

Dilemma of Orthodontic Treatment in Fluorosed / Hypomineralised Enamel Teeth: A Case Report

Noor Ayuni Ahmad Shafiai^{1*}, Alizae Marny Mohamed²

1. Cluster of Craniofacial and Biomaterial Science, Advanced Medical and Dental Institute (IPPT), Universiti Sains Malaysia.
2. Discipline of Orthodontics, Department of Family Oral Health, Universiti Kebangsaan Malaysia(UKM), Jalan Raja Muda Abdul Aziz, Kuala Lumpur, Malaysia.

Abstract

The most common iatrogenic damage during orthodontic treatment includes white spot lesion and gingivitis, and for a patient presented with hypomineralised enamel (fluorosis), orthodontic treatment requires emphasis on preventing further deterioration of enamel layer.

This case reports successful management of a 16-year-old orthodontic patient wearing fixed appliance, presented with class II division 2 malocclusion, complicated with severe crowding in upper and lower arch and the teeth were generally in moderate hypomineralised enamel.

The increase risk and challenges of treating fluorosed enamel for orthodontic treatment were discussed in this report, and they comprised of bracket failure, microfracture during debonding, minimizing plaque retention to prevent further decalcification, hypersensitivity of teeth and inefficient second order bend.

Case report (J Int Dent Med Res 2020; 13(2): 719-726)

Keywords: Canine extraction, Class II division 2, Fluorosis, Hypomineralised enamel, Orthodontic.

Received date: 15 August 2019

Accept date: 24 December 2019

Introduction

Fluoride promotes enamel remineralisation with a more acid-resistant fluoroapatite, formation of the apatite crystal lattice of enamel and it is widely recommended for anti-caries agent in oral healthcare. However, when there is an excessive fluoride ingestion during tooth formation, fluorosis occurs where it raises a concern with the aesthetic of the teeth as it appears mottled and in severe condition, physically damaged.

Fluorosis is characterised by a white opaque appearance of the enamel caused by increased subsurface porosity or poor in mineralisation (hypomineralisation). The degree and extent of the porosity depend on the concentration of fluoride in the tissue fluids during tooth development. The structural

arrangement of the crystals appears normal, but the width of the intercrystalline spaces is increased, causing pores.¹

Hypomineralised teeth can be challenging in the treatment of orthodontic using fixed appliance. The defect in the enamel leads to concern whether the enamel can withstand the force during treatment and when debonding the appliances. Above the hypomineralised layer in the enamel, there is an outer well-mineralised acid-resistant surface which prevents etching by conventional 37% phosphoric acid, resulting in inconsistent etch patterns and unreliable surface for orthodontic bonding.² Debonding of the appliance can cause fractures to the fragile enamel and must therefore be performed with caution.

Severe crowding is usually associated with difficulty in cleaning, hence increases the risk of caries and periodontal disease, justifying the benefit of orthodontic treatment. However there is weak evidence that severe crowding has a deteriorating effect in caries.³ In fact, a systematic review concluded that orthodontic treatment may even slightly increase the risk of developing periodontal disease.⁴ Therefore, for a patient with hypomineralised enamel and severe crowding to embark on orthodontic journey, the

*Corresponding author:

Noor Ayuni Ahmad Shafiai
Dental Lecturer and Orthodontist
Cluster of Craniofacial and Biomaterial Science,
Advanced Medical and Dental Institute (IPPT),
Universiti Sains Malaysia,
13200 Kepala Batas, Pulau Pinang, Malaysia
E-mail: noorayuni@usm.my

aim of the treatment must be realistic and compromised, in which to improve the appearance of the teeth in terms of alignment and addressing the complaint which is to ease the everyday routine effort in cleaning and maintaining the teeth. White spot lesion is a common side effect to orthodontic treatment, hence the treatment has to be designed in such that teeth cleaning can be performed at optimum with less anchorage demand at the shortest duration of time. Less anchorage demand would avoid under tie or other additional appliance such as transpalatal arch or temporary anchorage device which allows tooth and oral mucosa surfaces more accessible to cleaning. The aim of this case report is to discuss the risks and challenges of orthodontic patient with hypomineralised enamel wearing fixed appliance and the management of it.

