

COMPARISON BETWEEN ORTHODONTIC PERMANENT AND REMOVABLE RETAINERS: A REVIEW

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Abstract

Relapse is the term used when teeth go back to their original place after orthodontic treatment, so the success of an orthodontic treatment depends heavily on retention. Retainers, either permanent or removable ones, are used to avoid relapse. The purpose of this review is to compare the differences between fixed and removable retainers, and to determine which one works more efficient.

Keywords: Relapse, Retention, Orthodontic, Fixed retainers, Removable retainers.

Introduction:

Orthodontic retention, or the phase of treatment after orthodontic therapy that focuses on maintaining the teeth's new positions, is a crucial aspect of the overall treatment plan [1]. When the post-treatment period is not enough to ensure adequate retention, relapse develops. There are three main causes of relapse: first, the gingival and periodontal tissues are affected by orthodontic tooth movement and need time to reorganize when the appliances are removed; second, the teeth may be in an inherently unstable position after the treatment, so that soft tissue pressures constantly produce a relapse tendency; and third, changes produced by growth may alter the orthodontic treatment result [2]. All orthodontic patients must use a retainer after treatment to prevent unwanted tooth movement [1].

Retainers can be classified as either fixed (permanent) or removable. Removable retainers that can be removed by patients allowing them to clean fully around the teeth and to wear them on a part time basis if indicated, while fixed retainer is fixed to teeth and cannot removed by patient [3]. Fixed orthodontic retainers are widely used in clinical orthodontics because they have been found to be quite successful, particularly in avoiding relapse of front teeth [4].

Due to its technique-sensitive administration, fixed retainers have certain clinically unfavorable characteristics, such as increased calculus formation, restricting natural tooth mobility, a high failure rate, and increasing chair side time [5]. Mandibular canine to canine (3-3) bonded retainer bars (0.030 or 0.032 inch) are the most popular, followed by thin 0.0215-inch flexible retainers and spiral wire retainers. [6].

For retention therapy, fixed, removable, or dual retention treatments may be used, although none of them has been acknowledged as the optimal retention regimen [7,8]. Some people additionally recommend supplementary treatments like enamel reduction between teeth or even minor dental surgery. Almogradi et al. found in a Cochrane review that there is insufficient high-quality data to recommend one retention strategy over another in terms of stability [6].

Review of literature

History

For years, removable appliances have been utilized for retention. Fixed retainers were first developed in the 1970s to stop relapse in the lower incisor region [9]. Orthodontists are increasingly favoring these retainers because they are aesthetically pleasing and simple for patients to use for a prolonged period of time [10,11].

In 1965, Newman [12] was the first to document the use of direct bonding of orthodontic attachments to the tooth surface. Then, in 1973, Kneirim [13] was the first to document the use of bonded fixed retainers. While, Zachrisson in 1977 was the first who discussed the potential advantages of employing multistranded wires for bonding retainers, as opposed to the older practice of using round

orthodontic wire [14]. Later, in 1982, Artun and Zachrisson [15] developed a clinical method. In this method, the wire is exclusively bonded to the canine teeth. After that, Zachrisson [16] applied triple-stranded wires to all anterior teeth in his studies. Due to its flexibility, multistranded wire, allows for physiologic movement of teeth even when multiple neighboring teeth are bonded together. This results in improved mechanical retention for composite materials without the requirement for retention loops.

Fiber orthodontic retainers entered the market after the use of fiber materials in dentistry in the 1970s [17]. Resin fiberglass strips have gained usage as an alternative to multistranded wire [17,18,19].

Nowadays, bonded retainers can be created utilizing CAD-CAM technology. Because this technique is so new, there have only been a few investigations. Each company produced several manufacturing processes and kinds of wires for bonded retainers utilizing CAD-CAM technology. One method involves bending prefabricated wires by a machine's handle to create the retainers. This method is used to create the copper-nickel-titanium wire-based in SureSmile retainer (OraMetrix, Richardson, TX, USA) [20]. Another method involves creating bonded retainer by carving out of a block of wire. This method uses nickel-titanium wires that are 0.0140.014 inches thick to create the Memotain retainer (CA-Digital, Mettmann, Germany) [21].

