

## IN VIVO ORTHODONTIC RETAINER SURVIVAL - A REVIEW

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### Abstract

**Background.** Relapse following orthodontic treatment is a constant concern of orthodontists. Fixed retention is preferred especially for the lower arch by most orthodontists.

**Objectives.** This review focuses on in vivo studies. The main objective is to determine the survival rates of different types of retainer: glass-fiber reinforced composite resin, polyethylene or multistrand stainless steel wire bonded to each tooth from canine to canine in the mandibular arch. A second objective is to assess which of these types is less likely to cause additional problems and the third objective is to evaluate the factors that may influence retainer survival.

**Results and conclusions.** There were 8 studies identified that matched the objectives stated. Current in vivo studies on survival rate take little notice of the role of the material used for bonding of the fixed retainer. It is not possible to draw a conclusion on reliability of new types of retainers glass fiber reinforced composite resin or polyethylene compared to multistrand stainless steel wire. The multistrand wire remains the gold standard for fixed retention.

Although it is a logical outcome that retainer survival is dependent on the application technique, there seems to be no research outcome proving that operator experience, moisture control are essential, nor does patient age or sex have statistically proven effects on survival rates.

Adequate studies that involve such aspects should be performed.

**Keywords:** fixed retainer, orthodontic

### Background

Relapse following orthodontic treatment is a constant concern of orthodontists. The influences of the periodontal and gingival tissues, unstable positions of teeth, and continued skeletal growth are considered to be the major causes of relapse after removal of fixed appliances [1]. Lifelong retention is preferred by most orthodontists, as noted by Lai et al, who studied Swiss orthodontists' procedures in 2014 [2]. There are several types of contention available, but most [2] orthodontists seem to prefer fixed retention, as removable appliances effects are

influenced by the patient's degree of compliance. "The situation prior to treatment was the most important reason – more than ¾ of orthodontists listed it as a dominating factor dictating the choice of retention. The final result of treatment, the degree of interdigation, and motivation of patients were mentioned by more than half of the orthodontists as influencing their retention procedure (...), most orthodontists preferred fixed retention in both upper and lower dental arches except for two clinical situations: extraction treatment and maxillary expansion. In these cases a combination of fixed and removable retainers was preferred in the upper jaw." [2]

According to Sfondrini et al in 2014, when deciding the type of retainer to use, the following were considered

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most frequently: pretreatment malocclusion (91%), patient compliance (87%), patient oral hygiene (84%), and patients' expectations (81%) [3].

There are two basic designs of lingual bonded retainers: rigid mandibular canine-to-canine retainers, which are attached to the canines only and flexible spiral wire retainers that are bonded to each tooth in the bonded segment. The first are effective in maintaining intercanine width, but less so in preventing individual tooth rotations. The second design is more effective in preventing rotations of the teeth.

Failure of bonded retainers may occur at the wire-composite interface, at the adhesive-enamel interface or as a stress fracture of the wire. Failure of a retainer may lead to unwanted tooth movement. A disadvantage of fixed retainers is that they complicate oral hygiene procedures, and favor the accumulation of plaque and calculus. Nevertheless, the presence of a bonded retainer appears to cause no increase in incidence of caries or periodontal disease. Use of interdental cleaning aids is required to ensure adequate oral hygiene [4].

A survey carried out in Australia and New Zealand by Wong and Freer in 2004 [5] showed that upper clear retainers and lower canine-to-canine bonded retainers were most commonly used. Half of the surveyed orthodontists used a specific retention period, with a median of 2 years. Orthodontists applied permanent retention in either a very high or a very low percentage of their cases. The conclusion of that study was that retention procedures were variable and depended largely on personal preferences.

In another survey applied in the Netherlands, the bonded retainer was shown to be used in high percentages in both lower and upper arch. When bonded retainers were used, permanent retention was preferred by 84% of orthodontists [6].

### Objectives

The main objective of this review is to determine the survival rate of different types of retainer: glass-fiber reinforced composite resin, polyethylene or multistrand stainless steel wire bonded to each tooth from canine to canine in the mandibular arch. A second objective is to assess which of these types is less likely to cause additional problems, such as discomfort, plaque accumulation, periodontal problems. The third objective is to evaluate the factors that influence retainer survival such as type of adhesive or technique used, patient characteristics.

### Materials and methods

Inclusion criteria were the following types of articles: original research articles, reviews, meta-analysis indexed in the Medline and EBSCO databases in the time frame 2000-2014 that included the objectives mentioned above.

Articles were found with the help of the keywords:

“retention orthodontics”, “retainer bonded”, “fixed retention” and the use of wild cards “ret\* bond\*”. Research of articles was limited to in vivo studies in order to facilitate comparison of methodology and draw conclusions on the results obtained.

