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Caries associated with orthodontic care part 1: Aetiology, prevalence and prevention.

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Caries associated with orthodontic care: prevalence, prevention and management

Abstract

The orthodontist can effectively reduce demineralisation by applying fluoride varnish at each visit. It is recognised that wearing an orthodontic appliance increases the caries risk of the individual. The prevalence of demineralisation has been reported to be as high as 73%. Selecting patients on their oral hygiene clearly is one factor which can prevent patients suffering from demineralisation. Excellent home care with optimal use of fluoride will help prevent demineralisation. There is little evidence that fluoride releasing materials used for bonding orthodontic appliances offer protection from demineralisation.

Clinical relevance

Demineralisation is the most common complication of orthodontic care. The clinician should understand how to prevent this.

Objective

The reader should be able to describe the risk factors for demineralisation during orthodontic treatment and how to prevent this occurring.

Introduction

Orthodontic care involves the practitioner in an assessment of a number of risks and benefits. It would be inappropriate to continue treatment when unexpected complications, poor patient compliance or behaviour leads to detrimental effects for the patient as a result of orthodontic treatment.[1] One of the most commonly recognised complications of orthodontic care is demineralisation due to poor oral hygiene. Demineralisation is enamel caries and the first clinically recognisable stage of caries. Although such lesions can develop irrespective of orthodontic treatment, it has been shown to be a recognised complication of orthodontic treatment.[2]

Introducing fixed or removable orthodontic appliances to the oral environment alters the ecology of the mouth by adding another variable to the system. Figure 1 shows a proposed hypothesis suggested by Chang et al of the influences orthodontic appliances may have on the process of enamel demineralisation.[2]

The practitioner will wish to avoid iatrogenic damage by identifying patients at risk of caries before commencing care. For example male patients, at a preadolescent age at the time of treatment, patients with fair or poor pre-treatment oral hygiene, higher number of treatment appointments and white ancestry have all been shown to be associated with a greater incidence and severity of white spot lesions during orthodontic care .[4]

Increased levels of Streptococcus mutans and lactobacilli among other members of the oral biofilm are linked with greater caries risk and activity. Salivary levels of S.mutans and lactobacilli increase significantly during the first six months of active orthodontic treatment in spite of oral hygiene and dietary advice instruction.[5]

Demineralisation of enamel adjacent to orthodontic brackets is generally caused by poor oral hygiene and diet, compared to carious lesions found beneath orthodontic bands, which is more likely as a result of improper band cementation, loosening of the orthodontic band and unrestored cavities. Fixed orthodontic appliances increase the number of plaque retentive sites on teeth and increase the caries predilection sites that are usually less susceptible to caries development and make conventional oral hygiene methods even more challenging.[3] Figure 2 shows a fixed appliance with associated plaque accumulation because of poor oral hygiene.

This paper aims to describe the prevalence of demineralisation associated with orthodontic treatment, ways in which these early lesions can be prevented and the treatment available to aid remineralisation and improve aesthetics post orthodontic treatment.

Prevalence

Demineralisation of enamel and occasional dentine caries with cavitation is a recognised risk factor of orthodontic treatment. Figures 3 and 4 show dentinal caries in two patients who were wearing a removable appliance. Figures 5 a,b,c shows a patient prior to fixed orthodontic care and Figures 6 a, b, c show demineralisation in the same patient after debonding and Figure 7 is an example of more advanced dentinal and enamel caries as a result of wearing a fixed appliance together with poor oral hygiene and probably a cariogenic diet.