Types of Retainers

Both permanent and removable retainers exist. When comparing removable and fixed retainers, it is important to note that the former may be taken out by the patient for thorough cleaning around the teeth and can be worn intermittently if necessary [3]. Despite this finding, Naidu and Suresh identified the following characteristics of effective retainers: All of the teeth after orthodontic treatment should remain in their new locations, and allow the dentition to be subjected to typical functioning stresses without restriction, maintaining proper oral hygiene, ideally, it would be durable enough to withstand regular use [22].

Removable Retainers

Patients prefer removable retainers since they can take care of them, removing and reinserting them as needed [22]. Short chair-side time, effectiveness for minor malocclusion, ease of adjustment, and less professional training for handling, are only few of the advantages of removable retainers [23]. However, Bishara lists certain drawbacks of such retainers, including reliance on patient compliance, speech impediment, and inability to correct complicated malocclusion [24].

Types of removable retainers

I. The most popular retainer is Hawley's appliance, which is seen in figure (1) [25]. According to Naidu and Suresh, the traditional design includes clasps on the molars and a small labial bow that extends from canine to canine and has adjustable loops. It has strong retention, can close small spacing in the anterior segment, prevents extraction spaces from opening up, and prevents the anterior teeth from rotating or creating gaps [22].

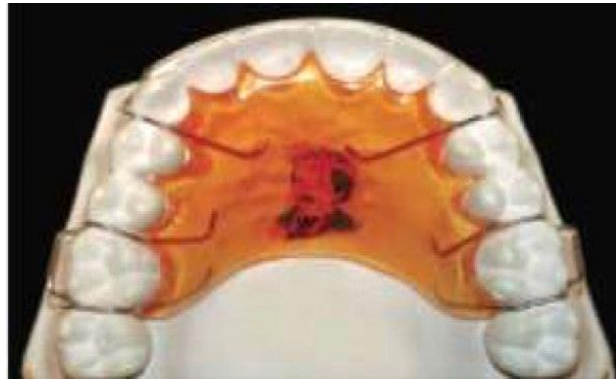


Figure 1: Hawley's retainer [25].

II. Begg's retainer: This type of retainer is made of a labial wire that goes to the last tooth that has come in and bends around it to be inserted in plastic that goes across the mouth [26]. As shown in figure (2) [25], there is no wire structure crossing the occlusion, so it is used when the occlusion needs to settle [27].



Figure 2: Begg's retainer [25].

III. Single arrowhead partial wraparound retainer: This retainer is a variation on Begg's retainer. It is used when the third or second molars are only partly erupted [27,28]. As shown in figure (3) [29].

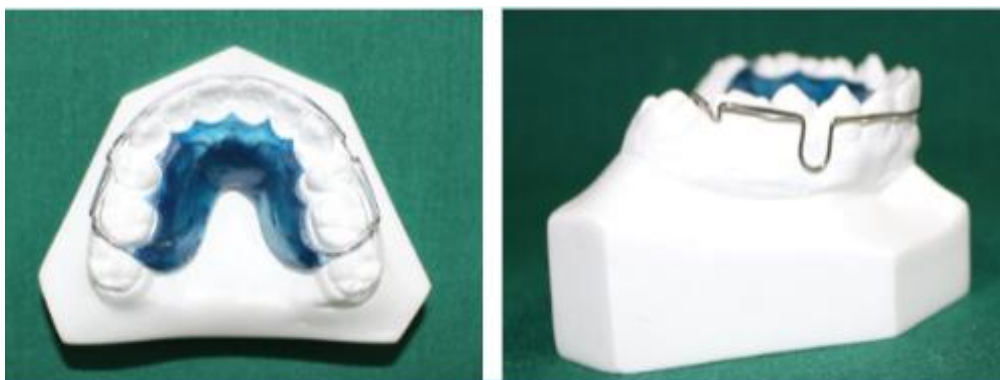


Figure 3: Single arrowhead partial wraparounds retainer [29].

IV. Spring retainers, also called spring realigners or clip-on retainers, are often used in the front teeth, as shown in figure (4) [25,27].



Figure 4: Spring retainer [25].

V. Kesling's tooth positioner: According to Luther and Moon, this form of retainer is suited for maxillary and mandibular teeth with a little portion of the gingiva. It is constructed of thermoplastic rubber material [27]. As see in figure (5) [30].



Figure 5: Kessling's tooth positioner [30].

VI. Vacuum formed retainers: It is also known as Essix retainers, clear plastic retainers, and transparent retainers, according to Simon and Bhalajhi. They are made of ultra-thin, clear acrylic pieces that cover the crowns and part of the gums as appear in figure (6) [31,32]. They provide a greater retention of the lower incisors and are more aesthetically pleasing. They are also cheaper, less prone to break, faster to manufacture, and less disruptive to speech [33].



