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Comparison of Different Fixed Retainers versus Prefabricated Printed NiTi Retainers with CAM CAD System: Literature Review

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Abstract: ***Introduction: Maintaining teeth in their ideal esthetic and functional positions following treatment is what is often meant by orthodontic retention. These retainers are recommended to prevent mandibular incisor relapse. One of the most crucial treatment phases is retention, although orthodontists are divided on the best designs and materials to use for this phase's retention as well as their relative importance. Methods: A systematic review of the literature considering reviews, clinical studies, original papers and articles from electronic data has been used. Results: different types of reteiners were used in these studies. Multistrained, 0.0215 inch, Direct-Bond Glass Fiber-Reinforced Composite Splints, They compared 0.0215-inch five-stranded wire (PentaOne, Masel; 0.016 × 0.022-inch dead-soft eight-braided wire (Bond-A-Braid, Reliance; 0.0195-inch dead-soft coaxial wire (Respond, Ormco;) and just in few studies The Memotain retainer (CA-Digital, Mettmann, Germany) that is produced by this technique is manufactured from nickel–titanium wires of 0.014×0.014 inch thickness. The material was compared for different parameters as: Dental Plaque Index, Gingival Index, Dental Calculus Index and Retainer Wire Calculus Index, breakage, de attachment, bonding system etc. Conclusion: Failure types, failure rates, comfort, strength thickness, alloy selection, brakeage, aesthetics and effects on periodontal health are main investigated issues in clinical studies related with bonded retainers. The quality of the available evidence is low according to majority of studies selected for this review paper. No conclusive evidence was found in order to guide orthodontists in the selection of the best protocol and best retainer of choice.***

Keywords: Fixed retainers, Multistranded retainers, Memotain CA-Digital retainers

1. Introduction

In order to rectify malocclusion, orthodontic treatment requires tooth movement. The correction should ideally continue following treatment, signifying stability. However, teeth have a propensity to revert to their pre-treatment positions. Therefore, to prevent relapse, post-treatment tooth position often needs care for a while. [(1)]

Mainly, preserving teeth in their ideal morphological and functional positions following treatment is what is meant by orthodontic retention [(1).] These retainers are recommended to prevent mandibular incisor relapse. One of the most crucial treatment phases is retention, although orthodontists are divided on the best designs and materials to use for this phase's retention as well as their relative importance [(2).] When the orthodontic appliance is taken out, the majority of patients are given a bonded lingual retainer because treatment stability varies depending on the patient [(3).] Occlusion was thought to be the most crucial element in the 19th century for the stability of the teeth following orthodontic treatment. Lundstrom [(4)] asserted as the 20th century approached that the most crucial element for stability.

Tweed [(5)] said in 1944 that upright incisors aid in retaining better stability during retention and that incisor inclination plays a function. There is a widespread understanding now that a retention phase is essential for the stability of therapy results. Additionally, in some situations, lifetime retention is recommended. [(6)] Some longitudinal studies evaluated post-treatment records and stated tremendous relapses in some occlusal relations, especially in the alignment of the mandibular anterior teeth [(7-10)]

Removable appliances have been used for many years for retention purposes.

In the vast majority of studies on fixed retainers, orthodontist researchers hold that a type of permanent retention is the only way to keep the optimal alignment following orthodontic treatment. This fixed retainer may be worn in the mouth for a very long time [(11-14)]

For the retention of post-treatment tooth position, various techniques have been employed. The earliest appliances recommended were banded fixed appliances, followed by some removable retainers and, most recently, the adoption of bonded fixed retainers.

In this sense, bonded fixed retainers are just a length of orthodontic wire that has been acid-etched and cemented to the teeth. [(15)]

In the 1970s, Knierim introduced fixed lingual retainers [(16)]

Fixed retainers were first used to stop relapse in the lower incisor region in the 1970s. These retainers that are bonded to the lingual faces of the teeth are increasingly preferred by orthodontists for being both aesthetic and easy to wear by patients for long-term use [(17, 18).]

