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ORIGINAL

# Evaluation of the failure rate of fixed orthodontic reteiners: A systematic review and meta-analysis

*Evaluación de la tasa de fracaso de los retenedores de ortodoncia fija: revisión sistemática y metanálisis*

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## Abstract

***Objectives:*** After completing and stopping orthodontic treatment, orthodontic retention is very important because optimal aesthetic positions must be maintained, and the function of the teeth must not change. The present study aimed to evaluate the failure rate of fixed orthodontic retainers.
***Methods:*** All articles published in international databases such as PubMed, Scopus, Science Direct, ISI Web of knowledge, and Embase between 2012 to May 2022 are included. The Cochrane Collaboration's tool and Newcastle-Ottawa Scale were used for risk assessment. 95% confidence interval on risk ratio were done with random effect model and Mantel-Haenszel method. Meta-analysis of data collected from selected studies was performed using STATA.V16 software.
***Results:*** In the initial review, duplicate studies were eliminated, abstracts of 518 studies were reviewed, two authors reviewed the full text of 70 studies, and finally, twelve studies were selected. Risk ratio of failure rates between fibers reinforced composite and the 0.0175" stainless steel wire was -0.09 (RR, 95% CI -0.34, 0.15; p=0.45) (I2=67.29%; P=0.03; moderate heterogeneity).
***Conclusions:*** Based on the findings of the present meta-analysis, No difference was observed between fibers reinforced composite and the 0.0175" stainless steel wire in terms of failure rate, and the highest failure rate is observed in the upper jaw.

*Key words:* Orthodontic appliances, orthodontic retainers, meta-analysis.

## Resumen

***Objetivos:*** Después de completar y detener el tratamiento de ortodoncia, la retención de ortodoncia es muy importante porque se deben mantener posiciones estéticas óptimas y la función de los dientes no debe cambiar. El presente estudio tuvo como objetivo evaluar la tasa de fracaso de los retenedores de ortodoncia fijos.
***Métodos:*** Se incluyen todos los artículos publicados en bases de datos internacionales como PubMed, Scopus, Science Direct, ISI Web of Knowledge y Embase entre 2012 y mayo de 2022. Para la evaluación del riesgo se utilizó la herramienta de la Colaboración Cochrane y la Escala de Newcastle-Ottawa. El intervalo de confianza del 95% en la razón de riesgos se realizó con el modelo de efectos aleatorios y el método de Mantel-Haenszel. El metanálisis de los datos recopilados de los estudios seleccionados se realizó con el software STATA.V16.
***Resultados:*** En la revisión inicial se eliminaron los estudios duplicados, se revisaron los resúmenes de 518 estudios, dos autores revisaron el texto completo de 70 estudios y finalmente se seleccionaron doce estudios. La relación de riesgo de las tasas de falla entre el compuesto reforzado con fibras y el alambre de acero inoxidable de 0,0175" fue de -0,09 (RR, IC del 95%: -0,34; 0,15; p=0,45) (I2=67,29%; P=0,03; heterogeneidad moderada).
***Conclusiones:*** Con base a los hallazgos del presente metanálisis, no se observaron diferencias entre el compuesto reforzado con fibras y el alambre de acero inoxidable de 0,0175" en cuanto a la tasa de fallas, y la tasa de fallas más alta se observó en el maxilar superior.

*Palabras clave:* Aparatos de ortodoncia, retenedores de ortodoncia, metanálisis.

## Introduction

After completing and stopping orthodontic treatment, orthodontic retention is very important because optimal aesthetic positions must be maintained, and the function of the teeth must not change. Therefore, orthodontic retention is a stage that is not separate from orthodontic treatment[1,2]. Specialists perform two methods for retention: 1- fixed (the device is averaged on the lingual tooth surfaces)[3]; 2- removable (in the form of transparent thermoform splints or acrylic plates)[4]. Based on the available evidence, several factors are effective in the stability of orthodontic treatment, including the individual characteristics of the patient (age, gender) and clinical characteristics (type of primary malocclusion, pathology of the surrounding soft tissues)[5]. Recurrence may occur after orthodontic treatment, which can be caused by various causes, such as muscle imbalance, stable reconstruction of periodontal tissues, or aging and growth-related changes[6]. Age is considered a very important factor in the movement of teeth, which generally occurs in all people with age, whether with or without orthodontic history[7].

