Evaluation of two different bonding materials for orthodontic retention treatment
A retrospective cohort study

Dennis Andersson
Daniel Rembson Appelros

Supervisor:
Ph. D Sofia Petrén
Ph. D Mikael Sonesson

Master thesis in Odontology (30 ECTS)
Dentistry
February, 2018

Malmö University
Faculty of Odontology
205 06 Malmö
Abstract

Introduction and Purpose
Orthodontic treatment means moving teeth in the dentoalveolar tissues to treat different malocclusions. After completed treatment, there is an inherent force of the teeth to move back to the original position. After the treatment is completed, retention is needed to avoid relapse. Retention is often done by fixed retainers, which are bonded with a resin-based bonding material. This study aimed to investigate which one of two different commonly used bonding materials that had the best clinical durability.

Material and method
By analysing patient records from orthodontically treated patients at the Department of Orthodontics at Malmö University, therein documenting the failure rate for detached retainers over the first six month after bonding. The documentation was conducted considering factors as bonding material, sagittal and vertical diagnoses, extraction or non-extraction patients, age, gender, the level of retainer detachment, and if the retainer had to be made anew or if it could be rebonded. After collecting data, statistical significance was tested by using Fishers Exact test.

Results
General detachment rate of the bonded retainers was 26.9%. The detachment rate for retainers in the different bonding materials were 35.1% with Transbond Supreme LV and 19.0% with Tetric EvoFlow. There was also a significant difference between the detachment rate in the maxilla for the patients with deep bite, 42.3%, compared to normal vertical relations, 7.7%, prior to orthodontic treatment.

Conclusion
The study concludes that there is a significant difference regarding the durability of the two different bonding materials for Tetric EvoFlow’s advantage. Vertical malocclusion prior to orthodontic treatment showed a clear connection to detached retainers in the maxilla.
Sammanfattning

**Introduktion och syfte**

**Material och metod**
Genom att analysera patientjournaler, från ortodontiskt färdigbehandlade patienter vid avdelningen för Ortodonti på Malmö Universitet samt dokumentera antal lossnade retainers under de första sex månaderna efter bondning. Dokumentationen gjordes utifrån faktorer som bondingmaterial, sagitella och vertikala diagnoser, hurvida patienterna genomgått tandextraktioner eller ej, ålder, kön, om retainern var delvis eller helt lossad samt om de behövdes göras en ny retainer eller om den lossade kunde rebondas. Efter insamling av data kunde statistiska analyser utföras genom användning av Fishers Exact test.

**Resultat**
I 26,9 % av fallen lossnade den bondade retainern inom 6 månader. Lossandefrekvens hos retainers för de olika bondingmaterialen var 35,1% med Transbond Supreme LV och 19,0% med Tetric EvoFlow. Det finns också en signifikant skillnad mellan lossandefrekvensen i maxillan för patienter med djupt bett, 42,3%, jämfört med normala vertikala förhållanden, 7,7%, inför ortodontisk behandling.

**Slutsats**
Introduction

1.1 Orthodontic treatment

Orthodontics involves the growth and development of the face, jaws and dentition, as well as diagnostics, prevention and corrective treatment of malocclusions.

The orthodontic treatment affects the teeth, jaws and facial growth by either removable or fixed appliances which moves the teeth that are in a deviant position to a more optimal one, thus promoting the occlusion's functionality and aesthetics.

Protruding, tipped teeth or malocclusion cause aesthetic problems, which may give more or less social acceptance. Oral dysfunction, such as difficulty with jaw movements, chewing, swallowing, speech and TMD (temporomandibular disorder) may also be the result of malocclusion. An increased susceptibility to dental trauma is also associated with malocclusion. (1) Dental trauma is three times more common for 12-year-old patients with large overjet of 4.5 mm or larger (2).

Ectopic eruption of canines during eruption may cause root resorption of the maxillary incisors. A study has shown that 12.5% of ectopic canines in the maxilla cause root resorption of upper incisors, which can be observed radiographically (3).

A person’s occlusion has a major impact on one's self-image and perception of one's appearance in both adults and adolescents. Dissatisfaction with dental appearance and experience of being bullied is more common among individuals with extreme overjet, deep bite and diastema. (4) Major malocclusion in the aesthetic zone has been shown to have a negative effect on the quality of life, especially regarding the social and emotional well-being of children and adolescents (5).

