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What is the truth behind the smile?

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What is the truth behind the smile?

There are a number of controversies that surround orthodontics and orthodontic treatment and this article aims to discuss the current thinking and evidence base. The topics that will be discussed in turn are:

Short term orthodontics – why isn't all treatment short term?

Appliances - What's in a name?

Can modern appliances make the teeth move faster?

Can we make the jaws grow?

Extraction vs. non-extraction treatment – does it affect the outcome?

Canine guidance- has it gone to the dogs?

Lower incisor position – so what?

TMD and orthodontics – cause or cure?

Short term orthodontics – why isn't all treatment short term?

In recent years, there has been a marketing drive which offers patients short-term orthodontic treatment, but what is meant by this and how does it differ from any other form of orthodontic treatment? The first and most obvious difference is the supposed length of the treatment. Short-term treatments are promoted with a promise that treatment will be completed within 6 to 8 months, using either full arch or sectional fixed appliances on the upper/lower anterior teeth. This short active treatment duration is attractive to patients and potentially lucrative for the practitioner. It is known that the average length of a course of orthodontic treatment with full upper and lower fixed appliances is typically around 18- 24 months, but it is also known that there are huge time variations. For example, a large study by Vig *et al.* 1998[1], which assessed 998 patients presenting with differing severities of malocclusion, reported treatment durations of 24.0 ± 11.2 months and 29.4 ± 11.3 months, for extraction and non-extraction cases respectively. Therefore comprehensive treatment in some cases took just 13 months to complete whilst others took up to 40 months.

What therefore is the likely explanation for the difference in treatment lengths between what is marketed as short term orthodontics and more conventional treatment with fixed

appliances? The answer is most probably limited treatment objectives and possibly a compromised treatment result as a consequence. Limited treatment objectives and shorter treatment times are often perfectly acceptable provided a proper orthodontic diagnosis is performed, all of the treatment options are determined and fully explained to the patient. In the absence of a proper orthodontic diagnosis, short-term treatments can be accompanied by risks for both the patient and the less experienced practitioner. The most immediate of these risks is a dissatisfied patient. But why might this occur? Whether one arch is treated in isolation, or both arches are treated simultaneously, without a full orthodontic diagnosis, there is a risk that teeth may be moved into a position of instability and/or a poor aesthetic result created. This might include increasing or decreasing the overjet, inappropriately expanding the arches to avoid extractions in cases of crowding and creating poor anteroposterior and transverse occlusal relationships. This is likely if the treatment aims are to merely align the anterior teeth, whilst ignoring other factors such as skeletal relationships, soft tissue form and function, crowding/spacing and occlusal relationships.

As part of informed consent, patients should be made fully aware of the different treatment options available to them, the risks and benefits involved with each option, including an estimate of the treatment length[2,3] and presented in a way in which they can understand[4]. Without this, the practitioner risks litigation if the patient's expectations are not managed appropriately. Mitigating this risk undoubtedly starts with a full orthodontic assessment, leading to an orthodontic diagnosis and determination of the appropriate treatment options. The assessment should include extra-oral skeletal and soft tissue relationships, followed by an intra-oral assessment of tooth positions and occlusal and soft tissue relationships. Finally, special investigations are performed such as extra-oral and intra-oral radiography, often entailing a cephalometric assessment. This exercise in data collection will enable the practitioner to populate the problem list, determine the appropriate aims of treatment and itemise the various treatment options for the patient. These options might include no treatment, a shorter treatment duration accepting some compromise, right through to more complex treatments utilising various appliances and other dental and surgical disciplines. It is important the consenting/treating practitioner is aware that if they delegate this treatment planning process to a third party, such as a dental company or

laboratory, the liability still resides with the practitioner if treatment is ineffective and the patient's expectations are not met[5].

The average length of a course of orthodontic treatment is 18-24 months, but the important point to note is that this is just an average. The concept of short courses of treatment is not new. What is new is the marketing of treatment in which the principal commodity is seen as time to completion rather than the treatment outcome.

Appliances - What's in a name?