Case Report

A 16-year-old female patient complained of difficulties to keep her teeth clean with brushing due to misalignment on the anterior part. She was presented with class II division 2 malocclusion on class I skeletal pattern with low maxillary mandibular plane angle (MMPA) and lower anterior face height (LAFH), which caused prominent deep overbite and labiomenthal fold. She was medically fit with no history of dental trauma.

In the frontal view, patient was presented with symmetrical face. Her lips were competent and there was normal incisal show upon smiling. In the lateral view, patient was presented with straight profile, normal nasolabial fold and deep labiomenthal fold. Intraorally, there was gingivitis and calculus especially on labial and lingual of anterior segments which indicated poor oral hygiene. Basic Periodontal Examination (BPE) scored 2 in all sextants. According to Dean's Index, the teeth were categorized as moderately hypomineralised with caries cavity on mesial of maxillary left lateral incisor.

Old composite restoration was noted on maxillary central incisors, mandibular canines and mandibular right molar, as well as amalgam restoration on mandibular left molar, in which all were still intact. There was severe crowding on upper and lower arches, deep overbite (80% complete to teeth) and crossbites involving maxillary laterals and mandibular canines.

Canine relationships were class I on the right and class III ¼ on the left, while molar relationship was class I bilaterally. Posterior segment interdigitation was good (Figures 1 and 2).

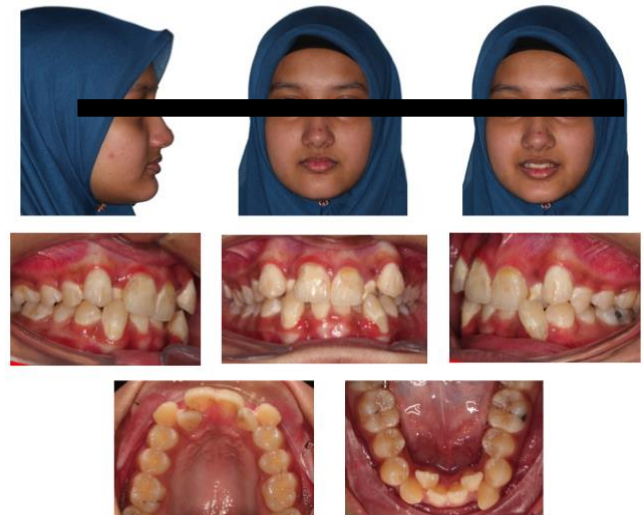


Figure 1. Pretreatment facial and intraoral photographs.



Figure 2. Pretreatment dental casts.

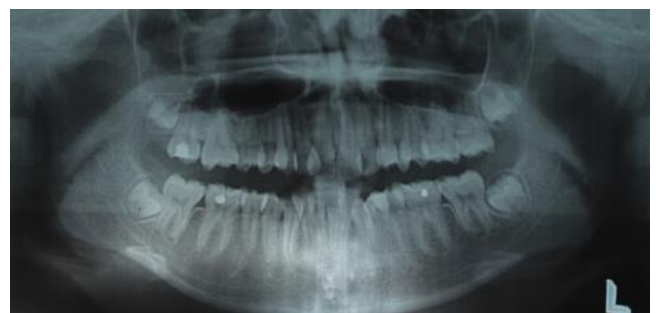


Figure 3. Pretreatment panoramic radiograph.

Panoramic radiograph (OPG) showed all the teeth were present with developing third molars. Radiolucency at the mesial of maxillary left lateral incisor confirmed the presence of caries. No other abnormality was noted (Figure 3). Cephalometrically, she had normal position of maxilla and mandible in relation to the cranial

base. The mandibular incisors were retroclined and maxillary teeth were uprighted, a typical presentation of class II division 2 malocclusion (Table 1 and Figure 4).