The prevalence of malocclusion of Swedish children and adolescents varies between 43-78%, the large span of prevalence is caused by different diagnostic procedures and at what age the patient is diagnosed (5,6). The average number of children who started orthodontic treatment in Sweden was 27% for each age group in 2004 (7).

1.2 Biology of the tooth movement

It is believed to be two biological mechanisms that collaborate in tooth movement; the bioelectric theory and the pressure-tension theory. (1)

The bioelectric theory assumes that the mechanical pressure against the tooth alters the bone remodelling by displacing the electrons within the bone, thereby deforming the crystalline structure. However, the bone remodelling during orthodontic treatment due to this theory is probably less significant, since the forces that create electric signals that cause stress to the crystal are more of a rhythmic nature in comparison to orthodontic forces which are more sustained. Nevertheless, there is no doubt that the maintenance of the skeleton is very much depended on the signals generated by mechanical stress. (1)

According to the classical pressure-tension theory of tooth movement it is a chemical stimulation of cell differentiation that affects bone remodeling. The mechanical pressure against
the tooth gives a compression of the periodontal ligament to the alveolar bone decreasing the blood supply, while on the opposite side of the tooth the periodontal ligaments are stretched and the blood flow kept unaffected. This causes the oxygen level to drop and carbon dioxide concentration to increase on the pressure side, while on the tension side the opposite takes place. This subsequently leads to a changed chemistry which directly or indirectly affect cell differentiation and cell activity. The mechanical pressure also stimulates the secretion of substances such as cytokines, prostaglandins and neurotransmitters which contributes to the process. (1)

1.3 Relapse and Retention

When removing braces for orthodontic treatment, an abrupt termination of orthodontic tooth stability occurs. The orthodontic appliance previously obtained the stability. The achieved treatment result must be phased out gradually to ensure permanent results, i.e., preventing relapse. (1)

There are three main causes of relapse. After removal of orthodontic appliances, the gingival fibers and the periodontal tissue need time to rebuild and reorganize. This results in an initial elastic recoil of periodontal fibers and an initial mobility of the displaced teeth. Another reason for relapse involves the interaction between the teeth and the surrounding soft tissues of the oral cavity. The teeth’s initial mobility makes them vulnerable to pressure from the tongue, lips and cheeks. The third main cause of relapse is the skeletal and dentoalveolar changes due to facial and jaw growth in not yet fully-grown patients. (1)

Retention treatment is applied to prevent relapse and should last at least 12 months to allow sufficient time for the remodelling of the gingival tissue in adults. In young patients who are still growing, the retention should be maintained at least until the patient is fully-grown. (1)

To avoid relapse after orthodontic treatment retention treatment is needed. Retainers may be fixed or removable.

Fixed retainers are usually made of a twisted thread of stainless steel, bended and formed by a dental technician to fit the lingual aspect of the incisors and canines. The retainers are usually bonded to the canines only or all six anterior teeth. A canine bonded retainer prevents the anterior teeth from rotating and tilting linguually. On the other hand, a retainer bonded to all the teeth is, in addition to the characteristics of the canine bonded retainer, better equipped to prevent direct relapse, for example crowding or diastema. Relapse caused by crowding can be prevented indirectly by canine bonded retainers since crowding in most cases results in lingual tipping of the incisors (1,8).

The advantage of a canine bonded retainer is that it is clearly visible when the retainer is detached. A retainer bonded to all teeth partially detached can go unnoticed for a long period of time, which can lead to relapse and side effects (8). It can therefore be concluded that the quality of the bonding material has a major impact on preventing relapse and to obtain the result from the orthodontic treatment.
1.4 Bonding

A previous study found that bonded retainers fail within the first six months in 37.9% of cases and most often during the first month. In the study Transbond LR was used as the bonding material (9).

At the Department of Orthodontics at Malmö University (DOMU) retainers have been routinely bonded with the bonding material Transbond Supreme LV (TBS). The bonding material is a resin-based light-curing material containing nanofillers and is of low viscosity. The resin contains dimethacrylate monomers Bis-GMA, TEGDMA and Bis-EMA, and the filler consists of silica- and zirconia nanofillers. (10)

Before bonding the retainer with TBS the surfaces of the teeth have been treated with etching using 37% phosphoric acid, followed by a self-etching primer, Transbond XT.

