Microscopic evaluation of fissure patterns of posterior permanent teeth: An in vitro study

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Abstract

Aim: Pits and fissures are considered the areas in the posterior teeth that are most susceptible to decay. The aim of this in vitro study was to evaluate the prevalence of fissure types in relation to tooth type and localization.

Methodology: A total of 100 extracted sound maxillary and mandibular molars and premolars were included in this study (25 teeth/group). The extracted teeth without any caries, cracks, fractures, anomalies, or restorations were classified according to tooth type and localization after disinfection. The teeth were sectioned in the buccolingual direction from the deepest part of the central fossa on the occlusal surface, and the fissure patterns were observed using a stereo microscope. The frequency distribution and percentages of the categorical data were obtained. Chi-square and exact tests were performed to compare the localization of the teeth and the prevalence of fissure types ($p < 0.05$).

Results: The V-type fissure pattern (59%) was statistically significantly more common in both the premolar and molar teeth, followed by the I-type (18%) and U-type (14%) patterns ($p = 0.000$). The rarest fissure pattern was the IK type. No relationships were found between fissure pattern, the tooth subgroups, and localization ($p = 0.390$).

Conclusion: Determining the types of fissure morphology is important for the prevention of caries on the occlusal surfaces of molars and premolars.

Keywords: Dental caries, dental fissure, fissure morphology, fissure pattern, posterior teeth

Introduction

Dentists are becoming increasingly interested in the prevention of caries, not only in its treatment. The minimal-intervention dentistry (MID) concept involves the prevention of caries and the preservation of the tooth structure. The primary purpose of MID is to determine the risk factors for the formation and progression of caries and how to prevent caries by controlling these factors (1). One of the risk factors of caries concerns the tooth morphology: the presence of deep pits and fissures, which cause plaque retention and are susceptible sites for caries initiation compared to flat surfaces (2). Accordingly, it is stated in the literature that the occlusal surfaces of the first and second molars are the most frequent sites of caries (3, 4).

The morphology, depth, and shape of the pits and fissure invaginations are related to caries development. It has been reported that susceptibility to caries is increased in deep fissures narrower than 70° (5). Wide fissures may show 70–90° angles and are less prone to caries formation. Fissures on the occlusal surface are classified as follows, according to morphological structure: type U (same width at the top and bottom), type I (in the form of a narrow slit), type V (wide at the top, narrowing toward the bottom), type IK (hourglass), and others (6, 7). The complexity of the fissure morphology may interfere with the early detection of caries. Unnoticed and untreated fissure caries may progress and eventually involve the pulp (8).

Although the early detection of fissure caries is important, the existence of variable fissure types may make early detection difficult. Hence, it is important to understand the pit and fissure patterns for proper diagnosis, assessment of caries risk, and application of appropriate preventive methods (9–11). Thus, this in vitro study was conducted to investigate the fissure types and their prevalence in extracted posterior teeth and to evaluate the relationships of the different fissure patterns with tooth type and localization.

Materials and Methods

The present study was conducted in accordance with the principles of the Declaration of Helsinki. The necessary permissions were obtained from the Scientific Research Ethics Committee of Trakya University (TÜTF BAEK 2021/61), and the patients were informed of the details of the study and asked to sign a written consent form before the extraction of their teeth to be used in the study. When 80% power and 0.05 error probability were determined, 100 extracted human premolars and molars teeth were included in the study.

A total of 100 extracted permanent human premolar and molar teeth without caries, cracks, or abrasions were selected. Teeth with caries, cracks, fractures, anomalies, and restorations were excluded. Following extraction, the tissue and calculus residues were removed from the teeth's surfaces, and the teeth were disinfected in 0.1% chloramine solution.

After the teeth were categorically classified as maxillary or mandibular according to their anatomical structure (n = 25 teeth/group), they were sectioned from the deepest part of the central fossa on the occlusal surface using diamond blades and underwater cooling at low speed in the buccolingual direction (Struers Minitom, Copenhagen, Denmark). The sections were fixed on a glass slide and examined under a stereo microscope (SZ 61, Olympus Corp., Japan) with 10X magnification, and the fissure patterns were recorded.

Statistical analysis

The statistical analyses were carried out using SPSS software (version 23.0; IBM Corp., Armonk, NY, USA). As descriptive statistics, the frequency distribution and percentages of the categorical data (i.e., the prevalence of fissure types in the maxillary-mandibular premolar and molar teeth) were obtained. Chi-square and exact tests were performed to compare the localization of the teeth and the prevalence of fissure types. The significance threshold for all the statistics was $p < 0.05$.

Results

The fissure patterns of the 50 premolar and 50 molar extracted teeth (25 maxillary, 25 mandibular) were assessed by examining the sections (Figure 1). The distribution of fissure types according to subgroups and localization is shown in Table 1.