On the other hand, individual characteristics cannot be changed, and other influencing factors must be well investigated; therefore, the retention phase protocol must be adjusted best. The demand for orthodontic cosmetic treatment has recently expanded significantly due to tooth beauty and smile design[8-10]. Therefore, the stability of treatment results is very important, and patients emphasize this point because recurrence may cause dissatisfaction with the treatment and bring physical and emotional problems for the patient[11]. Therefore, the patient should be examined several times over a year regarding the treatment process. The use of removable retainers is very challenging for the patient because, on the one hand, it is the patient's responsibility to maintain them, and on the other hand, it is the patient's responsibility to maintain oral and dental hygiene[12]. Using a fixed retainer makes retention less dependent on patient compliance[13]. One of the most discussed and challenging issues is the best stability of the treatment, which compares two methods of using wire or fiber splint; also, the materials used are very important for the best stability of the treatment. There are also many disagreements on the fixed bonding method; therefore, the present study aimed to evaluate the failures rate of fixed orthodontic retainers.

## Method

### Search strategy

Based on PRISMA guidelines[14], the present study conducts a systematic review and meta-analysis of all articles published between January 2012 and May 2022 in international databases, including PubMed, Scopus, Science Direct, Embase, and ISI Web of Knowledge. The Google Scholar search engine employed the PICO strategy to answer the research questions (**Table I**).

**Table I:** PICO strategy.

| PICO strategy | Description |
|---|---|
| P | Population: People with completion of orthodontic treatment |
| I | Intervention: fiber reinforced composite |
| C | Comparison: stainless steel wire |
| O | Outcome: failure rate |

The following keywords were used to search: (((((“Orthodontic Retainers”[Mesh]) OR ( “Orthodontic Retainers/adverse effects”[Mesh] OR “Orthodontic Retainers/classification”[Mesh] OR “Orthodontic Retainers/statistics and numerical data”[Mesh] )) OR ( “Orthodontic Appliances, Fixed”[Mesh] OR “Orthodontic Appliances, Removable”[Mesh] )) AND “Bone Wires”[Mesh]) OR “Orthodontic Wires”[Mesh]) AND “Restolux SP 4” [Supplementary Concept].

### Eligibility criteria

#### *Inclusion criteria:*

1. Randomized controlled trials, cohort studies, cross-sectional studies, and retrospective studies.
2. The article's full text was accessible and included information about the follow-up period.
3. Only English-language articles with published studies were selected.
4. Comparison of the intervention group with the control group.
5. Fixed retention failure defined.
6. Human samples.

#### *Exclusion criteria:*

1. in-vitro and in-vivo studies, Review studies, case reports, and letters to the editor.
2. No reporting fixed retention failure.

#### *Selection process and Data collection process*

Two reviewers blindly and independently extracted data from the included papers' full texts and abstracts for Data extraction. Kappa statistics were used to check the amount of agreement between the reviewers before the screening. The values of kappa were higher than 0.80. Studies data were reported by the first author's name, years, study design, several patients, and outcome.

#### *Risk of bias assessment*

The randomized control trial studies' quality was assessed using the Cochrane Collaboration's tool[15]. Low risk received a scale score of 1, while high and unclear risk received a score of 0. The scale scores have a range of 0 to 6. High quality means a higher score.

The non-randomized control trial studies' quality was assessed using The Newcastle-Ottawa Scale (NOS) [16], which measures three dimensions (selection, comparability of cohorts, and outcome) with a total of nine items, was

used to evaluate the quality of the cohort studies and case-control studies. Studies classified as low, medium, or high quality, had NOS scores of 1-3, 4-6, and 7-9.

### Data analysis

#### *Effect measures and Synthesis methods*

STATA.V16 software was used to analyze the data to examine the failure rate used a risk ratio (95% confidence interval) with a fixed effect model and the Mantel-Haenszel method.

The level of heterogeneity was assessed using the I2 index test (I2 50% = low levels, 50-I2 75% = moderate, and I2>75% = high levels).

## Results

After the initial search for them in databases, five hundred eighteen articles were identified. Duplicate articles were deleted (n=59) after importing all articles into the EndNote. X8 software. One hundred thirty-seven articles were entered and examined in the second stage. At this stage, 389 unrelated articles were excluded from the study while reviewing the titles and abstract articles. The full texts of 70 articles were reviewed in the third step. Twelve articles that met the inclusion criteria and were published between January 2012 and May 2022 eventually entered the analysis. (**Figure 1**).

### Characteristics

Ten randomized controlled trial studies and two Retrospective studies have been included in the present article. The total number of patients was 1261 (male: 552; female: 709). The mean follow-up period was 21.42 months (**Table II**).

### Bias assessment

According to Bias assessment tools, all studies had a moderate risk of bias (moderate quality).

### Failure rates

The Risk ratio of failure rates between fibers reinforced composite and the stainless steel wire was -0.09 (RR, 95% CI -0.34, 0.15; p=0.45) ($I^2$=67.29%; P=0.03; moderate heterogeneity). In terms of Failure rates, no statistically significant difference was observed between the two groups. These findings show that the two groups are almost identical in terms of Failures (**Figure 2**).