The naming of appliances and procedures is not unique to orthodontics and is particularly useful in aiding identification and communication, and also identifying the actions an appliance might perform. An example of the latter is the ELSAA, or the Expansion and Labial Segment Alignment Appliance[6] (**Figure 1**), which is used, as implied, for expansion and labial segment alignment. Sometimes appliances are named after the inventor/developer and examples include the Andreasen[7], the Harvold[8] and the Clark Twin Block appliances[9] (**Figure 2**). These are all functional appliances and the principal modes of action are the same in each case. Occasionally appliances are introduced which may take on an almost mystical air and assuming the mantle of a particular type of treatment or tooth movement. Often this is not the case and the tooth movements employed are nothing new. A recent and successful example is the Inman aligner. Similar to the ELSAA, it is an upper removable appliance with a palatal spring that used to procline the upper labial segment teeth against a labial bow. The principal difference is the use of Nickel Titanium rather than stainless steel springs.

Understanding the individual components of an appliance, how they work and any associated limitations, may be more important than simply using a particular eponymous appliance. The ability to compare and explain alternative approaches is also useful since individual patients will have different priorities and needs, which may favour the selection of one appliance over another.

Can modern appliances make the teeth move faster?

In recent years, self-ligating brackets have been heavily promoted as an alternative to more conventional fixed appliance brackets (**Figure 3**). Self-ligating brackets use a metal clip to

close the archwire slot rather than relying on an elastomeric ligature, and, as a result, are purported to have a number of clinical advantages over conventional brackets. These include less friction between the bracket and the arch wire, improved infection control procedures, faster tooth movement, shorter overall treatment times, fewer treatment visits and shorter appointment times[10]**.** However, more recently there have been a number of well executed randomised clinical trials aimed at studying these supposed advantages, including any potential differences between the two main types of self-ligating brackets, namely passive (*e.g.* Damon or SmartClip, in which the wire sits loosely within the bracket slot) and active (*e.g*. In-Ovation or Speed systems, in which the wire is actively pushed into the base of the bracket slot when the wire is of a certain diameter) self-ligating brackets.

In an assessment of overall treatment duration and the number of visits, a prospective study of 61 patients, treated with either the SmartClip self-ligating bracket or a conventional bracket, found no statistically significant difference in treatment parameters[11]. There was also no difference in treatment outcome when measured using the PAR index. However, is tooth movement faster with any particular type of bracket? A larger prospective randomised trial comparing an active self-ligating bracket (Damon®), a passive self-ligating bracket (In-Ovation®) and a conventional bracket (Ovation®) found that time to initial alignment was significantly faster in the case of the conventional bracket and there was no difference in the rate of extraction space closure between any of the bracket types[12].

It would seem therefore that irrespective of bracket type the teeth will still only move at the same biological rate, but is there anything else that can be used to promote faster tooth movement? Vibrational occlusal appliances such as AcceleDent™ (OrthoAccel Technologies Inc) have been suggested as a means of promoting faster tooth movement by stimulating faster bone remodelling. A recently published RCT found little evidence that vibration has any adjunctive clinical effect on the rate of tooth movement[13]. The same study showed that the initial irregularity of the teeth was the most important influence upon the speed for initial and overall alignment.

Despite the appeal of making teeth move faster and hence reducing the overall duration of treatment, it would appear that teeth move at the same pace, no matter which bracket is

used. It may be in the long term that other approaches, such as chemically altering the biological composition of the bone or increasing the turnover of collagen in the periodontal membrane could lead to faster tooth movement, but this could result in increased concerns regarding stability after the tooth is in its corrected position.

Can we make the jaws grow?

In the case of patients in which a skeletal discrepancy is considered to be contributing to the malocclusion, a commonly applied orthopaedic treatment is "growth modification" using functional appliances. This is likely in cases of a Class II skeletal pattern in growing individuals. Three possible modes of action of a functional appliance have been proposed, namely, dentoalveolar effects, skeletal effects and soft tissue effects[14]. In the case of a Class II functional appliance the dentoaveolar effects can include:

- Palatal tipping of the upper incisors
- Proclination of the lower incisors
- Arch expansion
- Distal movement of the upper buccal segment teeth
- Mesial movement of the lower buccal segment teeth
- Eruption of the lower buccal segments
- Reduced eruption of the lower incisors

In this way, an excessive overbite and overjet can be reduced and the molar relationship corrected, both antero-posteriorly and transversely.

