

CLINICAL  
SECTION

# Mandibular incisal edge demineralization and caries associated with Twin Block appliance design

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Demineralization and caries are well documented and unwanted complications of orthodontic therapy. These are most commonly reported in relation to fixed appliance therapy. Five cases are presented of patients undergoing Twin Block appliance therapy with the appliances incorporating lower labial segment capping, illustrating a pattern of demineralization and caries of the incisal tips of the mandibular labial segment, influenced by the incisal capping and the frequent intake of carbonated soft drinks.

*Key words:* Twin Block, adverse effects, orthodontics

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## Introduction

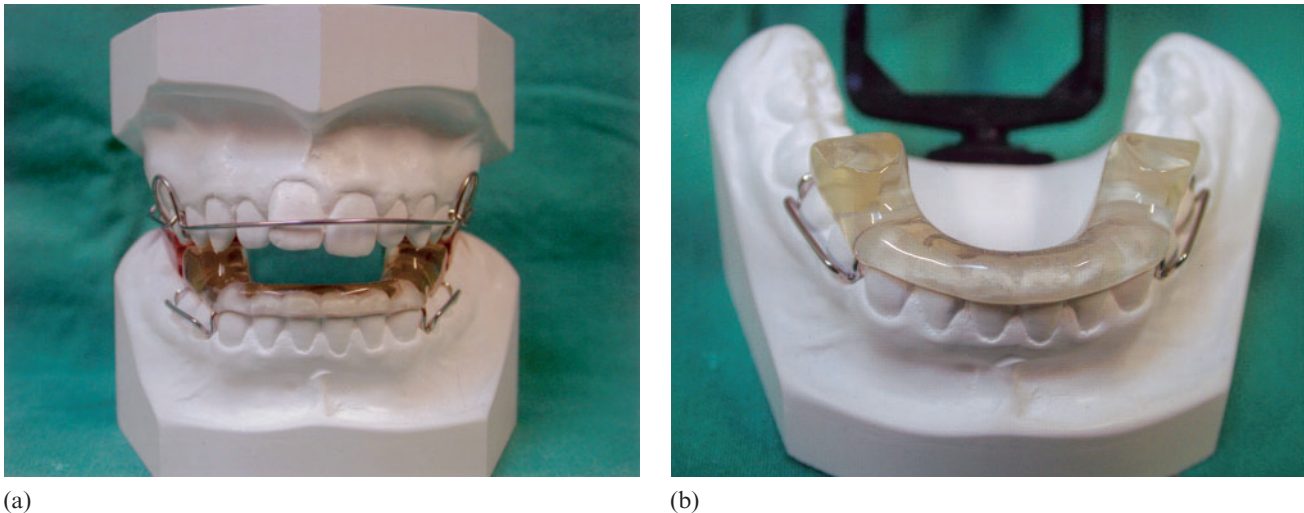
Demineralization and caries are well-documented complications of orthodontic appliance therapy<sup>1,2</sup> and are normally related to fixed appliance therapy.<sup>1</sup> Five cases are presented of a pattern of demineralization and caries occurring below Twin Block appliances that incorporated lower labial segment capping. These cases presented in the North-West of England at the Orthodontic Department of a District General Hospital and the Pediatric Dentistry Unit of a University Dental Hospital, between 1999 and 2003. All the children gave a history of frequent intake of carbonated soft drinks.

### *Demineralization, caries and carbonated soft drinks*

Demineralization of the dental hard tissues occurs when the pH of the surrounding area falls below 5.5, allowing calcium and phosphate ions to diffuse out of the enamel. This occurs when acidogenic bacteria break down dietary sugars and also when acidic fluids enter the mouth. The duration and frequency of the acid challenge can influence the level of damage to the tooth substance, which can range from small white spot lesions to frank cavitation.<sup>1</sup>

Carbonated soft drinks can demineralize enamel. This can occur in the absence of dental plaque due to the low pH of these drinks, in particular cola type drinks, which contain phosphoric acid.<sup>3</sup> Exposure to a cola-based soft drink for a single hour *in vivo* is sufficient to produce detectable enamel softening.<sup>4</sup> It has been shown that the demineralizing effects of the acids in carbonated soft drinks far exceeded the effects generated by oral microorganisms from the sugars in the drinks.<sup>5</sup> *In vivo*, the damage to the teeth can be very rapid<sup>6</sup> and, unfortunately, many patients are unaware of the potential risks associated with soft drinks.<sup>7</sup>