According to a subgroup meta-analysis examining the subgroups in terms of the follow-up period, it was observed that the follow-up period is non-effective in the effectiveness and survival rate (**Figure 3**).

**Figure 1:** PRISMA flowcharts.

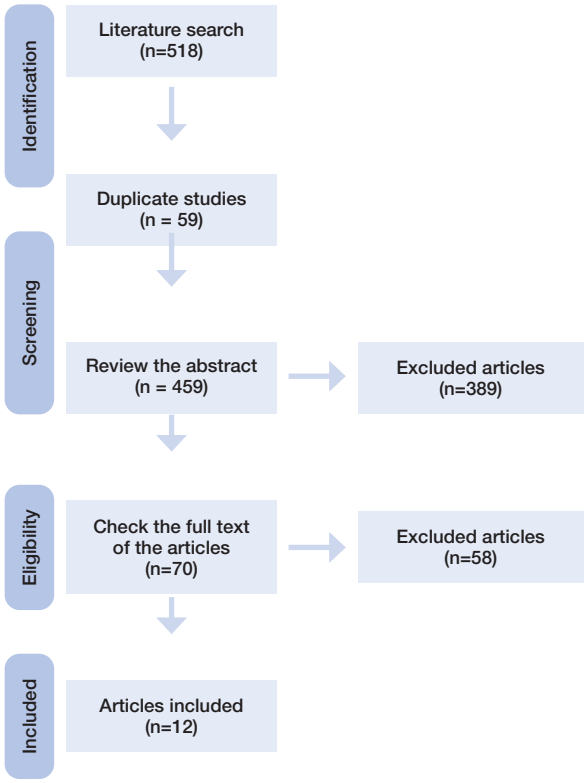



**Table II:** Summary of the findings reported in selected studies.

| Study. Years | Study design | Number of patients | | Follow-up (years) |
|---|---|---|---|---|
| | | Male | Female | |
| Scribante et al., 2020[17] | Randomized controlled trial | 50 | 50 | >1 |
| Kartal et al., 2020[18] | Randomized controlled trial | 20 | 32 | >1 |
| Gelin et al. 2020[19] | Randomized controlled trial | 18 | 43 | >1 |
| Arash et al., 2020[20] | Randomized controlled trial | 99 | 161 | >1 |
| Nagani et al., 2020[21] | Randomized controlled trial | 44 | 8 | 6 |
| Kocher et al., 2019[22] | Retrospective cohort study | 44 | 44 | >1 |
| Gunay et al., 2016[23] | Randomized controlled trial | 37 | 83 | >1 |
| Sobouti et al., 2016[24] | Randomized controlled trial | 60 | 68 | 2 |
| Sfondrini et al., 2014[25] | Randomized controlled trial | 35 | 52 | 1 |
| Farronato et al., 2014[26] | Retrospective cohort study | 60 | 59 | >1 |
| Bazargani et al., 2012[27] | Randomized controlled trial | 26 | 26 | >1 |
| Salehi et al., 2013[28] | Randomized controlled trial | 59 | 83 | 1.5 |

