuum formed retainer (VFR) (Figures 3) **(Sheridan *et al*., 1993; Bearn, 1995)**. Proposed advantages and disadvantages of BRs are shown in Table 1 **(Green, 2015; Abudiak *et al*., 2011)**.

Indications for a BR include those listed in Table 2 **(Meade and Millett, 2015)**.

A: Lower Vacuum Formed Retainer

B: Upper Hawley retainer

C: Lower BR bonded to both canines and all incisors

Figure 3: Different types of retainers (Meade and Millett, 2020).

Table 1. Advantages and disadvantages of BRs (Meade and Millett, 2020).

Advantages	Disadvantages
Aesthetics	Technique sensitive during placement
Wear not dependant on patient compliance	Difficulty bonding to artificial substrates such as porcelain
Patient and social acceptability	Unwanted tooth movement if active at placement or 'activated' during wear
Superior settling compared to a Hawley retainer or VFR	Bond failure or retainer breakage
	Difficulty with maintenance of optimal oral

	hygiene
	Occlusal interference

Table 2. Specific indications for a BR (Meade and Millett, 2020).

Pre-treatment Features	Post-treatment Features
Median diastema	Space closure following lower incisor extraction
Generalized anterior spacing	Proclination of lower incisors
Severe rotations	Increase in intercanine width
Impacted canines and incisors	Residual overjet in the absence of lower lip support
Severely displaced teeth	Minimal or no overbite after incisor crossbite correction
Severe incisor crowding	Deep overbite correction
Loss of periodontal support	Correction of anterior open bite by orthodontic means
Cleft lip and palate	Teeth with no opposing tooth contact

1.3.3 Bonding to only canines and bonding to all teeth

Fixed bonded retainers are generally used in two ways. First, thicker 0.032 inch wires are bonded to canines only. Although stainless steel wires are mostly preferred in this technique, **Liou *et al*. (2001)** reported successful results for nickel–titanium wires as well. Second, retainers made of 0.0175–0.0215 inch wires are bonded to each tooth usually from canine to canine. The indications for these two techniques differ from one another **(Bearn, 1995)**.

The indications for bonding fixed retainers to only canines were defined by Lee (1981) as follows:

• cases with severe rotations and crowding in the lower incisors,

• cases in which lower inter-canine width is changed,

• cases treated with lower incisor proclination,

• cases with mild crowding that are treated without extractions,

• cases with deep overbite

Retainers only bonded to the canines are associated with a small to moderate increase in mandibular incisor irregularity (0.4 ± 0.7 mm) in 40% of the cases after a period of five years. A downward trend of their use can be seen from 16% in 2005 to 6% in 2015 **(Lai *et al.*, 2014; Padmos *et al.*, 2018)**.

Figure 4: Bonding fixed retainer to only canines (Tacken *et al.*, 2009)

The indications for bonding fixed retainers to all teeth were defined by Zachrisson (1982) as follows:

• cases in which median diastema is closed,

• cases with diastemas between the anterior teeth,

• adult patient with a potential for migration of the teeth after orthodontic treatment,

• cases with tooth loss or large diastemas in the maxilla before treatment,

• cases treated with mandibular incisor extraction,

• cases with severely rotated teeth before treatment,

• cases in which the position of a palatinally impacted canine is corrected.

1.3.4 Material types and designs of bonded retainers

Lingually or palatally placed BRs typically comprise one of several material types and are held in place by a bonding adhesive **(Zachrisson, 2015)**.

1.3.4.1 Stainless steel wire

Multistrand stainless steel (SS) appears to be the most commonly used wire type for BRs **(Zachrisson, 2015)**. Figure 5 shows a range of SS wires used for BR fabrication.

