Laser fluorescence diagnosis of enamel remineralisation after fixed appliance therapy

K. MÁRTHA*, B. PETCU[a], C. BICĂ[b]
University of Medicine and Pharmacy Tîrgu Mureş, Faculty of Dentistry, Department of Orthodontics
[a]*University of Medicine and Pharmacy Tîrgu Mureş, Faculty of Dentistry, Department of Preventive Dentistry*
[b]*University of Medicine and Pharmacy Tîrgu Mureş, Faculty of Dentistry, Department of Pediatric Dentistry*

The aim of this study was to assess enamel remineralization and to perform early caries diagnosis after fixed appliance therapy using the laser fluorescence technique (DIAGNOdent Pen, KaVo Dental, USA). 15 patients were selected from those who were referred for orthodontic therapy. Early caries detection was performed right after debonding and one month after the fixed appliance was removed. The most affected teeth were found to be the upper first bicuspids but in 87.62% of the 176 examined surfaces remineralization took place in only one month after debonding. Remineralization after fixed appliance therapy is possible if good oral hygiene is maintained.

(Received November 6, 2015; accepted November 25, 2016)

Keywords: Laser fluorescence, Enamel remineralization, Orthodontic fixed appliances

1. Introduction

Before fixed appliance is directly bonded, labial surface of teeth should be prepared by acid etching. During therapy, bonded brackets will create an environment that can provide mineral loss from enamel surface and after debonding and remnant resin removal, the previously etched enamel surface can be affected by demineralization, and early caries could appear. Diagnosis of these demineralized zones and detection of early caries can be done by using several methods including visual and radiographic examination [1]. Since 1998, in order to improve the usual methods, first by introduction of optical fiber and digital radiographic techniques, followed by laser fluorescence method, the diagnostics of early caries became much easier. All optical diagnostic approaches are based on lighttissue interactions and the differences observed between the characteristics of normal and abnormal tissue sites [2]. Laser fluorescence based DIAGNOdent can be considered a complementary tool in decay detection [3]. Diode laser with 655 nm wavelength is irradiated on dental surface, metabolites of intraoral bacteria will absorb it and these metabolites will emit red fluorescence. The level of absorption and emission is indicated as a value varying between 0 and 99 which will appear on the screen of the device. Numbers between 0 and 10 will indicate sound enamel, values between 11 and 20 show early caries of enamel surface, results of 21-30 will appear in deeper enamel caries and numbers greater than 30 will show dentin caries, which can be detected visually. As all medical devices, laser fluorescence must have as main purpose to offer maximum efficiency for the patient without endangering life or health [4].

2. Experimental part

2.1. Material and methods

Fifteen subjects (8 female, 7 male), with a mean age of 16.2±1.1 years were selected for this study from patients referred for orthodontic treatment at the Orthodontic Department of University of Medicine and Pharmacy Tîrgu Mureș, Romania. All the selected subjects were treated with fixed appliance therapy; the average treatment time was 21.5±10.5 months. A written informed consent was obtained from the patients or their legal representative before the first measurement. The protocol was reviewed and approved by the Ethical Committee of Scientific Research of the University of Medicine and Pharmacy Tîrgu Mures, decision No. 117/21.11.2013.

Inclusion criteria were: (1) young permanent dentition, (2) good general health and oral hygiene (plaque index PI<2) before and during orthodontic treatment, (3) no resin remnants around brackets before debonding, (4) non smoking patients and (5) no extra fluoride administered during the last month before debonding.

Laser fluorescence measurements were performed at two times: (T1) right after debonding and remnant bonding material removal and (T2) one month after debonding. Debonding was performed with special plier, remnant bonding material was removed with low speed burs. Between the two measurements patients were instructed on the correct use of manual toothbrush and interdental brush and after T1 evaluation local fluoride varnish was applied on the labial surface of teeth.

Evaluation of the surface enamel structures was performed by laser fluorescence device (DIAGNOdent Pen, KaVo Dental, USA) on the mesial and distal third of each selected tooth surface by moving the tapered tip

along the surfaces, slightly tilted and rotated along its own axis to pick up the area where the demineralisation was most advanced. At both examination times a total of 176 sites were evaluated.

2.2. Statistical analysis

Obtained data was statistically analyzed using Fischer's exact test (Statistical Package for Social Sciences, Windows Version 15.0; SPSS Inc, Chicago, USA), the level of significance was set to 5%. Excel Version 2003 (Microsoft Corporation, Redmond, WA, USA) was used for the graphic design.

3. Results

Out of the 176 examined teeth, at T1 evaluation 131 (74.43%) sites presented values less than 10 which were considered negative. On 45 sites (25.56%) positive values were obtained. In teeth where laser fluorescence showed deeper decay, 36 (80%) presented surface enamel lesions, on 4 sites (8.88%) inner enamel decay value was obtained and on 5 teeth (11.11%) the results showed decay extended beyond enamel-dentin junction.