However, what are the skeletal effects of "growth modification", if any? It has been suggested that functional appliance effects may be threefold and involve:

- Encouraging growth of the mandible to create a larger mandible, whilst simultaneously restraining maxillary growth
- Altering the direction of growth of the jaws [15]
- Accelerating mandibular growth at the time the appliance is worn, but in an overall sense, there is little change in the amount of growth[16].

Functional appliances might also affect the surrounding soft tissues and produce tooth movement and additional bone growth. This particular theory revolves around a specific type of functional appliance known as the Fränkel appliance or Function Regulator, of which there are a number of variants. This appliance incorporating acrylic shields and labial pelottes (lip pads) (**Figure 4**) is thought to have two actions. Firstly, to encourage retraining of the soft tissues, so that the teeth move to desired positions under their influence and, secondly, the teeth are able to move to improved positions as a result of the new bone theoretically deposited by acrylic tissue effects caused by the appliance. The acrylic shields and pelottes are designed to stretch the buccal mucosa, which in turn is thought to place tension on the underlying periosteum and encourage buccal bone to be deposited[17,18] .

Of these three proposed modes of action of functional appliances, what actually happens? O'Brien *et al.* (2003)[19] examined the dental and skeletal effects of early functional appliance therapy in the correction of Class II division 1 incisor relationships. This RCT found that most of the observed overjet and molar correction was due to dentoaveolar effects. Although there was a skeletal effect that was statistically significant, it was small and the clinical significance was deemed to be questionable. The findings supported those of an earlier prospective trial by Tulloch *et al.* (1998)[20]. A systematic review of the mandibular changes produced by functional appliances in Class II malocclusion found 22 studies that reported a clinically significant supplementary elongation in total mandibular length, although this referred to a change greater than 2.0 mm in the treated group compared with an untreated group[21]. To date, there is no evidence to suggest that the theoretical soft tissue effects associated with Fränkel's Function Regulator appliance actually exist. Instead, the Functional Regulator likely acts in a similar way to any other functional appliance whose effects are principally dentoavleaolar.

Functional appliances may still be helpful in correcting Class II molar relationships and in altering the relationship of the lips with prominent teeth. Two-phase treatment using a functional appliance followed by fixed appliances has been associated with treatment of longer duration[20], and so any benefit must be carefully weighed against this potential

disadvantage. A recent Cochrane review of orthodontic treatment for children with prominent upper incisors supports the theory that early treatment of increased overjet (before the age of 11 years) will reduce the incidence of incisal trauma[22]. However, this benefit is considered to be in the order of 10% compared with treating similar patients during adolescence. It would therefore seem wise to assess the risk of trauma for the individual patient before considering early treatment.

Extraction vs. Non-extraction treatment – does it affect the outcome?

The extraction versus non-extraction debate has been discussed for decades and at times has polarised orthodontic opinion. In the early 20th Century, Edward Angle advocated non-extraction treatments and relied upon arch expansion and incisor proclination to deal with crowding. Angle's premise was that the teeth were designed to fit within the arches and so an effort should be made to generate alignment[23]. One of Angle's students, Charles Tweed, later noted the relapse of many of the non-extraction cases and therefore advocated extractions to manage crowding[24]. It is now known, whether cases are treated with extractions or not, they are equally likely to demonstrate relapse in the longer term and the overall occlusal treatment outcomes are likely to be the same[25,26].

More recently the introduction of self-ligating brackets has led to a "new" treatment philosophy of non-extraction and developing the arches[27]. Self-ligating brackets have not been shown to lead to improved treatment mechanics, faster treatments or improved outcomes[12]. It is therefore difficult to appreciate why non-extraction treatment is often associated with these brackets, any more than conventional brackets should just be associated with extraction treatments. The only difference between the two is the use of a metal clip to hold the wire into the bracket slot rather than an elastomeric module.

An additional factor in the extraction versus non-extraction debate has been the supposed detrimental changes to the soft tissue profile that might occur with extraction treatments. Recently, a number of published studies have shown that any effect on the soft tissue profile as a result of treatment is independent of whether teeth have been extracted[28,29,30,31]. The same is true for frontal facial attractiveness[32].

Therefore a combination of factors should be taken into consideration when making extraction choices. These relate to the degree and the site of the crowding, the condition of the teeth, the tooth movements planned and the overall desired aesthetics.

Canine guidance - has it gone to the dogs?