Multistrand stainless steel (SS) may be bonded to the 'end teeth' only of those requiring retention, usually the canines (sometimes called 'canine-to-canine'), or more commonly are bonded to the palatal/ lingual surfaces of all the teeth in the labial segments **(Bearn, 1995)**. Zachrisson suggests only extending the BR from lateral incisor to lateral incisor in the upper arch in children and adolescents, as failure rates are higher when canines are included **(Zachrisson, 2015)**. SS wires for BRs may be round or rectangular in cross section and are usually formed from 3−6 fine strands of wire that are either braided or arranged co-axially **(Meade and Millett, 2015; Zachrisson, 2015)**. The flexibility of the wire facilitates physiological movement of the teeth, even when several adjacent teeth are bonded. Common diameter sizes range from 0.0175" to 0.0215" **(Zachrisson, 2015)**.

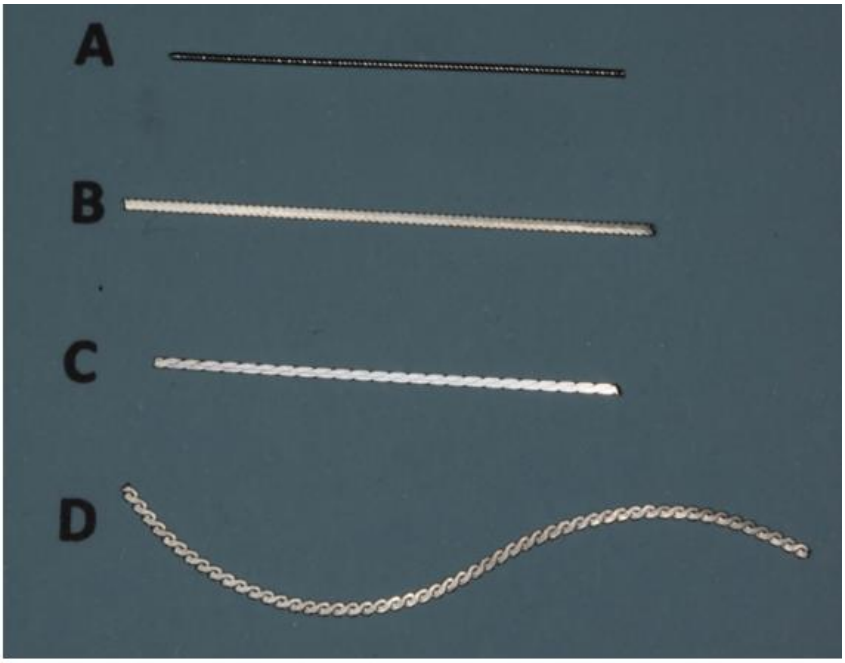

Figure 5: A range of SS wires used for BR fabrication. (a) 'Penta One Coaxial': 0.0215" (Ortho Organizers, Carlsbad, California). (b) 'Flattened multistrand': 0.01" x 0.03"' (Sheboygan, Wisconsin). (c) 'Braided Retainer Wire': 0.01" x 0.028" (Ortho Technology, Lutz, Florida). (d) 'Ortho-Flextech®': 0.016" x 0.038" (Reliance Orthodontic Products, Itasca, Illinois) (Meade and Millett, 2020).

Plain SS wire tends to have a greater diameter (usually 0.025" to 0.032") and is consequently more rigid. It is a common choice of wire for 'canine-to canine' retainers (Figure 6) **(Zachrisson, 2015)**. This thicker wire may reduce the risk of wire fracture but the lack of flexibility may make it more prone to failure. A thicker upper BR wire may also provide a 'biteplane' effect and help maintain correction of a deep overbite. The 'canine-to-canine' design may be indicated when there is alteration of the antero-posterior or lateral position of the lower labial segment during treatment and maintenance of the post-treatment intercanine width is essential **(Abudiak *et al.*, 2011; Zachrisson, 2015)**. It is potentially easier to place and more hygienic than a BR attached to all six anterior teeth **(Johnston and Littlewood, 2015)**. It is also 'fail safe'; the patient is immediately aware if attachment to one or both canine teeth fails **(Kucera and Marek, 2016)**.

Figure 6: Lower 'canine-to-canine' BR (0.032" round SS bonded to canines only) (Meade and Millett, 2020).

A 'V-loop' design involving 0.0195" multistrand SS has also been described with the potential advantage of facilitating easier oral hygiene **(Lee and Mills, 2009)**. Gold-coated, multi-stranded and round wires have been developed and are claimed to be more aesthetic **(Zachrisson, 2015)**.

