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Orthodontic retainers

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VÄSTRA GÖTALANDSREGIONEN
SAHLGRENSKA UNIVERSITETSSJUKHUSET

Orthodontic retainers
[Retention efter ortodontisk behandling]

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1. Summary of the Health Technology Assessment

Method and patient group

Malocclusions of the teeth that cause functional and esthetic problems are corrected by orthodontic treatment. The challenge in orthodontics is to maintain its result. A good early treatment result will most probably deteriorate to some extent, especially during the first year, if it is not properly retained. Therefore, when the orthodontic appliance is removed most patients are provided with a retainer. It can be fixed to the teeth or be removable. Since the retainer may fail or cause side effects, there is a need for regular follow-up visits. A special retention strategy that sometimes is used with bonded retainers is to cut the gingival fibers that are attached to the teeth (fiberotomy).

Question at issue

Do fixed retainers improve stability after orthodontic treatment and do they increase the risk of side effects on the teeth and periodontium in comparison with removable retainers, no retainer or fiberotomy?

PICO P= Patients, I= Intervention, C= Comparison, O=Outcome

P = Patients treated with fixed appliance due to malocclusion of teeth (excluding malocclusion caused by periodontitis or trauma)
I = Fixed retainer for more than 2 years
C_1 = Removable retainers
C_2 = No retainers
C_3 = Fiberotomy
O = Treatment stability (measured by validated index), periodontal outcomes (i.e. alveolar bone level, attachment loss, gingival recession), dental caries, dental plaque (i.e. biofilm), calculus, gingivitis, complications (e.g. retainer failure)

Studied risks and benefits for patients of the new health technology

The systematic literature search identified two systematic reviews, two randomised controlled trials (RCT), and four non-randomised, controlled studies that studied the effect of a fixed retainer compared to a removable retainer, or no retainer, after orthodontic treatment. Five case series were included with regard to complications.

Fixed orthodontic retainer versus removable retainer (PICO 1)

Treatment stability may be improved by fixed retainer compared to removable retainer.
Low quality of evidence (GRADE ⊕⊕◯◯).
It is uncertain whether *periodontal outcomes, dental caries, dental plaque, calculus,* or *gingivitis* differ between fixed retainer and removable retainer.
Very low quality of evidence (GRADE ⊕◯◯◯).

Fixed orthodontic retainer versus no retainer (PICO 2)

Treatment stability was not studied.
It is uncertain whether *periodontal outcomes, dental caries,* or *calculus* differ between a fixed retainer and no retainer. Very low quality of evidence (GRADE ⊕◯◯◯).
It is uncertain whether fixed retainer contributes to increased accumulation of *dental plaque*, or increases prevalence of *gingivitis*, compared to no retainer.
Very low quality of evidence (GRADE ⊕◯◯◯).

The most common *complications* were retainer failures. The incidence vary considerably between the different studies with a range from 0% to 100% of the retainers.

Fixed orthodontic retainer versus fiberotomy (PICO 3)
No studies were identified in which fixed retainer was compared with fiberotomy.

Ethical aspects
There are no major ethical concerns related to the use of orthodontic retainers. The patients are often aware of the treatment outcome, especially if the effect involves anterior teeth. Esthetic improvements are important for most patients and the retainer is considered to promote stability of the treatment results.

If an increasing number of patients have their retainers for many years the cost for check-ups as well as for repairs or maintenance of retainers will increase. This may affect the public dental care resources, and, thus, lead to displacement of other patient groups.

Economic aspects
The annual cost of orthodontic treatment in the Region Västra Götaland is 108 million SEK. The cost of the first application of a retainer is approximately 2,000 SEK per patient. The actual total treatment time, and, thus, the overall cost for the maintenance of a fixed retainer is not known. These retainers frequently fail and therefore need to be re-bonded or redone. Furthermore, professional cleaning of the retainers from calculus is time consuming. The total cost of these procedures is also not known.

If no retainer is applied the cost of the retainer and its maintenance is eliminated. However, the incidence of relapse and the need for a second orthodontic treatment period is unknown. Therefore, the theoretical overall cost for re-treatment cannot be estimated. Furthermore, the cost of complications during re-treatment can neither be estimated.

Concluding remark
Treatment stability may be improved by a fixed retainer after orthodontic treatment in comparison with a removable retainer or in comparison with no retainer. Low quality of evidence (GRADE ⊕⊕◯◯). It is also uncertain whether periodontal outcomes, dental caries prevalence, or presence of calculus differ between the various types of retainer regimens. The quality of evidence is very low (GRADE ⊕◯◯◯). Technical failures are a relatively common complications during treatment with a retainer. There are no major ethical concerns whereas cost aspects cannot be estimated.

2. Swedish Summary of the Health Technology Assessment- Sammanfattning på svenska

Metod och patientgrupp

Bettavvikelser som orsakar funktionella och estetiska problem korrigeras genom tandreglering (ortodontisk behandling). Tandregleringens egentliga utmaning är konsten att bibehålla behandlingsresultaten över tid. Ett lyckat behandlingsresultat kommer sannolikt att snabbt försämras om inte retentionsfasen utförs korrekt. Därför får de flesta patienterna en s.k. retainer när tandregleringsapparaturen avlägsnas. Retainern kan fixeras till tänderna, eller vara avtagbar. Eftersom retainern kan haverera eller orsaka sidoeffekter, behövs regelbundna efterkontroller. En särskild retentionsstrategi som ibland använd tillsammans med fastsittande retainer är att skära av de gingivala fibrerna som fäster till tänderna (fibrotomi).

Fokuserad fråga - PICO

Kan fastsittande retainers öka stabiliteten efter tandreglering, eller orsaka sidoeffekter på tänderna och parodontiet, i jämförelse med avtagbar retainer, ingen retainer, eller fibrotomi?

PICO: P= Patients, I= Intervention, C= Comparison, O=Outcome

P = Patienter behandlade med fastsittande tandregleringsapparatur på grund av bettavvikelse (ej bettavvikelse orsakad av parodontit eller trauma)
I = Fastsittande retainer > 2 år
C_1 = Avtagbar retainer
C_2 = Ingen retainer
C_3 = Fibrotomi
O = Stabilitet efter behandling (mätt med validerade index), parodontala utfall (tex. alveolär bennivå, fästeförlust, gingival retraktion), karies, plack (biofilm), tandsten, gingivit (tandköttsinflammation), komplikationer (tex. retainer haveri)

Resultat

Den systematiska litteraturgenomgången resulterade i två systematiska översikter, två randomiserade kontrollerade studier (RCT), och fyra icke-randomiserade kontrollerade studier som studerade effekten av fastsittande retainer, jämfört med avtagbar retainer, eller ingen retainer, efter tandregleringsbehandling. Fem fallserier inkluderades för att studera komplikationer.

Fastsittande ortodontisk retainer jämfört med avtagbar retainer (PICO 1)

Fastsittande retainer kan förbättra *stabilitet efter tandregleringsbehandling*, jämfört med avtagbar retainer. Begränsat vetenskapligt underlag (GRADE ⊕⊕◯◯).
Det är osäkert huruvida det finns någon skillnad avseende *parodontala utfall*, *karies*, *plack*, *tandsten*, eller *gingivit* mellan fastsittande och avtagbar retainer.
Otillräckligt vetenskapligt underlag (GRADE ⊕◯◯◯).

Fastsittande ortodontisk retainer jämfört med ingen retainer (PICO 2)

Stabilitet efter tandregleringsbehandling: Inga studier hade utfallsmåttet.
Det är osäkert huruvida det finns någon skillnad avseende *parodontala utfall*, *karies*, eller *tandsten*, mellan fastsittande retainer och ingen retainer.
Otillräckligt vetenskapligt underlag (GRADE ⊕◯◯◯).
Det är osäkert huruvida fastsittande retainer bidrar till ökad ansamling av *plack*, eller ökar förekomsten av *gingivit*, jämfört med ingen retainer.
Otillräckligt vetenskapligt underlag (GRADE ⊕◯◯◯).

Den vanligaste *komplikationen* var retainer haveri. Incidensen varierade avsevärt mellan studierna, med en spridning från 0% till 100%.

Fastsittande ortodontisk retainer jämfört med fibrotomi (PICO 3)
Inga studier lokaliserades.

Etiska aspekter
Det finns inga betydande etiska frågeställningar kring retaineranvändning efter tandreglering. Patienterna är oftast medvetna om behandlingsresultaten, särskilt avseende framtandsområdet. Estetiska förbättringar är viktiga för de flesta patienter, och retainern anses förbättra stabiliteten efter tandreglering.
Om ett ökande antal patienter har sina retainers i många år, kommer kostnaden för efterkontroller och reparationer att öka, vilket kan leda till undanträngningseffekter för andra tandvårdspatienter.

Ekonomiska aspekter
Den årliga kostnaden för tandregleringsbehandlingar i Västra Götalandsregionen är 108 miljoner SEK. Den första retainern kostar ca 2 000 SEK per patient. Den verkliga behandlingstiden och således den sammanlagda kostnaden för underhållet av en fastsittande retainer är okänd. Tekniska haverier av fastsittande retainers är vanligt förekommande, och kräver fastsättning eller tillverkning av en ny retainer. Professionell avlägsnande av tandsten och rengöring av en fastsittande retainer är tidskrävande. Kostnaden för dessa åtgärder är inte heller känd.
Om ingen retainer används, elimineras kostnaden för retainer och dess underhåll, men förekomsten av återfall och behovet för upprepad behandling är okänt. Därför kan inte den teoretiska kostnaden för upprepade tandregleringsbehandlingar, eller för eventuella komplikationer under upprepad behandling uppskattas.

Sammanfattande slutsats
Stabiliteten efter tandreglering kan förbättras av fast retainer jämfört med avtagbar retainer. Det vetenskapliga underlaget är begränsat (GRADE ⊕⊕◯◯).
Det är osäkert huruvida det finns någon skillnad avseende parodontala utfall, karies, plack, tandsten, eller gingivit mellan individer med olika typer av retainer. För dessa utfall är det vetenskapliga underlaget otillräckligt (GRADE ⊕◯◯◯).
Tekniska haverier är förhållandevis vanligt förekommande vid behandling med retainer. Det finns inga betydande etiska frågeställningar kring retention efter tandreglering, men kostnaderna kan inte uppskattas.

3. Participants in the project.

Participants, in the HTA group

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Conflicts of interest for the proposer or any of the participants in the HTA group

No conflicts of interest.

The HTA was accomplished during the period of 2013-09-24 – 2014-02-26
Last search updated in month September 2013

The Regional Health Technology Assessment Centre (HTA-centrum) of Region Västra Götaland, Sweden (VGR) has the task to make statements on HTA reports carried out in VGR. The statement should summarise the question at issue, results and quality of evidence regarding efficacy and risks, and economical and ethical aspects of the particular health technology that has been assessed in the report.

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4. Long-term retention after orthodonic treatment

Tooth position after treatment with orthodontic braces

Malocclusions that cause functional and esthetic problems are corrected by orthodontic treatment. The challenge in orthodontics is to maintain the result. A good early treatment result will most probably deteriorate to some extent, especially during the first year, if it is not properly retained (Little et al., 1988).

There is a lack of information to draw evidence based conclusions of long-term stability of orthodontic treatment results for most malocclusions (SBU, 2005; Bondemark et al., 2007). Treatment of crowding and Angle Class II (i.e. overbite) cases demonstrate in general good results at the end of the orthodontic treatment. However, the occlusion thereafter gradually deteriorates to an extent that is unpredictable at the individual level. This is due to short-term and long-term changes in the dento-alveolar area.