The retrieved studies were independently screened by two researchers, data were extracted and the quality of the studies was evaluated.

Types of studies included: randomized clinical trials, historical cohort studies, prospective randomized studies, parallel groups.

### Results

There were 152 studies found in the query and, after careful consideration, 144 were excluded as they did not correspond to the objectives. Firstly, the in vitro articles were excluded as this review aimed at evaluating clinical conditions for the retainer survival. Secondly, studies that involved questionnaires applied to orthodontists or patients were also excluded. Therefore, eight studies matched the objectives of this review. They are summarized in Tabel I.

#### *Types of included studies*

One of the studies was a randomized clinical trial, three were randomized prospective studies, three were parallel group studies and one was a historical cohort study.

#### *The area of the oral cavity being assessed*

The anterior lower segment of the arch was considered for fixed retainer bonding

#### *Outcomes of studies*

- survival of different types of fixed retainer;
- factors influencing survival;
- effects on dental and periodontal health.

#### *Methodology of included studies*

Blinding of patients and orthodontists was not possible in any of the studies due to the nature of the intervention. Withdrawals were, generally, not reported in a thorough manner.

### Discussion

There was a high degree of heterogeneity in the studies included, given by participant types, interventions and outcomes. Ideally, a meta-analysis would have been performed if studies with similar comparisons reported comparable outcome measures.

The clinical studies on retention that have been reported so far offer different results. The reasons for such high differences between studies may be: inadequate allocation concealment and lack of appropriate randomization, no reporting or analysis of withdrawals and drop-outs, inexistent sample size calculations, different follow-up times, lack of statistical interpretation of data obtained. Outcomes such as relapse in tooth position, effects on dental and periodontal health, and patient discomfort should be assessed further.

Table I. Synthesis of articles included in the review.

Study	Study type	Participants	Interventions	Results
Sfondrini 2014	Randomized longitudinal prospective study	n=87	GFR or MST retainer bonded directly, follow up 12 months	MST failure rate significantly (percentages) higher than GFR
Salehi 2013	Clinical prospective study	n=142	Bonding of woven polyethylene (Ribbond) or 0.0175 stainless steel (SS spiral), follow up 18 months	Mean survival rate mandible 15.60 months Ribbond – 42.6% failure rate, SS spiral – 37.8%. No statistically significant differences
Pandis 2013	Randomized clinical trial	n=220	Autopolymerisation / photopolymerisation MST	Failure rate 42.7% auto, 50% photo, no statistically significant differences
Tanner 2012	Parallel groups	n=66	MST bonded with Transbond LR direct or indirect procedure, follow up 6 months	Failure rate 46.9% direct method, 29.4% indirect method, no statistically significant differences Survival rate 62.1%, highest failure rate in the 1st month
Bolla 2012	Parallel groups	n=85	MST or GFR follow up 6 years	Failure rate GFR 11.76%, MST 15.62%, no statistically significant differences
Tacke 2010	Parallel groups	n=259	GFR 500, GFR 1000 or MST follow up 2 years	Failure rate GFR 51%, MST 12%. Parodontal problems associated with GFR
Lie Sam Foek 2008	Historical cohort study	n=277	MST bonded with flowable composite, follow up maximum 40 months	Debonding 35.7%, fracture 0.7%, both 1.4%, no differences of sex, patient age, practitioner experience.
Stormann 2002	Prospective randomized study	n=103	3 types of retainers: wire diameters of 0.0215” and 0.0195” and one prefabricated canine-and-canine retainer Two adhesives: Heliosit and Concise 2 different isolation methods	Canine-and-canine retainer - 18% detachment rate, 29% - 0.0195” canine-to-canine retainers, 53% 0.0215” canine-to-canine retainer. 37% detachment rate dry field bonding, 32% - relatively dry field bonding. Heliosit 73% Concise 27% detachment rates. Higher rate of discomfort and relapse for the canine-and-canine retainers

**Studies comparing types of retainers**

Salehi et al. [7] studied 142 orthodontic patients within a prospective randomized clinical trial. They compared two types of retainers: the polyethylene woven ribbon (Ribbond, Seattle, WA, USA) retainer and a 0.0175-in flexible spiral wire (Respond, Ormco, Glendora, CA, USA) retainer. The retainers were bonded from canine to canine in the maxillary and the mandibular arches of the participants by a single practitioner using the same composite material, Heliosit (Vivadent). The patients were re-evaluated every 3 months over a period of 18 months. “The mean survival of the flexible spiral wire retainer was 15.34±0.47 and 15.60±0.42 months in the maxillary and mandibular arches, respectively. The mean survival of the ribbon retainer was 13.95±0.55 and 14.26±0.57 months in the maxillary and mandibular arches respectively. Ribbon

retainers showed a failure rate of 50% in the maxillary and 42.6% in the mandibular arches. Flexible spiral retainers showed a failure rate of 36.5% in the maxillary and 37.8% in the mandibular arches. The differences were not statistically significant.”