Zachrisson [(19)] discussed the benefits of utilizing multi-stranded wires as bonded retainers in 1977. The method of bonding multi-stranded wires to canines alone was then introduced in 1982 by Artun and Zachrisson [(19-20).] Later, in his research, Zachrisson [(21)] used triple-stranded wires on all anterior teeth. However, based on failure rates seen in follow-up sessions, he reported in his paper where he highlighted his experience using fixed retainers for 20 years

that 0.0215 inch 5-stranded wires produce superior results [21]

In a study published in 2002 by Keim RG, was reported that one-third of orthodontists preferred fixed lingual retainer in the mandible, whereas 5% preferred fixed retainers in the maxilla [22].

Andrea Scribante [22] carried out a longitudinal prospective randomized trial in 2011 in which they made a clinical comparison between Direct-Bond Glass Fiber-Reinforced Composite Splints and Multistranded Wires. As a result of this investigation, it was determined that there was no statistically significant difference between the failure rates of the two varieties of bonded retainers. However, data from the visual analogue scale (VAS) revealed that the aesthetic outcome for polyethylene ribbon-reinforced resin retainers was substantially greater.

A study on the comparison of three different orthodontic wires for the production of bonded lingual retainers was carried out in 2012 by Bajsal A. and colleagues. They contrasted 0.016 0.022 inches dead-soft eight-braided wire (Bond-A-Braid, Reliance; group II), 0.0195 inches dead-soft coaxial wire, and 0.0215 inches five-stranded wire (PentaOne, Masel; group I) (Respond, Ormco; group III).

The study was done to test only detachment force, deformation, and fracture mode. They did not include periodontal values like plaque accumulation, gingival bleeding, pocket depth not inter canine width. They concluded that detachment force and fracture mode were similar for all wires, but greater deformations were seen in dead-soft wires. Wire pull-out force was significantly higher for five-stranded coaxial wire than for the other wires tested. Five-stranded coaxial wires are suggested for use in bonded lingual retainers. [23]

Also in 2011 there was study of Comparison of periodontal parameters after the use of orthodontic multi-stranded wire retainers and modified retainers by Lukiantchuki M. [24]

For this crossover study, 12 volunteers were selected and used the following retainers for six months: (A) a multi-stranded wire retainer and (B) a modified retainer. Both retainers were fixed to all anterior lower teeth. After this experimental period, the following evaluations were made: Dental Plaque Index, Gingival Index, Dental Calculus Index and Retainer Wire Calculus Index. A questionnaire about the use, comfort, and hygiene of the retainers was also given to the volunteers. They came to the conclusion that the multi-stranded wire retainer performed better than the modified retainer in terms of the periodontal characteristics they studied, as well as being more comfortable and the retainer that volunteers preferred.

They did not assess fixed retainer de-attachment, tooth alterations, or breakage. Additionally, it was carried out by volunteers during a 6-month evaluation period of patients who had not previously received fixed orthodontic treatment; hence certain information crucial for post-orthodontic alignment was disregarded. In recent years, CAD-CAM methods have been used to create bonded retainers. Since this technology is so new, there have only been a few research done in this area. Each company uses a different set of CAD-CAM manufacturing processes and wire kinds to create bonded retainers. One of the methods involves bending premade wires with a machine's handle to create retainers. This method produces the SureSmile retainer (OraMetrix, Richardson, TX, USA) using copper-nickel-titanium wires [25]. Another method involves slicing bonded retainers from a block of wire. This method is used to create the Memotain retainer (CA-Digital, Mettmann, Germany), which is made from nickel-titanium wires that are 0.014 **x** 0.014 inches thick

Clinical Evaluation of Fixed Retainers

Failure types, failure rates, comfort, strength thickness, alloy selection, brakeage, aesthetics and effects on periodontal health are main investigated issues in clinical studies related with bonded retainers. The quality of the available evidence is low according to majority of studies selected for this review study seminar. No conclusive evidence was found in order to guide orthodontists in the selection of the best protocol and best retainer of choice.

Bonded retainers, failure and hygiene status

A long-term retention technique that is mechanically effective is bonded fixed retention. There must be no negative impacts on dental health for these retainers to be clinically appropriate for long-term retention. The effects of bonded fixed retainers on cleanliness have been examined in five research. These investigations use a wide range of observation times. The shortest observational time was 4 months, while the longest was 103 months for any one person. [26]

None of the reports found any evidence of increased periodontal disease or enamel decalcification in relation to lingual bonded retainers. There was no evidence of greater plaque deposits on multistrand wire when compared with round wire. [27]

Two cases have been reported with surface enamel demineralization after 2 years of using labial bonded retainers in the buccal segments. [28]

In bonded fixed retainers, multistrand wire has taken the place of simple round or rectangular wire due to the advantages of enhanced mechanical retention, minimizing needless retentive loops, and enabling physiologic movement.