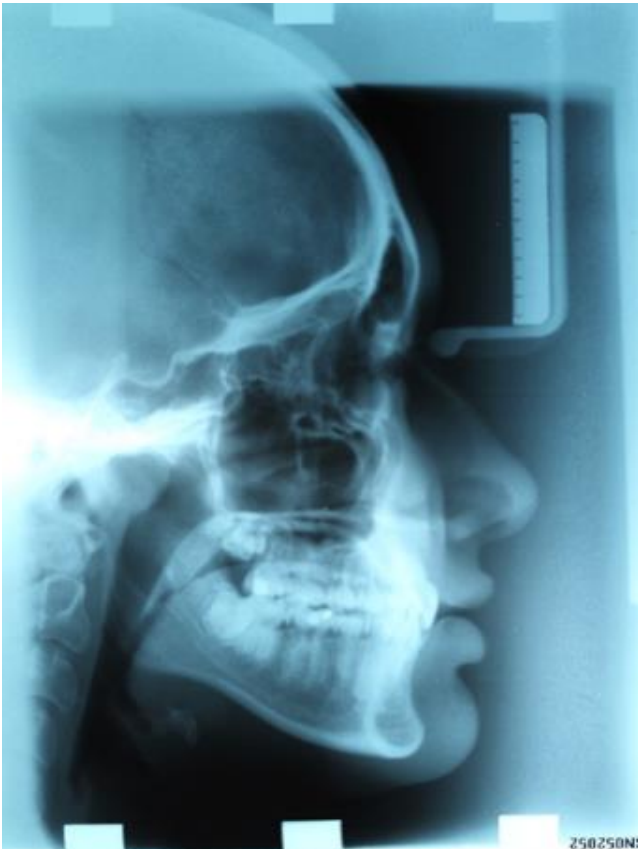


Figure 4. Pretreatment cephalometric radiograph.

The aims of this treatment were to improve oral hygiene, restore caries of maxillary left lateral incisor, relief crowding on upper and lower arch, establish ideal overbite, correct crossbite on maxillary lateral incisors, achieve favourable inclination of the maxillary and mandibular incisors, maintain the profile and avoid excessive lip protrusion. After thorough discussion with the patient and her mother, they decided on treatment option of extracting all canines. Mandibular canines presented with large composite on the buccal surface. They were also positioned directly to the buccal of lateral incisors, hence their extraction would align the lingually displaced lateral incisors in a short period of time. Extraction of lateral incisors would also reduce treatment time, however the canines shape and morphology was not in favour for substitution. Extraction of first premolars would increase treatment time during retraction of canines, where the retraction accessory such as

power chain elastic or close spring may increase plaque accumulation.

The main issue with the case of hypomineralised enamel teeth was to minimise factors which would cause further decalcification of her teeth, and the condition of her gingiva had to be improved before fixation of upper and lower appliance. Therefore, she had undergone oral hygiene care for 6 months. Gradually she received oral hygiene education, scaling, maintenance and assessment of the health of gingiva prior to treatment. Caries on maxillary left lateral incisor was restored. Upper and lower pre-adjusted edgewise appliance (0.022" x 0.028") with MBT prescription was prescribed. Every time patient attended appointments, she had to be consistently emphasised on using fluoridated toothpaste with the aid of interdental brushes. She was also reminded to regularly use fluoridated mouthwash.

The bonding of fixed appliance was delivered through self-etching primer (Transbond XT Primer). The initial alignment stage involved the use of 0.016" nickel titanium (NiTi) archwire on upper arch and 0.014" NiTi on lower arch. When the 0.018" stainless steel (SS) archwire was prescribed, the rotation of maxillary right lateral incisor was corrected with the use of powerchain elastic from the tooth to maxillary right first premolar, and close coil spring was used in the archwire between the two teeth to maintain the space for maxillary right lateral incisor alignment (Figure 5).



Figure 5. Mid-treatment photographs – alignment of palatally displaced and rotated UR2.

Levelling and alignment were further proceeded using 0.017"x0.025" NiTi, 0.019"x0.025" NiTi and 0.019"x0.025" SS archwires. During treatment, the use of ligature wires underneath the archwires was prevented to reduce the difficulty of cleaning her teeth. This patient also experienced teeth sensitivity on cold

water and air therefore the airblast from the handpiece during teeth cleaning and drying had to be restricted. There were concerns with decreased bracket bonding strength but there was no episode of bracket bonding failure on this patient. At 10 months of treatment where all spaces had closed, it was noted that the crown of maxillary left lateral incisor was not levelled and from OPG, the root was distally angulated, hence bracket was repositioned which took another 4 months of treatment for correction (Figure 6).



Figure 6. Near-end treatment panoramic radiograph.