In January 2015 the staff at the DOMU switched bonding material and started to use Tetric EvoFlow (TEF). Although this material also is light-cured, of low viscosity and resin based, its fillers are of nano-hybrid type. The resin part also contains dimethacrylate, however, other monomers; Bis-GMA (like TBS), urethane dimethacrylate and dicandiodimetakrylat. The filler parts consist of barium glass, ytterbium trifluoride, highly dispersed silicon dioxide, mixed oxides and copolymer. (11)

At the bonding moment the tooth is pre-treated by etching the lingual surface of the tooth with a 37% phosphoric acid for 60 seconds and a following thorough rinse with water, before finally applying the bonding material.

The staff at the DOMU who are performing the bonding of the retainers experienced that the retainers detached more often before 2015, that is, before the change of bonding material took place at the department. There was therefore a need to determine which bonding material had the best clinical durability.

1.5 Significance

The loss of retainers is a frequent problem for patients during retention treatment. It is time and cost consuming for the patients and the clinician. By comparing which of the bonding materials that has had the best clinical durability both the patient and the clinician can save time and money. It is also important that the retainer stays in place for as long as needed to avoid relapse or any other failure of the orthodontic treatment. This study may contribute as a guideline for caregivers in what option of bonding material is best suitable for retainers.

1.6 Objective

The aim of this study was to retrospectively review patient records from orthodontically treated patients at the Faculty of Odontology at Malmö University. This was to decide which of two different bonding materials being used for bonding retainers at the DOMU has had the best clinical durability during the first six month after bonding.
Hypotheses

- TEF has a higher clinical durability, compared to TBS.
- Retainers in the maxilla detach more often than in the mandible.
- There is a higher failure rate of bonded retainers in extraction cases.
- Patients with sagittal or vertical malocclusions have a higher failure rate of bonded retainers than patients with normal sagittal and vertical relations.
- Younger patients have a higher failure rate of bonded retainers than older patients.
- The patient’s gender has no effect on the clinical durability of the bonded retainer.

Material and method

2.1 Subjects involved in the study

Patients who have finished orthodontic treatment at the DOMU. Patients were randomly selected by searching in the patient records for a keyword routinely used at the final visit of orthodontic treatment. From this a complete list of patients who had finished orthodontic retention treatment was provided by the Orthodontic Department at the DOMU. All the patient records with a bonded retainer using TEF were examined. The number of retainers that were included worked as a reference for how many patient records with retainers bonded with TBS that were included, and therefore how far back in time the records were examined.

2.2 Inclusion criteria

- Patients who completed orthodontic treatment at the DOMU and have received retention treatment with a fixed retainer using either TBS or TEF as a bonding material.
- All ages.
- Both genders.

2.3 Exclusion criteria

- Patients without retainer.
- Patients where the bonding material was not mentioned.
- Patients where other than the bonding materials TBS or TEF had been used.
- Patients where both bonding materials had been used for the same retainer.
- Patients who could not be followed for at least six months after the first bonding.
- Patients were only allowed to be in the study once, per jaw. If the patient had two retainers, one in the maxilla and one in the mandible, both retainers are included in the study.
2.4 Collection of records

The reviewing of patient records was done in the autumn of 2016, with regards to different variables:

- Bonding material
- Gender
- Age
- Ex / NonEx: If the orthodontic treatment involved extraction of a permanent tooth it was recorded as “Ex”, otherwise as “NonEx”.
- The vertical diagnosis prior to orthodontic treatment: Normal relation, deep bite, open bite or tete-a-tete bite. The three latter diagnoses were considered “Vertical malocclusions”.
- The sagittal diagnosis prior to orthodontic treatment: Angle Class I, II or III. Angle Class II and III were considered as “Sagittal malocclusions”.
- Normal sagittal and vertical relations, and sagittal and/or vertical malocclusion prior to orthodontic treatment: Patients diagnosed with Angle Class I and normal vertical relation were considered to have “Normal sagittal and vertical relations”. Patients with any other diagnosis, sagittal or vertical, were considered to have “Sagittal and/or vertical malocclusion”.
- If there had been a rebonding of the retainer or if a new wire had to be produced (within six months from the first bonding).
- If the wire was detached partially or totally (within six months from the bonding).