Epidemiological studies<sup>8,9</sup> show that higher DMFT scores are recorded in patients with a high intake of carbonated soft drinks, with the frequency of intake being more statistically significant than the quantity consumed. In the UK, consumption of carbonated soft drinks has increased from 388 ml per person per week in 1985 to 884 ml per person per week in 1996.<sup>8</sup> The authors found that the number of cans of soft drinks consumed per week had a statistically significant correlation to the DMFT of 14-year-old children in the North West of England.<sup>8</sup> Similar results were found in a national US study, particularly with relation to the consumption of carbonated soft drinks between meals. They found the



**Figure 1** (a,b) A modified Twin Block appliance demonstrating incisal capping

12–17-year-old age range most significantly affected statistically.<sup>9</sup>

#### *Saliva and remineralization*

The oral cavity sustains a complex mix of physiological and biochemical activities. Saliva is important to the homeostasis of the oral environment. It has several major functions, including buffering, cleansing and antibacterial actions, as well as providing a supersaturated solution of calcium phosphate.<sup>10,11</sup> It has a key role in the prevention of caries and its absence is associated with increased rates of caries, particularly in smooth surface lesions.

A drop in the intra-oral pH stimulates the salivary flow rate, buffering the acid challenge. This increased flow of supersaturated saliva also inhibits demineralization and encourages remineralization, which is facilitated by fluoride ions within the saliva. A limited amount of damage to the dental hard tissues can be reversed, but this relies on the saliva being in direct contact with the teeth.

#### *The Twin Block appliance*

The Twin Block appliance is the most frequently used myofunctional orthodontic appliance in the UK.<sup>12</sup> The majority of practitioners advise the full-time wear of the appliance to maximize the benefit. This results in the appliance being in direct contact with the dental tissues for long periods of time, potentially increasing plaque retention and the risk of demineralization by reducing the self-cleansing and neutralizing actions of

saliva. However, when the oral hygiene is good and the diet is controlled this should be limited.

Clark's original Twin Block appliance<sup>13</sup> has evolved with time, with various modifications being reported.<sup>14–16</sup> Other modifications have been introduced in response to clinical findings and personal experience. Within the north west of England the use of mandibular labial segment capping is widely used in the construction of Twin Block appliances.

This modification was introduced to reduce the incidence of midline fracture in the lower block, which was found by a departmental audit to be the most common removable appliance breakage.<sup>17</sup> The use of a high quality self-curing acrylic and capping the lower labial segment eliminates the need for heat curing the appliance, increasing its structural integrity, whilst reducing laboratory time and costs. When constructing the lower block to include mandibular labial segment capping, the acrylic base is extended anteriorly from the lingual aspect of the canines and incisors, and extended 1–2 mm down the labial faces of the teeth (Figure 1a,b). This close fitting capping increases the strength of the appliance and a subsequent re-audit found a marked decrease in appliance fracture following this introduction. A recently completed audit in the West Midlands found that, by changing the design of the lower Twin Block to incorporate either an acrylated labial bow or lower incisor capping reduced the appliance fracture rate by 24%.<sup>18</sup>

When oral hygiene instruction and dietary advice are followed, this modification works well. However, five cases will be presented that show a pattern of damage that can be caused to the dentition if preventative advice is not followed.

## Cases

Five cases of lower labial segment demineralization and caries are presented at various stages of Twin Block treatment. The patients range from 12 to 14 years of age. They all demonstrate a pattern of softening of the enamel and dentine of the lower labial segment associated with the frequent intake of carbonated soft drinks and capping of the lower labial segment.

The five cases were treated by four different orthodontists over a 5-year period, and presented their symptoms in differing ways. Two of the cases were referrals to a pediatric emergency clinic, whilst the remaining three were treated and diagnosed within orthodontic departments. These three cases were all subject to the same pre-treatment regime of oral and written diet and tooth brushing instruction. The patients were not accepted for treatment until they had achieved satisfactory levels of oral hygiene, with no active caries, gingivitis or plaque deposits detectable. Instructions regarding diet and tooth brushing were provided pre-treatment and upon the fitting of appliances.