The interchangeable terms “canine guidance”, “cuspid guidance” and “cuspid-protected” refer to the position of the teeth when the patient slides their mandible laterally during which there is only contact of the upper and lower canines (or upper canine and lower first premolar). In this way, the posterior teeth are not in contact during lateral excursions. The alternative occlusion arises when all of the teeth on the same working side are in contact during the excursion, in which case the term ‘group function’ is applied. The purported advantage of canine guidance on the working side during lateral mandibular excursion is the reduced number of wear facets on other teeth[33] and certainly it may be thought that providing restorations in the buccal segments would be easier if the teeth are not in occlusion during lateral excursion. However, a recent systematic review which assessed occlusal schemes found insufficient evidence on which to establish firm guidelines for either canine guidance or group function when placing implants[34].

Hypodontia of the upper lateral incisors affects between 1-2% of individuals depending on the population studied[35,36]. Orthodontic treatment of the resultant spaces usually involves closing the space (canine substitution), or creating space for prosthetic replacements. The arguments for and against these approaches have been well-documented in the Point/Counterpoint series by teams led by Zachrisson and Kokich respectively[37,38], but the issue of the final occlusal scheme in relation to the position of the natural canines was not clarified. If a canine is moved mesially to substitute for a lateral incisor, the first premolar will be placed in the position of the canine and automatically create group function. Restoration of the missing teeth may also involve moving the natural canines into the lateral incisor spaces and creating spaces for prosthetic teeth more posteriorly. Whilst this approach may resolve aesthetic issues, such as gingival architecture around the prosthesis and the aesthetic demands of patients within gingival biotypes requesting implants, it does not resolve whether the canine should be ideally placed on the ‘cornerstone’ of the arch to permit disclusion of the posterior teeth on lateral excursion.

The canine tooth appears to have the most favourable anatomy to withstand lateral forces, and so it would seem to be appropriate, all other factors being equal, to place the canine in the natural canine position and aim to create canine guidance for orthodontic patients. However, since there is insufficient evidence within the literature to support one occlusal scheme, other factors, especially the patient's wishes regarding the restorative burden of replacing missing teeth, may be more important.

Lower incisor position – so what?

Traditional orthodontic teaching has long focussed on planning the position of the lower arch teeth first and then building the upper arch to fit. As part of the lower arch planning, the antero-posterior long term position of the lower incisors needs to be considered. Mills (1968)[39] suggested that the lower incisors are relatively stable in their pre-treatment position and that anything other than minor anteroposterior tooth movements are likely to lead to treatment relapse. Exceptions to this rule would include:

- Retroclination of the lower incisors in the correction of an anterior crossbite and where a positive final overbite and overjet will be attained
- Proclination of the lower incisors where they have previously been retroclined as a result of a thumb sucking habit
- Proclination of the lower incisors where they have been trapped in the palate during forward growth of the mandible.

Later work by Houston and Edler (1990)[40] showed that, irrespective of how much the lower incisors are moved from the pre-treatment labio-lingual position, it is not possible to determine by how much relapse is likely. Although the majority, (62%), were observed to relapse to their pre-treatment antero-posterior position, it was not necessarily those teeth moved the farthest during treatment which were the most likely to relapse.

Another suggested unwanted effect of proclination of the lower incisors as part of orthodontic treatment, is gingival recession. Although many studies have been published (references), a recent systematic review did not find the evidence to support this concept to

be compelling (Joss-Vassalli *et al*. 2010)[41]. In most of the studies in which proclination took place, a higher occurrence and greater severity of gingival recession was noted, but the results were often contradictory and lacking in clinical significance.

In view of the lack of strong evidence to the contrary, the most recent British Orthodontic Society guidelines recommend that "*the consensus of evidence supports the view that excessive lower incisor proclination should be avoided unless prolonged retention is planned*"[42].

Orthodontists continue to assess the position of the lower incisors as part of overall data collection, which may involve a radiographic assessment of their relationship to the mandibular base. The potential to alter their position must be balanced with the planned retention method and this should be discussed with the patient as part of treatment planning and informed consent.

TMD and orthodontics – cause or cure?