Patients were followed for six months after the first bonding. The time-frame of six months was decided to make it feasible to follow up on as many patients as possible since TEF was first used in January 2015. The period of six months is also confirmed by previous studies, according to Taner et.al (9) and Segner et.al (12) most of the bonding will fail during the first six months or, according to Tynelius during the first year (6).

2.5 Statistical analysis

After the records had been reviewed and the data of different variables were gathered, the results’ statistical significances were tested. The upper limit of the p-value was 0.05, in order to deem a result as statistically significant. This was done by using “Fishers Exact test” that is a statistical tool to use when the sample size is not substantial enough for a “Chi-squared test”, which is a test fitting to be used of sample sizes of a thousand or more. (13) The program used in this study was the “Easy Fisher Exact Test Calculator” on the website “Social Science Statistics” (14). Statistician Per-Erik Isberg, Assistant Lecturer at the Department of Statistics, Lund University, was contacted for statical discussions.

2.6 Ethical considerations

The head of the Department of Orthodontics at Malmö University Lars Bondemark has approved the journals to be used in the purpose of quality control. An ethical trial is not necessary to perform, since this is a quality assessment and is not to be published.
Results

The number of included patients were unevenly spread over different ages (12-23 years old). 79 females and 77 males were included. 77 patients were bonded using TBS and 79 using TEF. A total of 156 bonded retainers were observed, 58 in the maxilla and 98 in the mandible. The different bonded retainers were distributed as follows;

- 97 retainers were bonded between the canines in the mandible.
- 1 retainer was bonded between the lateral incisors in the mandible.
- 19 retainers were bonded between the canines in the maxilla.
- 38 retainers were bonded between the lateral incisors in the maxilla.
- 1 retainer was bonded between central incisors in the maxilla (11-21).

3.1 General failure

The overall failure rate of the first six months after the bonding of the retainers was 26.9%. For retainers bonded in the maxilla, the failure rate was 27.6%, while in the mandible the failure rate was 26.5%, which meant no significant difference (Figure 1). No significant difference was found between the failure rate in the different retainers, within each jaw.

![Bonded retainers](image)

*Figure 1. Total number of bonding failure in retainers. The numbers inside the bars indicate the amount of retainers.*
3.2 Bonding material

The general results of the failure rates over the first six months after the bonding of the retainers in the two different materials were 35.1% for TBS (n=77), 19.0% for TEF (n=79), which meant a significant difference between the two materials (p=0.030) (Figure 2).

![TBS vs. TEF](image)

*Figure 2. Percentage of bonding failures in relation to bonding material. The numbers inside the bars indicate the amounts of retainers.*

In the maxilla, the failure rate was 27.6%, the same for the two materials. In the mandible the failure rate was 32.8% for TBS and 14.0% for TEF, with a significant difference (p=0.006) between the two materials (Figure 3).

![Failure in relation to bonding material in both jaws](image)

*Figure 3. Number of bonding failures in retainers by material and in relation to the mandible and the maxilla. The numbers inside the bars indicate the amounts of retainers.*
3.3 Relapse in relation to diagnoses

For patients with Angle Class I and normal vertical relation prior to orthodontic treatment, the overall failure rate over the first six months after the bonding of the retainers was 17.0%, and 31.0% among patients with Angle Class II or III or a different vertical diagnosis prior to orthodontic treatment. The difference was not statistically significant (p=0.081). In the maxilla, the failure rate for patients with Angle Class I and normal vertical relation was 10.0%, respectively 21.2% in the mandible. For patients with Angle Class II or III or a different vertical diagnosis, the failure rate in the maxilla was 35.1%, respectively 28.6% in the mandible (Figure 4). The differences in failure rates when comparing patients according to diagnoses, in each jaw respectively, were not significant, with a p-value of 0.059 in the maxilla. Three retainers were not included since there was no information regarding the vertical or sagittal orthodontic diagnosis.

Figure 4. Numbers of bonding failure in relation to diagnosis prior to orthodontic treatment, divided by jaw placement. The numbers inside the bars indicate the amounts of retainers.

3.4 Relapse in relation to vertical diagnosis

In general, the failure rate of bonded retainers over the first six months was higher when comparing patients with normal vertical relations (17.1%) and patients with a different vertical diagnosis prior to orthodontic treatment (33.7%), showing a significant difference (p=0.026). The same was true comparing patients with normal vertical relations (n=70) to patients with open bites (62.5%, n=8) prior to orthodontic treatment (p=0.010).

