available at www.sciencedirect.com

ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/arob

In vitro evaluation of dentin permeability of fluorotic primary teeth with a new electronic hydraulic conductance measurement system with photosensors

Münciye Semra Özay Ertürk *, *Zuhal Kırzıoğlu*

Department of Pediatric Dentistry, Faculty of Dentistry, Süleyman Demirel University, 32260 Isparta, Turkey

ARTICLE INFO

Article history:
Accepted 9 May 2007

Keywords:
Dentin permeability
Dental fluorosis
Hydraulic conductance
Primary teeth
Fluid filtration

ABSTRACT

Objectives: The permeability characteristics of dentin have been used in many *in vitro* studies to evaluate longitudinally the efficacy of various restorative and preventative procedures. The easiest way to evaluate dentin permeability is to calculate its hydraulic conductance (Lp) by fluid filtration method. There are researches on electronic hydraulic conductance measurement systems which can give more precise and reliable results of permeability of dentine than the classical system. To the authors' knowledge, there are no studies on bonding properties of restoratives to fluorotic primary teeth and dentin permeability of those teeth in the literature.

The aim of this *in vitro* study was to determine the dentin permeability of fluorotic primary molars precisely with a new 'electronic hydraulic conductance measurement system with photosensors' and to compare the data with healthy primary molars.

Methods: A total of 40 fluorotic and healthy primary second molar teeth with 1/3 root resorption, which were extracted for orthodontic purpose and with no caries, restoration, fracture or crack were selected and used in this study. Teeth were classified according to the modified form of dental fluorosis index of Thylstrup&Fejerskov. Dentin discs were placed in the electronic hydraulic conductance measurement system with photosensors which was designed for the measurement of dentin permeability. The amount of distilled water passed through each dentin disk (μL/min) under a constant pressure was determined. Dentin permeability data of the fluorotic and healthy teeth were recorded and analysed statistically.

Results: It was observed that dentin permeability decreases, while dental fluorosis severity increases in primary teeth.

1. Introduction

Dentin is a heterogenic, permeable, mineralized tissue. *In vitro* permeability characteristics of dentin have been studied extensively and have been used to evaluate the efficacy of various preventative and restorative procedures.[1–6] The easiest way to evaluate dentin permeability is to calculate its hydraulic conductance (Lp) by fluid filtration method.[7] This is based on the measurement of the fluid volume forced through a slice of dentin under a hydrostatic pressure per unit area of time per unit of pressure. This classical system was first performed by Outwhaite et al.[8] and Pashley et al.[7] and includes visual observation of the movement of an air bubble produced in the system manually by means of a micro syringe,

* *Corresponding author*. Tel.: +90 246 211 33 19; fax: +90 246 237 06 07.
E-mail address: semra@med.sdu.edu.tr (M.S.Ö. Ertürk).

0003–9969/$ – see front matter
doi:10.1016/j.archoralbio.2007.05.001

which indicated the amount of fluid passed through the dentin disc. However, the measurements obtained by this system are relatively subjective because of direct visual readings. Besides this, manual production of the air bubbles can cause difficulties in the performance of the measurements. A fully electronic, reliable and digital hydraulic conductance measurement system is required to remove these deficiencies.

Fluoride in drinking water may help prevent dental caries, but excessive ingestion during the period of pre-eruptive tooth formation may also cause dental fluorosis. The prevalence of dental fluorosis have been reported to increase in both optimally fluoridated and nonfluoridated areas in the world.[9,10]

Heavy clay soils, groundwater, and lake water in the vicinity of volcanic areas can take up high levels of fluoride from these rocks.[11] Isparta city is one of the endemic fluorosis areas of Turkey and localized on a volcanic area. Gölcük Crater Lake and Andık River are the water sources of Isparta. The fluoride levels of these sources increase especially in spring and summer due to increases in temperature. Annual minimum and maximum fluoride levels of Gölcük Crater Lake and Andık River are 0.79 and 1.55 mg/L (mean $\pm$ S.D.: 1.12 $\pm$ 0.29), 2.55 and 3.40 mg/L (mean $\pm$ S.D.: 2.96 $\pm$ 0.31), respectively.[12] Dental fluorosis with different severities can still be observed in children's teeth living in Isparta. There are problems in bonding of the materials to fluorotic primary teeth and pulp response to the materials.[13] To the authors' knowledge, there are no studies on bonding properties of restoratives to fluorotic primary teeth and dentine permeability of those teeth in the literature.