It has been shown that patients undergoing fixed orthodontic treatment are at a higher risk of developing white spot lesions when compared to patients without. A study comparing 40 adolescents receiving fixed appliances with 40 matched controls, showed a resultant mean increase of white spot lesions of 1.9 in the orthodontic group compared to 0.4 in the control.[6] The increase in dentine caries in both groups were similar with a mean increase of 0.5 in the

orthodontic group compared with 0.7 lesions in the control. Studies have shown the incidence of developing white spot lesions during fixed appliance treatment to be as high as 73%, with 2.3% of patients developing cavities.[7]

A study looking into the incidence of white spot lesions in 400 patients wearing multi-bracket appliances for at least 1 year and with a retention period of at least 1 year, showed that after treatment 73% had lesions on the labial surface of their upper incisors. Of which 63.3% had mild demineralised lesions, 26.9% had severe lesions and 9.9% had resultant cavities. It is interesting to note that the incidence of cavities was higher than reported in the aforementioned study. Following the retention phase of treatment, 57.1% showed improvement in the white spot lesions, however 16.7% had deteriorated further.[8]

There is a significantly high incidence of white spot lesions therefore developing as a result of orthodontic treatment, and the clinician and patient must be aware of this risk. Prevention pre-operatively as well as during fixed orthodontic appliance treatment is paramount.

Prevention

Unfortunately, for some the only preventive action is to discontinue treatment prematurely however, it would clearly be better to avoid this if possible. Mandall et al, measured compliance with orthodontic treatment together with the reason for non-completion.[9] The reasons identified included poor oral hygiene, failed appointments and appliance breakages. This study incorporated 144 patients (aged 10-19 years), out of which a high number, 62 (43%) had their treatment abandoned. Figure 8 shows the categorisation of the main reasons for incomplete treatment. Poor oral hygiene and multiple failed appointments are the main reasons for orthodontic treatment being left incomplete. Unfortunately, this study also reported that clinical treatment need (IOTN), baseline quality of life measures, age, gender or socio-economic status were not predictors of successful completion of treatment.

A recent study by Chapman et al did identify risk factors for the development of demineralisation during orthodontic treatment. These included; pre-adolescent children at the outset, the number of times poor oral hygiene was documented throughout the course of treatment, white ethnic groups and inadequate oral hygiene at pre-treatment assessment appointments.[4]

Oral hygiene

Studies have shown that only permitting patients who achieve an adequate level of oral hygiene to commence active appliance therapy reduced the number of terminated treatments.[10, 11]

As orthodontic patients are at a greater risk of developing caries, all patients should be educated and motivated to achieve excellent oral hygiene, implementing the use of high fluoridated toothpastes, fluoride mouthwashes and varnishes.

'Delivering Better Oral Health Toolkit' advises that brushing should be carried out at least twice a day and indicates the most beneficial time of day to brush teeth is at night before bed.[12] Thorough cleaning takes at least two minutes and therefore three minutes brushing is what should be advised to patients.

Though the Toolkit states that no particular technique of brushing has been shown to be superior to any others, emphasis should be made to clean all tooth surfaces in a systematic approach. Many orthodontists and hygienists recommend that patients use single tufted brushes to improve access around the appliance (Figure 9). It also advised that rinsing with water or mouth rinses immediately after tooth brushing will dilute the concentration of fluoride. Rinsing after brushing should therefore be discouraged and spitting out excess toothpaste instead should be advised. A modified fluoride toothpaste technique where a

'slurry rinse' with toothpaste is carried out after brushing, has been shown to increase the efficacy of fluoridated toothpaste alone in young children.[13] This has been suggested for orthodontic patients but there are no clinical trials to support its use.

A Cochrane Systematic Review compared powered toothbrushes to manual brushes and reported powered brushes reduced plaque levels and gingivitis.[14] The rotating oscillating design was the only design of powered brush to be statistically significantly superior at all time points. A previous iteration of this review attempted to identify if powered brushes had any benefit for patients wearing fixed appliances and if these had any drawbacks such as increased breakages but due to the small number of studies was unable to draw conclusions Deery et al.[15]

According to the Children's Dental Health Survey (2013), the proportion of children brushing their teeth twice a day has remained relatively stable since 2003.[16]

Compliance with oral hygiene regimes has been an ongoing battle for clinicians. However modern technology offers new opportunities.[17] In one study the parents of 42 orthodontic patients received weekly text messages prompting oral hygiene. Oral hygiene significantly improved as measured by the Bleeding Index, Modified Gingival Index, Plaque Index and visual examination of white spot lesions, in those receiving the texts compared to the controls, who did not receive text messages.