Bonded retainer failure rates have been found to range from 10.3% to 47.0%. Zachrisson [19] discovered that using 0.0215-inch Penta One multistrand wire resulted in much lower failure rates. The failure rate in the maxilla is roughly two times higher than in the mandible, and this is most likely due to occlusal factors. To lessen the chance of failure, care must be given when inserting maxillary retainers to make sure they are free from occlusal damage.

The wire/composite interface is the most typical location of failure. The placement of insufficient adhesive and material loss due to abrasion is blamed for the wire coming away from the composite's surface. The longevity of the retainer

may be enhanced by using composite materials with more bulk or materials with higher abrasion resistance.

The use of lingual bonded retainers over an extended period of time has not been linked to any negative oral health impacts in any studies. Based on this evaluation of the literature, it is currently advised to utilize 0.0215-inch multistrand wire that is bound to the teeth with a sufficient layer of Concise composite. Although using restorative composites with more filler might theoretically increase strength and abrasion resistance while decreasing failure rate, there have been no published cases of either in vitro or in vivo failure with these materials. Additionally, no in vitro or in vivo research has examined the impact of the utilized composite's mass on the failure rate. There is a need for studies, both in vitro and in vivo, to provide the scientific basis on which to review these recommendations.

In the literature, there are several research looking into different kinds of retainer wires, adhesive materials, and bonding methods utilized for fixed retainers. For every single type of fixed retainer, a wide range of failure rates have been explored. Failure rates for stainless steel retainers that are only bonded to canines range from 13% to 37.7%. (25-28)

However, it has been found that when they are bonded to six lower incisors, the failure rates range from 9% to 14%. (29-30) The failure rates for multi-stranded retainers that became popular in recent years for their advantages are reported to be 8.8%–46% (31, 32, 33, 34) For resin fiberglass retainers, the failure rate was observed between 11% and 71%, and the risk of failure for maxilla was reported to be higher than that for mandible for all examined fixed retainer types (29, 31, 32)

Bonded fixed retainers can fail for a variety of causes, such as the tooth-adhesive interface separating, the wire-adhesive interface separating, the retainer wire breaking, and unintended torque movements of the teeth brought on by the retainer wire (32, 33) The majority of failures are reportedly noticed within the first six months of retainer use.

Teeth-adhesive interface separation is the most typical type of failure. In metal retainers, this failure type is claimed to occur at a rate of 3.5%-53%, but in fiber retainers, this rate ranges from 11% to 51%. (30-33). The strong biting pressures brought on by consuming hard meals nearly invariably play a role in the separation of the tooth-adhesive interface. Patients with fixed retainers should avoid biting directly into hard meals as a result. On the other hand, metal fatigue, which is seen when retainers are used for an extended period of time, is typically linked to retainer wire breakage.

It is mentioned that the reason for separation of retainer wires from adhesive materials may result from either inadequate use of adhesive materials during the bonding stage or loss of adhesive material from composite surface due to abrasion in long term use. Larger amounts of adhesive usage are recommended to increase the resistance to abrasion. (34)

Less frequent failure kinds include opening of spaces between teeth, occasionally shifting of teeth, or dehiscence brought on by sudden torque motions, even while the retainer is still attached to the tooth surface. (33, 34) Despite the fact that failure of fixed retainers is a multifaceted issue, problems with the bonding or location of the wires and the mechanical characteristics of the wires play a significant part in failures. (34) The success rate of fixed retainers is said to increase with passive adaptation of the retainer wire to tooth surface, minimizing saliva contamination during bonding, and refraining from biting hard meals.

A number of studies investigating various types of retainer wires, adhesive materials, and bonding techniques used for fixed retainers can be found in the literature. There is a wide range for failure rates examined for each different type of fixed retainers. For stainless steel retainers, which are bonded to canines only, the failure rates are reported to be 13%–37.7% (25, 26–28). On the other hand, the failure rates are reported to be 9%–14% when they are bonded to six lower incisors (29, 30).