1.3.4.2 Resin fiberglass bonded retainer

The Resin fiberglass bonded retainer was developed by Michael. This is a direct technique that solves the major problem with cuspid to cuspid retainer and takes very little time for preparation. The system uses glass fiber from woven fiberglass fabric **(Malandkar *et al*., 2019)**.

In fact the reinforcement of composite with short or long fibers (Carbon, Aramid, Polyethylene, Glass) provide better mechanical and physical properties over unreinforced materials **(Donova *et al*., 2016)**. Clinical reliability of fiber-reinforced composite retainers (FRC) retainers has been tested, showing conflicting results. Some reports reported similar or higher efficiency if compared with metallic splints **(Sobouti *et al*., 2016)**. On the other hand it was reported less reliable when compared to conventional retainers over time. The variability of the results can be related to different fibers and techniques tested in the various investigations. Therefore, it is still unclear if FRCs behavior allows better performances over metallic splints. However, FRC retainers are now a days widely used in clinical dentistry **(Sfondrini *et al*., 2017)**.

These retainers are translucent, easy to shape and can be cured at the same time as the bonding adhesive. They may be suitable for patients with nickel allergy as they contain no nickel. Their reduced ‘bulk’ and ease of repair are additional potential advantages. The increased rigidity of this retainer type, however, may run the risk of greater likelihood of failure during masticatory function **(Foek *et al*., 2009)**.

Figure 7: Ribbond fibre-reinforced BR (Meade and Millett, 2020).

1.3.4.3 Nickel-titanium retainer

Resilient nickel titanium (NiTi) arch wire is an excellent alternative to stainless steel multi-stranded or plain arch wire for use as a bonded lingual retainer or as an active appliance. This technique uses the NiTi mandibular bonded lingual 3-3 retainer (Figure 8) **(Eric *et al*., 2001)**.

Figure 8: Nickel-titanium retainer (Eric *et al*., 2001)

1.3.4.4 Memotain

A new CAD/CAM fabricated lingual retainer wire made of custom-cut nickel-titanium—as an alternative to multistranded lingual retainers. Memotain is a CAD/CAM fabricated lingual retainer made of 0.014x0.014-in rectangular nickel-titanium (Figure 9). The wire is very versatile and custom made exactly adapt to the patient's lingual tooth anatomy **(Kravitz *et al*., 2017).**

This retainer may be most advantageous in the maxillary arch, where multistranded wires frequently fail. Maxillary anterior teeth ordinarily have massive large ridges or atypical shapes (ie, peg-shaped lateral incisors, talon cusps, invaginations) that make close adaptation with hand-bent wires challenging. Memotain's tight interproximal wrap is beneficial in common break-point areas, such as the embrasure between the lateral incisor and the canine, or the step between the canine and the premolar. Furthermore, it is digitally positioned to prevent contact with the mandibular teeth **(Malandkar *et al*., 2019).**

Figure 9: CAD/CAM set up for Memotain (Malandkar *et al*., 2019)

Benefits of Memotain (Malandkar *et al*., 2019).

1. No need for wire measuring or bending.

2. Individually optimized placement, greater accuracy of fit

3. Tighter interproximal adaptation, less tongue irritation

4. Better durability, and resistance to microbial colonization.

The drawback of Memotain that it is manufactured by CA-Digital in Mettmann, Germany, and will soon be distributed by AOA Laboratory (Sturtevant, Wis) in the United States. Currently, the price for a single-arch Memotain retainer from canine to canine is €145, or approximately $162 including shipping and handling to the United States; however, domestic distribution will cost significantly less. Memotain comes with a 24-month warranty **(Kravitz *et al*., 2017).**

1.3.4.5 The Ling Lock ™ retainer (Amundsen and Wisth, 2005)

The main objective of the development of the Ling Lock ™ retainer has been to create an appliance for long-term retention of the lower anterior teeth without increasing the risk to the patients of developing periodontal disease or caries in the actual retention area. Additional objectives have been to:

- improve aesthetics
- increase patient comfort
- reduce the laboratory work and chair time
- reduce the risk of accidental breakage
- facilitate repair

The Ling Lock ™ retainer is made up of pairs of separate, but co-working retention elements constructed in ceramic aluminium oxide (Al2O3). It therefore has similar radio-opacity to a ceramic bracket. Pairs of elements are bonded to the lingual aspect of the lower anterior teeth from canine to canine. Retention is created by intimate contact of the complimentary shaped and outlined contact surfaces of the retention elements. These are co-working interlocking, male and female parts (see Figure 10).