Knowing you are being observed has an influence on behaviour, this is known as the Hawthorne effect. In a recent study 40 patients with a history of poor oral hygiene were randomised into two groups one being given the impression that they were part of a research project and the other acted as a control.[18] The experimental group believed they were part of a research study because they were given consent forms, received toothpaste labelled 'experimental' and instructions to brush their teeth twice a day for 2 minutes. The control

group received no intervention. In the experimental group the plaque level significantly reduced from an initial 71% to 52% at 6 months. While plaque levels for the control group increased from 74% to 79%. Whether this approach is truly ethical or applicable to everyday practice is questionable.

Finally a systematic review of oral hygiene advice in orthodontic patients identified only six small trials.[19] They concluded that an oral hygiene promotion programme produces a short term, five month improvement in plaque level and gingival health.

Diet advice

Orthodontists advise patients about cariogenic diets and, to avoid breakages, the avoidance of sticky foodstuffs. It is important to recognise that honey, fruit smoothies, fresh fruit juices and dried fruits all contain cariogenic sugars and therefore advice should be given to patients to reduce the frequency of these, if present in their diet, as many patients consider these and other items 'healthy choices'. It must be recognised that the evidence for the effectiveness of dietary advice in terms of sugar reduction is weak.[20] However, it seems only sensible to advise a reduction both in the amount and frequency of consuming foods and drinks that contain non-milk extrinsic sugars.

Topical Fluoride

Topical fluoride application on teeth has been a longstanding proven method of reducing the risk of dental caries, and therefore this form of treatment should protect patients from demineralised areas during their fixed orthodontic appliance treatment.

A Cochrane Systematic Review assessed the evidence for the effectiveness of fluoride in preventing dental caries during orthodontic treatment.[21] Three studies with 458 participants were included in the review:

1. Fluoride varnish versus placebo varnish
2. Different formulations of fluoride toothpaste and mouthwash
3. Fluoride-releasing component attached to the braces versus mouthwash.

The most robust study (273 patients, aged 12-15 years) reduced the risk of demineralisation by nearly 70%.[22] This involved orthodontists placing fluoride varnish around the teeth and appliance each time the appliance was adjusted, whilst the control group had a placebo varnish placed. Figure 10 shows 5% sodium fluoride varnish being applied at a visit to adjust the appliance.

Another study compared two patient groups receiving different formulations of fluoride. One group were allocated amine fluoride/stannous fluoride toothpaste and mouthrinse and the other sodium fluoride toothpaste and mouthrinse.[23] This study found there was an increase in the number of white spot lesions from baseline in the sodium fluoride group but not the amine fluoride group, suggesting that the amine fluoride/stannous fluoride combination is more effective. There was also a slightly larger increase in visible plaque and gingival bleeding index in the group prescribed sodium fluoride. However, the significance of these findings do need to be interpreted with caution as it was reported that caries increment was low, at 4.3% and 7.2% respectively.

A smaller study of only 37 patients, compared the use of fluoride-releasing glass beads attached to the braces versus daily fluoride mouthwashes.[24] The experimental group received a carbonate-based bead containing 13.3% fluoride and the control group was asked to use a daily fluoride mouth rinse (0.05% NaF). The findings showed that the glass beads were very fragile and 18 were reported broken. As the study was small and assessed as having a high risk of bias, there was insufficient evidence to determine whether the beads were more or less effective than mouth rinses in reducing white spot lesions. The results of recent as yet

unpublished study with a redesigned version of the bead suggest that the problem with breakages has been overcome and the placement of these fluoride slow release devises is effective at preventing demineralisation during fixed appliance therapy.[25]