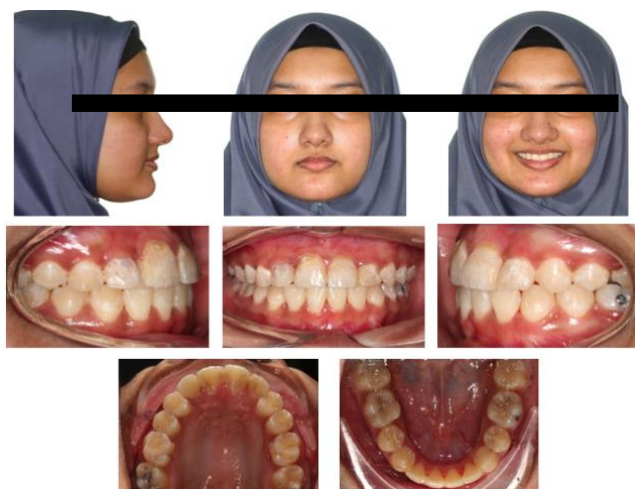


Figure 7. Posttreatment extra- and intraoral photographs.



Figure 8. Posttreatment dental models.

The total treatment time was 14 months. She was given vacuum formed retainers with the protocol of wearing full time for six months followed by night-time wear for another six months.

This patient was successfully treated by orthodontic camouflage over 14 months. She was generally happy with the alignment of her teeth and original treatment aims were accomplished (Figures 7 and 8). At the near-end treatment cephalometric radiograph, records showed antero-posterior skeletal pattern was maintained and there was a favourable vertical increase in LAFH and MMPA (from 19° to 22°) and it could largely be due to the proclination of the mandibular incisors. The inclination of maxillary incisors was increased from 109° to 120° to allow for correction of the mandibular incisors inclination (from 86° to 90°). This action caused overbite correction as well (from 80% to 20%). The mandibular incisors inclination at 90° was still considered retroclined (as this patient had low MMPA), however further uprighting the mandibular incisors would require for more proclination of the maxillary incisors and high chances of relapse. 120° was already beyond the average inclination of maxillary incisors. Interincisal angle was reduced but still within an average value (125°).

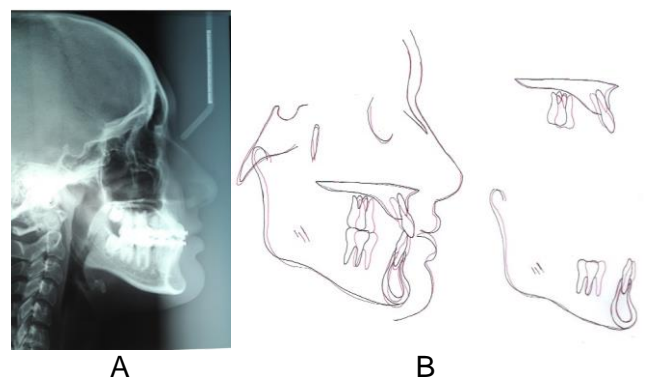


Figure 9. Near-end cephalometric radiograph (A) and superimposition of initial (black) and final (red) tracing (B).

According to soft tissue superimposition, there was a slight retrusion of the upper lip shown by the increased in nasolabial angle as well as additional distance of 1mm of lower lip to the Ricketts E plane. At the maxillary superimposition, it was noted that the maxillary incisors tip was maintained at its position and the increase in the inclination was due to palatal root

torque. In addition, there was extra 3.5mm of space after extraction on upper arch which may cause lip retrusion. However, clinically this was not significant and patient still maintained the favourable straight profile (Figure 9 and Table 1). Posterior segment interdigitation was maintained providing a stable occlusion. There was absence of canine guidance, however group function during lateral excursion of the mandible was achievable with no associated non-working side interferences.

	Measurements	Normal	A	B	Diff. A/B
Skeletal pattern	SNA	82°	81°	82°	+1°
	SNB	80°	79°	80°	+1°
	ANB	2°	2°	2°	0°
	Wits	0 ± 2mm (female) 1 ± 2mm (male)	2mm	-2mm	-4mm
	SN-Mx PA	8°	15°	12°	-3°
	MMPA	27°	19°	22°	+3°
	FMA	25°	19°	22°	+3°
Dental pattern	1-Mx	108°	109°	120°	+11°
	1-Mn	92°	86°	90°	+4°
	Interincisal angle	133°	145°	125°	-20°
	1-APO	0-2mm	-1mm	1mm	+2mm
Profile	LAFH ratio	55%	54%	54.4	+0.4%
	Lower lip-Ricketts E Plane	-2mm	-3mm	-4mm	-1mm
	Nasolabial angle	102°	110°	117°	+7°

Table 1. Cephalometric status at the pretreatment and near-end treatment stages.