In the mandible, no significant difference was observed in the failure rate between the patients with normal vertical relations (22.7%) and patients with deep bite (24.4%), any other vertical diagnosis or all of the different vertical diagnoses combined. In the maxilla, a significant
difference ($p=0.009$) could be observed between the failure rates, with 7.7% for the patients with normal vertical relations and 42.3% for patients with deep bites (Figure 5). A significant difference was also observed in the maxilla when comparing patients with normal vertical relations ($n=26$) to patients with all the different vertical diagnoses combined ($p=0.006$, $n=31$) and open bite ($p=0.042$, $n=3$) separately. Three retainers were excluded since there was no information regarding their vertical orthodontic diagnosis.

![Figure 5. Number of bonding failure in retainers in relation to normal vertical relation and to deep bite prior to orthodontic treatment, divided by jaw placement. The numbers inside the bars indicate the amounts of retainers.](image)

### 3.5 Relapse in relation to sagittal diagnosis

In general, the failure rate of bonded retainers over the first six months showed no significant difference when comparing patients with Angle Class I (21.4%) and patients with Angle Class II or III combined prior to orthodontic treatment (31.9%). The same was true comparing patients with Angle Class I to patients with Angle Class II (40.5%) or Angle Class III (50.0%, $n=10$) separately, prior to orthodontic treatment ($p=0.010$).

In the mandible, no significant difference was observed in the failure rate between the patients with Angle Class I (25.5%) to patients with Angle Class II or III combined (26.8%), or the two classes compared separately. In the maxilla, a significant difference ($p=0.038$) could be observed between the failure rates, with 13.8% for the patients with Angle Class I ($n=29$) and 39.3% for patients with Angle Class II or III combined ($n=28$). No significant difference was observed in the maxilla when comparing patients with Angle class I to Angle Class II or III separately. Three retainers were not included since there was no information regarding their sagittal orthodontic diagnosis.
3.6 Relapse in relation to diagnoses vs. choice of bonding material

When comparing the failure rate of bonded retainers over the first six months of the two materials (TBS and TEF) in relation to vertical and sagittal diagnoses prior to orthodontic treatment, no significant differences showed when comparing retainers bonded with TBS on patients with Angle Class I with normal vertical relations (31.8%) and patients diagnosed with Angle Class II or III with any other vertical diagnosis (34.6%). However, a significant difference (p=0.037) was observed when the same comparison was conducted for retainers bonded using TEF, with failure rates at 6.5% for patients with Angle Class I with normal vertical relations and 27.1% for patients diagnosed with Angle Class II or III with any other vertical diagnosis. Three retainers were excluded since there was no information regarding their orthodontic diagnosis.

When comparing the failure rate of bonded retainers over the first six months of the two materials in relation to vertical and sagittal diagnoses prior to orthodontic treatment and jaw placement, the highest discrepancy was observed between patients with Angle Class I with normal vertical relations (8.3%) and patients diagnosed with Angle Class II or III with any other vertical diagnosis (41.2%) in the maxilla using TEF as a bonding agent. In the mandible the same comparisons were 19.3% for patients with diagnosed with Angle Class II, III or any vertical diagnosis and 5.3% for patients with Angle Class I and normal vertical relations. However, the difference was not statistically significant (p=0.093), nor were the other comparisons, equivalent to the previously mentioned. Three retainers were not included since there was no information regarding their orthodontic diagnosis.

When comparing the failure rate of bonded retainers over the first six months of the two materials in relation to vertical and sagittal diagnoses prior to orthodontic treatment separately, the highest discrepancy was observed between patients with normal vertical relations (5.3%) and patients diagnosed with vertical deviations (31.7%) in the maxilla using TEF as a bonding agent. The difference was statistically significant (p=0.004). All the other comparisons, equivalent to the previously mentioned showed no significant difference.

The failure rate of TEF-bonded retainers in the maxilla over the first six months in relation to vertical diagnoses prior to orthodontic treatment, was 7.1% in patients with normal vertical relations and 46.2% patients diagnosed with a different vertical diagnosis. The difference was statistically significant (p=0.033). Three retainers bonded with TBS had no record of the patient’s sagittal diagnosis. The same was true for the vertical diagnosis among TBS bonded retainers.