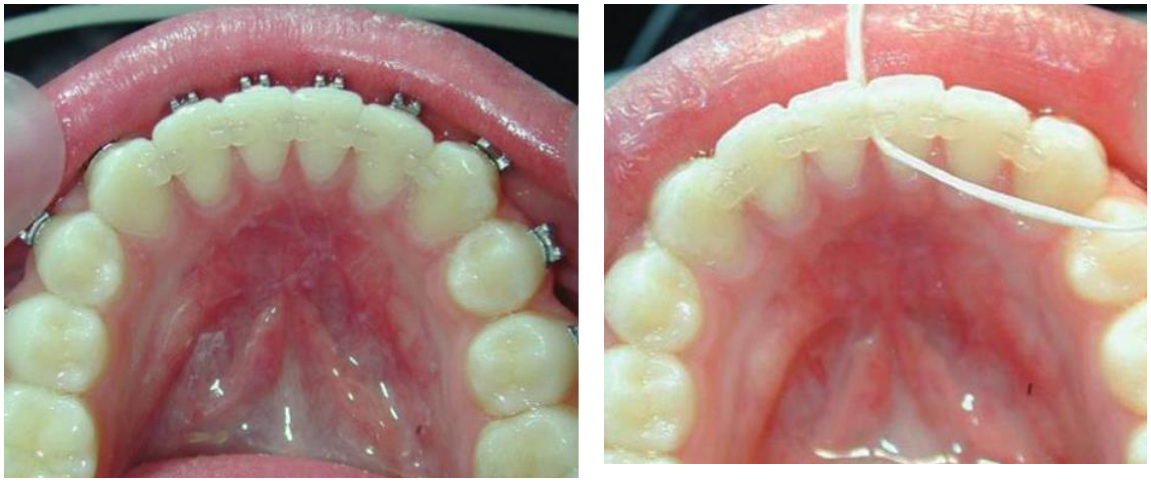

Figure 10: The Ling Lock ™ retainer enables the patient to floss the teeth in the actual retention area.

1.3.4.6 Ortho FlexTech

This system entails placing a passive, flexible wire that extends canine to canine and fixing the wire to every incisor with flowable composite. This retainer is intended for use as a lingual retainer Wire: Ortho Flex Tech'" is best used for lower lingual 3 to 3 retainers and upper lingual 2 to 2 fixed retainers. which comes as a gold or stainless steel chain (Figure 11) (Reliance Orthodontic Products) **(Moskowitz *et al*., 2004)**.

Figure 11: Ortho-FlexTech. 0.016” x 0.038” (Reliance Orthodontic Products, Itasca, Illinois) (Meade and Millett, 2020).

1.4 Fixation method

Authors differ in their approach, and many methods for locating the wire have been described. These include the use of dental floss, orthodontic elastics, wire ligatures, wires tack welded to the retainer wire localizing devices, or fingers. It is recommended that a small amount of composite be used to tack the retainer in place at each end before adding the bulk of material. The composite can be shaped with an instrument dipped in unfilled resin to produce the desired contour various methods for fixation are shown in (figure 12) **(Eapen and Prakash, 2017)**. Different methods of stabilizing wire includes timesaving fixed lingual retainer using DuraLay resin transfer, acrylic transfer tray for direct-bonded lingual retainers, W-shaped lingual retainer wire stabilizer, modified Kesling's separators for stabilizing lingual retainer wire, Wire Jigs for stabilizing lingual retainers, Retainer Positioner, Stabilizing Springs for fixed lingual retainer, lingual retainer stabilized by Modifying Archwire, indirect method of fixing lingual retainer using addition polysilicone tray and an indirect method of fabrication of lingual bonded retainer **(Ajithesh *et al*., 2018)** .