Buccal surfaces of teeth are regarded as being more caries prone than lingual surfaces and therefore using lingual orthodontic brackets to inhibit white spot lesions can be considered as a viable option. A small (28 subjects) randomised control trial using a split-mouth approach looked into the incidence of white spot lesions, where subjects were randomly allocated into a group receiving buccal or lingual brackets on the maxillary teeth and the contrasting brackets on the mandibular teeth. The number of early enamel lesions that developed or progressed on buccal surfaces was found to be 4.8 times greater than the number that appeared on the lingual surfaces, as measured by quantitative light-induced fluorescence.[26, 27]

Fluoride Releasing Materials

A Cochrane Systematic Review looked into the effect of using fluoride containing materials. These included fluoride-releasing composite bonding materials; glass ionomer cements (GIC), compomers and resin-modified GICs. The majority of the studies were small and had other methodological limitations which meant they were excluded from the subsequent review.[21] The summmaries below give a feel for these studies.

One split mouth controlled clinical trial with 22 patients compared a light-activated fluoride-releasing composite with a conventional light-activated, non-fluoridated composite control.[28] More decalcification was observed in the control group involving four patients, compared to no decalcification noted in the experimental group. However, a later trial of a fluoride releasing primer versus a non-fluoride releasing primer demonstrated no difference.[29]

Six studies compared GIC (fluoride group) and composite (non-fluoride group) for their use in bonding brackets. Out of the six trials, half showed no significant difference between using GIC containing fluoride and the composite control group in the level of demineralisation. Three studies, all with minimal risk of bias showed a significant increase in mineral loss in the composite control group in comparison to using GICs.[30, 31, 32, 33, 34, 35]

No statistically significant difference in the degree of demineralisation was found between two fluoride releasing materials GIC and compomer, nor were these materials found individually to be superior to resin in terms of reduced demineralisation.[32]. When these materials were considered together however, and when compared with the resin group there was a significant benefit. This suggests that the trial was under powered, as is the case with many of the trials looking at the effect of materials on demineralisation.

Similar results were reported by Millett et al, who showed the percentage of teeth affected by demineralisation was significantly better for compomer than composite.[36] However, a larger trial (98 subjects) conducted by Gillgrass et al comparing conventional GIC with composite found no statistically significant difference between the two cement groups.[37]

A trial that compared fluoridated modules with non-fluoridated ones, though the number of lesions were high (31 out of 49 in the fluoridated group and 33 out of 45 in the non-fluoridated elastics group) found no significant difference between the two, with the study being rated as having a high risk of bias.[38]

The application of resin sealant on the enamel surfaces surrounding orthodontic brackets should protect the enamel surface from demineralisation. A randomised split mouth study with sixty adolescent patients aged between 11 and 16 years reported six lesions were identified on the teeth with sealants compared to 22 on the teeth without. This made the teeth without sealants almost four times more likely to develop white spot lesions.[39]

Conclusion

Despite recent advances in dental materials and methods to reduce the incidence of enamel demineralisation, studies indicate the development of white spot lesions continues to be a significant problem amongst orthodontic patients. The incidence of developing at least one white spot lesion during multi-bracket orthodontic treatment has been reported to be as high as 73%.[7,8]

The prevention of demineralisation relies on selecting motivated patients with excellent oral hygiene at the outset. There is a benefit from the optimal use of fluoride including mouthrines in addition to toothbrushing. There is also evidence that fluoride varnish should be applied at each appliance adjustment visit.[22] The second of these papers will discuss the management of white spot lesions when they do occur.

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Legends to figures

Figure 1
A hypothesis of the influences orthodontic appliances can have on the process of enamel demineralisation (after Chang et al[4]).

Figure 2
A fixed appliance with associated plaque accumulation due to poor oral hygiene

Figure 3
Palatal caries in a patient wearing a removable appliance, with an anterior bite plane.

Figure 4
Buccal caries associated with the Adams Clasp of a removable appliance.