The tendency of the teeth to return to their pretreatment position in the short time perspective is referred to as *relapse*. It occurs if the tissues, especially the gingival fibers surrounding the teeth, fail to adapt to the new position (Reitan, 1959). The term relapse is also often incorrectly used for long-term changes. These late changes will take place regardless of any orthodontic treatment, and are caused by continuous growth and development, i.e. are due to normal aging (Thilander, 2000).

Since treatment stability is unpredictable at the individual level, most patients are provided with a bonded lingual retainer when the orthodontic appliance is removed. The retainer is used to stabilize the teeth. Studies have indicated that a majority of all relapses occurs during the first years after orthodontic treatment (Al Yami *et al*., 1999). The retainer is kept for several years in order to maintain the teeth positions. It is still not clarified if retention promotes long-term treatment stability.

Presently, many patients receive bonded retainers. Due to higher esthetic demands and the risk of relapse the retainers are no longer removed after a certain period of time, which was more common earlier. This new clinical routine generates an increasing number of individuals in need of retainer maintenance. This increases the workload for the clinics, as well as the costs for the society and for the patient (as an adult). Currently, there are discussions regarding the responsibility of this workload and the costs. Should the general dentist or the orthodontist be responsible for the maintenance?

Furthermore, it is discussed whether fixed or removable retainers are most effective. Retainers also have a potential to cause damage to hard and soft tissues in the oral cavity. They provide places for food and dental plaque accumulation, and they keep the teeth fixed in their orthodontically corrected positions.

☐ Risk of premature death.
☐ Risk of permanent illness or damage, or reduced quality of life.
☑ Risk of disability and health-related quality of life.

Prevalence and incidence of malocclusion

Only a few persons have an ‘ideal’ occlusion. Malocclusions are divided in; sagittal, transversal, vertical, space or positional problems. The prevalence of different malocclusions varies, but is also different between populations. The most common malocclusions in Sweden are *crowding* and *overbite*. Not all malocclusions are of such severity that they require treatment. It is estimated that approximately 25% of the population in Region Västra Götaland requires or requests treatment. Almost all patients that have orthodontic treatment with fixed appliance will receive retainers after its completion.

Present treatment of malocclusions and the use of retainers after orthodontic treatment

Orthodontic treatment with a fixed appliance takes approximately two years and is performed by an orthodontic specialist.

A retainer, prepared in the clinic or by a dental technician, is provided when the fixed appliance is removed. The retainer can be permanently fixed to the teeth, or it can be removable. Usually the patient will receive a combination of these two types of retainers.

There is a need for regular dental check-ups since the retainer may fail, or cause side effects, without the patient noticing. The time interval for controls varies. During the initial period after the fixed appliance has been removed the controls are performed by the orthodontist. Thereafter, a general dentist usually performs the control annually.

Since there is a high risk of relapse if the intervention with the retainer fails, the patient is instructed to immediately contact the dentist if he/she notices any malfunction. The patient is also informed that a relapse can take place whenever the retainer is removed. Therefore, provided that the retainer does not cause any problems, it is often kept for a long period of time, often more than 10 years.

The number of patients per year who receive orthodontic treatment followed by a retainer

Approximately 3,700 patients annually in the Region Västra Götaland receive treatment with a fixed appliance. The cost is 108 million SEK. Because of the unpredictable stability of the treatment results almost all patients receive a bonded lingual retainer, and often also an additional removable retainer.

The normal pathway of a patient through the dental care system

The general dentist is responsible for supervising tooth eruption and occlusal setting. If a malocclusion develops the dentist consults an orthodontic specialist. The orthodontist will then decide on the need for treatment, possible treatment regime, and when to start.

If the patient is still growing a removable appliance might be indicated. This treatment can be given by a general dentist. However, for more complex malocclusions the patient will need a fixed appliance. This must be performed by an orthodontic specialist. The orthodontist is also responsible for the planning of the retention regime after the fixed appliance has been removed, and for the initial retainer controls. The patient is thereafter referred back to the general dentist who will be responsible for the following controls.

Actual wait time for orthodontic treatment

The actual waiting time for orthodontic treatment in Region Västra Götaland varies from six months up to three years between the clinics. The retainer is prepared and delivered the same day the orthodontic appliance is removed.

5. Present treatment

Retention for stabilising tooth position after orthodontic treatment

Retention to stabilise the tooth position after orthodontic treatment is a common clinical measure to avoid post-treatment relapse. The retention appliance can either be a removable or a fixed, bonded retainer to the teeth.

Bonded retainers most commonly are wires made of stainless steel with various dimensions. They can also be manufactured in other materials, e.g. a glass fiber-reinforced composite material. The retainer is made either directly by the orthodontic specialist when the fixed appliance is removed, or it can be prepared by a dental technician from a cast of the tooth impression.

The retainers are either bonded to the lingual surfaces of all the teeth in the anterior region 'bonded lingual retainer' or to the canines 'cuspid retainer' (Figure 1). A retainer bonded to all teeth prevents movements in all directions. A cuspid retainer only prevents the front teeth from rotating and to tip lingually. The advantage of a cuspid retainer is that the patient easily will notice if the retainer fails. A failure of a bonded lingual retainer can be undetected for a long time, and may therefore lead to a relapse and to side effects.

Figure 1. Fixed retainers bonded to anterior teeth in lower dental arch

Bonded lingual retainer (left), and cupid retainer (right)

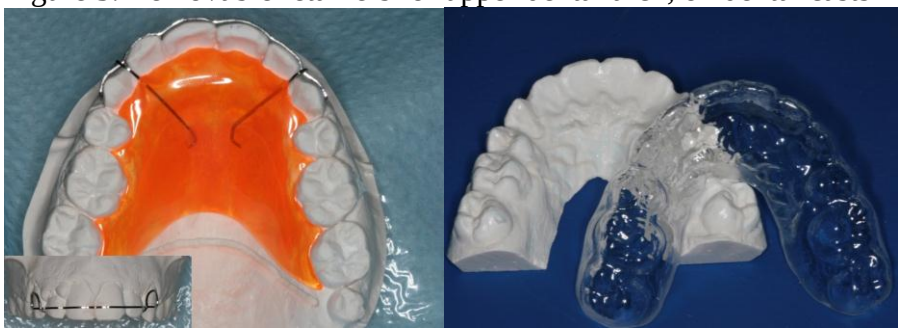
A removable retainer is either a vacuum formed plastic splint, or a plastic appliance with stainless steel details, including clasps etc (Figures 2 and 3). The removable appliances are made on a cast from an impression taken at the clinic. The vacuum formed splints are sometimes made at the clinic while the dental technician makes the more complicated removable appliances.

Usually the removable retainer is extended to cover all the teeth. It is recommended that the retainer is used the whole time during the first months. Thereafter it is used during nighttime for at least one year. The advantages of a removable retainer are that it is less prone to fracture/failure, and that it is easier for the patient to brush the teeth.

Figure 2. Removable and fixed retainer in upper dental arch

Removable retainer with steel details, combined with a bonded lingual retainer.

Figure 3. Removable retainers for upper dental arch, on dental casts



Removable retainer with steel details (left), and a vacuum formed splint (right)

A disadvantage of the use of removable retainers is that the long-term effect on treatment stability is highly depending on the patient's compliance. This implies that fixed retainers are preferable. However, a drawback of fixed retainers is that they are technically more demanding to handle. A fixed retainer may also increase the retention of dental plaque and calculus, which may cause adverse effects with dental caries or periodontal destructions.

A special retention strategy that sometimes is used with bonded retainers is to cut the gingival fibers that are attached to the teeth (fiberotomy).

The group's understanding of the potential value of long-term retention

There is a risk of relapse when the teeth are corrected after orthodontic treatment. Most patients do not accept a visible change in the tooth positions after such treatment. Since treatment stability is unpredictable at the individual level a retention procedure is used as a prerequisite to guarantee treatment stability when the fixed appliance is removed. To start orthodontic treatment again due to a relapse is usually not an option since it is both cumbersome (additional two years with fixed appliance) and costly for the patient and/or the clinic. Furthermore, it may increase the risk of side effects on the teeth and periodontium.

The central question for the current HTA project

Do fixed retainers improve stability after orthodontic treatment and do they increase the risk of side effects on the teeth and periodontium in comparison with removable retainers, no retainer or fiberotomy?

PICO P= Patients, I= Intervention, C= Comparison, O=Outcome

P = Patients treated with fixed appliance due to malocclusion of teeth (excluding malocclusion caused by periodontitis or trauma)

I = Fixed retainer for more than 2 years

C_1 = Removable retainers

C_2 = No retainers

C_3 = Fiberotomy

O = <u>Critical for decision making</u>
Treatment stability (of teeth alignment measured by validated index)

<u>Important but not critical for decision making</u>
Periodontal outcomes (i.e. alveolar bone level, attachment loss, gingival recession)
Dental caries

<u>Not important for decision making</u>
Dental plaque (i.e. biofilm)
Calculus
Gingivitis
Complications (e.g. retainer failure)

6. Review of Quality of Evidence

Search strategy, study selection and references (Appendix 1)

During September 2013 two librarians (ELD, AL) performed systematic searches in PubMed, Embase, the Cochrane Library, and a number of HTA-databases. Reference lists of relevant articles were also scrutinized for additional references. Search strategies, eligibility criteria and a graphic presentation of the selection process are accounted for in Appendix 1. The librarians conducted the literature searches, selected studies and independently assessed the obtained abstracts and a first selection of full-text articles for inclusion or exclusion. Any disagreements were resolved in consensus. The remaining articles were sent to the work group, who read the articles independently and then decided in a consensus meeting which articles that should be included.

The literature search identified a total of 1,151 articles (after removal of duplicates). The librarians then excluded 1,038 articles after reading their abstracts. Another 77 articles were excluded by the librarians after reading the articles in full text.

The remaining 36 articles were sent to the project group, and 13 of them were finally included in the report, two were systematic reviews, two were randomized controlled trials (RCT), four were non-randomized controlled studies. The remaining articles are case series.

These studies have been critically appraised. The appraisal of original articles is based on checklists from SBU (Swedish Council on Health Technology Assessment) regarding randomized controlled trials, cohort studies and systematic reviews (AMSTAR).

Included studies – design and patient characteristics (Appendix 2)
Excluded articles – (Appendix 3).
Outcome tables – (Appendix 4)
Summary of Findings, SoF-table (Appendix 5)

Ongoing research

A search in www.clinicaltrials.gov (2013-12-20) using the search terms *retainer OR retainers OR postretention* identified ten trials. Eight of these trials did not investigate orthodontic treatment retention. The remaining two studies were irrelevant for this HTA.

Medical societies or health authorities that recommend the technology

The Swedish National Board of Health and Welfare (2011) concludes that most malocclusions can be successfully treated with orthodontic fixed appliances, and also states that there is a risk for relapse, especially in the treatment of deep and open bites. Regular follow-up visits and retention are therefore recommended. However, there are currently no recommendations for any specific type of retention.

Brief description of the present knowledge of retention after orthodontic treatment

The systematic literature search identified two systematic reviews, two randomised controlled trials (RCT), and four non-randomised, controlled studies that studied the effect of a fixed retainer compared to a removable retainer, or to no retainer, after orthodontic treatment. Five case series were included with regard to complications.