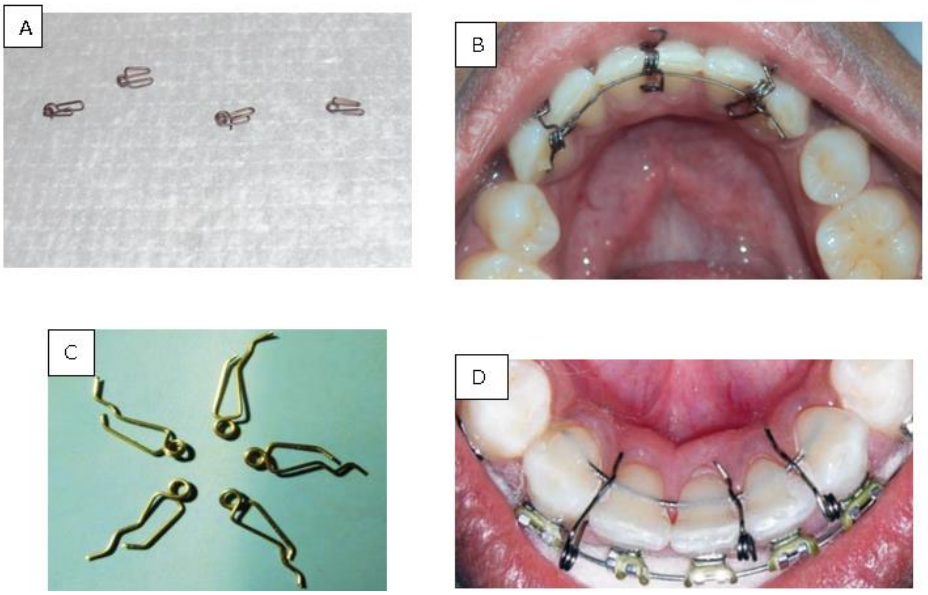

Figure 12: A and B, Stabilising Springs. C and D Retainer positioner (Sahu *et al*., 2012)

1.5 Bonding protocol

Two main techniques have been described: 1. Direct technique; 2. Indirect technique.

1.5.1 Direct technique

This involves placement of the BR without the need for an intermediate (laboratory) step. The wire must be 'shaped' or fabricated to conform to the morphology of the surfaces of the teeth on which the BR is to be placed. It must be correctly positioned and kept passive to ensure optimal bonding and prevent inadvertent activation **(Bearn, 1995)**. Dental floss, orthodontic elastics and SS ligatures have been used to assist in maintenance of correct position during placement (Figure 13) **(Abudiak *et al*., 2011)**.

Figure 13: Dental floss used to maintain correct position of BR (0.010" x 0.028" braided SS) during direct bonding (Meade and Millett, 2020).

1.5.2 Indirect technique

The indirect technique involves fabrication of the BR on a cast of the patient's dentition, typically recorded shortly prior to the completion of

treatment. The BR is then transferred to the mouth via, for example, a silicone putty or an acrylic positioning matrix (Figure 14) **(Waring and Cappelli, 2009)**. Potential advantages of the indirect technique include more accurate positioning of the BR as well as minimal disturbance during bonding **(Abudiak *et al*., 2011)**. Additional time for preparation of the BR and the extra laboratory costs may be potential disadvantages **(Egli *et al*., 2017)**.