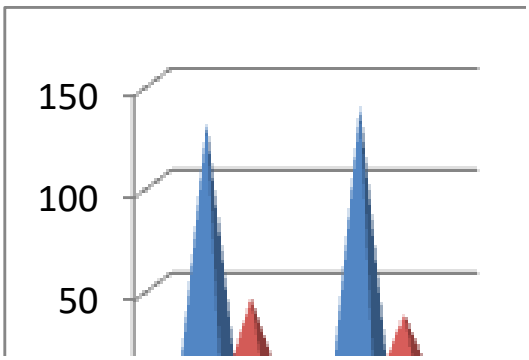

Fig. 1. Comparison of positive and negative values at T1 and T2 measurements

Regarding the type of the teeth, comparing the mean values (D medium T1) of digital values, the right first bicuspid was the most affected tooth, followed by the right central incisor and the left first bicuspid. The smallest values were obtained for the right lateral incisor. No statistically significant differences were observed among T1 and T2 values.

Comparing mean values of the two examination times (D medium T1 and D medium T2), in 87.62% of the cases smaller values were obtained for the second time as a sign of enamel remineralization which took place in one month after debonding.

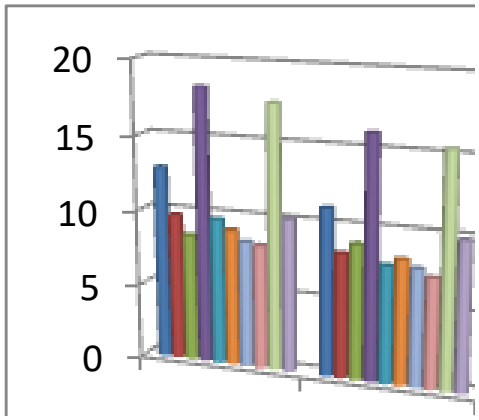

Fig. 2. Evolution of medium values for every tooth between the two examination times

4. Discussions

The laser fluorescence caries diagnostic method proved to have high sensitivity and low specificity in early caries diagnostics of young permanent teeth [5]. Examination is simple, the penetration and absorption of laser waves will describe the alteration of subsurface enamel structures, so early caries can be detected in a phase in which visual diagnostics is impossible to achieve. Teo *et al*. [6] showed that the in vivo results of International Caries Detection and Assessment System (ICDAS) and DIAGNOdent pen were satisfactory and comparable to those obtained in vitro and concluded, that The DIAGNOdent pen must be employed with caution according it's clinical relevance.

Enamel demineralization is a common risk of fixed orthodontic therapy, several studies reported that approximately a third of orthodontic patients have at least one white lesion [7,8,9]. On the other hand, orthodontic treatment is the result of orthodontic forces promoting resorption, healing, and remodeling of alveolar bone tissue [10]. The irregular surfaces of brackets, wires limit self-cleansing mechanisms based on the movement of the oral musculature or the action of the saliva, their insertion creates retentive places for plaque stagnation and makes tooth cleaning more difficult, the risk of new caries laesion appearance may increase [11]. In most of the cases, early detection of incipient caries laesions is required, for this reason DIAGNOdent is one of the tools used for that purpose [12].

Studying the incidence of white-spot-lesions on different types of teeth, maxillary anterior teeth seems to be the most commonly affected with the order of incidence being lateral incisors, canines, premolars, and central incisors however, all teeth are potentially at risk [13,14,15]. Our findings revealed that right first premolars, right central incisors and left first premolars are the most affected teeth by subsurface enamel structure alteration.

Remineralization of altered enamel or white spot lesion will occur in the first few weeks after removal of appliance and in half a year almost half of these post-treatment lesions will disappear with no specific treatment [16]. Whilst the demineralized surface remains intact,

there is a possibility of remineralization and lesion reversal [17]. It is generally believed that, when the appliances are removed and oral hygiene is restored, these lesions regress [18].

Chen *et al.* (2015) comparing caries experience of patients formerly treated with fixed appliances, calculating the DMF (decayed-missed-fiiling) index pretreatment, posttreatment and 7 years after debonding and comparing the treated group with an untreated one, showed that there was no significant difference between the treated groups and untreated groups for the DMF before received fixed orthodontic treatment. The same result was found after orthodontic treatment and the average number of DMF in the treatment jaw after fixed orthodontic treatment was lower than in the without treatment jaw after long-term follow-up period [19].

The efficacy of various remineralizing agents on the remineralization of white spot laesions was evaluated clinically and by DIAGNOdent immediately after debonding and subsequently after 1, 3, and 6 months of their use by Singh *et al.* (2015). They emphasised, that application of fluoride varnish along with twice daily use of fluoride toothpaste for 6 months significantly decreased the severity and prevalence of white spot laesions and the addition of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) had no additional benefit in the remineralization of post-orthodontic white spot laesions [20].

The same quantitative light-induced fluorescence was used to assess enamel demineralization to compare the effects of CO_2 and Nd:YAG lasers associated or not with topical fluoride application on the prevention of caries lesions around brackets by Seino *et al.* (2015). The highest demineralization occurred in the Nd:YAG laser group and CO_2 laser alone was able to control enamel demineralization around brackets at the same level as that obtained with topical fluoride application [21].