Figure 6: Invisible retainer [32].

VII. Crozat Retainer: A Crozat device with a 4-to-4 configuration features cribs on the first bicuspid, recurved double-lapped lingual finger springs, and a labial bow figure (7) [34]. It offers solid retention and labiolingual control of the front teeth but it also has significant drawbacks, including being expensive and breakable [35,34].



Figure 7: Crozat retainer [34].

Fixed Retainers

The majority of the time, fixed or bonded retainers are attached to the teeth using cement or bonding resin [25]. Stainless steel multi-strand wires are used to make them for the most part. These are made up of many, very thin stainless-steel wires that are twisted together to produce a single, thin archwire, although often, circular cross-sectional multi-strand wires are employed, with total thicknesses ranging from 0.0175 to 0.022 inches [27].

Fixed retainers offer several benefits including less patient cooperation required, suitability for permanent retention, no tissue irritation compared to removable retainers, better patient tolerance, and effectiveness [23]. The disadvantages of permanent retainers include more chair side time, higher cost, and greater risk of breakage [24,35].

Indication of fixed retainers

According to profit et al. [2] the indications for using fixed retainers are:

1. They are often employed when more retention is desired for a longer period and intra-arch instability is anticipated [25].
2. Diastemas or closure of widely spaced or significantly misplaced teeth, notably palatal canines, also in situations of non-surgically corrected anterior open bite with incisor extrusion.
3. Impacted teeth or those with no apposing (to avoid over-eruption). Also in those with cleft lip and palate. When an adult's extraction gap has to be closed, a bonded retainer is paired with a removable device to preserve the transverse connection.

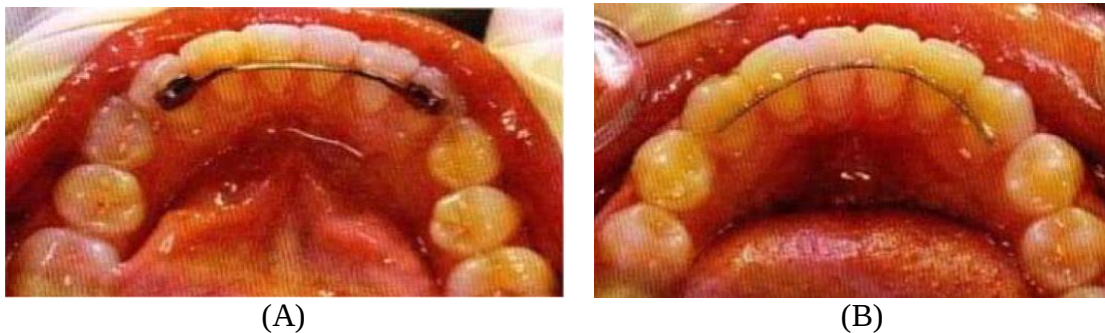
Types of fixed retainers:

I) Banded canine-to-canine retainer: Singh states that the lower anterior area is popular for this kind of retainer. Figure (8) [25] illustrates how to band the canines and curve a thick wire over the lingual surfaces before soldering it to the canine bands. Because the bands are unattractive, more likely to encourage poor oral hygiene, and less successful at retaining teeth than bonded retainers, banded retainers are less common than bonded retainers [25,32].



Figure 8: Banded canine to canine retainer [25]

II) Bonded lingual retainers: These are stainless steel wire retainers that are bonded on the lingual aspect of the teeth to follow the anterior curvature. The ends of the wire are curved over the canines where they are bonded; alternative wires, such as etched or perforated metal cast wire, may be used in place of the wire shown in Figure (9A). This design has the drawback that the anterior teeth may sometimes swivel. To address this issue, bonded retainers that are bonded to each of the anterior teeth from canine to canine are recommended as see in Figure (9B) [32].



**Figure 9: A- Bonded canine to canine retainer that is bonded only on the canine.
B- Bonded canine to canine retainer that is bonded on each tooth [32].**

III) Multistrand-twist flex wire retainers are the most popular kind of retainer. In the labial segment the wire is individually bonded to each tooth, ensuring that no incisor rotation is possible and that all of the individual teeth are preserved [33, 36]. As shown in figure (10) [32]



Figure 10: Multistrand-twist flex wires retainer [32]

IV) Mesh pad retainers: As illustrated in Figure (11) this form of retainer is constructed of a wire mesh pad that is directly connected to the lingual or palatal portion of teeth [25].