According to reports, multi-stranded retainers' failure rates, which have gained popularity in recent years because to their benefits, range from 8.8% to 46%. (31, 32, 27, 33, 34). For all evaluated fixed retainer types, the failure rate for resin fiberglass retainers ranged from 11% to 71%, and the risk of failure for the maxilla was reported to be higher than that for the mandible (35)

Fixed Retainers' Effects on Periodontal Health

The fundamental question surrounding bonded fixed retainers is if long-term use will make dental hygiene more challenging and have a negative impact on periodontal health (8, 20, 26, 27). However, a survey of the literature reveals that there is no agreement on this issue. Bonded fixed retainers have been linked to increased plaque and calculus buildup as well as gingival inflammation, according to studies. There are other studies as well that don't indicate any harm.

Bonded fixed retainers enhance plaque buildup, gingival recession, and bleeding upon probing, according to research by Levin et al. (36) According to Pandis et al. (8), bonded fixed retainers increase pocket depth, marginal gingival recession, and calculus accumulation as a result of long-term tissue irritation. However, rather than being tied to the materials utilized, these outcomes were associated with prolonged usage of fixed retainers. It was noted that because bonded fixed retainers were difficult to clean, more calculus formed in the interproximal area beneath them. (37)

Fixed retainers were inserted in the mandibular anterior teeth by Rody et al. (38) who reported that although plaque accumulation increased, periodontal health was unaffected.

However, there are other studies that contradict these claims. These investigations shown that even prolonged usage of fixed retainers in most patients did not result in gingival tissue damage. (38, 39) Another study observed a decline in bone density and noted that orthodontic therapy rather than a particular retention strategy was to blame. (40)

What do we know about new evidence

Recently, a brand-new nickel-titanium retainer made using CAD/CAM has been proposed. (Fig.1). The retainer is electro polished after being specially cut from nickel-titanium sheets. Without occlusal obstruction or microbial colonization, it permits more exact bonding.

A bond failure or wire break occurs in around 50% of maxillary and 1/5 of mandibular multi-stranded lingual retainers during retention. As an alternative to multi-stranded lingual retainers, Memotain is a new CAD/CAM manufactured lingual retainer wire made of custom-cut nickel-titanium. Compared to the conventional multi-stranded stainless steel wire, it reportedly offers a number of benefits, including precise fit, avoidance of interferences, corrosion resistance, and even the potential for slight tooth movement when used as an active lingual retainer. Memotain is a rectangular nickel-titanium lingual retainer that was created using CAD/CAM technology [(41)]

The wire has been specially cut and is extremely flexible to perfectly fit the patient's lingual tooth architecture. Pascal Schumacher, an orthodontist, created it in 2012. Because the lingual wire is made of nickel-titanium, the name "Memortain" is a fusion of the words "memory" and "retainer."

Figure 1: Memotain precision-fit nickel-titanium lingual wire.

Butler and Dowling [(42)] reported that thicker and rigid wires were able to maintain intercanine width better than flexible ones. To the contrary, Alrawas et al. [(43)] found no significant difference in intercanine width changes between two different fixed retainer wires. A possible explanation could have been comparable rigidity of the different wires observed. Another explanation could have been variability in orthodontic treatment, such as treatment duration and extent of changes in intercanine width. [(44)]

2. Conclusion

Our findings emphasize the value of individual variability and importance to take serious cautious of retention protocols after a thorough consideration of various factors such as anatomic, hygiene, bad habits, social, and cultural factors.

So far, most importantly, the evidence gathered highlights the importance of close monitoring of patients with bonded fixed retainers in both groups through frequent recalls, since there has been slight tendency to receive higher values in periodontal parameters in long term period of time.

Patients wearing CAD/CAM multistranded stainless steel fixed retainers had less intercanine width relapse six months after retention than patients with conventional flexible multistranded stainless steel fixed retainers. In contrast to patients who had fixed retainers manually bent by a doctor, patients with CAD/CAM fixed retainers showed reduced increase in incisor irregularity and failure.

Still there is low evidence which model or shape is superior for stability and periodontal response, but again a bonded fixed retainer serves better in dental stability after all.