The systematic reviews addressed issues that slightly differed from the PICO of this HTA. Bondemark *et al*., 2007, evaluated morphologic stability and patient satisfaction after at least five years of orthodontic treatment. Littlewood *et al*., 2006a, included only one of the studies included in the present HTA. Both RCTs had some study limitations, mainly regarding randomization and blinding. They also had serious problems with regard to directness and precision (Appendix 5).

The non-randomised, controlled studies had also serious problems with regard to directness and precision (Appendix 5).

PICO 1: Fixed orthodontic retainer versus removable retainer

Treatment stability (Appendix 4.1.1)

The systematic reviews did not report any comparisons of different types of retainers. Two RCTs and one non-randomised, controlled study compared treatment stability with fixed retainer and removable retainer.

One RCT reported a significant difference in the treatment stability in the lower dental arch in favour of a fixed retainer (change in Little's irregularity index, Δ LII: 0.6) after two years of retention in comparison with removable retainers (Δ LII: 1.6). There was also a significant difference regarding other measurements of dental alignment between the three study groups, but the interventions were mixed between upper and lower arch. This makes it difficult to draw any meaningful conclusions. The other RCT did not report significant differences regarding treatment stability.

The non-randomised, controlled study reported a significantly higher proportion of relapse in the removable retainer group. However, the outcome was not reported on the individual patient level, but on the dental arch level. Furthermore, there was no information of baseline characteristics of the study groups.

Conclusion: Treatment stability may be improved by fixed retainer compared to removable retainer. Low quality of evidence (GRADE ⊕⊕◯◯).

Periodontal outcomes (Appendix 4.1.2)

One RCT and three non-randomised, controlled studies reported on periodontal outcomes after treatment with fixed retainer and removable retainer. One non-randomised, controlled study reported statistically significant (0.27 mm), but clinically not important, deeper gingival crevices in the fixed retainer group than in the removable retainer group. There were no significant differences between study groups group in any other periodontal outcome across the studies.

Conclusion: It is uncertain whether periodontal outcomes differ between fixed retainer and removable retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Dental caries (Appendix 4.1.3)

One RCT and two non-randomised, controlled studies reported on the caries prevalence after treatment with fixed retainer and removable retainer. No dental caries was detected in any of the study groups.

Conclusion: It is uncertain whether the prevalence of dental caries differs between individuals with fixed retainer or removable retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Dental plaque (Appendix 4.1.4)

One RCT and three non-randomised, controlled studies reported the accumulation of dental plaque after treatment with fixed retainer and removable retainer. There were no significant differences between the study groups.

Conclusion: It is uncertain whether accumulation of dental plaque differs between individuals with fixed retainer or removable retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Calculus (Appendix 4.1.5)

One RCT and two non-randomised, controlled studies reported on the presence of calculus after treatment with fixed retainer and removable retainer. There were no significant differences between the study groups.

Conclusion: It is uncertain whether presence of calculus differs between individuals with fixed retainer or removable retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Gingivitis (Appendix 4.1.6)
One RCT and three non-randomised, controlled studies reported on the prevalence of gingivitis after treatment with fixed retainer and removable retainer. No study reported any significant difference between individuals with fixed or removable retainers.
Conclusion: It is uncertain whether prevalence of gingivitis differs between individuals with fixed retainer or removable retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Complications (Appendix 4.1.7)
Complications were reported in two RCTs, one non-randomised, controlled study, and five case series. The most common complication reported in all the studies is retainer failure. The incidence varies substantially in the different studies with a range from 0% to 100% of the retainers. Littlewood *et al*., 2006a reported in his systematic review that there were no differences in the technical survival rates of fixed or removable retainers over three years follow-up. This conclusion was based on data from Årtun *et al*., 1997. However, in the RCT published 2013 failures were significantly more common for fixed retainers

PICO 2: Fixed orthodontic retainer versus no retainer
Treatment stability
No study reported any data on this outcome variable.

Periodontal outcomes (Appendix 4.2.1)
Three non-randomised, controlled studies compared periodontal outcomes in subjects with fixed retainer or without any type of retainer. Only one study reported significantly less lingual gingival retraction in the removable retainer group. The difference was not clinically important (0.08mm). For all other periodontal outcomes there were no significant differences between the study groups.
Conclusion: It is uncertain whether periodontal outcomes differ between individuals with fixed retainer or no retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Dental caries (Appendix 4.2.2)
One non-randomised, controlled study reported on the caries prevalence after treatment with fixed retainer or with no retainer. No caries was detected on the lingual surfaces in the two study groups.
Conclusion: It is uncertain whether caries prevalence differs between individuals with fixed retainer or no retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Dental plaque (Appendix 4.2.3)
Three non-randomised, controlled study reported the dental plaque accumulation after treatment with fixed retainer or with no retainer. Two of them reported a significantly higher accumulation of plaque on the tooth surfaces adjacent to the fixed retainer compared to same tooth surfaces in individuals without a retainer (82% vs 52, and 60% vs. 10%, respectively).
Conclusion: It is uncertain whether fixed retainer contributes to increased accumulation of dental plaque compared to no retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Calculus (Appendix 4.2.4)
One non-randomised, controlled study reported on the presence of calculus after treatment with fixed retainer or with no retainer. There was no significant difference between the study groups.
Conclusion: It is uncertain whether presence of calculus differs between individuals with fixed retainer or no retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Gingivitis (Appendix 4.2.5)
Three non-randomised, controlled studies reported prevalence of gingivitis after treatment with fixed retainer or with no retainer. There was significantly more gingivitis in areas adjacent to the fixed retainer compared to same areas in individuals without retainer in two of the studies.
Conclusion: It is uncertain whether the prevalence of gingivitis is higher among individuals with fixed retainer compared to those with no retainer. Very low quality of evidence (GRADE ⊕◯◯◯).

Complications
See above, PICO 1.

PICO 3: Fixed orthodontic retainer versus fiberotomy
No studies were identified in which fixed retainer was compared with fiberotomy.

7. Ethical consequences

(Appendix 6)

There are no major ethical concerns related to the use of orthodontic retainers. The patients are often aware of the treatment outcome, especially if the effect involves anterior teeth. Esthetic improvements are important for most patients and the retainer is considered to promote stability of the treatment results.

Frequent failures/fractures of the retainer can be expensive for the patient and/or the public dental insurance system.

If an increasing number of patients have their retainers for many years the cost for check-ups as well as for repairs or maintenance of retainers will increase. This may affect the public dental care resources, and, thus, lead to displacement of other patient groups.

8. Organisation

The use of retainer after orthodontic treatment has been in the clinical routine for many years in all orthodontic clinics in Region Västra Götaland, Sweden.

Consequences of the use of retainer after orthodontic treatment for personnel

There is an increasing number of patients who use retainers for longer periods of time. This increases the workload due the required maintenance. It is necessary for the general dentist to have adequate knowledge of how to handle situations such as emergency visits when the retainer has failed. For some dentists and dental assistants there may be a need for further training and education.

Consequences for other clinics or supporting functions in Region Västra Götaland of Sweden

Since approximately 3,700 patients in Region Västra Götaland annually receive bonded retainers that are kept for longer periods of time than previously there is a growing need for maintenance. This will lead to an increased workload and cost for the clinics.

9. Economical aspects

Present costs of orthodonic treatment and the use of retainers

The annual cost of orthodontic treatment in the Region Västra Götaland is 108 million SEK. The cost of the first application of a retainer is approximately 2,000 SEK per patient. The actual total treatment time, and, thus, the overall cost for the maintenance of a fixed retainer is not known. These retainers frequently fail and therefore need to be re-bonded or redone. Furthermore, professional cleaning of the retainers from calculus is time consuming. The total cost of these procedures is also not known.

If no retainer is applied the cost of the retainer and its maintenance is eliminated. However, the incidence of relapse and the need for a second orthodontic treatment period is unknown. Therefore, the theoretical overall cost for re-treatment cannot be estimated. Furthermore, the cost of complications during re-treatment (see above 6) can neither be estimated.

Expected costs of orthodonic treatment and the use of retainers

Already in routine practice.

Total change of cost

Not applicable.

Can retainer after orthodontic treatment be adopted and used within the present clinic budgets

Yes.

Available analyses of health economy, cost advantages or disadvantages.

No relevant studies were identified in the literature search.

10. Unanswered Questions

Important gaps in scientific knowledge

Relapse after orthodontic treatment is unpredictable. There are probably many underlying causes. The uncertainties of the prognosis and of the reasons that are most important hamper the retention strategy at the individual basis. There is still a lack of long-term studies with good scientific quality, and adequately designed studies that address both these issues are needed.

Interest in the own clinic to start studies within the research field at issue

The Department of Orthodontics is interested to start RCTs to address the questions of both PICO 1 and PICO 2, i.e. to compare the effectiveness of fixed and removable retainers, but also to no retention, in the short- and long term perspective.

HTA-retainer

Appendix 1, Search strategy, study selection and references

Question(s) at issue:
Do fixed retainers improve stability after orthodontic treatment and do they increase the risk of side effects on the teeth and periodontium in comparison with removable retainers, no retainer or fiberotomy?

PICO: (*P=Patient I=Intervention C=Comparison O=Outcome*)
P = Patients treated with fixed appliance due to malocclusion of teeth (excluding malocclusion caused by periodontitis or trauma)
I = Fixed retainer for more than 2 years

C_1 = Removable retainers
C_2 = No retainers
C_3 = Fiberotomy

O = Critical for decision making
Treatment stability (of teeth alignment measured by validated index)

Important but not critical for decision making
Periodontal outcomes (i.e. alveolar bone level, attachment loss, gingival recession)
Dental caries

Not important for decision making
Dental plaque (i.e. biofilm)
Calculus
Gingivitis

Complications (e.g. retainer failure)