Figure 11: Mesh pad type retainer [25].

V) Resin fiberglass bonded retainer: Michael created this straightforward method, which takes very little time to prepare and directly addresses the main issue with cuspid-to-cuspid retainers. Glass fiber from woven fiberglass fabric is used in this system figure (12) [37].



Figure 12: Resin fiber glass retainer) [37].

Factors that affecting retention protocols and Duration

- Biological aspects include maintaining periodontal health, practicing good dental hygiene, and applying functional stresses to each tooth [38].
- Lower incisor alignment: Both respondents who have not had orthodontic treatment and patients who have received it have lifelong increases in lower incisor irregularity. Lower incisor crowding may be less severe if the lower labial segment is retained for a longer period of time until the completion of facial development [39].
- Anterior Dental Crossbite: No retention regimen is necessary when the incisor overbite and posterior interception are sufficient to preserve the correction [40].
- Deep bite: Orthodontic therapy has trouble correcting a deep bite since the outcome is unstable [41]. It is recommended to adopt a passive anterior bite plane when a very deep overbite has been corrected until all of the facial development has occurred. When there is evidence of an anterior mandibular growth rotation, this may be very helpful [40].
- Anterior open bite correction: According to Profit et al., anterior open bite malocclusions with poor development patterns should be retained for a long time with retainers including posterior bite blocks [2].
- Growth modification therapy: Retention utilizing a modified activator appliance has been found as successful in sustaining Class II correction after the use of headgear or functional appliances. The value of this retention method hasn't been supported by any comparison research, nevertheless [39].
- Spacing in the dentition: Permanent retention is advised after addressing cases of widespread spacing or a midline diastema [38].

- Tooth rotation: Long-term preservation of corrected rotations may aid to lower recurrence. It has been shown that supplementary circumferential supracrestal fibrotomy (CSF) reduces recurrence during the first 4-6 years after debonding [39].
- People who have had root resorption or periodontal disease in the past Permanent retention is suggested for individuals with severe periodontal disease who have had prior treatment. In instances with root resorption or crystal bone loss, there is evidence that the alignment of the lower incisors is more likely to deteriorate after retention [42].

Discussion

Orthodontic variables, including as periodontal and gingival factors, occlusal factors, and factors linked to soft tissue pressures and limitations of the dentition, might cause relapse following orthodontic treatment, in addition to normal aging changes [43].

Relapse risk varies, although research suggests that 70% to 90% of patients exhibit some relapse in the lower arch during the post-retention period, with the upper arch being impacted but to a lesser amount [44].

Rotation, midline diastema, anterior open bite, and deep bite are only a few of the conditions that are very likely to recur [27]. Many retainers are used to prevent relapse.

According to Renkema et al. dental hygiene, treatment outcomes, periodontal tissue health, patient motivation, and patient age are the factors that have the most influence on the choice of retention type. Other factors include interditation after orthodontic treatment [11]. Only a few studies [6,45,46] have examined the clinical effectiveness of fixed and/or removable retainers

In contrast to the vacuum-produced retainer, which normally comprises 0.030-inch plastic that fully covers all tooth surfaces, the Hawley device has an acrylic palatal section and a labial bow composed of 0.020 to 0.036-inch stainless steel wire. When intra-arch instability is expected and a patient needs longer retention, fixed retainers are often employed [2,34].

Both of the removable retainers are popular. The vacuum-produced retainers are much more acceptable than the Hawley retainers in terms of speaking ability, appearance, gingival irritation, swallowing capacity, self-confidence, and comfort during the first six months after their fitting [47]. Even though the Hawley retainers had acrylic labial bows, a recent clinical trial found that vacuum-formed retainers performed marginally better than Hawley retainers in maintaining alignment of both upper and lower labial segments, at least for the first six months [48].

According to a 2002 prospective randomized study comparing two types of fixed mandibular retainers about relapse, periodontal issues, and patient discomfort, the bonded retainer for all anterior teeth has greater stability than the one that is only bonded to the canine [49].

Little Said that, long-term retention is best and that a fixed retainer is the best way to keep the jaw anterior section from pressing again [7]. Watted et al. looked at how mandibular canine-to-canine lingual braces attached to 2 to 6 teeth affected the movement of incisors. The number of teeth bound to the retainer made the teeth less likely to move [50].