Upon diagnosis of the demineralization, details were taken with regards dietary risk factors, and this was completed verbally and additionally by the use of diet diaries in the Pediatric Dentistry Unit.

### Case 1

A fit and healthy 12-year-old boy was referred to the Orthodontic Department of his local General Hospital by the dental service for orthodontic treatment of a severe overjet. He presented with a Class II division I incisor relation on a Class II skeletal base with a 10 mm overjet. There was evidence of active caries and of previous trauma to the maxillary central incisors. The oral hygiene was poor.

In the light of his high risk of further incisor trauma and severity of malocclusion, orthodontic treatment was planned once restorative treatment and intensive preventive advice had been provided by the Community Dental Officer. A removable anterior bite-plane was initially provided. This achieved some reduction of the overbite and was worn successfully for a 5-month period, whilst he maintained a satisfactory oral hygiene standard.

A modified Twin Block appliance was then constructed with acrylic capping of the mandibular labial segment and maxillary advancement screws.<sup>14</sup> This was fitted and the patient given written and verbal instructions regarding appliance care, oral hygiene and diet.

Initial progress was good, with the overjet reduced to 3.5 mm in 9 months. Unfortunately, the patient's oral

hygiene was erratic with a candidal infection of the palate present in month 2, and generalized cervical demineralization noted at month 9. Diet history revealed frequent intake of carbonated soft drinks, particularly between meals. Despite further oral hygiene reinforcement and the recommendation of regular fluoride mouth rinses, this deteriorated by month 11, when exposed dentine was observed over the tips of the lower labial segment (Figure 2a–e). Radiographic examination revealed carious lesions in five other mandibular teeth. Appliance therapy was ceased, with referral back to the Community Dental Officer.

### Case 2

A 13-year-old girl was referred to the Pediatric Dentistry Unit of the University Dental Hospital by her General Dental Practitioner (GDP) for assessment of lower incisor demineralization. The patient had been undergoing functional appliance therapy with a modified Twin Block appliance including lower incisor capping. This had produced a satisfactory result and she was using an inclined bite plane for retention. During the course of treatment she had been given dietary advice and the GDP had specifically asked the patient to stop her carbonated soft drink intake.

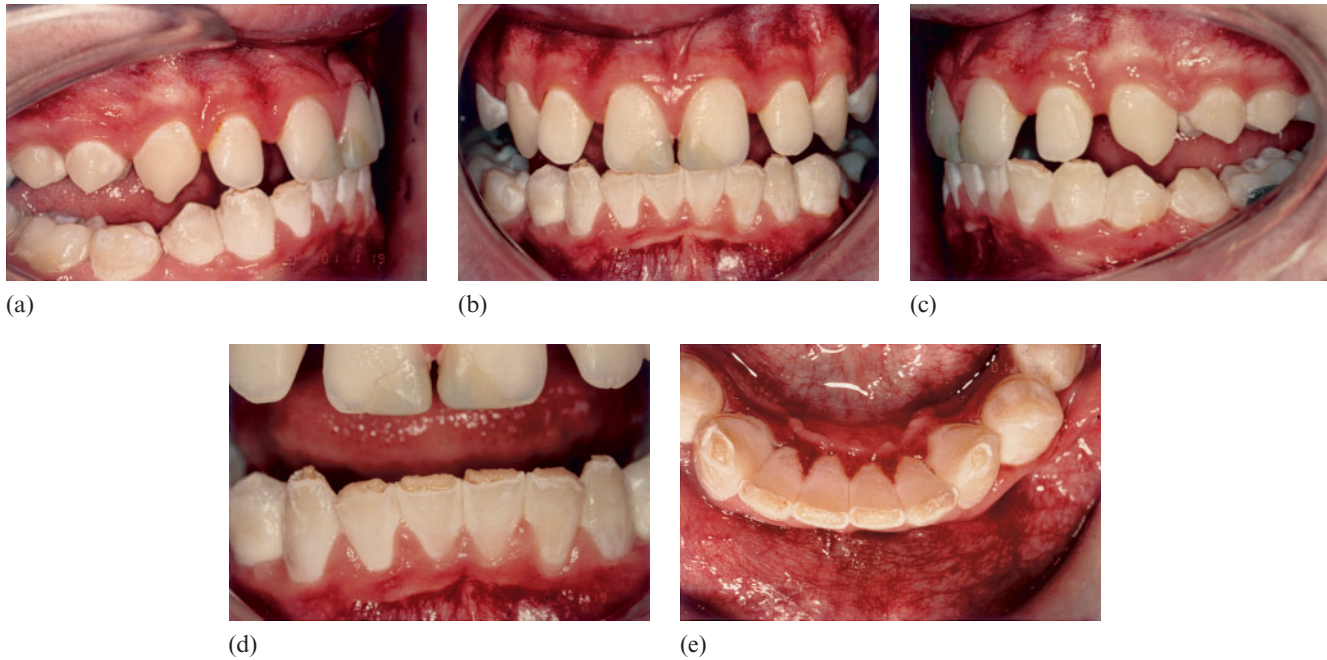
On examination the oral hygiene was good and many areas of demineralization were noted including the tips of the lower labial segment, which had softened dentine exposed (Figure 3a–e). The upper molars were noted to be grossly carious. Intensive preventive advice was given and the patient discharged to the GDP with preventative and restorative treatment plans.