Traditionally orthodontic teaching has recommended that if there is an irregularity of the teeth and a crossbite with an associated mandibular displacement when biting into centric occlusion, it would be advantageous to offer treatment in order to prevent the development of TMD at a later date[43]. Similarly, if a patient presented with TMD and the same occlusal characteristics, then correction was thought to help in TMD management[44]. However, as a result of litigation in the US in the late 1980's, in which a patient successfully claimed compensation for TMD that arose during a course of orthodontic treatment[45], the American Association of Orthodontists sponsored a research programme to identify a relationship, if any, between orthodontic treatment and TMD. The research was subsequently published in a themed issue of the AJODO[46] and the conclusions were summarised in an opinion piece by Behrents and White (1992)[47] as follows:

- Consistently significant associations between structure (dental and osseous) and TMD have not been demonstrated. Any relationship that might exist is not simple, frequent, or dramatic
- The development of TMD cannot be predicted.
- No method of TMD prevention has been demonstrated.

- The prevalence of TMD symptoms increases with age; thus TMD may originate during orthodontic treatment, but is not be related to the treatment.
- Orthodontic treatments *per se* do not initiate TMD.
- Evidence favours the beneficial nature of orthodontic treatment; orthodontics, as a part of the regimen of care, may assist in the lessening of symptoms.
- Once TMD is present, TMD cures cannot be assumed or assured.

Research and reviews undertaken since the late 80's support these points[48,49,50,51] **.** As the average course of orthodontic treatment commonly takes 18-24 months and TMD is a relatively common condition, it is perhaps not surprising that some patients will encounter TMD during their orthodontic course of treatment. It would however be inappropriate to assume cause and effect[52].

Careful evaluation of the patient, including a thorough history and examination will help form the basis for appropriate treatment planning. An understanding of simple measures to ease symptoms is also beneficial and helps with the care of those individuals who are susceptible to TMD.

Summary

This article has attempted to highlight some of the current controversies in contemporary orthodontics that might be of interest to the both the orthodontist and the general dental practitioner in their everyday practice.