DIAGNOdent pen was also use to compare the effectiveness of fluoride varnish and 2% chlorhexidine gel for controlling white spot laesions around orthodontic brackets by Restrepo *et al.* (2016) showing, that the treatment with F was capable of controlling the progression of the WSLs in a shorter period of time [22].

Our results showed that this remineralization is present in 87.62% of the studied surfaces with no fluoride or other type of application between the two measurements. This could mean that proper plaque control, efficient manual toothbrush cleaning can be quite helpful in salivary conducted remineralization. Some white spot lesions may remineralize and return to normal conditions or at least to a visually acceptable appearance. However, white spot lesions may also persist, resulting in aesthetically unacceptable result, as opaque and/or hypoplastic areas [23].

5. Conclusions

- The use of the DIAGNOdent pen in caries detection after debonding is prooved to be a harmless diagnostic procedure.
- Laser fluorescency can detect precisly all enamel demineralisations, which cannot be detect by visual or radiological examination.
- When incipient caries laesions are examined, upper first bicuspids showed the highest values.
- Clinically undetectable surface enamel demineralisation spots can be detected right after debonding, but values obtained one month after debonding showed that salivary remineralisation processes are efficient in case of good oral health.

Further studies are required to follow these subsurface enamel structures and caries detection can be possible only if regular controls are conducted.

References

[1] J. A. Chapman, W. E. Roberts, G. J. Eckert, K. S. Kula, C. González-Cabezas, Am. J. Orthod. Dentofacial Orthop. **138**(2), 188 (2010).
[2] E. Boriskova, L. Angelova, Al. Zhelyazkova T. S. Genova, O. Semyachkina, J. Optoelectron. Adv. M. **16**(9-10), 1196 (2014).
[3] H. Nokhbatolfoghahaie, M. Alikhasi, N. Chiniforush, F. Khoei, N. Safavi, J. Lasers Med. Sci. **4**(4), 159 (2013).
[4] A. M. Stoica, A. A. Stetiu, M Buruian, M. Stetiu, M. Monea, J. Optoelectron. Adv. M. **18**(5-6), 562 (2016).
[5] A. M. Toraman, I. Peker, H. Deniz Arisu, O. Bala, B. Altunkaynak, Lasers Med Sci. **23**(3), 307 (2008).
[6] P. F. Ashley Teo, C. Louca, Clinical oral investigations **18**(3), 737 (2014).
[7] S. Lovrov, K. Hertrich, U. J. Hirschfelder, Orofac Orthop. **68**(5), 353 (2007).
[8] A. E. Richter, A. O. Arruda, M. C. Peters, W. Sohn, Am. J. Orthod. Dentofacial Orthop. **139**(5), 657 (2011).
[9] E. Tufekci, J. S. Dixon, J. C. Gunsolley, S. J. Lindauer, Angle Orthod. **81**(2), 206 (2011).
[10] A. Monea, M. Monea, D. Pop, G. Beresescu, Optoelectron. Adv. Mat. **9**(1-2), 286 (2015).
[11] A. C. B. da Silva, D. R. da Silva, P. A. P. de Oliveira, D. C. C. Souza, F. C. Sampaio, Issues in Contemporary Orthodontics Published by IntechOpen, 2015.
[12] E. Betrisey, M. Rizcalla, I. Krejci, S. Ardu, Odontology **102**(2), 330 (2014).
[13] L. Gorelick, A. M. Geiger, A. J. Gwinnett, Am. J. Orthod. **81**(2), 93 (1982).
[14] J. Artun, B. O. Brobakken, Eur. J. Orthod. **8**(4), 229 (1986).
[15] J. A. Chapman, W. E. Roberts, G. J. Eckert, et al., Am. J. Orthod. Dentofacial Orthop. **138**(2), 188 (2010).

[16] Willmot, Derrick, Seminars in Orthodontics **14**(3), 209 (2008).
[17] H. Travess, D. Roberts-Harry, J. Sandy, Br. Dent. J. **196**(2), 71 (2004).
[18] T. R. Sudjalim, M. G. Woods, D. J. Manton, Aust. Dent. J. **51**(4), 284 (2006).
[19] Chen, Weiting, Zhou, International journal of clinical and experimental medicine **8**(2), 2815 (2015).
[20] S. Singh, S. P. Sombir, A. Goyal, A. G. Utreja, A. K. Jena Progress in Orthodontics **17**(1), 25 (2016).
[21] P. Y. Seino, P. M. Freitas, M. M. Marques, F. C. de Souza Almeida, S. B. Botta, M. S. N. A. Moreira, Lasers in medical science, **30**(2), 611 (2015).
[22] M. Restrepo, D. G. Bussaneli, F. Jeremias, R. C. L. Cordeiro, D. B. Raveli et al., Journal of Clinical Pediatric Dentistry **40**(4), 274 (2016).
[23] A. Consolaro, M. F. M. Consolaro, O Rev. Clín. Ortodon. Dental Press **5**(4), 104 (2006).

*Corresponding author: marthakriszti@yahoo.com