Pandis et al. [8] performed a randomized controlled clinical trial to compare the survival rates of mandibular lingual retainers bonded with chemically cured or light-cured adhesive. Two hundred and twenty patients were included and followed up for a minimum of two years. Researchers evaluated first time lingual retainer breakage and adapted ARI scores. Patients were reviewed at 1, 3, and 6 months and then every 6 months after placement of the retainer until completion of the study. At a minimum follow-up of 2 years, 42.7% of chemically cured retainers and 50.0% of the light cured retainers had some type of

failure. There was weak evidence that age is a significant predictor for lingual retainer failures (HR, 0.96; 95% CI, 0.93-1.00; P=0.08). Adhesive remnant index scoring was possible for only 64.7% of failures and did not differ between composites. Authors concluded that no serious harm was observed other than gingivitis associated with plaque accumulation.

The study published by Bolla et al. [9] in 2012 compares bond failure and breakage rates of two types of bonded lingual orthodontic retainers, GFR and .0175" multi-stranded stainless steel wire [MST], after a 6-year retention period. Eighty-five young adults were randomly divided into two groups: 40 subjects received 48 GFR retainers (14 maxillary and 34 mandibular retainers), and 45 subjects received 50 MST retainers (18 maxillary and 32 mandibular retainers). The maxillary detachment rates were 21.42% for the GFR group and 22.22% for the MST group; the mandibular detachment rates were 11.76% for the GFR group and 15.62% for the MST group. The maxillary breakage rates were 7.14% for the GFR group and 16.66% for the MST group; the mandibular breakage rates were 8.82% for the GFR group and 15.62% for the MST group. The differences were not statistically significant. GFR and multi-stranded stainless steel retainers showed similar results in terms of bond failure and breakage after 6 years of retention. The authors conclude that the use of GFR retainers as a retention strategy should not be discouraged and could be considered a viable esthetic alternative to stainless steel wire retainers.

Another study comparing multi-strand wire to glass fiber reinforced is Sfondrini et al's [3] from 2014. This longitudinal prospective randomized study included 87 patients who were randomly assigned either a multi-strand metallic wire retainer or a silanised-treated glass fibers-reinforced resin. They were followed for 12 months, monthly check-ups. The rates of detachments of the two different retainers were 17.73% for flexible spiral wires and 11.25% for glass fiber-reinforced resin retainers, respectively. No significant difference in term of failure rates between the two different splints was detected. Kaplan Meier survival plots for the two different types of retainers showed no significant difference in retainer failure risk over the 12 months of follow up. The authors conclude that glass fiber-reinforced (FRC) resin composite retainers and multi-stranded metallic wires showed no significant difference in single bond failure rates over a one-year follow up. Sfondrini's study has a much shorter follow up - 12 months compared to 6 years, but the monthly checkups may lead to less bias given by the fact that the patient is present in the office only when they find it necessary.

Tacklen et al.'s [10] two-year parallel study involved 184 patients scheduled to receive bonded retainers in the upper and lower arches. In three centers, the patients were sequentially assigned to receive GFR retainers containing 500 unidirectional glass fibers (GFR500), 1000

unidirectional glass fibers (GFR1000), or multi-stranded retainers (gold standard). After bonding, retainer failures and periodontal conditions were checked every 6 months. There was also a control group of 90 subjects without retainers, whose periodontal conditions were examined. Following thorough statistical analysis, GFR retainers showed higher failure rates than the multi-stranded retainers in the percentage of 51 versus 12. The most important periodontal conditions were found in patients with GFR retainers with no significant differences between the GFR500 and the GFR1000 group for any parameter at any time point. The control group had significantly lower levels of gingival inflammation and plaque compared with patients in any retainer group. The authors conclude that multi-stranded retainers should remain the gold standard for retention, although periodontal complications are highly possible and that the use of GFR retainers should be discouraged.

Tacklen's study includes the highest number of patients, and the time interval is a medium one, much shorter than Bolla's 6 years, but more satisfactory than Sfondrini's 12 months. It is also the one that observes the periodontal conditions and concludes that the GFR groups seem to help develop such problems.

