Original Article

The Structure of Cemento-dentinal Junction in Mandibular Deciduous Second Molars and Permanent First Molars in Egyptian Populations (Scanning Electron Microscope Study)

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ABSTRACT

Introduction: Cementodentinal junction (CDJ) is the interface between cementum and dentin. The cause of this attachment was described by the intermingling of cemental and dentinal fibers or the accumulation of adhesive proteoglycans at the cementodentinal junction. Cementum was classified to three major types according to the type of fibers; Acellular extrinsic fiber cementum, Cellular intrinsic fiber cementum and Cellular mixed stratified cementum.

Aim of Work: To observe the cemento-dentinal junction in human mandibular deciduous 2nd molar and mandibular permanent 1st molar by scanning electron microscopy combined by NaOH maceration.

Materials and Methods: Twenty extracted mandibular deciduous 2nd molar and mandibular permanent 1st molar with complete root(s), were collected. The teeth preserved in 10% formalin then divided into two groups consisted of 10 teeth each. All teeth were cut mesiodistally into halves with a diamond desk, then the sectioned halves were demineralized by formic acid 10% for one month then were immersed in 10% NaOH aqueous solution for 2-3 days at room temperature and rinsed in distilled water overnight (24 hours).

Results: Acellular cementum in mandibular deciduous 2nd molars showed a gap with complete separation, while in cellular cementum there is fibril poor gap and fibril intermingling between the intrinsic fibers of cellular cementum and dentin root fibers. The gap and the intermingling fibers were not observed in the examination of cellular cementum in mandibular permanent 1st molars while in acellular cementum there is a fiber intermingling observed.

Conclusion: Fibril intermingling plays a role in cementum to dentin attachment.

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Key Words: Cementodentinal junction, deciduous molar, fiber intermingling, NaOH maceration, permanent molar.

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INTRODUCTION

Cementodentinal junction (CDJ) is defined as the zone at the interface between cementum and dentin. The cause of the cementodentinal attachment was described by 2 different hypotheses, the first was the intermingling of cemental and dentinal fibers which creates firm attachment through mineralization, the second one is due to accumulation of adhesive proteoglycans at the cementodentinal junction which assumed to be more important than the fibril intermingling[1].

Cementum is an essential mineralized dental tissue and is a part of the attachment apparatus within the periodontium, it is considered the medium for the attachment of the principal collagen fibers of the periodontal ligament thus attaching the tooth to the alveolar bone[2,3].

Cementum was classified according to the absence or presence of cells in the mineralized cementum matrix, two types of cementum are well known: acellular cementum covering the coronal two-third of the root and cellular cementum covering the apical third. Layers of cellular and acellular cementum may alternate[4].

Also, according to the type of fibers cementum was classified to three major types;(1) Acellular extrinsic fiber cementum (AEFC) contains tightly packed extrinsic fibers and no cementocytes[2]. Cellular intrinsic fiber cementum (CIFC) contains intrinsic fibers and cementocytes[3]. Cellular mixed stratified cementum (CMSC) contains both extrinsic and intrinsic fibers and cementocytes[5,6].

The surface of the dentin upon which the cementum is deposited is normally smooth in permanent teeth, however the cemento-dentinal junction, in deciduous teeth appeared scalloped. The attachment of the cementum to the dentin, in either case, is quite firm despite the nature of this attachment[7,8].

The aim of this study was to observe the cemento-dentinal junction in human mandibular deciduous 2nd molar and permanent 1st molar by scanning electron microscopy combined by NaOH maceration.

MATERIALS AND METHODS

Teeth preparation

Twenty extracted mandibular deciduous 2nd molar and permanent 1st molar with complete root(s), were collected

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from pedodontics and surgical departments from the authors universities.

The teeth had been preserved in 10% formalin then they were divided into two groups consisted of 10 teeth each.

All teeth were cut mesio-distally into halves with diamond desk, then the sectioned halves of each group were demineralized by formic acid 10% for one month[1,6]. After demineralization, specimens were immersed in 10% NaOH aqueous solution for 2-3 days at room temperature and rinsed in distilled water overnight (24 hours)[9]. NaOH maceration is said to remove interfibrillar substances without damaging collagen.

Scanning Electron Microscope

Samples were examined by scanning electron microscope (SEM). SEM evaluation was done at the 'THE EGYPTIAN MINERAL RESOURCES AUTHORITY', Central Laboratories Sector. Using SEM Model Quanta 250 FEG (Field Emission Gun) attached with EDX Unit (Energy Dispersive X-ray Analyses), with accelerating voltage 30 K.V., magnification14x up to 1000000 and resolution for Gun.1n). FEI company, Netherlands.