3.7 Extraction cases vs. nonextraction cases

The total number of patients treated orthodontically with extractions was 46, compared to 110 patients who were not. The failure rate of bonded retainers over the first six months was 23.4% for Ex-patients and 28.2% among NonEx-patients. The difference was not statistically significant.
3.8 Ages and gender

The failure rate in relation to different genders over the first six months was 24.4% for the females (n=79) and 29.9% for the males (n=77). The difference between the sexes was not statistically significant.

The failure rate for each age could not be statistically tested since there was a wide variety of population sizes within each age group.

3.9 Type of failures

![Percentage of retainers partly failed and of retainers needed to be rebonded in relation to bonding material](image)

Figure 6. Percentage of retainers needed to be treated with rebonding. Also, percentage of retainers which were partly detached. Both in relation to bonding material. The numbers inside the bars indicate the amount of retainers

There was no statistically significant difference (p=0.068) in between the materials regarding retainers who needed to be rebonded, TBS 27.8% (n=72) and TEF 14.7% (n=75). However, in patients who got their retainer partly detached, significant difference could be seen (p=0.034). The rate of partly detached retainers with TBS was 27.5% (n=69) and with TEF 12.3% (n=73) (Figure 6).

There was no significant difference in failure rates resulting in replacement with a new retainer (5.5% for TBS and 5.9% for TEF) between the two materials, nor did any material result in a more frequent total detachment of the retainers (TBS 10.7%, TEF 5.9%).

Among the 38 detached retainers 81.6% resulted in rebonding, 18.4% resulted in production of a new retainer. 73.7% detached partly while 26.3% detached totally. Among the patients with detached retainers, two had missing records regarding if the detachment was treated with a new retainer or rebonding, two others received no further treatment with retainers. Also, among the detached retainers, there was missing records regarding four retainers’ total or partial detachment.
Discussion

4.1 General failure

There was a larger amount of retainers in the mandible than in the maxilla (n=98/58), this is due to the more seldom use of bonded retainers in the maxilla.

This retrospective study showed that the general failure rate of the retainers was 26.9% (n=156), which was a lower prevalence than a previous study (9). There was no significant difference in failure rate between the maxilla and the mandible. This contradicts the hypothesis and the general perception of the staff at the DOMU, which was that the retainers bonded in the maxilla detached more often, due to occlusal forces.

4.2 Bonding material as failure factor

The general results of the failure rate in the two different materials clearly showed a higher failure rate within the first six months after application for the material TBS (35.1%), compared to the failure rate of TEF (19.0%). The two groups compared were evenly distributed (n=77/79), and the comparison showed a clear statistical significance. An earlier study shows a similar result to TBS, however, the study used the material Transbond LR (37.9%) (9). Another study showed a failure rate of only 8% for TBS and 18% for Tetric-N-Flow, a complete different outcome than the one of this study, however with no statistical significance (15).

In the mandible, there was a clear and statistically significant difference in the failure rate between the two materials for bonded retainers, similar although more substantial compared to the general results. For retainers in the maxilla, the study showed no difference between the two materials.

The results indicate an overall stronger hold from TEF than TBS. Although, in the maxilla, this attribute does not seem to be the decisive marker to determine detachment of the retainers. Instead, other factors might be more important such as occlusal forces.

4.3 Influence of sagittal and vertical diagnoses

When comparing the diagnoses, regardless of what bonding material used, the results indicate that patients with Angle Class I with normal vertical relations prior to orthodontic treatment had less bonding failure than other patients.

In this study, observations of the mandible could not prove that there is a higher risk of failure depending on sagittal or vertical diagnosis prior to orthodontic treatment. In the maxilla, where no difference in relapse due to bonding material could be found, the study undoubtedly shows that a patient with vertical or sagittal deviation is of much higher risk for bonding failure. This is strongly connected to the patient’s vertical diagnosis, especially deep bite, where 11 out of 26 lost their retainer during the first six-month period. Deep bite is a diagnosis that might cause a lot of stress to the retainer, due to the fact that orthodontic treatment generally is terminated without a complete transition to normal vertical relation. The different sagittal and vertical relations after completed orthodontic treatment were not noted in this study. No earlier study was found regarding the failure rate of bonded retainers in patients with deep bite. One study
aimed to exam the relapse of deep bite cases but failed to draw conclusions regarding the prevalence and risk factors (16). A systematic review showed low evidence of low prevalence of relapse in patients after being treated for deep bite (17). In this study no other specific diagnosis, than deep bite, had this impact, except open bite. However, the results for open bite are unreliable since there were only three patients in this study with open bites who had a retainer in the maxilla. Also, patients with a sagittal diagnosis of Angle class II or III combined showed a higher failure rate than Angle I. However, this was only observed in the maxilla and no single diagnosis showed a higher rate alone.