Eligibility criteria

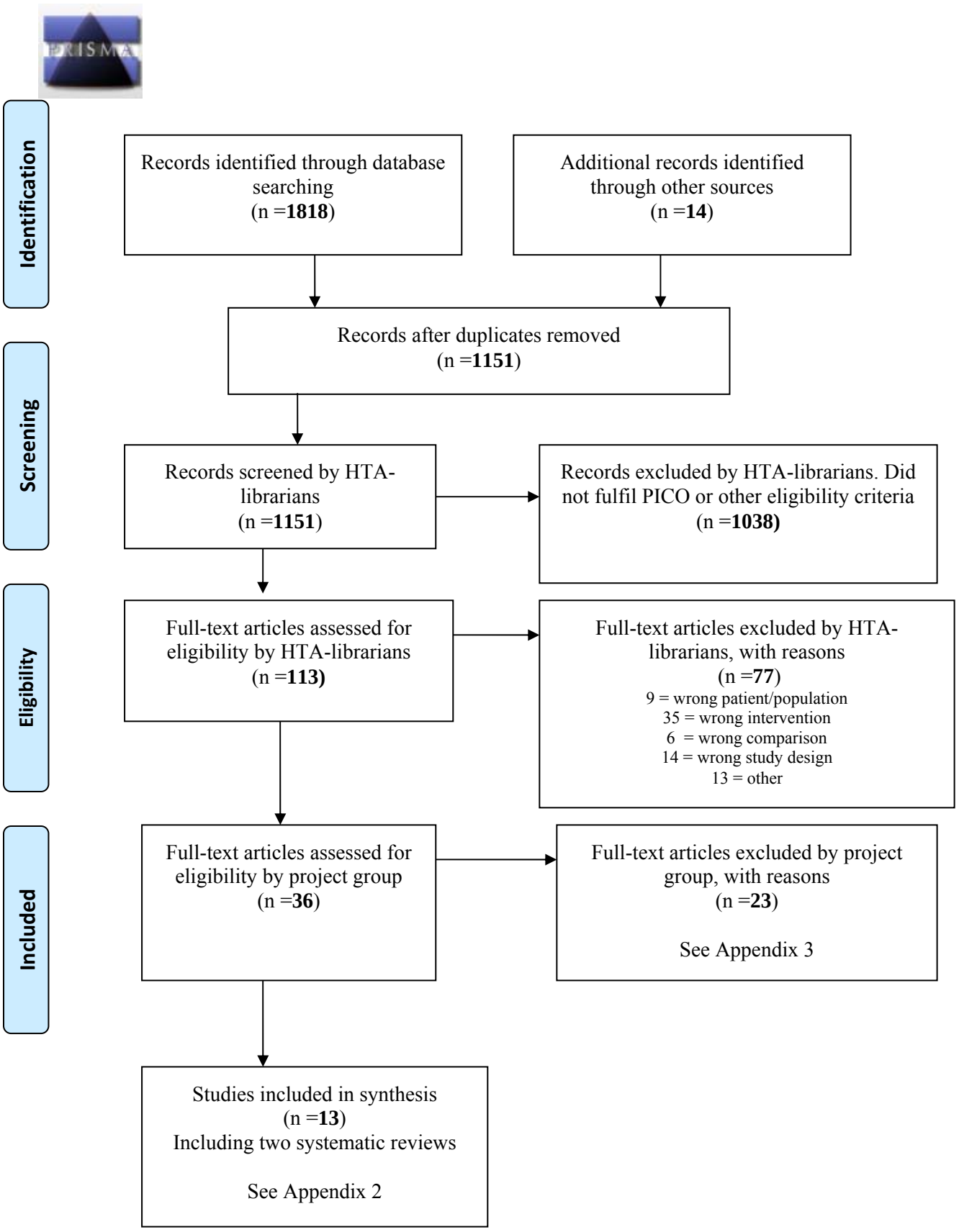
Study design:
Systematic reviews
Randomized controlled trials
Non-randomized controlled studies
Case series if ≥ 60 patients (for complications)
No case reports or review articles

Language:
English, Swedish, Norwegian, Danish

Publication date: 1977-

Kommentar Med utgångspunkt i SBUs rapport ”Bettavvikelser och tandreglering i ett hälsoperspektiv”, 2005 bedöms studier publicerade efter detta år för utfallet ”Mått på bibehållet resultat med relevanta validerade index”

Selection process – flow diagram



Search strategies

Database: PubMed
Date: 2013-09-30
No of results: 924

Search	Query	Items found
#25	**Search #23 NOT #24 Filters: Publication date from 1977/01/01; Danish; English; Norwegian; Swedish**	**924**
#24	Search ((animals[mh]) NOT (animals[mh] AND humans[mh])) Filters: Publication date from 1977/01/01; Danish; English; Norwegian; Swedish	2926033
#23	Search #21 NOT #22 Filters: Publication date from 1977/01/01; Danish; English; Norwegian; Swedish	951
#22	Search Editorial[ptyp] OR Letter[ptyp] OR Comment[ptyp] Filters: Publication date from 1977/01/01; Danish; English; Norwegian; Swedish	1155531
#21	Search #10 AND #13 AND #14 Filters: Publication date from 1977/01/01; Danish; English; Norwegian; Swedish	965
#16	Search #10 AND #13 AND #14	1074
#14	Search permanent[tiab] OR fixed[tiab] OR stabilis*[tiab] OR stabiliz*[tiab] OR bonded[tiab] OR stability[tiab] OR long-term[tiab] OR longterm[tiab]	1120767
#13	Search #11 OR #12	116989
#10	Search #8 OR #9	49742
#12	Search retainer*[tiab] OR retention[tiab] OR postretention[tiab]	116702
#11	Search "Orthodontic Retainers"[Mesh]	728
#9	Search orthodontic*[tiab]	26247
#8	Search "Orthodontics"[Mesh]	42437

Database: EMBASE (OVID SP)
Date: 2013-09-30
No of results: 722

#	Searches	Results
1	exp orthodontics/	29055
2	orthodontic$.ti,ab,kw.	26223
3	1 or 2	40331
4	exp dental retainer/	11
5	(retainer$ or retention or Postretention).ti,ab,kw.	148961
6	4 or 5	148970
7	(Permanent or Fixed or stabilis$ or stabiliz$ or bonded or stability or long-term or longterm).ti,ab,kw.	1396738
8	3 and 6 and 7	834
9	limit 8 to ((danish or english or norwegian or swedish) and yr="1977 -Current")	735
10	(animal not (animal and human)).ti,ab,kw.	309360
11	9 not 10	731
12	**limit 11 to (article or conference paper or "review")**	**722**

Database: The Cochrane Library
Date: 2013-09-30
No of results: 161
Cochrane reviews 4
Other reviews 1
Trials 156

ID	Search	Hits
#1	MeSH descriptor: [Orthodontics] explode all trees	1741
#2	orthodontic*:ti,ab,kw (Word variations have been searched)	1847
#3	#1 or #2	2445
#4	MeSH descriptor: [Orthodontic Retainers] explode all trees	48
#5	retainer* or retention or postretention:ti,ab,kw (Word variations have been searched)	6479
#6	#4 or #5	6479
#7	permanent or fixed or stabilis* or stabiliz* or bonded or stability or long-term or longterm:ti,ab,kw (Word variations have been searched)	57422
#8	**#3 and #6 and #7**	**161**

Database: CRD
Date: 2013-09-30
No of results: 10
DARE 9
NHS EED 1

Line	Search	Hits
1	MeSH DESCRIPTOR Orthodontics EXPLODE ALL TREES	106
2	(Orthodontic*)	138
3	#1 OR #2	159
4	MeSH DESCRIPTOR Orthodontic Retainers EXPLODE ALL TREES	3
5	(retainer* OR retention OR postretention)	478
6	#4 OR #5	478
7	(permanent OR fixed OR stabilis* OR stabiliz* OR bonded OR stability OR long-term OR longterm)	12090
8	**#3 AND #6 AND #7**	**10**

The web-sites of **SBU, Kunnskapssenteret** and **Sundhedsstyrelsen** were visited 2013-09-30. One reference which was commented on in the report was identified.

Reference lists
A comprehensive review of reference lists brought 14 new records

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Project: Retainers in orthodontic treatment

Appendix 2: Included studies - Design and patient characteristics.

Case-series were only used to record complications.

Author, Year, Country	Study Design	Follow-up period (years)	Study Groups; Intervention vs control	Patients (n)	Mean Age (years)	Men/women	Outcome variables
Bondemark, 2007	Systematic review	≥ 5 years	Various different	38 studies[1]	nr	nr	Treatment stability
Littlewood, 2006a	Systematic Review	> 3 months	Various different	5 studies n=442	nr	nr	Treatment stability Retainer failure
Edman Tynelius, 2013	RCT	2 years	Removable upper retainer and Fixed lower retainer Removable upper retainer and Stripping lower anterior teeth Removable upper and lower retainer (positioner)	25 25 25	14	30/45	Treatment stability Retainer failure
Årtun, 1997	RCT	3 years	Fixed retainer Removable retainer	35 14	nr	nr	Calculus Dental caries Gingivitis Incisor irregularity Loss of attachment Plaque Retainer failure

Project: Retainers in orthodontic treatment

Appendix 2: Included studies - Design and patient characteristics.

Case-series were only used to record complications.

Author, Year, Country	Study Design	Follow-up period (years)	Study Groups; Intervention vs control	Patients (n)	Mean Age (years)	Men/women	Outcome variables
Cerny, 2010	Cohort	> 15 years ≤ 2 years	Fixed retainer (mixed groups) Removable retainer	41 18	nr	nr	Treatment stability Alveolar bone level Calculus Dental caries Periodontitis (Gingival recession) Gingivitis Plaque Retainer failure
Levin, 2008	Cohort	4.6 years	Fixed retainer No retainer	48 arches 72 arches	21	46/46	Gingival pocket depth Gingival recession Gingivitis Plaque
Rody, 2011	Cohort	≥ 4 years	Fixed retainer Removable lower retainer No retainer	10 11 10	28 24 27	3/7 9/2 5/5	Gingivitis Gingival pocket depth Plaque
Årtun, 1984	Cohort	Approx. 1-9 years	Fixed 3-3 retainer No 3-3 retainer Fixed maxillary retainer Removable maxillary retainer	49 25 14 20	17-19 17 22 16	nr	Calculus Dental caries Gingivitis Periodontitis (Gingival pocket depth) Plaque

Project: Retainers in orthodontic treatment

Appendix 2: Included studies - Design and patient characteristics.

Case-series were only used to record complications.

Author, Year, Country	Study Design	Follow-up period (years)	Study Groups; Intervention vs control	Patients (n)	Mean Age (years)	Men/women	Outcome variables
Andrén, 1998	Case-series	≥ 5 years	Fixed retainer	103	35	22/81	Complications
Dahl, 1991	Case-series	3-6 years	Fixed retainer	142	nr	nr	Retainer failure
Renkema, 2011	Case-series	5 years	Fixed retainer	221	nr	146/75	Other complications Retainer failure
Störmann, 2002	Case-series	2 years	Fixed retainer	103	13-17		Patient discomfort Retainer failure
Tacken, 2010	Case-series[2]	2 years	Fixed retainer	184	14	90/94	Gingivitis Plaque Retainer failure

[1] Number of included patients, not reported.

[2] Cohort study, in this context considered as case-series regarding fixed retainer (control group without orthodontic treatment).

nr = not reported.

Project: Retainers in orthodontic treatment
Appendix 3: Excluded articles

Study (author, publication year)	Reason for exclusion
Al Yami *et al*., 1999	Stability after orthodontic treatment, published before year 2005.
Booth *et al*., 2008	Wrong comparison (time point when retainer was lost was not stated).
Danz *et al*., 2012	Wrong patient groups (data not extractable for different types of retainers).
Devreese *et al*., 2007	Wrong outcome (case-series, no complications reported).
Freitas *et al*., 2013	Wrong intervention and comparison (compares other interventions).
Johnsson *et al*., 2007	Wrong intervention and comparison (compares two clinics).
Kuijpers *et al*., 2009	Wrong outcome (studies occlusal wear).
Lagerström *et al*., 2011	Wrong comparison (time point when retainer was lost was not stated).
Lagravere *et al*., 2005	Wrong intervention (studies rapid maxillary expansion).
Lang *et al*., 2002	Stability after orthodontic treatment, published before year 2005.
Littlewood *et al*., 2006b	Same data as in Littlewood *et al*., 2006a.
Maia *et al*., 2010	Wrong outcome (case-series, no complications reported).
McNamara *et al*., 2003	Wrong intervention (studies rapid maxillary expansion vs. no orthodontics).
Millet *et al*., 2012	Wrong Intervention studied in systematic review.
Morton and Pancherz, 2009	Wrong outcome (case-series, no complications reported).

Project: Retainers in orthodontic treatment
Appendix 3: Excluded articles

Study (author, publication year)	Reason for exclusion
Myser *et al*., 2013	Case-series with too few patients (included 25 out of 66 eligible)
Renkema *et al*., 2008	Data not extractable.
Renkema et al., 2013a	Wrong outcome (case-series does not study complications)
Renkema et al., 2013b	Wrong intervention (does not study retainer).
Renkema *et al*., 2013c	Wrong intervention (does not study retainer).
Sari et al., 2009	Wrong intervention (too short follow-up)
SBU, 2005	Data presented in Bondemark *et al*., 2007
Tofeldt *et al*., 2007	Wrong intervention and comparison (compares two clinics).