In a randomized, prospective trial, examined two distinct fixed mandibular retainer designs. Canine to canine (bonded to 6 teeth) or canine to canine (bonded to 2 teeth) were used in 103 cases. Canine-to-canine bonded retainers was associated with less relapse using little's irregularity index over 24 months compared to canine and canine removable retainers, likely due to the lack of incisor bonding [51]. Numerous research concluded that the majority of orthodontists utilized fixed retention in the lower arch and a vacuum-formed splint or a Hawley retainer in the upper arch [52].

Due to the lack of conclusive proof, choosing a retainer often depends on personal choice. With full-time usage of removable retainers being most common in the USA and Saudi Arabia, there is evidence of significant regional variance with maxillary Hawley or vacuum-formed retainers and mandibular fixed lingual retainers [53,54].

A predilection for the use of fixed retainers in both arches has been seen in the Netherlands [52],

while mandibular fixed and maxillary vacuum-formed retainers are the most common combination in Australia and New Zealand [6]. While, vacuum-formed retainers for the upper and lower arches were the favored method for orthodontists in Ireland [3].

Alrahma et al. who found that, the majority of orthodontists in Norway employed fixed mandibular retention and a mix of fixed and removable retention for the maxilla [43].

The majority of Malaysian orthodontists recommended wearing the retainer full-time (greater than 20 hours per day) for 3 to 9 months [54].

According to two investigations, there is no difference in the effectiveness of the removable appliances whether used part- or full-time [3]. As a result, they recommended that orthodontists advise patients to wear the maxillary and mandibular Hawley retainer at night for a year, beginning as soon as active treatment is completed [43].

Almograbi et al. mentioned that, the majority of orthodontists recommended wearing removable retainers full-time for nine months before switching to a lifetime part-time schedule [6].

Conclusions

The following conclusions can be made based on the evidence provided in this review:

- There is inadequate evidence to determine which method of retention is more useful for sustaining the outcome of orthodontic treatment. Only relative indications may be taken into account for any specific mean of retention,
- The selection should be patient-specific due to variations in recurrence risk and other circumstances.
- The dentition can be stabilized using both fixed and removable retention.
- In situations of severe tooth rotation, diastema closure, and over-expansion in the upper or lower arch, fixed bonded retainers are often advised.
- If there is a little alteration after class II or class III cases correction, a vacuum produced retainer with elastics may be employed.
- The removable retainers may be altered to allow for retention of instances including deep bites, open bites, and extractions.

Conflict of interest

Authors declare no conflict present.

References

1. Littlewood SJ, Millett DT, Doubleday B, Bearn DR, Worthington HV. Retention procedures for stabilising tooth position after treatment with orthodontic braces. *Cochrane Database Syst Rev*. 2016 Jan;2016(1).
2. Profit WR, Fields HW, Larson BE, Sarver DM. *Contemporary orthodontics* .6th edition. St. Louis, Mo: Mosby Elsevier; 2019. P: 579-591.
3. Wouters C, Lamberts TA, Kuijpers-Jagtman AM, Renkema AM. Development of a clinical practice guideline for orthodontic retention. *Orthod Craniofac Res*. 2019; 22:69–80.
4. Bazargani F, Jacobson S, Lennartsson B. A comparative evaluation of lingual retainer failure bonded with or without liquid resin. *Angle Orthod*. 2012 Jan;82(1):84-7.
5. Gökçe B, Kaya B. Periodontal effects and survival rates of different mandibular retainers: comparison of bonding technique and wire thickness. *Eur J Orthod*. 2019 Nov;41(6):591-600.
6. Al-Mograbi D, Pandis N and Fleming P. The effects of fixed and removable orthodontic retainers: a systematic review. *Prog in Orthod*. 2016 Dec;17(1):24.
7. Little RM. Clinical implications of the University of Washington post-retention studies. *J Clin Orthod*. 2009 Oct;43(10):645-51.
8. Padmos JAD, Fudalej PS, Renkema AM. Epidemiologic study of orthodontic retention procedures. *Am J Orthod Dentofacial Orthop*. 2018 Apr;153(4):496-504.