Figure 5 a, b, c
A patient prior to fixed orthodontic care. Visible food debris is visible on the left side (C)

Figure 6 a, b, c
Demineralisation in the same patient as Figure 5 after debonding of the appliance

Figure 7
Enamel and dentine caries associated with wearing a fixed appliance.

Figure 8
Reasons for abandonment of orthodontic treatment n=144 (after Mandall et al[8])

Figure 9
Single tufted brush to improve access for cleaning

Figure 10
One of the most effective interventions to prevent demineralisation: 5% sodium fluoride

varnish being applied at a visit to adjust the appliance.[22]

Figure 1

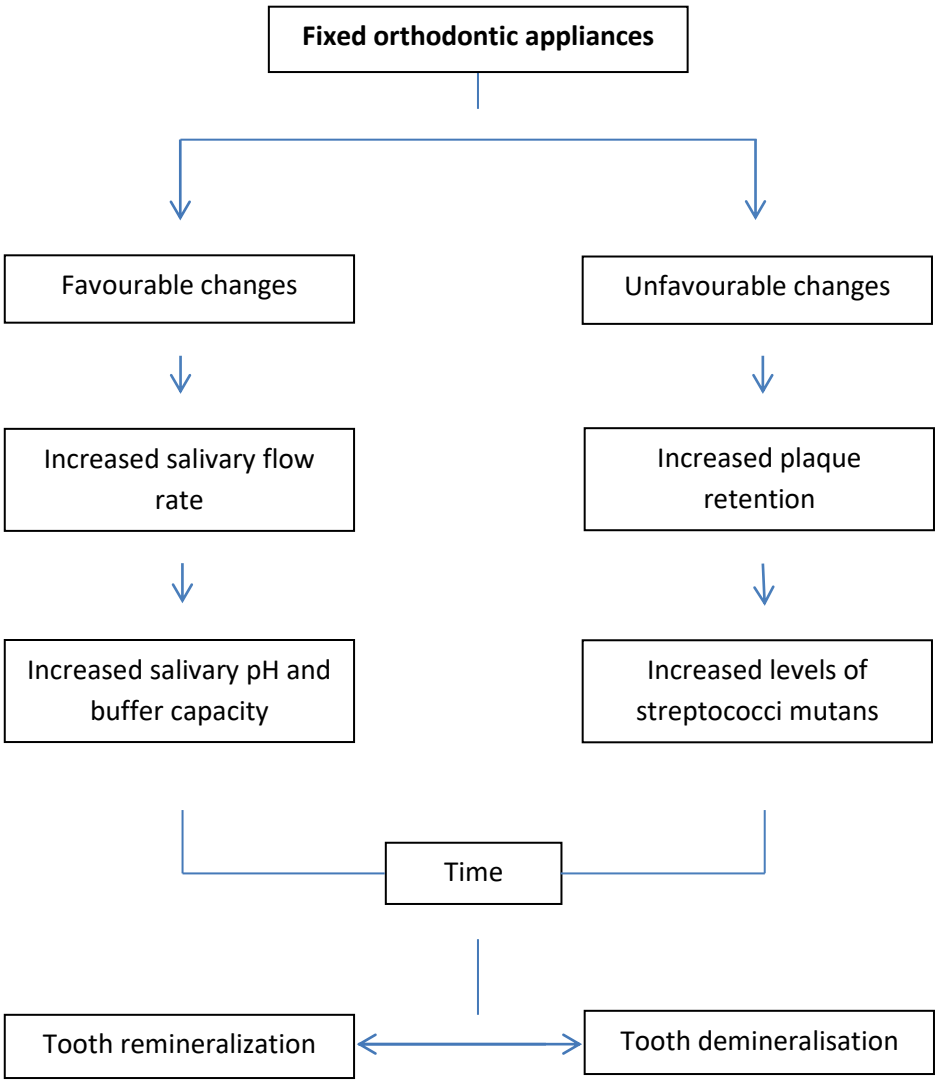

Fixed orthodontic appliances
Favourable changes
Unfavourable changes
Increased salivary flow rate
Increased plaque retention
Increased salivary pH and buffer capacity
Increased levels of streptococci mutans
Time
Tooth remineralization
Tooth demineralisation