Project: Retainers in orthodontic treatment
Appendix 4.1.1: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Treatment stability

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
Edman Tynelius, 2013	Sweden	RCT	n=75 Group 1 n=25 Group 2 n=25 Group 3 n=25	n=6	Maxilla Group 1 at 2 years: Δ LIl 0.5 (sd 0.8) Mandible Group 1 at 2 years: Δ LIl 0.6 (sd 0.7) Overjet Group 1 at 2 years: Δ -0.3 mm (sd 1.1)	Maxilla Group 2 at 2 years: Δ LIl 0.9 (sd 1.1) Group 3 at 2 years: Δ LIl 1.1 (sd 1.4) ns. Mandible Group 2 at 2 years: Δ LIl 0.9 (sd 0.8) Mandible Group 3 at 2 years: Δ LIl 1.6 (sd 1.4) p<0.001 between group 1 and 3 Overjet Group 2 at 2 years: Δ 0.5 mm (sd 1.1) Group 3 at 2 years: Δ 0.4 mm (sd 1.0) p< 0.05 between group 1 and 2	Little's Irregularity Index (LII)= the linear distance from anatomic contact point to adjacent anatomic contact point of mandibular anterior teeth (sum of five measurements) Group 1= upper removable retainer (vacuum formed) and lower fixed retainer. Group 2= upper removable retainer (vacuum formed) and lower stripping. Group 3= removable retainer upper and lower (positioner). Occlusal traits	?	+	+

Project: Retainers in orthodontic treatment
Appendix 4.1.1: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Treatment stability

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
					Overbite Group 1 at 2 years: Δ -0.4mm (sd 1.1)	Overbite Group 2 at 2 years: Δ 0.4mm (sd 0.9) Group 3 at 2 years: Δ 0.2mm (sd 1.3) ns.	Occlusal traits			
					Intercanine width maxilla Group 1 at 2 years: Δ -1.0 mm (sd 0.8)	Intercanine width maxilla Group 2 at 2 years: Δ -0.9 mm (sd 0.9) Intercanine width maxilla Group 3 at 2 years: Δ -1.8 mm (sd 1.5) p<0.01 group 1 & 2 vs. group 3	Occlusal traits			
					Intercanine width mandible Group 1 at 2 years: Δ 0.2 mm (sd 0.5)	Intercanine width mandible Group 2 at 2 years: Δ -1.0 mm (sd 1.0) Intercanine width mandible Group 3 at 2 years Δ -1.1 mm (sd 1.2) p<0.001 group 1 vs. group2 & 3	Occlusal traits Intermolar widths and arch lengths were statistically non-significant. between groups			

Project: Retainers in orthodontic treatment
Appendix 4.1.1: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Treatment stability

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
Årtun, 1997	USA	RCT	n=49 Group 1 n=11 Group 2 n=13 Group 3 n=11 Group 4 n=14	?*	Group 1 Baseline: 0.65 (se 0.24) At 3 years: 1.19 (se 0.27) Group 2 Baseline: 0.20 (se 0.08) At 3 years: 0.36 (se 0.12) Group 3 Baseline: 0.30 (se 0.16) At 3 years: 0.30 (se 0.16)	Group 4 Baseline: 0.36 (se 0.13) At 3 years: 0.66 (se 0.25) ns.	Little's Irregularity Index Group 1= Mandibular cuspid retainer .032 plain wire Group 2= Mandibular cuspid retainer .032 spiral wire Group 3= Mandibular 3-3 retainer .0205 flexible spiral wire Group 4= Removable lower retainer Cuspid retainer- bonded only to cuspids 3-3 retainer- bonded to each tooth Little's Irregularity Index= the linear distance from anatomic contact point to adjacent anatomic contact point of mandibular anterior teeth (sum of five measurements)	-	-	-

Project: Retainers in orthodontic treatment
Appendix 4.1.1: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Treatment stability

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
Cerny, 2010	UK	Cohort	n=61 Group 1 n=46 Group 2 n=43	?*	At 15 years follow up: No relapse: 89.0% Mild relapse: 11% Moderate relapse: 0.0% Severe relapse: 0.0% Totals: 26 mm Mean: 0.26mm	At 15 years follow up: No relapse: 7.0% p<0.001 Mild relapse: 40% p<0.001 Moderate relapse: 42% p<0.001 Severe relapse: 11% ns. Mean: 3.37 mm	Little's Irregularity Index Group 1= Permanent bonded retainer (PBR) (upper or lower). Group 2= Removable retainer (RR). Proportion individuals with relapse in the anterior teeth according to Little's Irregularity Index relapse category: No relapse: 0-1 mm Mild relapse: 1-3 mm Moderate relapse: 3-6 mm Severe relapse: (>6 mm) The retainers were used different times for different individuals, after treatment. The groups were analyzed according to retainer type used for each dental arch. Not for each individual. Smokers and those >50 years were excluded from analysis.	-	-	-

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 4.1.2: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Periodontal outcomes

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
Årtun, 1997	USA	RCT	n=49 Group 1: n=11 Group 2: n=13 Group 3: n=11 Group 4: n=14	?*	Group 1: 0.85mm (sd 0.55) Group 2: 0.63mm (sd 0.20) Group 3: 0.62mm (sd 0.25)	Group 4: 0.72mm (sd 0.33) ns.	Attachment loss (i.e. probing attachment level from cement-enamel junction to the bottom of the gingival pocket). Group 1= Mandibular cuspid retainer .032 plain wire. Group 2= Mandibular cuspid retainer .032 spiral wire. Group 3= Mandibular 3-3 retainer .0205 flexible spiral wire. Group 4= Removable lower retainer. Cuspid retainer- bonded only to cuspids. 3-3 retainer- bonded to each tooth.	-	-	-
Cerny, 2010	UK	Cohort	n=61 Group 1: n=46 Group 2: n=43	?*	No gingival recession Alveolar bone level Group 1: maxilla: Good or very good: 85% Group 1, mandible: Good or very good: 100%	No gingival recession Alveolar bone level Group 2, maxilla: Good or very good: 90% Group 2, mandible: Good or very good: 90% ns.	Gingival recession Alveolar bone level rating: Very good, good, fair, poor, very poor. Group 1= Permanent bonded retainer (PBR) (upper or lower). Group 2= Removable retainer (RR). Smokers and those >50 years were excluded from analysis.	-	-	-

Project: Retainers in orthodontic treatment
Appendix 4.1.2: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Periodontal outcomes

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
Rody, 2011	Canada	Cohort	n=31 Group 1: n=10 Group 2: n=11 (Group 3: n=10)	?*	Group 1 Incisor: 1.85 mm (sd 0.81) Premolar: 2.15 mm (sd 0.94)	Group 2 Incisor: 1.68 mm (sd 0.46) Premolar: 2.04 mm (sd 0.56) ns.	Probing depth Group 1= 3-3 fixed lower retainer Group 2= Removable lower retainer (Group 3= No retainer).	-	-	-
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n=18 Group 3: n=14 Group 4: n=20 (Group 5: n= 25)	?*	Group 3 1.87mm (sd 0.44)	Group 4 1.60mm (sd 0.31) p<0.05	Crevice depth Group 1= Mandibular cuspid retainer .032 spiral wire. Group 2= Mandibular cuspid retainer .032 plain wire. Group 3= Maxillary .0195 flexible spiral wire retainer. Group 4= Maxillary retainer plate. (Group 5=No retainer). Cuspid retainer = bonded only to cuspids. 3-3- retainer = bonded to each tooth.	-	-	-

* Withdrawals and drop-out not explicitly stated

Project: Retainers in orthodontic treatment
Appendix 4.1.3: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Dental caries

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control Removable retainer				
Årtun, 1997	USA	RCT	n=49 Group 1: n=11 Group 2: n=13 Group 3: n=11 Group 4: n=14	?*	No caries	No caries	Group 1= Mandibular cuspid retainer .032 plain wire Group 2= Mandibular cuspid retainer .032 spiral wire Group 3= Mandibular 3-3 retainer .0205 flexible spiral wire Group 4= Removable lower retainer Cuspid retainer- bonded only to cuspids. 3-3 retainer- bonded to each tooth	-	-	-
Cerny, 2010	UK	Cohort	n=61 Group 1: n=46 Group 2: n=43	?*	No caries	No caries	Group 1= Permanent bonded retainer (PBR) (upper or lower) Group 2= Removable retainer (RR) Smokers and those >50 years were excluded from analysis.	-	-	-
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n=18 Group 3: n=14 Group 4: n=20 (Group 5: n= 25)	?*	No caries	No caries	Group 1= Mandibular cuspid retainer .032 spiral wire. Group 2= Mandibular cuspid retainer .032 plain wire. Group 3= Maxillary .0195 flexible spiral wire retainer. Group 4= Maxillary retainer plate. (Group 5= No retainer). Cuspid retainer = bonded only to cuspids. 3-3- retainer = bonded to each tooth.	-	-	-

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 4.1.4: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Dental plaque

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control Removable retainer				
Årtun, 1997	USA	RCT	n=49 Group 1: n=11 Group 2: n=13 Group 3: n=11 Group 4: n=14	?*	Group 1 Baseline: 0.32 (se 0.20) At 3 years: 0.06 (se 0.02) Group 2 Baseline: 0.17 (se 0.08) At 3 years: 0.10 (se 0.03) Group 3 Baseline: 0.26 (se 0.2) At 3 years: 0.13 (se 0.07)	Group 4 Baseline: 0.31 (se 0.11) At 3 years: 0.13 (se 0.06) ns.	Plaque index Group 1= Mandibular cuspid retainer .032 plain wire. Group 2= Mandibular cuspid retainer .032 spiral wire. Group 3= Mandibular 3-3 retainer .0205 flexible spiral wire. Group 4= Removable lower retainer. Cuspid retainer- bonded only to cuspids. 3-3 retainer- bonded to each tooth.	-	-	-
Cerny, 2010	UK	Cohort	n=61 Group 1: n=46 Group 2: n=43	?*	Group 1 Mandibular lingual Good or very good 40%	Group 2 Mandibular lingual Good or very good 80% ns.	Group 1= Permanent bonded retainer (upper or lower). Group 2 = Removable retainer. Dental plaque accumulation rating: Very good, good, fair, poor, very poor. Smokers and those >50 years were excluded from analysis.	-	-	-
Rody, 2011	Canada	Cohort	n=31 Group 1: n=10 Group 2: n=11 (Group 3: n=10)	?*	Group 1, incisors: 60 % (sd 52) Group 1, premolars: 10 % (sd 31.6)	Group 2, incisors: 18.18% (sd 40) p<0.05 Group 2, premolars: 9.1% (sd 30) ns.	Group 1= 3-3 fixed lower retainer. Group 2= Removable lower retainer. (Group 3= No retainer). Proportion of tooth surfaces with dental plaque.	-	-	-

Project: Retainers in orthodontic treatment
Appendix 4.1.4: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Dental plaque