9. Pandis N, Vlahopoulos K, Madianos P, Eliades T. Long-term periodontal status of patients with mandibular lingual fixed retention. *Eur J Orthod.* 2007;29: 471-6
10. Renkema AM, Renkema A, Bronkhorst E, Katsaros C. Long-term effectiveness of canine-to canine bonded flexible spiral wire lingual retainers. *Am J Orthod Dentofac Orthop.* 2011; 139:614–21.
11. Renkema AM, Sips ET, Bronkhorst E, Kuijpers-Jagtman AM. A survey on orthodontic retention procedures in The Netherlands. *Eur J Orthod.* 2009 Aug;31(4):432-7.
12. Newman GV. Epoxy adhesives for orthodontic attachments: progress report. *Am J Orthod.* 1965; 51:901–12.
13. Knelrim RW. Invisible lower cuspid to cuspid retainer. *Angle Orthodontist.* 1973; 43:218 – 219
14. Zachrisson BU. Clinical experience with direct-bonded orthodontic retainers. *Am J Orthod.* 1977; 71:440–448.
15. Årtun J, Zachrisson B. Improving the handling properties of a composite resin for direct bonding. *Am J Orthod Dentofac Orthop.* 1982; 81:269–76.
16. Zachrisson BU. Multistranded wire bonded retainers: From start to success. *Am J Orthod Dentofac Orthop.* 2015; 148:724–7.
17. Ardeshtna AP. Clinical evaluation of fiber-reinforced-plastic bonded orthodontic retainers. *Am J Orthod Dentofacial Orthop.* 2011 Jun;139(6):761-7.
18. Sobout F, Rakhshan V, Saravi MG, Zamanian A, and Shariati M. Two-year survival analysis of twisted wire fixed retainer versus spiral wire and fiber-reinforced composite retainers: A preliminary explorative single-blind randomized clinical trial. *Korean J of Orthod.* 2016; 46(2):104–110.
19. Al-Attar AM, Al-Shaham S, Abid M. Perception of Iraqi Orthodontists and Patients toward Accelerated Orthodontics. *Int. J. Dent.* 2021;2021(7). <https://doi.org/10.1155/2021/5512455>
20. Sachdeva RCL. SureSmile technology in a patient-centered orthodontic practice. *J Clin Orthod.* 2001; 35:245–53.
21. Kravitz ND, Grauer D, Schumacher P, Jo Y. Memotain: A CAD/CAM nickel-titanium lingual retainer. *Am J Orthod Dentofac Orthop.* 2017; 151:812–5.
22. Naidu S and Suresh A. Orthodontic retainers. *Orthodontics.* 2018, 32(2), 38-40.
23. Kartal, E. Fixed Orthodontic Retainers: A Review. *Turkish Journal.* 2019Jun; 32(2):110-114.
24. Bishara, SE. Textbook of orthodontics. 1st edition. Elsevier; 2001.
25. Singh, G. Textbooks of orthodontics. 2nd edition. Jaypee Brothers; 2007.
26. Rinchuse, DJ, Miles PG, Sheridan JJ. Orthodontic retention and stability: a clinical perspective. *J Clin Orthod.* 2007; 41(3):125-32.
27. Luther F, Moon ZN. Orthodontic retainers and removable. Wiley-Blackwell; 2012 Dec. 200.
28. Ahn JH, Newton T, Campbell C. Labial frenectomy: Current clinical practice of orthodontists in the United Kingdom. *Angle Orthod.* 2022;92(6):780-786.
29. Sahoo KC, Pattanaik S. Modified Wrap-Around Retainer: A Quick Tip To Enhance the Retention of the Appliance. *J Clin Diagn Res.* 2016;10 <https://doi.org/10.7860/JCDR/2016/19112.8131>
30. Lyros I, Tsolakis IA, Maroulakos MP, Fora E, Lykogeorgos T, Dalampira M, Tsolakis AI. Orthodontic Retainers-A Critical Review. *Children (Basel).* 2023 Jan 28;10(2):230.
31. Simon JL, Laura M. An Introduction to Orthodontics. 5th edition. N.p. Oxford University; 2019.
32. Bhalajhi SL. Orthodontics: The Art and Science. 5th edition. Arya (Medi) publ; 2012. 613-627
33. Littlewood SJ, Kandasamy S, Huang G. Retention and relapse in clinical practice. *Aust Dent J.* 2017 Mar;62(1):51-57. doi: 10.1111/adj.12475.
34. Zachrisson, BU. Long- term retention of treated posterior crossbites. *World J Orthod.* 2006 Feb; 7(1):84-91
35. Alrawas MB, Kashoura Y, Tosun Ö, Öz U. Comparing the effects of CAD/CAM nickel-