No complaint of temporomandibular joint dysfunction (TMD) was reported. No significant changes in the root length of the dentition were detected. Gingiva appeared healthy, however inevitably there was some evidence of decalcification surrounding the position of brackets. This was expected as orthodontic patients do have increased prevalence of white spot lesion⁵ and the risk is higher for those with fair (2.7 times) or poor (3.5 times) oral hygiene and poor gingival health (2.3 times) during treatment.⁶

Patient was reassured that there would be enamel remineralisation in the first 6-12 weeks following fixed appliance removal, provided that she maintained good oral hygiene.

Discussion

The malocclusion of this case can be considered simple but the main objective with this report is the risks and challenges

encountered during the treatment on hypomineralised enamel. Orthodontic treatment is commonly associated with adverse effects such as decalcification, caries, periodontal disease, root resorption and pain.⁷ For a patient initially presented with white spot lesion due to enamel hypomineralisation, complicated by severe crowding and poor oral hygiene, proceeding with orthodontic treatment weighs more on risks rather than benefit. However, it is not contraindicated as long as preventive measures are taken to minimize the risks. Thorough explanation to the patient and parents even before commencing treatment is very important as it will give them overall expectation towards the aim and process of treatment, and the crucial issue of maintaining high standard of oral hygiene.

The main challenges in treating fluorosed/hypomineralised teeth are whether the enamel can withstand the force during treatment, and when debonding the appliances. Fluorosed enamel significantly decreases the bond strength of bracket as there is an outer well-mineralised acid-resistant surface which prevents etching, resulting in inconsistent etch patterns and unreliable surface for orthodontic bonding.^{2,8} Several methods have been suggested for these limitations. For the issue of weak bond attachment, glass ionomer cement-based adhesives were recommended as they rely on chelation with calcium ions rather than mechanical tagging to attach. Other methods include the use of sodium hypochlorite to improve quality of etch and also increase etch time but all these had been proven to be weak in evidence.⁹ One case study reported the use of microabrasion before etching for fluorosed teeth.¹⁰ It was performed using Microetcher II dental instrument with 50 µm of aluminium silicate for 5 seconds to remove the acid-resistant hypermineralised surface layer and to increase orthodontic bracket bonding efficiency.

In this case, self-etching primer was used to bond the brackets as it was proven to increase shear bond strength of brackets to fluorosed enamel.^{2,8} The hydrophylic component in the hydroxyethyl methacrylate (HEMA) molecules contained in the self-etching primer helps resin to infiltrate enamel etched at the level of the prisms, hence reducing interfacial porosity and increasing adhesion. There was no incident of bracket failure in this patient. However, although

the bond strength is increased, bond failure using self-etching primer is found to be more at the enamel-adhesive interface.⁸

During debonding where enamel surface was initially compromised, microfracture is inevitable. The procedure was performed using slow speed tungsten carbide bur as it was found to remove the least enamel in comparison to high speed carbide bur and ultrasonic scaler.¹¹ Plastic brackets are also an alternative from metal ones, as they can be removed with a handpiece without damaging the enamel surface. Dental fluorosis is characterized by opaque lines following the outline of perikymata. As the fluorosis become severe, the opaque lines merge and more irregular cloudy areas become visible and in much severe cases, the enamel surface has total opaque chalky appearance.

The unaesthetic appearance of fluorosis, combined with the inevitable white spot lesion from the orthodontic treatment are not a favourable condition for patients. Reducing the amount of plaque accumulation during treatment would minimize the appearance of white spot lesion. This action requires collaboration from both sides; the orthodontist and patient. At the beginning of treatment, orthodontist must highlight the importance of maintaining high standard of oral hygiene during application of fixed appliance. For this case, patient was presented with poor oral hygiene, hence she was placed for oral hygiene care for six months which included oral hygiene education, scaling, maintenance and assessment of the health of gingiva. When the oral hygiene was good, discussion on the orthodontic treatment plan was discussed. Things to consider when planning the treatment were to keep the duration of treatment as short as possible and to use less under wire ligation.