Statistical analysis

Statistical analysis was performed via Microsoft excel statistical analyzer, AVERAGE, STDEV.P and *P value* calculated by T test to compare variables between the two groups. The results were considered statistically significant if the *p value* was ≤ 0.05.

RESULTS

Scanning Electron Microscope

By the examination with the SEM of acellular cementum in mandibular deciduous 2nd molars showed gap with complete separation between acellular cementum and root dentin after NAOH maceration, the intermingling between intrinsic fibers of acellular cementum and dentinal fibrils at the cementodentinal junction was not observed (Figure 1).

In cellular cementum, the cementodentinal junction is fibril poor gap; fibril intermingling between the intrinsic fibers of cellular cementum and dentin root fibers (Figure 2). The fibers bundle of cellular cementum showed unorganized distribution (Figure 3).

In the examination of acellular cementum in mandibular permanent 1st molars, they revealed poor gap between the acellular cementum and root dentin in some areas. While other areas, there were fibers intermingling between the internal fibers of acellular cementum and root dentin fibers (Figure 4).

The gap and the intermingling fibers were not observed in the examination of cellular cementum in mandibular permanent molars (Figure 5).

Statistical analysis

Regarding the gap between the cellular cementum and root dentin in mandibular deciduous 2nd molar the average range was 5.9 µm while in the acellular cementum the average range was 9.43 µm and the *p-value* showed 1.013 which statistically not significant. In mandibular permanent 1st molar, the average range of the gap between acellular cementum was 3.46 µm. (Table 1, Figure 6)

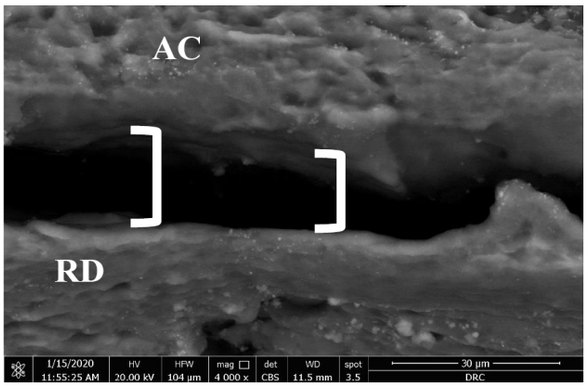

Fig. 1: Scanning electron micrograph of mandibular deciduous 2nd molars showing gap ( ]) with complete separation between acellular cementum (AC) and root dentin (RD) after NAOH maceration x4000

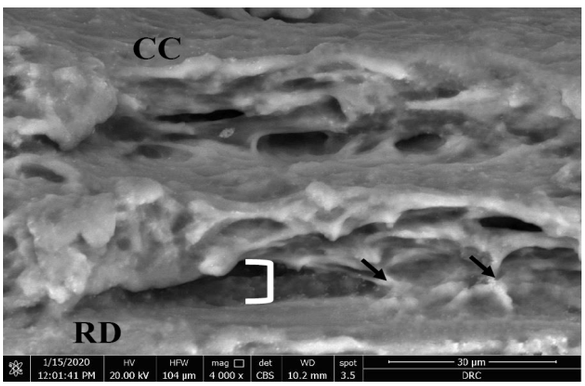

Fig. 2: Scanning electron micrograph of mandibular deciduous 2nd molars showing fibril poor gap in cellular cementum (CC) (]) and fibril intermingling between the intrinsic fibers of cellular cementum (CC) and root dentin (RD) fibers (arrows) x 4000

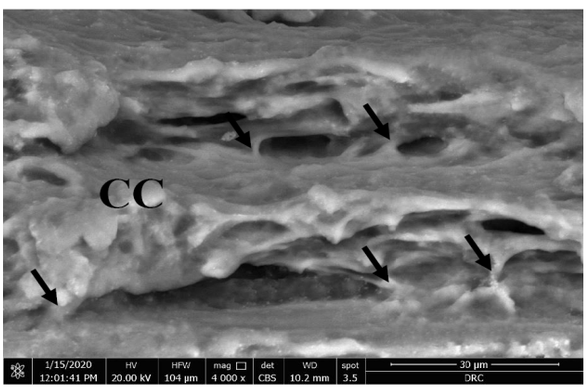

Fig. 3: Scanning electron micrograph of mandibular deciduous 2nd molars in inner surface of cellular cementum (CC) showed the protruded fibers bundles (arrows) with unorganized distribution . X4000