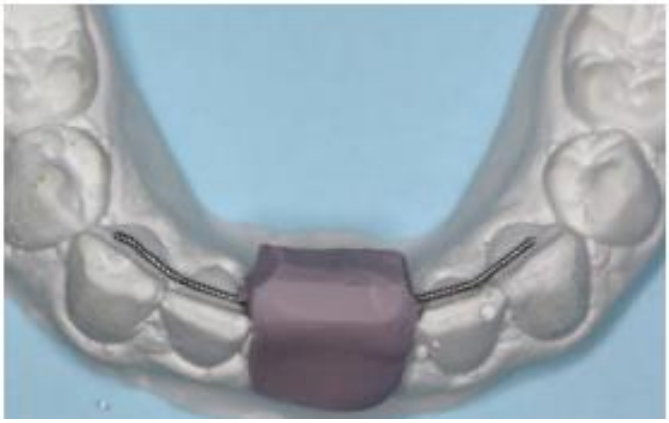

Figure 14: Silicone putty and BR (0.0215" five stranded SS) prior to direct bonding (Meade and Millett, 2020).

1.6 Failure and unintended effects

Bonded retainers may fail in the following ways:

- At the wire-composite interface;
- At the adhesive-enamel interface;
- Stress fracture of wire.

1.6.1 At the wire-composite interface

Bond failure, with the detachment of the retainer from the CR, is often due to mechanical/masticatory forces and may explain reported increased failure rates of upper BRs. Sufficient CR must be used. A thickness of 1 mm covering a bonding surface area of 3.5 mm per tooth has been suggested **(Abudiak *et al*., 2011)**.

Cutting a groove in the palatal surfaces of the upper anterior teeth, in which the BR can be bonded, has been suggested as a way of minimizing occlusal interference **(Andrén *et al.*, 1998)**. A more heavily filled CR may be helpful in resisting occlusal forces on upper BRs **(Rinchuse *et al.*, 2007)**.

1.6.2 At the adhesive-enamel interface

To ensure optimal enamel adhesion, a dry field is essential. Rubber dam use has been proposed to minimize the risk of moisture contamination during BR placement but its use did not reduce bond failure rates **(Conway *et al.*, 2011)**. The enamel surface requires thorough cleaning, with some advocating sandblasting **(Gange, 2015)**.

1.6.3 Stress fracture of wire

This may be associated with wire fatigue or be due to excessive bite force. Breakage may occur in thinner wires, whereas thicker wires may 'detach' rather than break due to their increased rigidity **(Meade and Millett, 2020).**

Figure 15: Different types of failures of bonded retainers. a) Type 1 – detachment on the enamel-composite interface. b) Type 2 – gradual wear and fractures of the adhesive on the wire-composite interface. c) Type 3 – wire fracture (Kučera *et al.*, 2021)

1.7 Effects of Fixed Retainers on Periodontal Health

The biggest concern for bonded fixed retainers in long-term use is whether they make it more difficult to maintain oral hygiene and cause negative effects on periodontal health **(Booth *et al*., 2008; Al-Nimri *et al*., 2009)**. However, no consensus is found about this subject when the literature is reviewed. There are studies that show that bonded fixed retainers cause increased plaque and calculus accumulation or gingival inflammation. There are also other studies that show no negative effect. Artun (1982) compared the effects of different types of fixed retainer wires on caries formation and periodontal health and reported that although fixed retainers cause more plaque accumulation, they do not cause caries. **Levin *et al*. (2008)** showed that bonded fixed retainers cause increased plaque accumulation, gingival recession, and bleeding on probing. **Pandis *et al*. (2007)** reported that as a result of long-term tissue irritation, bonded fixed retainers cause an increase in pocket depth, marginal gingival recession, and calculus accumulation. However, these results were related with long-term wearing of fixed retainers rather than the materials used **(Årtun, 1982)**. It was remarked that the interproximal area beneath bonded fixed retainers was difficult to clean, thus more calculus was accumulated in this area **(Pandis *et al*., 2007; Butler and Dowling, 2005)**. On the other hand, there are many studies that argue against these opinions. These studies revealed that even long-term wearing of fixed retainers caused no gingival tissue damage in most patients **(Rody *et al*., 2011)**.

Rody *et al*. (2011) placed fixed retainers in the mandibular anterior teeth and reported that although there is an increase in plaque accumulation, periodontal health is not affected. **Booth *et al*., (2008)** reported acceptable gingival values in the mandibular anterior teeth after long-term wear of fixed retainers. Another study reported a decrease in bone level and remarked that it

was due to orthodontic treatment rather than type of retention protocol **(Westerlund *et al*., 2017)**.