Figure 2

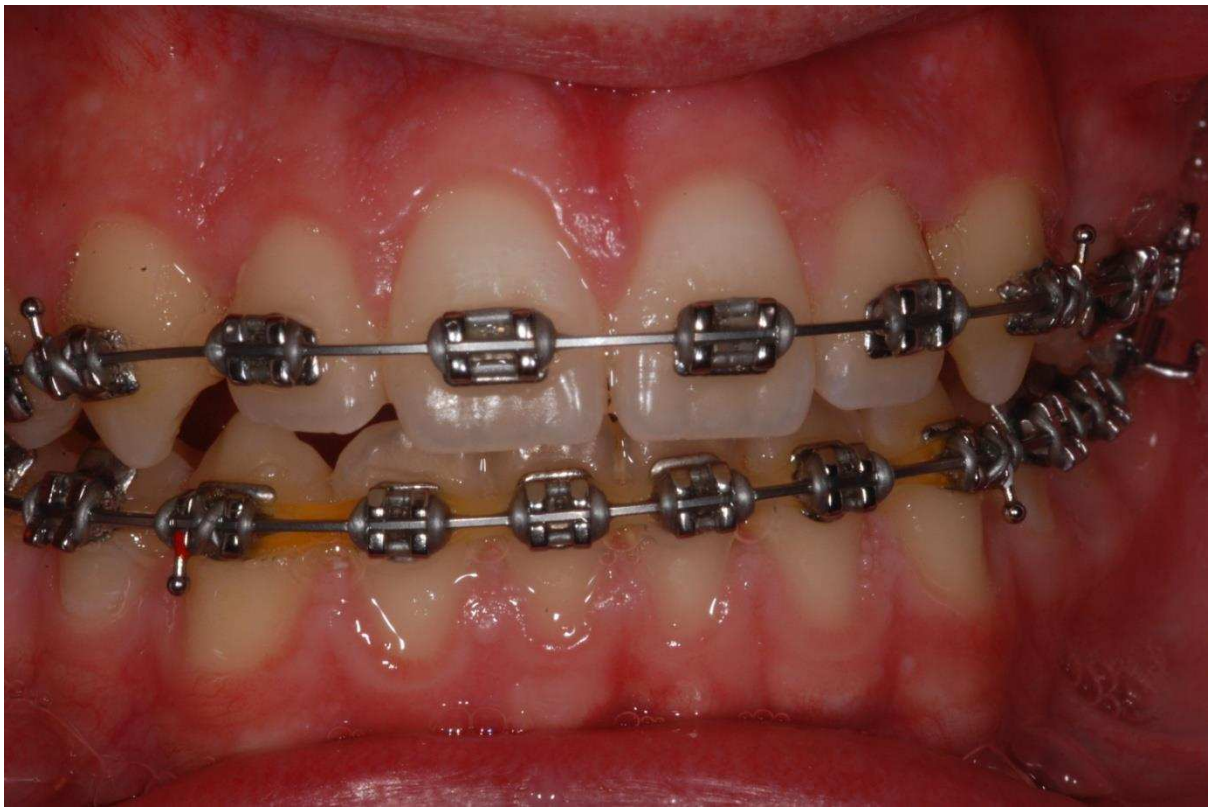


Figure 3

Figure 4

Figure 5

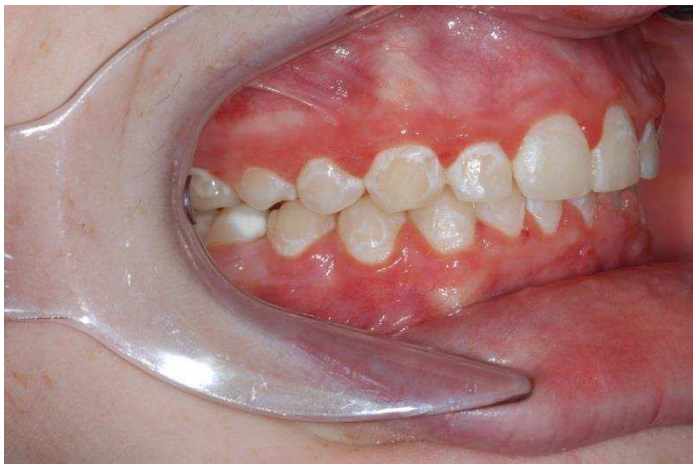
A

B

C

Figure 6

A



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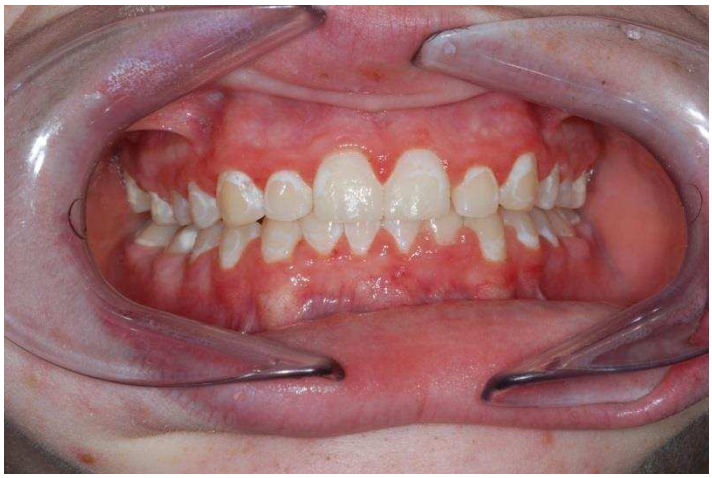