#### *Influence of technique on retainer survival*

Taner et al.'s [11] prospective study of 2012, which used parallel groups, evaluated the failure rate of bonded lingual retainers, the influence of direct or indirect bonding procedures on survival, and determined the distribution of failures over a 6 month period. Sixty-six patients had canine to canine lingual retainers applied in the mandibular arch. Thirty-two retainers were bonded using a direct method and 34 by an indirect method. They used a 0.016 × 0.022 inch Bond-a-Braid retainer wire (eight-braided, flattened, stainless steel dead soft wire) with Transbond LR composite material. and made monthly check ups. The failure rate was 46.9 percent with the direct method and 29.4 per cent with the indirect method, but the difference between the methods was not statistically significant. The total failure rate was 37.9 per cent, the highest failure rate was seen in the first month. Seven patients had repeated failures and the failure rate was higher in the right quadrant. However, the very short time interval that evaluated survival is an important flaw in this study.

Foek et al. [12] retrospectively evaluated, for a 4-year period of time, the clinical survival rate of flexible, braided, rectangular bonded stainless steel lingual retainers. They also investigated the influence of the patient's gender and age, as well as the operator's experience on survival after orthodontic treatment. The study group included 277 patients, who had canine to canine retainers bonded with a flowable resin composite Tetric Flow (Ivoclar Vivadent). The flexible, braided, rectangular, stainless steel wire retainers (Quad Cat®, 0.022 × 0.016 inch, GAC International) were initially prepared indirectly by dental



technicians. Data was retrieved from the patient files that were updated every 6 months or when failure was reported by the patient. A failure was recorded when there was debonding, fracture, or both, occurring in one arch and only first failures were used for statistical analysis. Debonding occurred in 35.7 per cent of the failures, 0.7 per cent were fractures, and 1.4 percent were debonding and fracture. The authors find that the failures occurred mostly in the first 6 months after the retainers were bonded and the explanation provided was the insufficient composite bond strength to enamel that is presumably technique sensitive. Another reason suggested may be post-treatment relapse was that it produces forces exceeding the adhesive strength of the bonded retainers and causes them to fail. No significant effect of gender or patient age was observed. The failure rate did not differ due to operator experience. Statistical analysis showed a 63 per cent success rate for the bonded lingual retainers over a 41.7 month period.

A possible bias of this study is the time interval between check-ups. Patients were only called into the office every six months or when they reported the debonding or fracture of the retainer. This may lead to longer intervals being obtained for failure rates than the actual situation, as patients tend not to notice the debonding of the retainers unless there is considerable discomfort. Sometimes, debonding of an incisive may go unnoticed for more than one month as it may be visible only under careful examination. Authors also suggest that new prospective studies should concentrate on other factors such as moisture control, light intensity of the polymerization device and the composite and adhesive resin used.

One study that takes into consideration such factors such as moisture control and type of composite used is the one performed by Stormann and Ehmer in 2002 [13]. Their prospective, randomized study compared different types of fixed retainers used for stabilization of the lower anterior segment, by considering detachment rate, relapse, periodontal and oral hygiene problems, as well as subjective patient discomfort. Two types of fixed, customized canine-to-canine retainers that were bonded to each tooth with wire diameters of 0.0215" and 0.0195" and one type of prefabricated canine-and-canine retainer, bonded to canines only, were investigated in 103 patients. The isolation methods differed, as some retainers were inserted under a rubber dam and others under cotton rolls only. There were also two types of composite, Heliosit and Concise, that were used. The canine-and-canine retainer displayed an 18% detachment rate, a value significantly lower than the 29% determined for the 0.0195" canine-to-canine retainers. The 0.0215" canine-to-canine retainer had the highest detachment rate of 53%. The 37% detachment rate with dry field bonding was slightly higher than the 32% with relatively dry field bonding. Comparison of the composites showed a significantly higher detachment rate for Heliosit of 73% than for Concise 27%. Plaque accumulation

increased with all retainer types in the course of the study, but with no significant inter-group differences. There was a higher rate of subjective discomfort for the canine-and-canine retainers and relapse of incisive rotations, thus making this type of retainer the less desirable one, in the authors' opinion.

### Conclusions

Current in vivo studies on survival rate take little notice of the role of the material used for bonding of the fixed retainer. It is not possible to draw a conclusion on the reliability of new types of retainers, glass fiber reinforced composite resin or polyethylene compared to multistrand stainless steel wire, as there are no studies found that obtained statistically significant differences between different types and the heterogeneity of the studies is very high. The multistrand wire remains the gold standard for fixed retention.

Although it is a logical outcome that retainer survival is dependent on the application technique, there seems to be no research outcome proving that operator experience, moisture control are essential, nor that patient age or sex have statistically significant effects on survival rates.

Adequate studies that involve such aspects should be performed.

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