### Case 3

A 13-year-old girl was referred to the Pediatric Dentistry Unit's casualty department of the University Dental Hospital concerning her lower teeth. A letter from her GDP stated that the patient had been urgently referred by her orthodontist regarding rapidly progressive carious lesions in the lower anterior teeth. The GDP also noted that her oral hygiene had been previously recorded as poor.

The orthodontist had provided a modified Twin Block appliance with lower incisor capping 5 months earlier. The patient had not attended for review. When she did attend the orthodontist noted that, whilst the overjet had reduced satisfactorily, the condition of the lower incisors was extremely poor.

Examination showed poor oral hygiene with generalized chronic hyperplastic gingivitis. Carious lesions were diagnosed in 13 teeth. The most notable caries involved



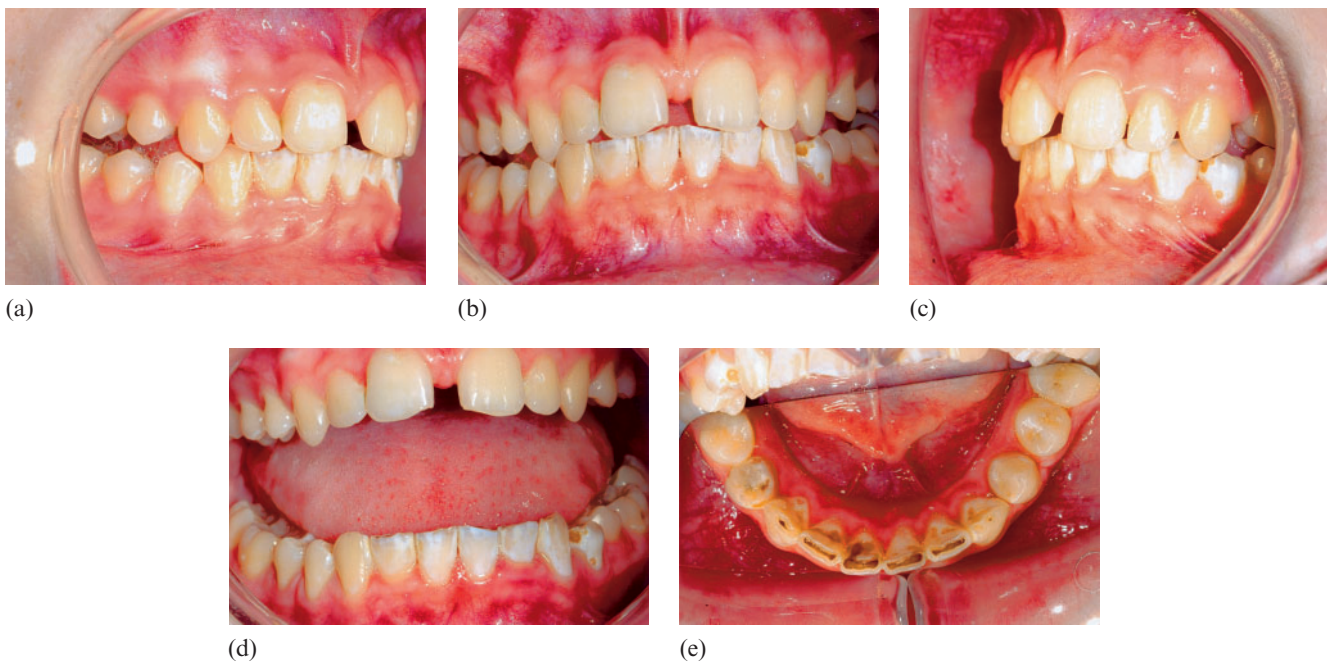
**Figure 2** (a–e) Case 1: intra-oral views