- titanium lingual retainers on teeth stability and periodontal health with conventional fixed and removable retainers: A randomized clinical trial. *Orthod. Craniofac. Res.* 2021; 24: 241–250
36. Rezaei N, Bagheri Z, Golshah A. Survival analysis of three types of maxillary and mandibular bonded orthodontic retainers: A retrospective cohort. *BMC Oral Health.* 2022; 22(1). DOI: [10.1186/s12903-022-02202-5](https://doi.org/10.1186/s12903-022-02202-5)
 37. Sfondrini MF, Vallittu PK, Lassila LVJ, Viola A, Gandini P, Scribante A. Glass Fiber Reinforced Composite Orthodontic Retainer: In Vitro Effect of Tooth Brushing on the Surface Wear and Mechanical Properties. *Materials.* 2020; 13:1028.
 38. Vinuta S, Malabade SH, Bailwad SA, Pandey A, Randhawa S, Kamal K. Orthodontic retention: A review. *Journal of Bio Sciences and Informatics.* 2013; 5(3) 514-519
 39. Garg D and Goje SK. A Roadmap to Retention Protocols Applicable to Various Clinical Cases: An Overview. *Indian J Dent Adv.* 2018;10(1): 35-40.
 40. Graber LW, Vig KW, Vanarsdall RL and Huang GJ. *Orthodontics current principles and techniques.* Elsevier; 2017. p: 981-996.
 41. Bahreman A. Retention considerations in the assessment of long-term stability in early versus late orthodontic treatment. *Semin Orthodontic.* 2017; 23:123-48
 42. Johnston C, Burden D, Morris D. Clinical guidelines: orthodontic retention. The Royal College of Surgeons of England. 2008; 1-9.
 43. AlRahma WJ, Eleftherios G, Kaklamanos and Athanasiou AE. Performance of Hawley-type retainers: a systematic review of randomized clinical trials. *Eur J Orthod.* 2017; 1– 11.
 44. Arn ML, Dritsas K, Pandis N, Kloukos D. The effects of fixed orthodontic retainers on periodontal health: A systematic review. *Orthop.* 2020; 157:156-64.
 45. Xu XC, Li RM, Tang GH. Clinical evaluation of lingual fixed retainer combined with Hawley retainer and vacuum-formed retainer. *Shanghai Kou Qiang Yi Xue.* 2011 Dec;20(6):623-6.
 46. O'Rourke N, Albeedh H, Sharma P, Johal A. Effectiveness of bonded and vacuum-formed retainers: A prospective randomized controlled clinical trial. *Am J Orthod Dentofacial Orthop.* 2016 Sep;150(3):406-15.
 47. Saleh M, Hajeer MY and Muessig D. Acceptability comparison between Hawley retainers and vacuum-formed retainers in orthodontic adult patients: a single-centre, randomized controlled trial. *Eur J of Orthod.* 2017; 1-9 doi:10.1093/ejo/cjx024
 48. Johnston CD, Littlewood SJ. Retention in orthodontics. *Br Dent J.* 2015 Feb 16;218(3):119-22
 49. Vignesh PK, Sumathi Felicita A. Long Term Effectiveness of Various Orthodontic Retention - A Review. *IOSR Journal of Dental and Medical Sciences.* 2015;14(2):56-59
 50. Watted N, Muhamad AAH, Borbely P. Is the Physiological Mobility of the Teeth Disturbed Because Of the Retainer- Comparative Study between the Different Retainers. *IOSR Journal of Dental and Medical Sciences.* 2016;15(3):92-100. <http://dx.doi.org/10.9790/0853-153192100>
 51. Padmos JAD, Fudalej PS, Renkema AM. Epidemiologic study of orthodontic retention procedures. *Am J Orthod Dentofacial Orthop.* 2018 Apr;153(4):496-504
 52. Bahije L and Mohammed V. A systematic review of orthodontic retention systems. *International Orthodontics.* 2018; X: 1-16 <http://dx.doi.org/10.1016/j.ortho.06.023>
 53. Edwards JG. Asurgical procedure to eliminate rotational relapse. *Am. J. Orthod.* 1970; 57 (1): 35-46
 54. Al-Jewair TS, Hamidaddin MA, Alotaibi HM. Retention practices and factors affecting retainer choice among orthodontists in Saudi Arabia. *Saudi Med J.* 2016; 37:895–901.