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control Removable retainer				
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n=18 Group 3: n=14 Group 4: n=20 (Group 5: n= 25)	?*	Gingival margin: Group 3 Interprox: 0.83 (sd 0.41) Lingual: 0.49 (sd 0.47) Gingivally along wire: Group 1 Lingual: 0.17 (sd 0.23) Group 2 Lingual: 0.32 (sd 0.29) p<0.05 Between group 1 and 2 Gingivally along wire Interproximal: Group 1 versus Group 2 ns. Incisally along wire: Group 1 versus Group 2 ns. Gingival margin: Group 1 versus Group 2 ns.	Gingival margin: Group 4 Interprox: 0.64 (sd 0.43) Lingual: 0.38 (sd 0.40) ns.	Group 1= Mandibular cuspid retainer .032 spiral wire. Group 2= Mandibular cuspid retainer .032 plain wire. Group 3= Maxillary .0195 flexible spiral wire retainer. Group 4= Maxillary retainer plate. (Group 5= No retainer). Cuspid retainer = bonded only to cuspids. 3-3- retainer = bonded to each tooth.	-	-	-

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 4.1.5: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Calculus

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control Removable retainer				
Årtun, 1997	USA	RCT	n=49 Group 1: n=11 Group 2: n=13 Group 3: n=11 Group 4: n=14	?*	Group 1 Baseline: 16.67 (se 8.03) At 3 years: 3.33 (se 2.22) Group 2 Baseline: 8.64 (se 4.45) At 3 years: 3.09 (se 3.09) Group 3 Baseline: 17.36 (se 6.84) At 3 years: 17.36 (se 8.87)	Group 4 Baseline: 9.52 (se 5.45) At 3 years: 8.33 (se 5.61) ns.	Calculus index Group 1= Mandibular cuspid retainer .032 plain wire. Group 2= Mandibular cuspid retainer .032 spiral wire. Group 3= Mandibular 3-3 retainer .0205 flexible spiral wire. Group 4= Removable lower retainer. Cuspid retainer- bonded only to cuspids. 3-3 retainer- bonded to each tooth.	-	-	-
Cerny, 2010	UK	Cohort	n=61 Group 1: n=46 Group 2: n=43	?*	Group 1 Mandible Good or very good: 80% Maxilla No calculus	Group 2 Mandible Good or very good: 100% ns. Maxilla No calculus	Calculus index Group 1= Permanent bonded retainer (PBR) (upper or lower). Group 2= Removable retainer (RR). Smokers and those >50 years were excluded from analysis.	-	-	-

Project: Retainers in orthodontic treatment
Appendix 4.1.5: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Calculus

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control Removable retainer				
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n=18 Group 3: n=14 Group 4: n=20 (Group 5: n= 25)	?*	<u>Gingivally along wire</u>: Group 1 Interproximal: 0.22 (sd 0.37) Lingual: 0.15 (sd 0.28) Group 2 Interproximal: 0.54 (sd 0.53) Lingual: 0.37 (sd 0.43) p<0.05 (group 1 vs. 2) <u>Incisally along wire</u>: Group 1 Interproximal: 0.07 (sd 0.21) Lingual: 0.06 (sd 0.18) Group 2 Interproximal: 0.05 (sd 0.12) Lingual: 0 (sd 0) ns. (group 1 vs. 2) <u>Gingival margin</u> Group 1		Presence of calculus at different locations (different calculus indices) Group 1= Mandibular cuspid retainer .032 spiral wire. Group 2= Mandibular cuspid retainer .032 plain wire. Group 3= Maxillary .0195 flexible spiral wire retainer. Group 4= Maxillary retainer plate (Group 5= No retainer). Cuspid retainer = bonded only to cuspids. 3-3- retainer = bonded to each tooth.	-	-	-

Project: Retainers in orthodontic treatment
Appendix 4.1.5: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Calculus

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control Removable retainer				
					Interproximal: 0.29 (sd 0.35) Lingual: 0.18 (sd 0.28) Group 2 Interproximal: 0.49 (sd 0.43) Lingual: 0.30 (sd 0.30) ns. (group 1 vs. 2) <u>Gingival margin</u>: Group 3 Interproximal: 0 (sd 0) Lingual: 0 (sd 0)	<u>Gingival margin</u>: Group 4 Interproximal: 0 (sd 0) Lingual: 0.01 (sd 0.04) ns. (group 3 vs. 4)				

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 4.1.6: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Gingivitis

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control Removable retainer				
Årtun, 1997	USA	RCT	n=49 Group1: n=11 Group 2: n=13 Group 3: n=11 Group 4: n=14	?*	Group 3 Baseline: 1.14 (se 0.07) At 3 years: 0.39 (se 0.15)	Group 4 Baseline: 1.08 (se 0.07) At 3 years: 0.77 (se 0.11) ns.	Gingivitis Group 1 = Mandibular cuspid retainer .032 plain wire. Group 2 = Mandibular cuspid retainer .032 spiral wire. Group 3 = Mandibular 3-3 retainer .0205 flexible spiral wire. Group 4 = Removable lower retainer. Cuspid retainer- bonded only to cuspids. 3-3 retainer- bonded to each tooth.	-	-	-
Cerny, 2010	UK	Cohort	n=61 Group 1: n=46 Group 2: n=43	?*	<u>Maxilla</u> Good or very good 100% <u>Mandible</u> Good or very good 80%	<u>Maxilla</u> Good or very good 100% <u>Mandible</u> Good or very good 95% ns.	Modified gingival index. Group 1 = Permanent bonded retainer (PBR), upper or lower. Group 2 = Removable retainer (RR). * Smokers and those >50 years were excluded from analysis.	-	-	-
Rody, 2011	Canada	Cohort	n=31 Group 1. n=10 Group 2. n=11 (Group 3: n=10)	?*	Group 1 Incisor: 30% (sd 48.3) Premolar: 20%(sd 42.16)	Group 2 Incisor: 0% Premolar: 18.18% (sd 40.45) ns.	Bleeding on probing BOP Group 1 = 3-3 fixed lower retainer. Group 2 = Removable lower retainer. (Group 3 = No retainer)	-	-	-

Project: Retainers in orthodontic treatment
Appendix 4.1.6: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Gingivitis

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control Removable retainer				
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n=18 Group 3: n=14 Group 4: n=20 (Group 5: n= 25)	?*	Group 1 GI Interproximal: 1.34 (sd 0.29) Lingual: 1.05 (sd 0.10) Group 2 GI Interproximal: 1.26 (sd 0.25) Lingual: 1.08 (sd 0.17) ns. (group 1 vs. 2) Group 3 GI: Interproximal: 1.20 (sd 0.23) Lingual: 1.04 (sd 0.13) Group 1 NBP interproximal: 0.75 (sd 0.28) Group 2 NBP interproximal: 0.67 (sd 0.27) ns. (group 1 vs. 2)	Group 4 GI: Interproximal: 1.23 (sd 0.23) Lingual: 1.05 (sd 0.13) ns. (group 3 vs. 4) Group 4	GI = Gingival index. NBP =Non bleeding papilla. Group 1= Mandibular cuspid retainer .032 spiral wire. Group 2= Mandibular cuspid retainer .032 plain wire. Group 3= Maxillary .0195 flexible spiral wire retainer Group 4= Maxillary retainer plate (Group 5= No retainer) Cuspid retainer = bonded only to cuspids. 3-3- retainer = bonded to each tooth.	-	-	-

Project: Retainers in orthodontic treatment
Appendix 4.1.6: PICO 1: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Gingivitis

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control Removable retainer				
					Group 3 NBP interproximal: 0.52 (sd 0.34)	NBP interproximal: 0.58 (sd 0.31) ns. (group 3 vs. 4)				

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 4.1.7: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Complications

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
Edman Tynelius, 2013	Sweden	RCT	n=75 Group 1: n=25 Group 2: n=25 Group 3: n=25	n=6	Failure During 24-months: Group 1 7/25 (28%) In 3 patients one failure. In 3 patients two failures. In 1 patient four failures.	Lost appliance During (24-months): Group 1 and 2 5/50 (10%) Group 3 0/25 (0%) p<0.01 (group 1 vs. 3) ns. (group 1 & 2 vs. 3)	Failure rate (retainer loosening) Lost appliance Group 1= upper removable retainer (vacuum formed) and lower fixed retainer. Group 2= upper removable retainer (vacuum formed) and lower stripping. Group 3= removable retainer upper and lower (positioner). p-values calculated from study data (Fisher's exact test).	?	+	+
Årtun, 1997	USA	RCT	n=49 Group 1 n=11 Group 2: n=13 Group 3: n=11 Group 4: n=14	?*	All fixed 8/35 (22.9%) Group 1: 1/11 (9.1%) Group 2: 4/13 (30.8%) Group 3: 3/11 (27.3%)	Group 4: 2/14 (14.3%) ns.	Failure rate Group 1= Mandibular cuspid retainer .032 plain wire. Group 2= Mandibular cuspid retainer .032 spiral wire. Group 3= Mandibular 3-3 retainer .0205 flexible spiral wire. Group 4= Removable lower retainer. Cuspid retainer- bonded only to cuspids. 3-3 retainer- bonded to each tooth	-	?	-/?

Project: Retainers in orthodontic treatment
Appendix 4.1.7: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Complications

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
Cerny, 2010	UK	Cohort	n=61 Group 1: n=46 Group 2: n=43	?*	<u>Clinical examination</u> 6/46 (13%) patients with: 3 bond failures, 5 broken wires <u>Anamnesis (recall)</u> PBR fracture rate: 3.15%/year. Bond/wire fracture rate: 0.58%/year	-	Failure rate (loosening or broken retainer). Group 1 = Permanent bonded retainer (PBR) (upper or lower). Group 2 = Removable retainer (RR).	-	-	-
Andrén, 1998	Sweden	Case-series	n=103	n=11	<u>Loosening</u> Maxilla: 25/67 (37%) retainers Mandible: 18/52 (35%) retainers <u>Wire fracture</u> Maxilla: 11 occasions Mandible: 1 occasion	-	Failure rate (loosening or wire fracture). Bonded lingual retainers maxilla and/or mandible (during 5 years of observation) 16 both arches, 41 maxillary retainers, 36 mandibular retainers.			