loss of the tips of the lower incisors and canines, with soft dentinal caries exposed (Figure 4a–e). Further questioning revealed a diet history of regular carbonated soft drink intake. Intensive preventive advice was given, but the long-term prognosis for the lower incisor teeth was felt to be in doubt as radiographic examination indicated pulpal involvement of the lower central and lateral

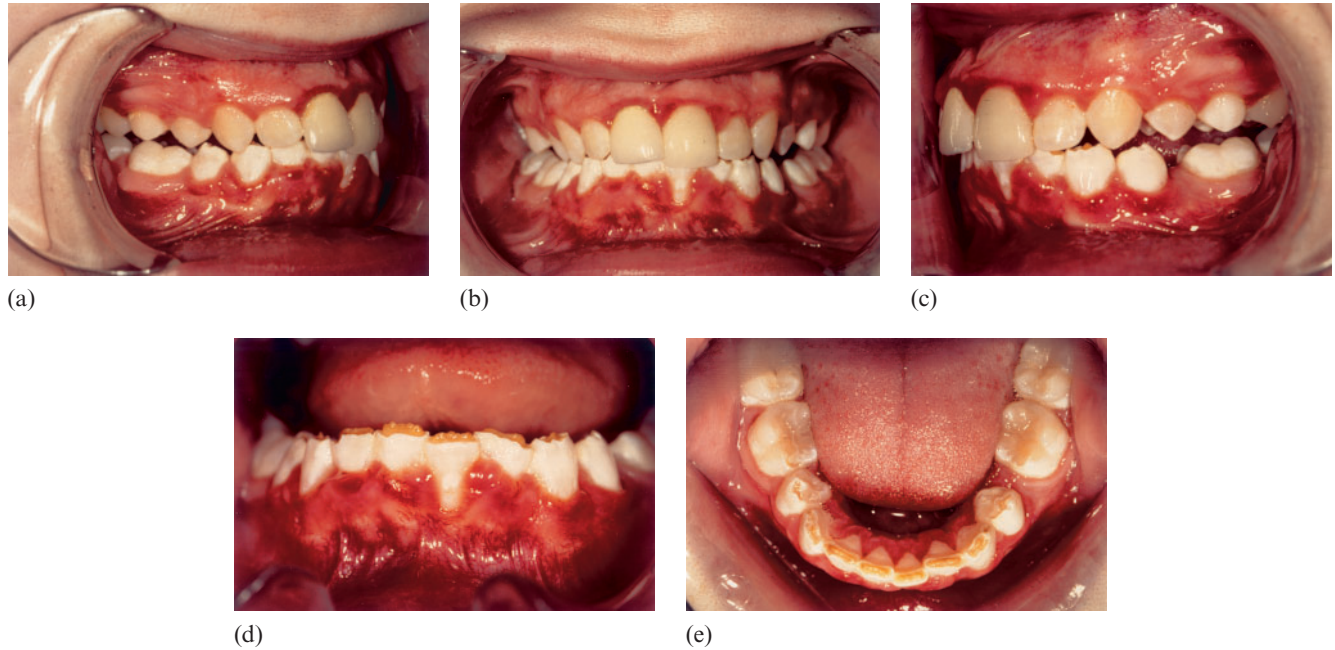
incisors. The patient was discharged back to her GDP with restorative and preventative treatment plans, and advised to discontinue wear of her Twin Block appliance.