The aim of this *in vitro* study was to determine the dentin permeability of fluorotic primary molars precisely with a new 'electronic hydraulic conductance measurement system with photosensors' and to compare the data with healthy deciduous teeth.

2. Materials and methods

A total of 40 fluorotic and healthy primary second molar teeth (from children aged 9–10 years) with 1/3 root resorption, which were extracted for orthodontic purpose were selected and used in this study. Prior to the study, patients and their parents were informed about the extracted teeth would be used in an *in vitro* study and their informed consent was obtained under a protocol approved by the Süleyman Demirel University Ethical Committee.

Fluorotic and healthy primary teeth were obtained from patients with normal past medical histories who have been living in the neighbourhoods with high water fluoride levels (>0.79 mg/L) in Isparta since birth and who have been living in the centers of population with low water fluoride levels (<0.3 ppm) since birth, respectively. Because of the difficulties in adequate identification, grading and evaluation of primary-tooth fluorosis compared to fluorosis in permanent teeth in epidemiological studies, dental fluorosis index of Thylstrup&Fejerskov[14] was modified as shown in Table 1 and used in the classification of the teeth with no caries, restoration, fracture or crack. Table 2 shows the design of the study.

Table 1 – Modified form of dental fluorosis index of Thylstrup&Fejerskov for the study

0 TFI score → healty tooth tissue
1–2 TFI scores → mild fluorosis
4–5 TFI scores → moderate fluorosis
7–8 TFI scores → severe fluorosis

Table 2 – Design of the study

PRIMARY MOLARS (n=40)

HEALTHY TEETH	MILD FLUOROSIS	MODERATE FLUOROSIS	SEVERE FLUOROSIS
(TFI score: 0)	(TFI scores : 1-2)	(TFI scores: 4-5)	(TFI scores: 7-8)
n =10	n =10	n =10	n =10

After the removal of the soft tissues, the teeth were stored at 4 °C in 10% formalin solution and used within 6–8 weeks after extraction. Prior to the preparation of dentin discs, radiographs were taken in order to observe the height of the pulpal horns and it was signed on the teeth with a water-resistant pencil. Besides this, two guide grooves were prepared with a fissure bur and a high speed tour under water cooling, on the mesial and buccal surfaces (in the middle of the surfaces) of the crowns in order to prevent the possible confusion of pulpal or occlusal surfaces and to standardize the measurement area of the dentin discs. Divergent roots were cut and mandibular teeth were embedded in colorless and maxillary teeth were embedded in red translucent orthodontic acrylic resin in standardized moulds (Fig. 1).

Plane parallel dentin sections were cut parallel to the occlusal surface of the teeth using a low speed diamond saw (Isomet, Buehler LTD, Lake Bluff, IL, USA) with water coolant. The dentin sections closest to the pulp chamber, but lacking any evidence of a pulpal horn, were chosen. Both sides of the dentin discs were further ground with 600-grit silicone carbide abrasive discs (Buehler, Germany) placed on the polishing device (Ecomet 5, Buehler, Germany) under running water for 15 s in order to create a standardized smear layer. The final thickness (1.00 $\pm$ 0.05 mm) of the dentin slices was measured with an accuracy of 0.001 mm, using a digital micrometer (40 EX Digital Micrometer, Mahr Federal Inc., USA).

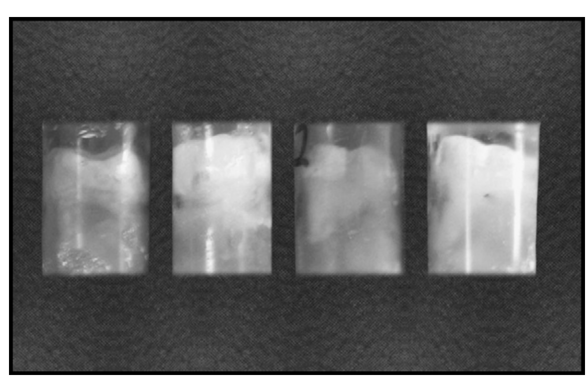

Fig. 1 – Samples of the teeth embedded in two colors of translucent orthodontic acrylic resin.