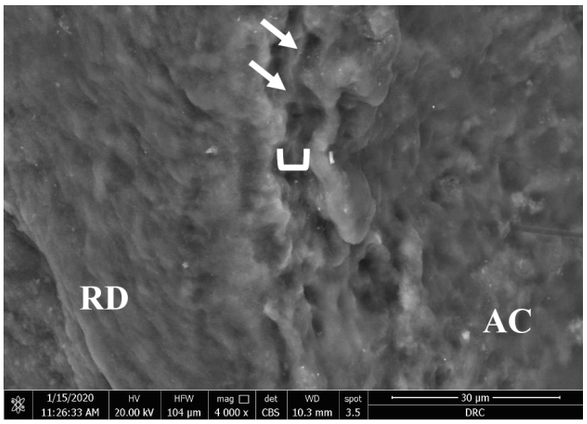

Fig. 4: Scanning electron micrograph of acellular cementum in mandibular permanent 1st molars showed poor gap (]) with fibers intermingling between internal fibers of acellular cementum (AC) and root dentin (RD) fibers (arrows) x 4000.

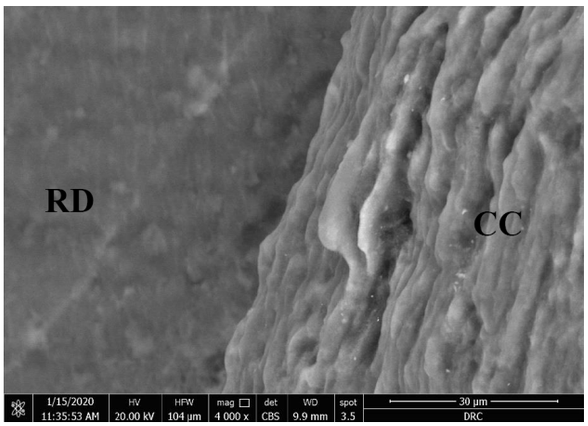

Fig. 5: Scanning electron micrograph of cellular cementum in permanent lower molars showed no gap or fibers intermingling between internal fibers of cellular cementum (CC) and root dentin (RD) fibers. x 4000.

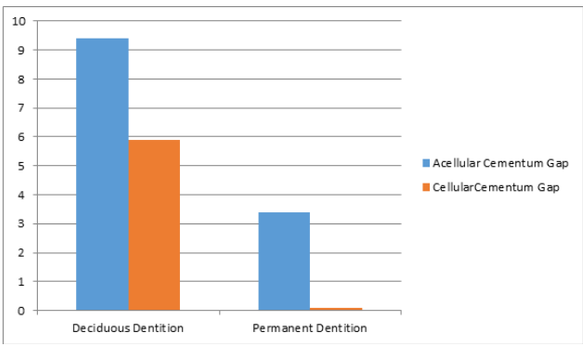

Fig. 6: Chart showing the average distance of gap in the cementodentinal junction.

Table 1: Showing the average distance of gap in the cementodentinal junction

	Cementum	AVERAGE	STDEV.P	*P value*
Deciduous teeth	Cellular	5.904733333	0.60771369	1.013
	Acellular	9.434133333	0.566278479	
Permanent teeth	Acellular	3.464473333	0.611685434	

DISCUSSION

The histogenesis and mechanism of attachments of the cemento-dentinal junction of permanent teeth of humans and different species were widely discussed in previous studies[1,10,11]. while few were interested about deciduous teeth so that the purpose of this study was to observe the cemento-dentinal junction in human mandibular deciduous 2nd molar and the mandibular permanent 1st molar by scanning electron microscopy combined by NaOH maceration.

This study showed gap between acellular cementum and root dentin with average width 9.4 µm in mandibular deciduous 2nd molars by examination with the SEM, while in cellular cementum, a fibril poor gap was observed in most of the specimens with average width 5.90 µm. In mandibular permanent 1st molars specimens, poor fibril groove with average width 3.46 µm were detected in acellular cementum while in cellular cementum this groove was not detected. The specimens of deciduous 2nd molar of the current study showed no signs of intermingling between intrinsic fibers of acellular cementum and dentinal fibrils at the cementodentinal junction however in cellular cementum was detected in some areas with amorphous appearance, while in mandibular permanent 1st molar, it showed either poor fibril groove or completely absent in both the acellular and cellular cementum consecutively.