Katie et al (2013) reported nearly 25% of patients significantly developed white spot lesion depending on fluorosis severity, treatment time, pre-existing white spot lesion and oral hygiene.¹² In this case, extraction of all canines had clearly resolved crowding much faster especially on the lower arch where the canines were positioned directly buccal to the lateral incisors. Extraction of the mandibular canines allowed for quick alignment of lingually displaced lateral incisors. Besides, there was also large composite restoration at the labial of mandibular canines. Thiruvengkatachari et al. (2017) reported no

significant difference was found in the smile attractiveness between subjects with canine or premolar extraction.¹³

Another main issue in treating patients with hypomineralised enamel is teeth sensitivity. From patients self-reporting sensitivity level, 28.7% of fluorosis group positively answered to teeth sensitivity in their daily life, but only 5.42% of them actually showed positive teeth sensitivity when subjected to clinical examination. However the sensitivity level frequency was significantly different when compared between fluorosis and non-fluorosis group.¹⁴ This could be due to the effect of fuorosis on enamel structure. High amount of dentin fluoride concentration is related to increased porosity, higher protein levels, lower amounts of minerals and in severe cases, the formation of pitted surface.¹⁵

One study reported wider dentin tubules were shown in higher dentin fluoride concentration.¹⁶ Due to the widening of dentinal tubules, some even suggested bacterial invasion causing an inflammatory response in the pulp which leads to hypersensitivity. Inflammatory changes in the pulp of hypomineralised enamel were observed¹⁷ but inflammation due to bacterial invasion have yet to be reported. This patient was very sensitive towards cold air. Airblast from the handpiece during teeth cleaning and drying had to be restricted hence the cotton pellet and gauze were used regularly around the brackets for the comfort of patient.

Alignment of the crown and closing up space was actually achieved within 10 months of treatment and another 4 months was spent on correcting the alignment of the root of maxillary left lateral incisor by bracket repositioning. Another method of correcting the angulation of the root, and also more suitable for cases with enamel hypomineralisation is performing second order bend on the archwire. This will prevent additional microfracture of the enamel during debonding and tooth sensitivity. However, applying second and third order bends can be difficult in hypomineralised teeth, as there is lack in uniformity in the enamel coverage, hence more detailing bend is needed.¹⁸ This was a difficult choice whether to correct the root angulation or not, as the main plan was to finish treatment as soon as possible, however patient was determined at correcting the root alignment.

For class II division 2 cases, correction of the overbite and interincisal angle can be

achieved by proclination of the maxillary or mandibular incisors, or both, so that the tip of mandibular incisor occludes onto the cingulum of the maxillary incisor. It is highly recommended to place permanent retention on the lower lingual segment for the enhancement of stability of lower incisors¹⁹; however for this case, the changes in proclination was only 2mm and considered stable.²⁰ Dual retention (bonded retainer and vacuum formed retainer) may be prescribed to this patient. However, considering this patient's poor oral hygiene, only vacuum formed retainer was prescribed. Permanent retention is usually associated with significant long term failure rate and collecting greater plaque and calculus deposition.²⁰

Post-orthodontic decalcification should not be managed in a rush, as time should be given for remineralisation of the white spots. For this patient, she was advised to continue using fluoridated toothpaste while toothbrushing. It was not advisable to apply fluoride varnish at early stage after debonding, as it would arrest the lesion and the chance of remineralisation will be diminished.⁷

It would be appropriate to review this patient regularly in terms of monitoring the relapse and reduction in white spot lesions. Should in later life, improvement of the white lesion due to hypomineralisation is required, the treatment options will be microabrasion, vital tooth bleaching or restoration.

Conclusions

Treating orthodontic cases with hypomineralised teeth is not a contraindication for using fixed appliance, however the risk and challenges with this enamel defect need to be acknowledged. The increase risk and challenges are 1) bracket failure, 2) microfracture during debonding, 3) minimizing plaque retention to prevent further decalcification 4) hypersensitivity of teeth and 5) inefficient second order bend.

Acknowledgements

This work has been presented at 2019 Association of Orthodontic Singapore Conference as poster. All authors have made substantive contribution to this study and/or manuscript, and all have reviewed the final paper prior to its submission.

Ethical Approval: All procedures performed in studies involving in human participations were in accordance with the ethical standards of the institution and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Declaration of Interest

The authors declares that there is no conflict of interest.