*Case 4*

A 13-year-old boy was referred to the Orthodontic Department of his local General Hospital for treatment



**Figure 3** (a–e) Case 2: intra-oral views



**Figure 4** (a–e) Case 3: intra-oral views

of his overcrowded dentition and increased overjet. Clinically, he had a severely crowded Class II division 2 malocclusion. Active caries was evident in four molar teeth and oral hygiene was assessed as fair to poor. The patient's GDP was asked to restore the carious molars and to give intensive preventive advice. When he was reviewed, the oral hygiene was good and there was no evidence of further caries. It was decided to treat him with a modified Twin Block appliance.

Early treatment was promising with proclination of the upper labial segment and reduction of the overjet. His oral hygiene, however, was consistently problematic, with instructions being reinforced regularly. At month 12 slight cervical demineralization and gingival hyperplasia were noted, which intense OHI appeared to address by month 13. Unfortunately, the oral hygiene deteriorated further and at the next visit severe demineralization of the mandibular incisal edges with

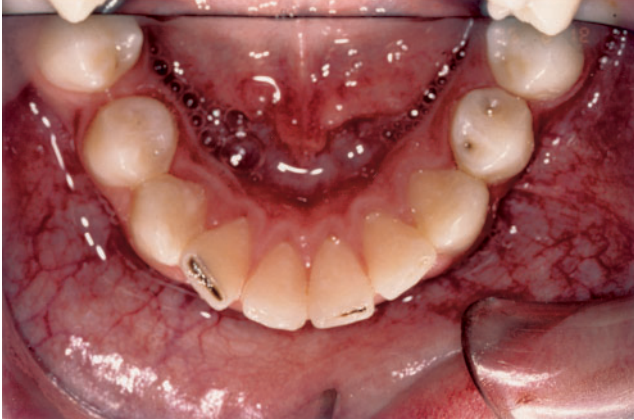
frank caries was evident (Figure 5a–c). Radiographs showed carious lesions in five other teeth. The patient reported an increased intake of carbonated drinks, particularly between meals. Appliance therapy was discontinued and he was urgently referred to his GDP for restorative work.

#### Case 5

A 14-year-old boy was referred to the Orthodontic Department of his local General Hospital for treatment of an increased overjet. He presented with a 15 mm overjet, crowding in both arches and unacceptable oral hygiene. The initial treatment plan was to remove the remaining deciduous second molars and the heavily restored lower first permanent molars. This was combined with vigorous oral hygiene instruction. At review his oral hygiene had improved sufficiently to start



**Figure 5** (a–c) Case 4: intra-oral views



**Figure 6** Case 5: intra-oral views

functional appliance therapy with a modified Twin Block appliance.

The overjet was reduced by 14 mm in 10 months, then retained with nocturnal wear of the appliance. Unfortunately, during this period of retention, his oral hygiene and attendance deteriorated. After 9 months, demineralization and caries of two of the incisal tips of the mandibular incisors was observed (Figure 6). The patient revealed a diet history of an increased intake of carbonated drinks; particularly frequent sipping of carbonated drinks between meals and late at night. Orthodontic treatment was ceased immediately and the patient referred to his general dental practitioner with a preventative treatment plan to stop the lesions progressing.

## Discussion

The majority of patients benefit from their Twin Block treatment with positive treatment outcomes. These five cases all had traits in common, four demonstrated problems with oral hygiene and all five had a high intake of carbonated soft drinks. It is easy with hindsight to say that lower labial segment capping should not be used for these patients. Indeed, it could be argued that these patients should not have received orthodontic treatment. However, all had demonstrated good oral hygiene and good compliance prior to active treatment. The demineralization and caries experienced in all five was rapid in its onset, and in the more advanced cases additional carious lesions were diagnosed further posteriorly in both the mandibular and maxillary teeth.

The cases illustrated demonstrate a range in severity of lower incisor demineralization; case 3 having the most advanced lesions with pulpal involvement and case 5 the mildest symptoms, demonstrates the location of the earliest lesions starting at the tips of the incisors,

demineralizing the enamel before softening the dentine and progressing into carious lesions.