Project: Retainers in orthodontic treatment
Appendix 4.1.7: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Complications

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
Dahl, 1991	Sweden	Case-series	n=153 Group 1: n=81 Group 2: n=72	n=11 (Group 1)	<u>Loosening (n=retainers)</u> Group 1 Maxilla: 14/56 (25.0%) Mandible: 3/29 (10.3%) Group 2 Maxilla: 5/64 (7.8%) Mandible: 1/17 (5.9%) <u>Wire fracture (n=retainers)</u> Group 1 Maxilla: 13/56 (23.2%) Mandible: 3/29 (10.3%) Group 2 Maxilla: 2/64 (3.1%) Mandible: 0/17 (0.0%) <u>Opening of small spaces</u> Group 1 and 2: In 7 patients with retainer loosening In 4 patients with intact retainers	-	Failure rate (loosening or wire fracture). Other side effects. Group 1 = Lingual bonded retainers (.0195'' or .0215'' three-stranded spiral wire). (45 maxillary retainers, 14 mandibular retainers, 15 both arches). Group 2 = Lingual bonded retainers (.0215 five-stranded spiral wire). (55 maxillary retainers, 8 mandibular retainers, 9 both arches). Mean period between orthodontic treatment and examination was 4.57±2.2 years Small spaces = 0.5-1mm openings between teeth within the retained segments			

Project: Retainers in orthodontic treatment
Appendix 4.1.7: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Complications

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
Renkema, 2011	Netherlands	Case-series	n=221	n=0	At least one bonding failure 70/221 (31.7%) Less failures in incisors than canines p<0.001 Central vs. lateral incisors ns.	-	Failure rate Bonded lingual mandibular retainer (.0195'' 3-strand, heat-treated twist wire). Observation period 5 years			
Störmann, 2002	Germany	Case-series	n=103 Group 1: n=31 Group 2: n=38 Group 3: n=34	n=5	Failure (% retainers) Group 1: 29% Group 2: 53% Group 3: 18% Increased patient discomfort with cuspid retainer	-	Failure rate Group 1 = Bonded retainer .0195''. Group 2 = Bonded retainer .0215''. Group 3 = Cuspid retainer. Cuspid retainer= bonded only to cuspids.			
Tacken, 2010	Belgium	Case-series	n=275 Group 1: n=45 Group 2 n=48 Group 3 n=91 Group 4: n= 90	n=15	Success rate (n=retainers) Group 1 and 2: (92/186) 49% Group 3 161/182 (88%) p<0.001 <u>Failure</u> Group 1 and 2: Maxilla: Broken retainer 37/48 (77%) of all failures	-	Success rate Failure (loosening or broken retainer) Group 1 = Glass fiber reinforced bonded retainer 500 fibres. Group 2 = Glass fiber reinforced bonded retainer 1000 fibers. Group 3 = Multi-stranded bonded retainer. Group 4 = No retainer no treatment.	-	-	-

Project: Retainers in orthodontic treatment
Appendix 4.1.7: Fixed orthodontic retainer vs. removable retainer
Outcome variable: Complications

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision *
					Intervention Fixed retainer	Control Removable retainer				
					Mandible: Loosening 34/46 (74%) of all failures Group 3 Maxilla: Loosening 10/13 (77%) of all failures. Mandible: Loosening 8/8 (100%) of all failures.					

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment

Appendix 4.2.1: PICO 2: Fixed orthodontic retainer vs. no retainer

Outcome variable: Periodontal outcomes

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control No retainer				
Levin, 2008	Israel	Cohort	n=92 Group 1: n=48 dental arches Group 2: n=72 dental arches	n=0	Group 1 GR lingual 0.09 mm (sd 0.18) GR labial: 0.14 mm (sd 0.24) PD 1.88 mm (sd 0.24)	Group 2 GR lingual 0.01 mm (sd 0.08) p=0.005 GR labial: 0.13 mm (sd 0.29) ns. PD 1.87 mm (sd 0.23) ns.	Gingival recession (GR). Probing depth (PD). Group 1 = One or two fixed retainers. Group 2 = No fixed retainer.	-	-	-
Rody, 2011	Canada	Cohort	n=31 Group 1. n=10 Group 2. n=11** Group 3: n=10	?*	Group 1 Incisors: Mean: 1.85 mm (sd 0.81) Premolars: Mean: 2.15 mm (sd 0.94)	Group 3 Incisors: Mean: 1.7 mm (sd 0.63) ns. Premolars: Mean: 2.05 mm (sd 0.59) ns.	Probing depths. Group 1 = 3-3 fixed lower retainer. Group 2 = Removable lower retainer. Group 3 = No retainer.	-	-	-
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n=18 Grpoup 3: n=14 (Group 4: n=20) Group 5: n= 25	?*	Groups 1 and 2 Interproximal Mean: 1.46 (sd 0.30) Lingual Mean: 1.07 (sd 0.15)	Group 5 Interproximal Mean: 1.42 (sd 0.32) ns. Lingual Mean: 1.11 (sd 0.16) ns.	Crevice depth Group 1 = Mandibular cuspid retainer .032 spiral wire. Group 2 = Mandibular cuspid retainer .032 plain wire Group 3 = Maxillary .0195 flexible spiral wire retainer. (Group 4 = Maxillary retainer plate). Group 5 = No retainer. Cuspid retainer = bonded only to cuspids. 3-3- retainer = bonded to each tooth.	-	-	-

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 4.2.2: PICO 2: Fixed orthodontic retainer vs. no retainer
Outcome variable: Dental caries

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control No retainer				
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n=18 Group 3: n=14 (Group 4: n=20) Group 5: n= 25	?*	No caries	No caries	Dental caries on lingual surfaces Group 1 = Mandibular cuspid retainer .032 spiral wire. Group 2 = Mandibular cuspid retainer .032 plain wire. Group 3 = Maxillary .0195 flexible spiral wire. (Group 4 = Maxillary retainer plate). Group 5 = No retainer. Cuspid retainer = bonded only to cuspids. 3-3- retainer = bonded to each tooth.	-	-	-

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 4.2.3: PICO 2: Fixed orthodontic retainer vs. no retainer
Outcome variable: Dental plaque

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Results		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control No retainer				
Levin, 2008	Israel	Cohort	n=92 Group 1: n=48 dental arches Group 2: n=72 dental arches	n=0	Group 1 Lingual 82.4%	Group 2 Lingual 51.6% p<0.0001, between groups	Group 1 = One or two fixed retainers. Group 2 = No retainer.	-	-	-
Rody, 2011	Canada	Cohort	n=31 Group 1: n=10 (Group 2: n=11) Group 3: n=10	?*	Group 1 Incisors: 60% (sd 51.6) Premolars: 10% (sd 31.6)	Group 3 Incisors: 10% (sd 31.6) p=0.03, between groups Premolars: 0% (sd 0) ns. between groups	Group 1 = 3-3 fixed lower retainer. (Group 2 = Removable lower retainer). Group 3 = No retainer.	-	-	-
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n=18 Group 3: n=14 (Group 4: n=20) Group 5: n= 25	?*	Group 1 and Group 2 Interproximal Mean: 0.94 (sd 0.57) Lingual Mean: 0.59 (sd 0.48) Group 3 Interproximal Mean: 0.20 (sd 0.25) Lingual Mean: 0 (sd 0)	Group 5 Interproximal Mean: 1.12 (sd 0.59) ns. between groups Lingual Mean: 0.62 (sd 0.48) ns. between groups Group 3 was not compared to group 5	Plaque along the gingival margin Group 1 = Mandibular cuspid retainer .032 spiral wire. Group 2 = Mandibular cuspid retainer .032 plain wire. Group 3 = Maxillary .0195 flexible spiral wire retainer. (Group 4 = Maxillary retainer plate). Group 5 = No retainer Cuspid retainer = bonded only to cuspids 3-3- retainer = bonded to each tooth.	-	-	-

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 4.2.4: PICO 2: Fixed orthodontic retainer vs. no retainer
Outcome variable: Calculus

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control No retainer				
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n=18 Group 3: n=14 (Group 4: n=20) Group 5: n= 25	?*	Groups 1 and 2 Interproximal: Mean: 0.37 (sd 0.39) Lingual: Mean: 0.22 (sd 0.29)	Group 5 Interproximal: Mean: 0.38 (sd 0.36) ns. Lingual: Mean: 0.14 (sd 0.20) ns.	Group 1= Mandibular cuspid retainer .032 spiral wire. Group 2= Mandibular cuspid retainer .032 plain wire. Group 3= Maxillary .0195 flexible spiral wire retainer. (Group 4= Maxillary retainer plate). Group 5= No retainer. Cuspid retainer = bonded only to cuspids. 3-3- retainer = bonded to each tooth.	-	-	-

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 4.2.5: PICO 2: Fixed orthodontic retainer vs. no retainer
Outcome variable: Gingivitis

* + No problem
? Some problems
- Major problems

Author, year	Country	Study design	Number of patients (n)	With drawals - dropouts	Result		Comments	Directness*	Study limitations*	Precision*
					Intervention Fixed retainer	Control No retainer				
Levin, 2008	Israel	Cohort	n= 92 Group1: n= 48 Group 2: n= 72	n=0	Group 1 Lingual: 53.9%	Group 2 Lingual: 37.8% p<0.012	Bleeding on probing Group 1= One or two fixed retainers Group 2= No retainer	-	-	-
Rody, 2011	Canada	Cohort	n=31 Group 1: n= 10 (Group 2: n= 11) Group 3: n= 10	?*	Group 1 Incisor: 30% (sd 48.3) Premolar: 20% (sd 42.16)	Group 3 Incisor: 20% (sd 42.16) ns. Premolar: 20% (sd 42.16) ns.	Bleeding on probing Group 1= 3-3 fixed lower retainer. (Group 2= Removable lower retainer). Group 3= No retainer.	-	-	-
Årtun, 1984	Norway	Cohort	n=108 Group 1: n= 31 Group 2: n= 18 Group 3: n= 14 (Group 4: n= 20) Group 5: n= 25	?*	Groups 1 and 2 GI Lingual: Mean: 1.06 (sd 0.13) GI Interproximal: Mean: 1.31 (sd 0.28) NBP Interproximal: Mean: 0.63 (sd 0.27)	Group 5 GI Lingual: Mean: 1.13 (sd 0.15) p<0.05 GI Interproximal: Mean: 1.35 (sd 0.27) ns. NBP Interproximal: Mean: 0.68 (sd 0.23) ns.	Gingival index (GI) Non bleeding papilla (NBP) Group 1= Mandibular cuspid retainer .032 spiral wire. Group 2= Mandibular cuspid retainer .032 plain wire. Group 3= Maxillary .0195 flexible spiral wire retainer. (Group 4= Maxillary retainer plate). Group 5= No retainer. Cuspid retainer = bonded only to cuspids 3-3- retainer = bonded to each tooth.	-	-	-

* Withdrawals and drop-outs not explicitly stated.

Project: Retainers in orthodontic treatment
Appendix 5 - Summary of Findings

Outcome variable Number of studies	Design	Study limitations	Consistency	Directness	Precision	Publication bias	Magnitude of effect	Absolute effect	Quality of evidence GRADE
PICO 1: Fixed retainer (I) versus removable retainer (C)									
Treatment stability 3	2 RCT 1 Cohort	Some limitations (?)[1]	No inconsistency	Serious indirectness (-1)[2]	Some imprecision (?)[3]	Unlikely	Not relevant	I= Δ LII: 0.6 [8] C=Δ LII: 1.6	⊕⊕◯◯
Periodontal outcomes 4	1 RCT 3 Cohort	Serious limitations (-1)[1]	No inconsistency	Serious indirectness (-1)[4]	Serious imprecision (-1)[3]	Unlikely	Not relevant	Not applicable[9]	⊕◯◯◯
Dental Caries 3	1 RCT 2 Cohort	Serious limitations (-1)[1]	No inconsistency	Serious indirectness (-1)[4]	Serious imprecision (-1)[3]	Unlikely	Not relevant	I=0 C=0	⊕◯◯◯
Dental plaque 4	1 RCT 3 Cohort	Serious limitations (-1)[1]	No inconsistency	Serious indirectness (-1)[2]	Serious imprecision (-1)[3]	Unlikely	Not relevant	Not applicable[9]	⊕◯◯◯
Calculus 3	1 RCT 2 Cohort	Serious limitations (-1)[1]	No inconsistency	Serious indirectness (-1)[4]	Serious imprecision (-1)[3]	Unlikely	Not relevant	Not applicable[9]	⊕◯◯◯

Project: Retainers in orthodontic treatment
Appendix 5 - Summary of Findings

Outcome variable Number of studies	Design	Study limitations	Consistency	Directness	Precision	Publication bias	Magnitude of effect	Absolute effect	Quality of evidence GRADE
Gingivitis 4	1 RCT 3 Cohort	Serious limitations (-1)[1]	No inconsistency	Serious indirectness (-1)[4]	Serious imprecision (-1)[3]	Unlikely	Not relevant	Not applicable[9]	⊕◯◯◯

High quality of evidence = ⊕⊕⊕⊕
Moderate quality of evidence = ⊕⊕⊕◯
Low quality of evidence = ⊕⊕◯◯
Very low quality of evidence = ⊕◯◯◯

Footnotes:
1. Limitations in randomization procedure, and no blinding.
2. Study population strictly defined in one RCT, and undefined patient characteristics in the other RCT.
3. Small groups in some studies, and no 95%CI presented.
4. Patient characteristics not clearly described.
5. Unclear patient selection. No blinding.
6. Patients from a different setting.
7. No CI 95% presented.
8. Data from Edman Tynelius *et al*., 2013. LII=Little's irregularity index.
9. No pooled effect estimates, due to different outcomes across the studies.