When considerations to bonding material and diagnoses were taken, a statistical significance in success rate could be seen in retainers bonded with TEF. A TEF-bonded patient has a much lower risk of failure in Angle Class I cases with normal vertical relations. This could however not be shown for each jaw separated, due to small sample size. 8.3% of the patients with Angle Class I with normal vertical relations lost their retainers in the maxilla, compared to 41.2% with a different diagnosis. For the mandible, the rate of subjects failing was not as high as in the maxilla, 5.3% respectively 19.3%.

Regarding the patients bonded with TBS no statistical significance could be seen for patients with Angle Class I with normal vertical relations, compared to patients with a different diagnosis, neither in general nor for the jaws separated.

This indicates that the failure rate for patients bonded in the maxilla is more dependent on the diagnosis prior to orthodontic treatment. This confirms the hypothesis, which stated that patients with a sagittal or vertical malocclusion prior to orthodontic treatment have a higher failure rate of bonded retainers than patients without these malocclusions. However, this was not true for the mandible or for the jaws in general. Failure rates in the mandible could be more depended on other factors, such as which bonding material was being used.

4.4 Extraction vs. nonextraction patients

There was no significant difference in failure rates between patients orthodontically treated with extractions vs. patients who did not receive this treatment. The population was unevenly divided, with a larger amount of nonextraction cases (n=46/110). Comparisons were also made separately for each jaw, and comparisons between Ex and NonEx between the jaws, all with similar results and no significant differences. An earlier systematic review showed no large difference in orthodontic relapse prevalence between extracion and nonextraction cases (17).

The results clearly falsify or fails to answer the hypothesis, that patients treated with extractions could be more prone to relapse due to migrating teeth because of a supposed more severe dental crowding. This appears not to be the case, based on these results.

4.5 Ages and gender

The sample in this study was unevenly spread over ages (12-23 years old). Therefore, no statistically reliable results of failure rate according to age could be compared. The hypothesis, that younger patients would have a higher failure rate than older patients due to a supposed difference in compliance, remains unanswered.
The distribution between genders was even (77/79). The comparison between genders showed very similar results in failure rates, without any statistically significant difference. This confirmed the initial hypothesis, which had its basis in a supposed similar compliance between the genders. This has also been observed in previous studies where no difference in compliance could be seen between the genders. (18)

4.6 Existing vs. new retainer

Of all detached retainers, only 18.4% required the manufacturing of a new retainer, thus 81.6% of detached retainers were rebonded. This could be because a retainer can be rebonded in cases with both partial and total detachment. It is only necessary to produce a new retainer when the previous one is missing or deformed. When comparing the need for new retainers, no statistically significant difference was observed between the groups. The same result was found in comparison between the maxilla and the mandible, with and without taking the material used in regard.

Surprisingly, no significant difference was found when comparing amount of not detached retainers to rebonded retainers in relation to bonding material, even though the results show a clear discrepancy between the two materials, (TBS was rebonded in 27.8% compared to 14.7% for TEF). However, this can be due to small sample size. In this case, one must point out that the significance level reached (p=0.068) was fairly close to the level chosen (p<0.05), and four patients were lost in the calculation due to lack of records and discontinued treatment, all four with detached retainers bonded with TBS. No significant difference was found doing the same comparison for the production of new retainers. This result was expected considering the low frequency of this treatment overall in the population, impairing the possibility of conducting statistical testing.

It was clearly more common for detached retainers to only detach partly (73.7%) than a total loss of retention (26.3%) of the retainers. This is probably because of the simple fact that a higher force is required for the retainer to detach completely from all the surfaces, than from a single surface. Among the detached retainers, no significant difference was found regarding the relation between total and partial retention failure when comparing the bonding materials. The same result was found in comparison between the maxilla and the mandible, with and without taking the material used in regard.