C

Figure 7

Figure 8

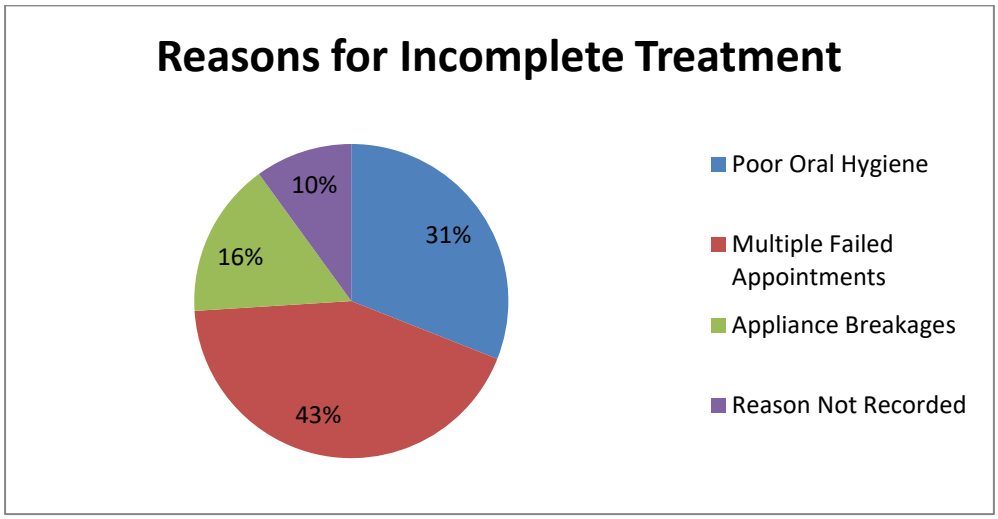
Reasons for Incomplete Treatment
10%
31%
16%
43%
Poor Oral Hygiene
Multiple Failed Appointments
Appliance Breakages
Reason Not Recorded

Figure 9

Figure 10