Yamamoto and Domon *et al*., 2000[1] stated that the cemento-dentinal interface in human molars contained a smaller amount of collagen fibrils and more proteoglycans with mucopolysaccharides compared to the root dentin and cementum, and that intermingling of fibers between them was not a constant feature, that comes in accordance with the present observations of mandibular permanent 1st molar specimens.

Although the structure of the cemento-dentinal junction may vary between different teeth and between different species, the adhesive proteoglycans are considered to be responsible for this attachment mechanism of the cemento-dentinal junction and that fibril intermingling plays a secondary or accessory role in this attachment[6,12].

The fibril intermingling between the root dentin and cementum was described as point-like processes and occurred only in places at the cement-dentinal interface. No detachment of the cementodentinal junction was reported, unless the specimens were treated by NaOH-maceration method, and it is reported that NaOH-maceration method does not damage collagen fibril structure and architecture[9,13].

Previous studies stated that the width of the healthy cemento-dentinal junction ranges between 2-4 µm in different permanent teeth,[112] which come in agreement with the results of mandibular permanent 1st molar with average width 3.46 µm.

The average width of the cemento-dentinal junction in the deciduous 2nd molar may be relatively higher than that of permanent which may be related to the difference between the structure and chemical composition of dentin and cementum between the deciduous and permanent teeth.

Also, Sudhakar and Pratebha, 2015[13] stated that the cement-dentinal junction is rich in unmineralized collagen which gets easily denatured and degraded due to any physiological or pathological changes and any loss of these collagen fibers and other proteins, that may lead to increase in the width of the cement-dentinal junction and its subsequent weakening.

CONCLUSION

- Fibril intermingling plays a role in cementum to dentin attachment.
- Other methods of cementum to dentin attachment could be postulated due to the adherence of the cementum to the dentin even in zones devoid of fibril intermingling at the cemento – dentinal junction.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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الملخص العربى

هيكل التقاطع الملاطي-العاجي في الأضراس الثانية اللبنية للفك السفلي والأضراس الأولى الدائمة في السكان المصريين (دراسة المجهر الإلكتروني الماسح)

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مقدمة: الوصل الإسمنتي (CDJ) هو الواجهة بين الملاط وعاج الأسنان. تم وصف سبب هذا الارتباط من خلال تمازج الألياف الملاطية والعاجية أو تراكم البروتيوغليكان اللاصق عند التقاطع الملاط العقدي. تم تصنيف الأسمنت إلى ثلاثة أنواع رئيسية حسب نوع الألياف ؛ ملاط ليفي خارجي لا خلوي ، ملاط ليفي خلوي خلوي وملاط خلوي طبقي مختلط.

الهدف: مراقبة الوصل الملاط-العاجي في الضرس الثاني اللبني البشري والضرس الدائم الأول في الفك السفلي عن طريق مسح المجهر الإلكتروني المركب بواسطة NaOH النقع.

المواد والطرق: تم جمع عشرين ضرسًا سفليًا مستخرجًا من الضرس الثاني اللبني والضرس الدائم الأول في الفك السفلي الدائم مع جذر (جذر) كامل.حفظت الأسنان في فورمالين ١٠٪ ثم قسمت إلى مجموعتين تتكون كل منهما من ١٠ أسنان. تم تقطيع جميع الأسنان بشكل متوسط إلى نصفين باستخدام مكتب ماسي ، ثم تم نزع المعادن من النصف المقطوع بواسطة حمض الفورميك بنسبة ١٠٪ لمدة شهر ثم غمرها في محلول مائي ١٠٪ NaOH لمدة ٢-٣ أيام عند درجة حرارة الغرفة وشطفها في ماء مقطر طوال الليل (٢٤ ساعة).

النتائج: أظهر الملاط اللاخلوي في الأضراس الثانية اللبنية للفك السفلي فجوة مع فصل كامل ، بينما في الملاط الخلوي هناك فجوة ليفية ضعيفة وتداخل ليفي بين الألياف الجوهرية للملاط الخلوي وألياف جذر العاج. لم يتم ملاحظة الفجوة والألياف المتشابكة في فحص الملاط الخلوي في الأضراس الأولى الدائمة للفك السفلي بينما لوحظ تداخل الألياف في الملاط اللاخلوي.

الخلاصة: يلعب تداخل الألياف دورًا في ارتباط الملاط بالعاج