When comparing total loss of retention to no loss of retention in relation to bonding material, no significant difference could be seen. This is probably because of the low sample size of retainers with total loss of retention. A statistically significant difference was however shown between retainers with partial retention-loss and retainers without failure in relation to bonding materials, with TBS showing a higher rate of partial retention loss compared to TEF.

The results show that when the retainers detached, they could be rebonded in most cases, and also that a loss of retention was more often partial than total. The study did not show any relationship between the retainer’s placement and the requirement for the production of a retainer, the rebonding of one, or a total loss of retention. The same result was seen in relation to material and the three previously named variables. However, the fact that TBS shows a more frequent partial loss of retention, and also a general higher rate of retention loss has effects on the cost-effectiveness of the treatments. Although, the rate of production of new retainers and total rebondings of retainers are not affected by the choice of material, partial rebondings probably take place more often when using one of the materials (TBS). This results in higher
monetary costs of materials and chair time, as well as costs for the patient, if not funded by the health-care system, and the inconvenience of extra visits for the patient. Moreover, the loss of retention exposes the patient to a higher risk of orthodontic relapse.

4.7 Methodological aspects

Since the study was aimed only as a control of quality and clinical guideline for the Department of Orthodontics at the DOMU, no ethical trial was deemed necessary. Also, since the study was a retrospective cohort study the patients were already treated and no sensitive data were collected. All the patients received a code after being included in the study and were in this way anonymized.

The staff at DOMU provided patient records for the study of treated patients at the DOMU over the last couple of years. No specific date was set as a limit for starting review of patients, instead it was merely estimated by the staff to provide a large enough sample. However, this probably does not affect the result since the staff did not know which patients failed or not. The provided patient records span over years. Consequently, there is no guarantee that the staffs’ procedures have not changed over the years in some way and therefore may have influenced the result. Aspects such as etching time, light-curing time, routines for moisture control and the amount of different caregivers that bonded the retainers may have changed over the years and therefore may have influenced the results.

The patients were randomly selected with no prior knowledge of the failure rate. The only knowledge provided was which orthodontist had treated the patient, however no prior knowledge of the orthodontist’s skill levels existed. Also, regardless of which orthodontist being the caregiver, the bonding of the retainers was in most cases conducted by one of two orthodontic assistants. The randomisation of patient selection gives the study less risk of bias.

Subjects were excluded in the study where there was no information about the bonding material. How many patients that were lost due to missing information was not recorded. One cannot draw conclusions how this could affect the result because of the obvious lack of information.

When obtaining the results, they were all tested for significance with “Fishers Exact Test”. The “Fishers Exact Test” is more exact than a “Chi-squared Test”, and more appropriate when the sample size is smaller (13). The small sample size in some parameters resulted in no conclusions, although there was a clear discrepancy between groups compared and p-value under 0.1. With just a small increase in sample size one could probably have drawn conclusion from these measures.

The study did not record any diagnosed transversal malocclusions before orthodontic treatment. This was the case because patients with transversal malocclusions normally receives retention treatment with inactivated Quad Helix or expansion plate at the DOMU. Therefore, this did probably not affect the results.

4.8 Impacts of the study and future research

The study primarily works as a quality assessment for fixed retainers at the DOMU, as well as providing guidelines in the process of choosing bonding materials for fixed retainers for future
treatment. Further guidelines are also provided in assessing risk of retainer detachment, considering patients’ diagnoses, extractions as an orthodontic treatment, and other potential risk-factors, such as gender. The ability to prevent retainer detachment could result in less risk of orthodontic relapse, as well as monetary costs for the society, clinics and for the patient.

This study was a retrospective cohort study which limited the amount of individuals that were included. The study-design also resulted in the loss of control of the noted variables in the patients records as well as the loss of control of bonding procedures. Further studies, i.e. prospective RCT’s with larger sample sizes, including Power-analysis, could minimize these problems and result in more reliable conclusions.

Conclusion

The study concludes that there is a significant difference regarding the durability of the two different bonding materials for Tetric EvoFlow’s advantage. However, for bonded retainers in the maxilla there was no difference in duration due to the choice of bonding material. Instead, vertical malocclusion prior to orthodontic treatment showed a clear connection to detached retainers in the maxilla. For retainers in the mandible, the failure rate showed a distinct and significant connection to the choice of bonding material.
References


(14) http://www.socscistatistics.com/tests/fisher/Default2.aspx; 2017-03-20