1.8 Cost

A recent randomized controlled trial compared the costs of three retention methods: a bonded retainer to the maxillary four incisors, a bonded retainer to the maxillary four incisors and canines, and a removable VFR in the maxilla. there was no difference in costs for the three types of retention methods **(Sonesson *et al*., 2022)**.

Indirect bonding of a BR in the mandible was significantly faster compared to time of for direct placement. This, however, may not result in significant cost saving as there was no difference in BR failure rates placed using either technique **(Moskowitz *et al*., 2004)**.

1.9 Care

It is essential that the orthodontist provides guidance to the patient on the care and maintenance of BRs with an appropriate recall plan. This involves discussion with the patient during the informed consent process prior to starting orthodontic treatment **(Meade *et al*., 2019)**.

Patients, however, should be advised by the orthodontist that long term regular review is necessary to check that the BR is ‘intact’ and dental tissues around the BR remain healthy **(Johnston and Littlewood, 2015)**. To this end, long-term surveillance regarding care and maintenance can be delegated to GDPs, as this is within their scope of practice, but only following discussion and mutual agreement with the orthodontist **(Alkadhimi and Sharif, 2019)**.

A recall schedule with a checklist of what to ascertain regarding the BR and supporting tissues and instructions as to how this can be undertaken should

be provided by the orthodontist. In particular, the review should include careful examination to ensure that the CR has not become detached from the enamel surface. Recall intervals should be tailored to the individual patient. It has been recommended that the BR should be checked at least once every year **(Johnston and Littlewood, 2015)**. The BR review may be incorporated into the patient's regular check-up. Instructions for appropriate use of dental floss, 'floss-spreaders' and effective brushing to minimize plaque and calculus around the BR should be reinforced **(Johnston and Littlewood, 2015)**. Care should be exercised when scaling around the BR to avoid accidental 'debonding'. Advice issued on placement in relation to cautious eating/ chewing to avoid breakage, inadvertent activation or 'debonding' of the BR should also be repeated **(Kucera and Marek, 2016)**.

If the BR is distorted, broken or has come off entirely, referral to a specialist orthodontist may be required as any unwanted tooth movement may require addressing **(Patel and Sandler, 2010)**. If the patient had been provided with a removable retainer at the end of orthodontic treatment, then the GDP should encourage its wear until the BR can be repaired. If the BR requires rebonding, and provided the GDP has received training and is confident to undertake the procedure, then the steps outlined in Table 3 should be followed **(Patel and Sandler, 2010; Alkadhimi and Sharif, 2019)**.

Table 3. repair of debonded BR (Meade and Millett, 2020)

Procedure for repair of a BR
• **Remove residual Composite resin (tooth/teeth/BR) with fluted Tungsten carbide bur/ Slow speed handpiece Ensure BR not distorted**
• **Etch enamel (15−20 second) with 35% phosphoric acid**
• **Rinse/dry thoroughly with moisture/oil-free air**
• **Isolate with rubber dam/cotton rolls/saliva ejectors**
• **Apply unfilled resin to etched surface**
• **Apply/adapt Composite resin With high filler content to BR using Teflon-coated instrument or foam Microbrush dipped lightly in bonding agent**
• **Ensure Composite resin covers middle third of crown, lies above and below wire and covers BR**
• **Light cure Composite resin, ensure no ledge at tooth− Composite resin interface**
• **Remove excess Composite resin with Tungsten carbide bur in Slow speed handpiece**

Chapter two: Discussion

Retention is necessary following orthodontic treatment to prevent relapse of the final occlusal outcome. Relapse can occur as a result of forces from the periodontal fibers around the teeth which tend to pull the teeth back towards their pretreatment positions **(Johnston and Littlewood, 2015)**

The ability to achieve long-term stability and the subsequent understanding of factors affecting stability are an indication for the need to retain the achieved results **(Edman-Tynelius *et al*., 2013; Littlewood *et al*., 2006)**. In the absence of a retention phase, teeth tend to return to their initial position. To prevent recurrence, it is necessary to perform some form of retention **(Littlewood *et al*., 2006)**.