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Figures

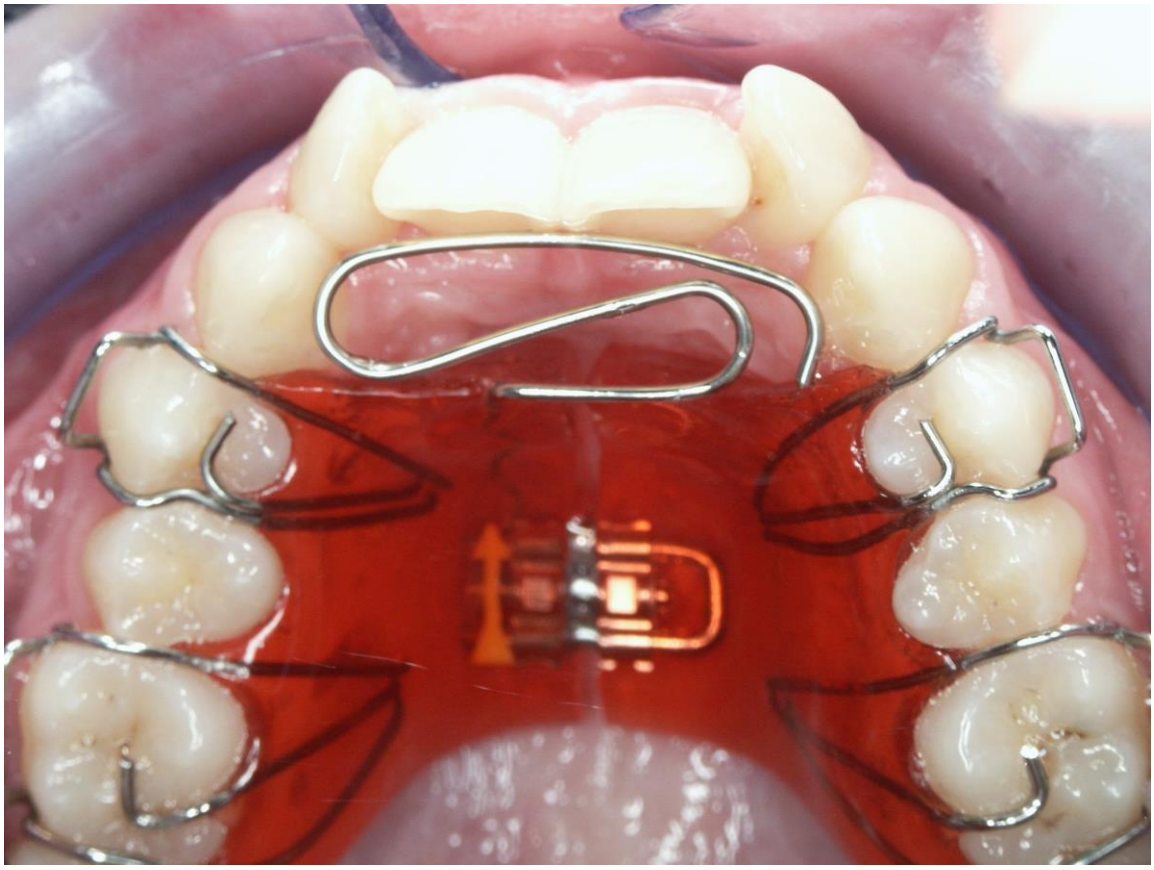

Figure 1 – An Expansion and Labial Segment Alignment Appliances (ELSAA)

Figure 2 – A lateral view of a Modified Clark Twin Block showing the upper and lower buccal blocks with the inclined plane promoting forwards posturing of the mandible

Figure 3 – In-Ovation® active self-ligating brackets

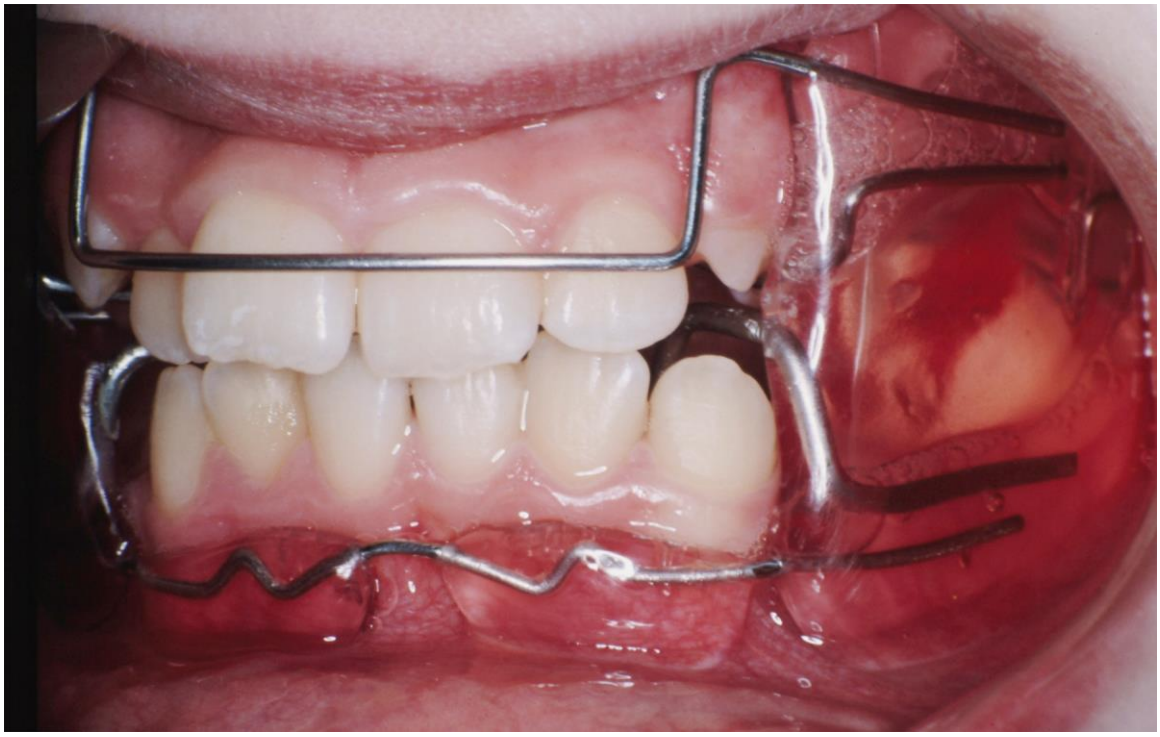

Figure 4 - Class II Fränkel appliance with labial pelottes in the lower arch