These cases highlight a specific problem of patient compliance. Twin Block appliance therapy is associated with around a 16% non-cooperation rate.<sup>19</sup> However these five patients wore their appliances well, as can be seen by the lateral open bites demonstrated in cases 1–4, and case 2 also demonstrated excellent oral hygiene. What they all have in common is an increased frequency of intake of carbonated soft drinks leading to the pattern of disease seen. It is relatively easy to monitor compliance to wearing an appliance by measuring its effects, and by changes, such as speech and scuffing of the appliance surface caused by general wear. Oral hygiene is also relatively easy to monitor, with plaque scores and bleeding indices. Dietary compliance is more difficult to monitor as patients are often economical with the truth and problems may only become apparent when demineralization is present.

Capping of the lower labial segment produces a potential stagnation area, which harbors plaque if oral hygiene and appliance care are not followed. Frequent sipping of carbonated soft drinks will result in a persistent and prolonged drop in pH, and as the drink flows around the incisors it will pool below the appliance. It may be beyond the buffering and self-cleansing actions of the saliva to inhibit remineralization. In such a hostile environment rapid demineralization can occur.

Several alternative modifications to the anterior retention of the Twin Block appliance have been described. These include the use of heat-cured acrylic and ball clasps for retention, or the use of acrylated lower labial bows<sup>17</sup> and lower 'suck-down' appliances incorporating the mandibular acrylic blocks. However, the final choice of appliance design will always remain the responsibility of the prescribing clinician. There appears to be scope to test the merits of the various appliance designs in the clinical environment.

If using incisal capping, the orthodontist must check the lower incisors at each visit for signs of demineralization. At the first sign of demineralization reinforcing tooth brushing instruction, advising a daily fluoride mouthwash, and applying a topical fluoride varnish may help stop the demineralization and encourage remineralization (Table 1). It is also beneficial to have the patient compile a detailed diet diary in order to identify potential risk factors.

Adolescence is a time of new found independence and rapid physical growth. Eating patterns alter as appetites increase, leading to snacking between meals, often with a high proportion of the food and drinks containing added sugar.<sup>7–9</sup> The increased consumption of carbonated soft drinks between meals within this group is of

**Table 1** Preventive regime in the event of demineralization

Document pattern of demineralization			Clinical photographs
Appliance wear			Consider pause in treatment. Cessation of treatment if severe
Counsel patient and parent			Letter to general dental practitioner
Tooth brushing instruction	1450 ppm fluoride paste	After all meals	Spit away excess toothpaste without rinsing
Fluoride mouth rinse	0.05%	Once daily	Remove appliance
		At different time to brushing	Rinse for 1 minute. Replace appliance immediately
Topical fluoride varnish (Duraphat)	23,000 ppm	At diagnosis	Apply to areas of clinical demineralization at monthly visits
Diet diary		At diagnosis	To include all foods and drinks. No sugary foods or drinks between meals. Avoid acidic drinks

concern to orthodontists and the dental profession in general. Frequent sipping of acidic carbonated soft drinks is the most destructive pattern as it allows very little recovery time for the oral environment to achieve a neutral pH balance. The effects of these drinks are two-fold. Their low pH is sufficient to leach ions directly from the dental hard tissues, and they can supply acidogenic bacteria with a sugary substrate to further decrease pH and prolong the acid challenge to the teeth. The move by the soft drinks industry to package drinks in screw-top plastic bottles, rather than aluminium cans raises the concern that more damage may occur as many teenagers carry these bottles with them, sipping regularly, rather than consuming an entire can in a shorter time. Whatever the answer may be, warnings about frequent carbonated soft drink consumption remain high on diet advice regimes.

## Conclusion

Frequent sipping of carbonated soft drinks in patients wearing appliances incorporating lower labial segment capping can lead to a pattern of rapid demineralization and caries of the incisor and canine tips. It may be preferable to omit this capping for patients with a previous checkered history of poor motivation and poor oral hygiene, and to use alternative designs or materials in appliance construction to provide sufficient structural integrity. Even without capping, however, it is possible for demineralization to occur under other parts of the appliance (such as the occlusal covering over the cusps of the premolars and molars).

Patients (and their orthodontists) may benefit from lower labial segment capping producing a stronger appliance, and avoiding the inconvenience caused by

appliance fractures, providing they have good oral hygiene and limited exposure to carbonated soft drinks.

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