With the introduction of the adhesive technique, the lingual retainer has become widely used in recent decades to preserve the changes achieved during orthodontic treatment **(Aasen and Espeland, 2005)**. This consists of a wire of certain length usually bonded from canine to canine on the lingual surface **(Al-Kuwari *et al*., 2014)**. Since its introduction in 1977, several modifications have been made to the wires used. The first generation consisted of a rounded wire (0.032- 0.036 inches) with terminal folds, bonded to the canines only. The second generation did not require terminal folds, since the wire spiral offered good retention; the disadvantage of this retainer is that its diameter (0.032 inches) produces less stability **(Zachrisson, 1995)**.

Rigid multi-stranded wires of a bigger diameter (0.032 inches) have been used in the last ten years (0.032 inches) bonded to the canines only, as well as another type of multi-stranded wire usually more flexible and of a smaller diameter (0.017- 0.021 inch), bonded on each tooth from canine to canine **(Katsaros *et al*., 2007)**. The advantage of using multi-stranded wires is that their irregular surface increases mechanical retention with no need of making

retentive folds, and the flexibility of the wire allows the physiological movements of teeth **(Sifakakis *et al*., 2011)**.

As an alternative to this type of wire, glass fiber-reinforced resin tapes are used with the disadvantage that they create a very rigid splint that limits the physiological movement of teeth and can cause fissures **(Russell, 1995)**.

Fixed retainers are increasingly used nowadays because they are esthetic, require less patient cooperation, and provide greater stability in the long term, thus being more predictable **(Zachrisson, 2007)**. However, these retainers may produce gingival recessions, loss of insertion, gingivitis, and the subsequent periodontal destruction **(Batista *et al*., 2010)**. So, this will make oral hygiene more difficult as the lingual surface becomes more susceptible to the formation of calculus **(Kaji *et al*., 2013)**. In addition, Tooth decay may also appear on the lingual surfaces adjacent to the retainer.

The effect of these retainers on periodontal health is currently debatable **(Kaji *et al*., 2013)**. There is association between gingival recessions and fixed retainers in the long term; however, there is no alteration of the alveolar bone level. The studies recommend encouraging patients to maintain good oral hygiene **(Wasserman *et al*., 2016)**.

Chapter three: Conclusion and Suggestions

3.1 Conclusion

1. Bonded retainers are the most favorable type of fixed retainers both by orthodontist and by patients as they are esthetically superior with minimal interference with speech and mastication, however they are more costy and require a well experienced orthodontist or well trained general practitioner.

2. There are different types of materials and designs available for orthodontic fixed retainers. The most preferred bonded retainer is the thin multi stranded wire retainers but the primary problem of multistranded lingual wires is their high failure rate. Resin fiberglass bonded retainers are translucent, easy to shape and can be cured at the same time as the bonding adhesive. The Ling Lock retainer enables the patient to floss the teeth in the actual retention area Ortho FlexTech system entails placing a passive, flexible wire that extends canine to canine and fixing the wire to every incisor with flowable composite CAD CAM retainers provide Individually optimized placement, greater accuracy of fit, Tighter interproximal adaptation and resistance to microbial colonization

3. Prior to bonding, good cleaning (sandblasting) of tooth surface and isolation is required to ensure the best results and using of high quality bonding resin is essential for best results.

4. Whenever possible; indirect bonding technique should be more accurate as it allows accurate placement of the retainer wire in the exact intended position with minimal disturbance during bonding.

5. Retainer positioner provides intimate contact of the retainer wire to tooth surface and provide easier and more accurate work environment.

6. Flowable composite could be used to fix the retainer to the tooth surface and then highly filled composite applied over the retainer wire as they have high compressive and tensile strength in thin layers.

7. Inform patients about importance of routine follow up to check for possibility of failure, caries, periodontal diseases and unwanted tooth movement

3.2 Suggestions

1- To do a research to find what preferred type of fix retainer used by Iraqi orthodontist

2- To do research about components of retainer (type bonding, wire, bonding technique)

3-To do a research compare between different type of fixed retainers

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