Project: Retainers in orthodontic treatment
Appendix 5 - Summary of Findings

Outcome variable Number of studies	Design	Study limitations	Consistency	Directness	Precision	Publication bias	Magnitude of effect	Absolute effect	Quality of evidence GRADE
PICO 2: Fixed retainer versus no retainer									
Periodontal outcomes 3	3 Cohort	Serious limitations (-1)[5]	No inconsistency	Serious indirectness (-1)[4]	Serious imprecision (-1)[3]	Unlikely	Not relevant	Not applicable[9]	⊕◯◯◯
Dental Caries 1	1 Cohort	Serious limitations (-1)[5]	No inconsistency	Serious indirectness (-1)[4]	Serious imprecision (-1)[7]	Unlikely	Not relevant	I=0 C=0	⊕◯◯◯
Dental plaque 3	3 Cohort	Serious limitations (-1)[5]	No inconsistency	Serious indirectness (-1)[6]	Serious imprecision (-1)[3]	Unlikely	Large effect (+1)	Not applicable[9]	⊕◯◯◯
Calculus 1	1 Cohort	Serious limitations (-1)[5]	No inconsistency	Serious indirectness (-1)[4]	Serious imprecision (-1)[7]	Unlikely	Not relevant	Lingual: I=0.22 C=0.14	⊕◯◯◯
Gingivitis 3	3 Cohort	Serious limitations (-1)[5]	No inconsistency	Serious indirectness (-1)[4]	Serious imprecision (-1)[7]	Unlikely	Not relevant	Not applicable[9]	⊕◯◯◯

Project: Retainers in orthodontic treatment
Appendix 5 - Summary of Findings

Outcome variable Number of studies	Design	Study limitations	Consistency	Directness	Precision	Publication bias	Magnitude of effect	Absolute effect	Quality of evidence GRADE

High quality of evidence = ⊕⊕⊕⊕
Moderate quality of evidence = ⊕⊕⊕◯
Low quality of evidence = ⊕⊕◯◯
Very low quality of evidence = ⊕◯◯◯

Footnotes:
1. Limitations in randomization procedure, and no blinding.
2. Study population strictly defined in one RCT, and undefined patient characteristics in the other RCT.
3. Small groups in some studies, and no 95%CI presented.
4. Patient characteristics not clearly described.
5. Unclear patient selection. No blinding.
6. Patients from a different setting.
7. No CI 95% presented.
8. Data from Edman Tynelius *et al*., 2013. LII=Little's irregularity index.
9. No pooled effect estimates, due to different outcomes across the studies.

Project: Retainers in orthodontic treatment

Appendix 6 – Ethical analysis

Question	Answer/ comment
1. From the patient's perspective, how does an orthodontic retainer affect the patient's quality of life and life expectancy?	Patients treated for a malocclusion are quite aware of the treatment outcome, especially if the effect involves alignment of anterior teeth. These esthetic improvements are important for most patients and the retainer promotes a stability of the treatment result.
2. How severe is the patient's need that the orthodontic retainer must meet?	A major relapse in the front is often considered as an unsuccessful treatment and may result in a re-treatment.
3. Does an orthodontic retainer have any influence on how others view the patient (concerning humanity and human dignity), or on how the patient views himself or herself (concerning humanity and human dignity)?	No.
4. Can an orthodontic retainer affect the patient's ability and possibility to be independent?	Probably not.
5. If implemented, does an orthodontic retainer require any special steps to not compromise the patient's autonomy?	No.
6. How does an orthodontic retainer affect the patient's physical, moral and personal integrity?	No effect.
7. Is an orthodontic retainer cost-effective?	Yes in most cases the retainer is cost-effective in relation to the treatment length with fixed appliance. However, failure /fracture of the retainer in some patients can be expensive.
8. How does an orthodontic retainer affect resources?	If an increasing number of patients have the retainers indefinitely the cost for check-up of retainers and repair of fractured/lost retainers will increase. This will probably affect the dental care resources.
9. Is an orthodontic retainer in conflict with professional values?	No.
10. Does an orthodontic retainer change the role of the professional in relation to the patient?	No.

11. Does an orthodontic retainer affect, or does it put any new demands on, a third party?	The dentists in public dental care service or private practitioners will have more patients with retainers and subsequently have higher demands for taking care of the check-ups and repair of these.
12. Is there any legislation of relevance with regard to an orthodontic retainer?	No.
13. Is there any risk of conflict between the procedure of an orthodontic retainer and values of the society, or values of different groups?	No.
14. Is there a risk that an introduction of an orthodontic retainer will cause a conflict with particular interests?	No.
15. Can an introduction of an orthodontic retainer influence the trust of the health care system?	Probably not, it is already commonly used.
Conclusions	There are no major ethical concerns related to orthodontic retainers. Patients are often aware of the treatment outcome, particularly regarding the anterior teeth. Esthetic improvements are important for most patients and the retainer is considered to promote the treatment stability. If an increasing number of patients have the retainers indefinitely the cost for check-ups of retainers and frequent repairs will increase, and may lead to displacement of other patient groups.

Region Västra Götaland, HTA-centrum

Health Technology Assessment
Regional activity-based HTA

HTA

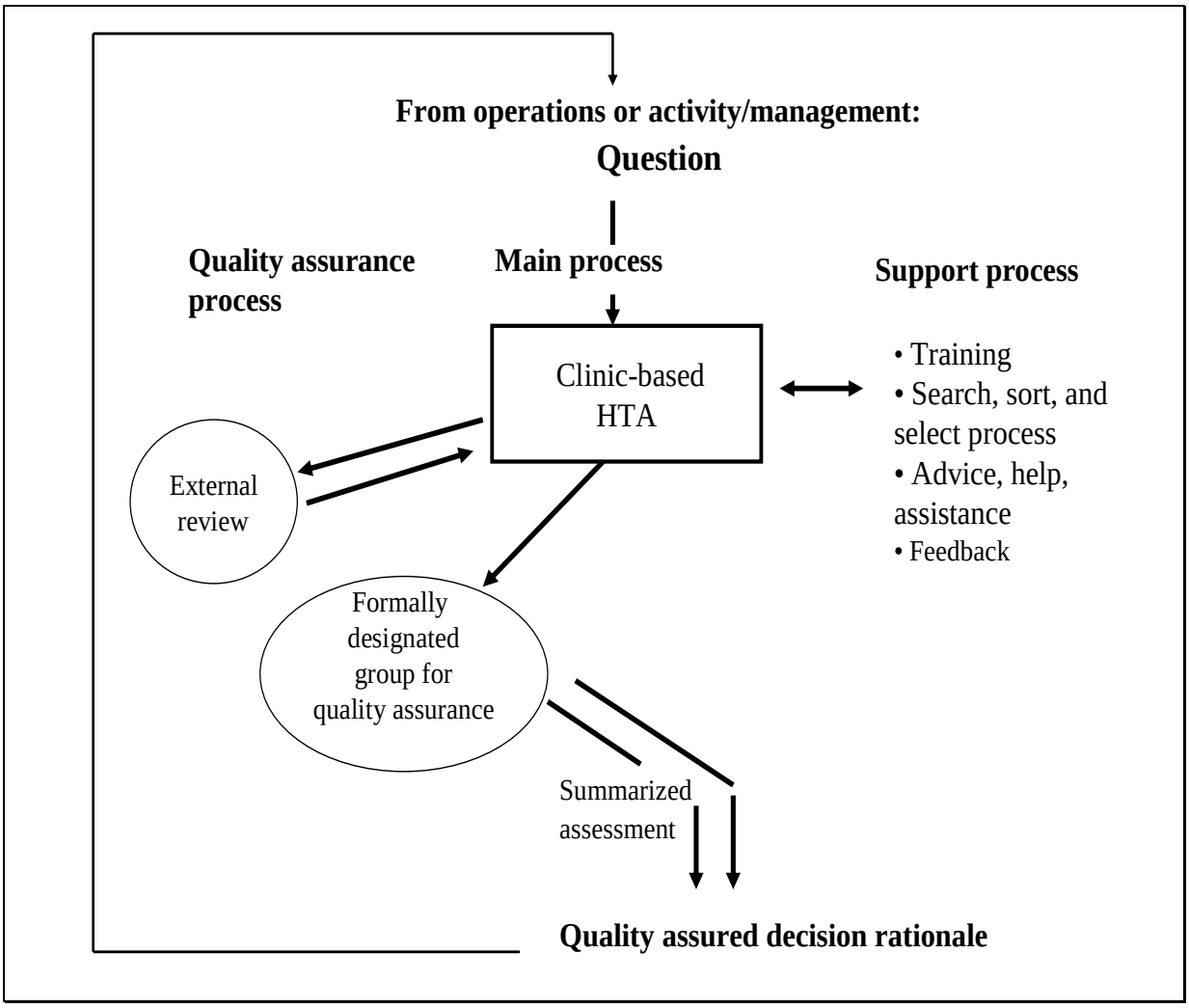
Health technology assessment (HTA) is the systematic evaluation of properties, effects, and/or impacts of health care technologies, i.e. interventions that may be used to promote health, to prevent, diagnose or treat disease or for rehabilitation or long-term care. It may address the direct, intended consequences of technologies as well as their indirect, unintended consequences. Its main purpose is to inform technology-related policymaking in health care.

To evaluate the quality of evidence the Centre of Health Technology Assessment in Region Västra Götaland is currently using the GRADE system, which has been developed by a widely representative group of international guideline developers. According to GRADE the level of evidence is graded in four categories:

High quality of evidence	= (GRADE⊕⊕⊕⊕)
Moderate quality of evidence	= (GRADE ⊕⊕⊕O)
Low quality of evidence	= (GRADE ⊕⊕OO)
Very low quality of evidence	= (GRADE ⊕OOO)

In GRADE there is also a system to rate the strength of recommendation of a technology as either “strong” or “weak”. This is presently not used by the Centre of Health Technology Assessment in Region Västra Götaland. However, the assessments still offer some guidance to decision makers in the health care system. If the level of evidence of a positive effect of a technology is of high or moderate quality it most probably qualifies to be used in routine medical care. If the level of evidence is of low quality the use of the technology may be motivated provided there is an acceptable balance between benefits and risks, cost-effectiveness and ethical considerations. Promising technologies, but a very low quality of evidence, motivate further research but should not be used in everyday routine clinical work.

Christina Bergh, Professor, MD.
Head of HTA-centrum


From operations or activity/management:
Question
Quality assurance process
Main process
Support process
Clinic-based HTA
• Training
• Search, sort, and select process
• Advice, help, assistance
• Feedback
External review
Formally designated group for quality assurance
Summarized assessment
Quality assured decision rationale

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