References

1. Mascarenhas AK. Risk Factors for Dental Fluorosis: A Review of the Recent Literature. *Pediatr Dent* 2000;22(4):269-77.
2. Wiltshire WA, Noble J. Clinical and Laboratory Perspectives of Improved Orthodontic Bonding to Normal, Hypoplastic, and Fluorosed Enamel. *Semin Orthod* 2010;16(1):55-65.
3. Hafez HS, Shaarawy SM, Al-Sakiti AA, Mostafa YA. Dental Crowding as a Caries Risk Factor: A Systematic Review. *Am J Orthod and Dentofacial Orthop* 2012; 142(4):443-50.
4. Bollen A-M, Cunha-Cruz J, Bakko DW, Huang GJ, Hujoel PP. The Effects of Orthodontic Therapy on Periodontal Health: A Systematic Review of Controlled Evidence. *J Am Dent Assoc* 2008;139(4):413-22.
5. Sundararaj D, Venkatachalapathy S, Tandon A, Pereira A. Critical Evaluation of Incidence and Prevalence of White Spot Lesions During Fixed Orthodontic Appliance Treatment: A Meta-Analysis. *J Int Soc Prev Community Dent* 2015; 5(6):433-39.
6. Brown MD, Campbell PM, Schneiderman ED, Buschang PH. A Practice-Based Evaluation of the Prevalence and Predisposing Etiology of White Spot Lesions. *Angle Orthod* 2016;86(2):181-86.
7. Talic NF. Adverse Effects of Orthodontic Treatment: A Clinical Perspective. *Saudi Dent J* 2011; 23(2):55-9.
8. Adanir N, Turkkahraman H, Yalin Güngör A. Effects of Adhesion Promoters on the Shear Bond Strengths of Orthodontic Brackets to Fluorosed Enamel. *Eur J Orthod* 2009;31(3):276-80.
9. Chen C-F, Hu JC, Bresciani E, Peters MC, Estrella MR. Treatment Considerations for Patient with Amelogenesis Imperfecta: a Review. *Braz Dent Sci* 2013;16(4):7-18.
10. Marure P, Mahamuni A, Ambekar A, Kangane S, Joshi Y, Khanapure C. Orthodontic Bracket Bonding Challenge for Fluorosed Teeth. *J Int Oral Heal* 2016;8(4):476-80.
11. Ireland AJ, Hosein I, Sherriff M. Enamel Loss at Bond-Up, Debond and Clean-Up Following the Use of a Conventional Light-Cured Composite and a Resin-Modified Glass Polyalkenoate Cement. *Eur J Orthod* 2005;27(4):413-19.
12. Katie C. Julien, Peter H. Buschang, Philip M. Campbell. Prevalence of White Spot Lesion Formation During Orthodontic Treatment. *Angle Orthod* 2013;83(4):641-47.
13. Thiruvengkatachari B, Javidi H, Griffiths SE, Shah AA, Sandler J. Extraction of Maxillary canines: Esthetic Perceptions of Patient Smiles Among Dental Professionals and Laypeople. *Am J Orthod Dentofac Orthop* 2017; 152(4):509-15.
14. Mine Ozturk Tonguc, Yener Ozat, Tugba Sert, Yonca Sonmez, F. Yesim Kirzioglu. Tooth Sensitivity in Fluorotic Teeth. *Eur J Dent* 2011;5(3):273-80.
15. Lyaruu DM, Bervoets TJM, Bronckers ALJJ. Short Exposure to High Levels of Fluoride Induces Stage-Dependent Structural Changes in Ameloblasts and Enamel Mineralization. *Eur J Oral Sci* 2006;114(Suppl. 1):111-15.

16. Vieira APGF, Hancock R, Dumitriu M, Limeback H, Grynpsas MD. Fluoride's Effect on Human Dentin Ultrasound Velocity (Elastic Modulus) and Tubule Size. *Eur J Oral Sci* 2006; 114(1): 83-8.
17. Rodd HD, Boissonade FM, Day PF. Pulpal Status of Hypomineralised Permanent Molars. *Paediatr Dent* 2007;29:514-20.
18. Arkutu N, Gadhia K, McDonald S, Malik K, Currie L. Amelogenesis Imperfecta: The Orthodontic Perspective. *Br Dent J* 2012;212(10):485-89.
19. Millett DT, Cunningham SJ, O'Brien KD, Benson PE, De Oliveira CM. Treatment and Stability of Class II Division 2 Malocclusion in Children and Adolescents: A Systematic Review. *Am J Orthod and Dentofacial Orthop* 2012; 142(2):159-69.
20. Johnston CD, Littlewood SJ. Retention in Orthodontics. *Br Dent J* 2015;218(3):119–22.