**Figure 2:** The Forest plot showed failure rates.

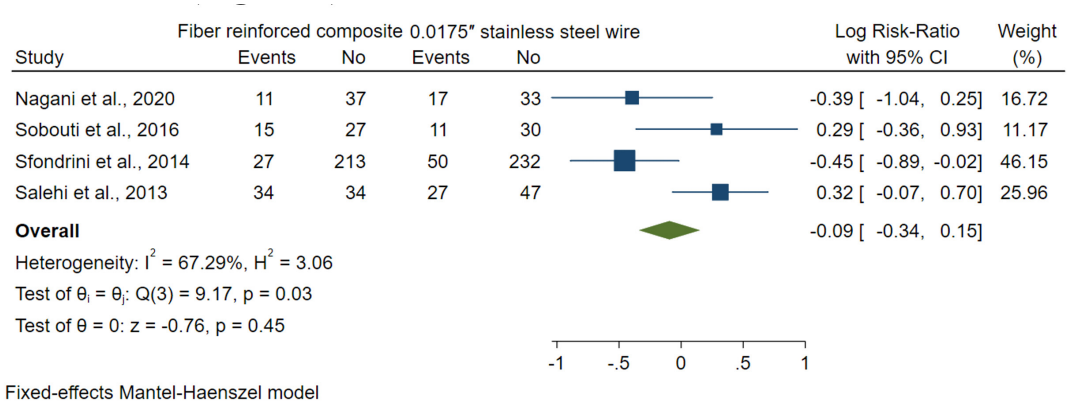
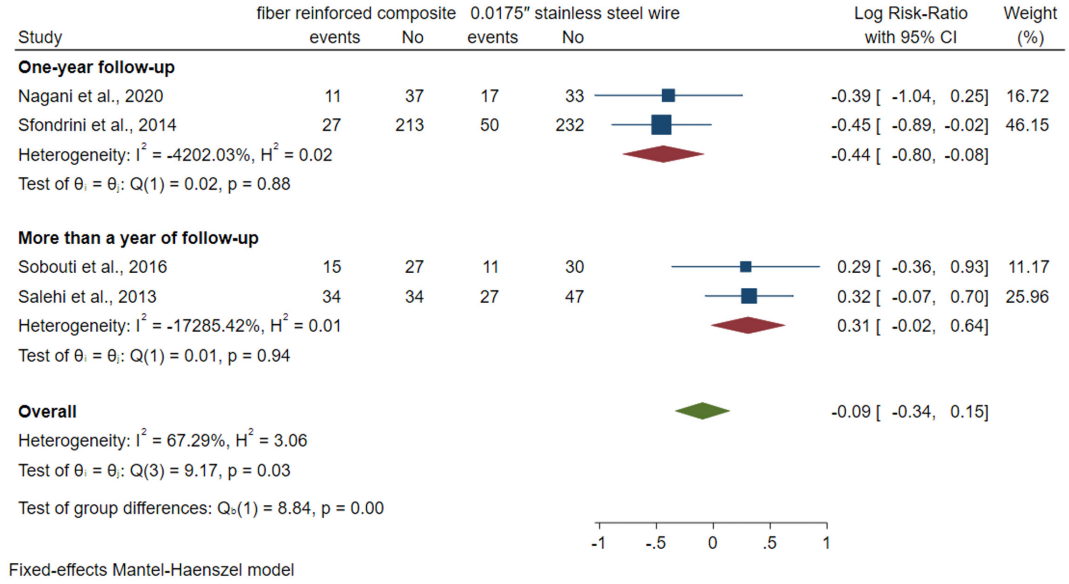



**Figure 3:** The Forest plot showed a subgroup meta-analysis of the different follow-up periods.




## Discussion

The present Systematic Review and Meta-analysis study aims to evaluate the failure rate of fibers reinforced composite orthodontic retainers. The aim of orthodontic retention, the last stage of treatment, is to maintain the teeth in their corrected positions after orthodontic treatment[29]. A study reported that failures occur more often after two years of retainer placement[30]. Evidence shows that the clean enamel surface to be bonded, avoiding occlusal interference and dry field can be important factors in bonding considered successful maintainers[31]. In the current study, among the selected and eligible studies, only four studies were eligible for meta-analysis, none of which mentioned wire untwisting. Also, another very important factor affecting failure is the interface between composite and enamel, which should be well investigated. The evidence shows that the bonding agent can improve the bonding efficiency. The meta-analysis of the present study showed that the risk ratio of failure rates between fibers reinforced composite and the stainless steel wire was -0.09, and no difference was observed between the two groups.

In Jazer's study, no difference was observed between the two investigated groups (fibers reinforced composite and the 0.0175" stainless steel wire) in terms of failures; one of the factors affecting failures is wire fracture.

The studies found no correlation between the patient's periodontal condition and the wire used[19,32]. Research has shown that the placement of retainer is non-effective in the occurrence of symptoms of periodontal tissues[33]. According to the findings of a study, one of the most important factors affecting failures is the presence of plaque, plaque or inflammation and the patient's lack of oral and dental hygiene[33]. The studies have not investigated the final effect of etching times, which varies between 15 and 60 seconds based on available evidence, on debonding rates.

### Limitations and future suggestions

providing information about this is very important, and it is suggested that future studies focus on etching or rinsing time to increase knowledge in this field. The present study had limitations that can be pointed to the difference in bonding factors, differences in different studies, and children the growing age. Since studies have shown that growth in children and adolescents can affect retention stability[20,25,28], it is also observed that with age, tooth movement occurs in all general populations. In terms of heterogeneity between studies, it was medium to high due to the type of study design, the use of different types of wire, measurement time, and the type of study. The follow-up period in the studies was very variable; One of the most important factors affecting stability in the retention phase is the growth variable. In this study, failure and fractures were considered together due to the small number of studies, but from a scientific point of view, the fracture is observed due to the material's stiffness.

## Conclusion

According to the findings of the present study, follow-up periods of one year or more than one year are not effective on the failure rate. The failure rate in the one-year follow-up periods was 44%, and in the higher follow-up periods, it was 31%. No difference was observed between fibers reinforced composite and stainless steel wire in terms of failure rate.

### Conflict of Interest

The authors declared that there is no conflict of interest.

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