The V-type fissure pattern (59%) was statistically significantly more common, followed by the I-type and U-type patterns (18% and 14%, respectively; $p = 0.000$). The most common fissure pattern in both the premolar and molar teeth was the V-type pattern, and the rarest was the IK-type pattern. Although the U-type fissure pattern was more common in the molar teeth, no statistically significant relationships were found between the tooth subgroups and the fissure pattern ($p = 0.321$). The most frequently observed fissure pattern in the maxillary and mandibular teeth was also the V-type pattern, and no significant relationship was found between tooth localization and fissure pattern ($p = 0.584$).

When the premolar and molar teeth were examined separately, no relationship was found between jaw localization and fissure pattern ($p = 0.184$ and $p = 0.935$, respectively). Similarly, no relationships were observed between fissure pattern, tooth subgroups, and localization ($p = 0.390$).
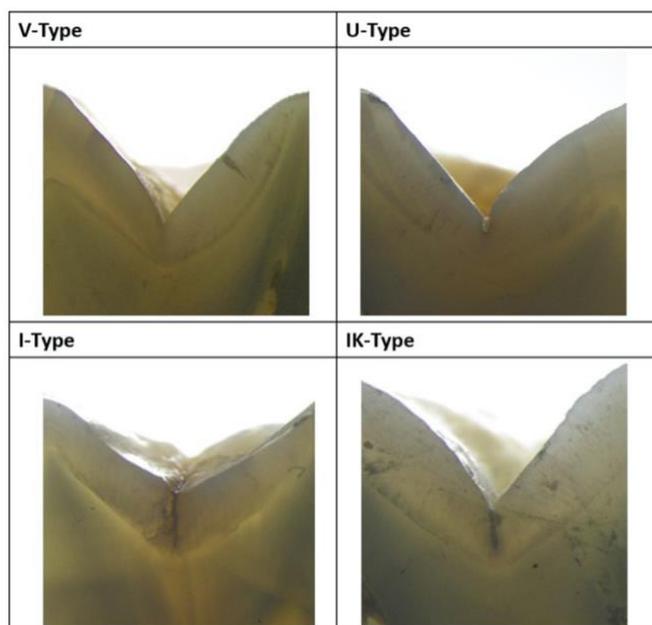

Figure 1. Representative images of fissure types

Table 1. Distribution of fissure types by subgroup and localization

Teeth type	Jaw	Fissure types				p
		U type	I type	V type	IK type	
Premolar	Maxillary	1 (%4)	8 (%32)	15 (%60)	1 (%4)	
	Mandibular	3 (%12)	3 (%12)	15 (%60)	4 (%16)	0.390
Molar	Maxillary	6 (%24)	3 (%12)	14 (%56)	2 (%8)	
	Mandibular	4 (%16)	4 (%16)	15 (%60)	2 (%8)	

Chi-square test, *$p < 0.05$

Discussion

The occlusal morphology of human molars and premolars consists of fissures, adjacent grooves, and fossae, which are the most vulnerable sites for caries development (12). The presence of various fissure patterns causes plaque retention. Moreover, due to the differences in the anatomies of fissures, the bristles of toothbrushes may not be able to fully reach some fissures, making these areas risky for caries (13). In addition, previous studies have found that the enamel in pits and fissures does not receive the same level of benefit from fluoride applications as smooth surfaces (12, 14). Therefore, tooth caries is more likely to initiate in occlusal fissures.

Visual inspection has been shown to be clinically effective and sufficient for the diagnosis of pit and fissure caries (15). However, as pits and fissures are prone to discoloration, occlusal caries can be difficult to diagnose only through visual inspection (16). Moreover, the use of a probe for the diagnosis of fissure caries has been questioned in the literature due to the variability of the fissure pattern and the pressure exerted on the probe by the examiner (17). It has also been proven that dental radiography has limitations in the diagnosis of pit and fissure caries (15). Thus, new auxiliary methods for the detection of inconspicuous fissure caries have been developed, such as DIAGNOdent (18). However, knowing the fissure types with a risk for occlusal caries and their prevalence may be better than early caries detection as it can help prevent caries development by providing the necessary data for preventive measures such as fissurotomy or prophylactic odontotomy in routine clinical practice. Therefore, it is important to investigate and know the morphology of occlusal fissures where the diagnosis of caries is difficult.

The most common fissure patterns in the literature are the U and V types (6, 19). In the present study, the V type was the most common fissure pattern (59%), followed by the I and U types (18% and 14%, respectively). However, in a study conducted by Garg et al. (6), the U-type fissure pattern was found to be more prevalent (33.3%), followed by the V type (28.9%). On the other hand, Celiberti and Lussi (20) reported that the V-type fissure pattern was more common than the U-type pattern (25.6% vs. 22.2%) in their study, as in the present study. Both the studies by Garg et al. (6) and Celiberti and Lussi (20) revealed that the least common fissure pattern was the IK type. However, the previous studies were performed on either molar or premolar teeth, and no study has compared the aforementioned dental subgroups.

The depth of the occlusal fissures of molar teeth was evaluated by Cho and Kim (7), and it was determined that the deepest fissures were the I and V types. The mean depth of the occlusal fissures was 1.15 mm in the I type, 1.11 mm in the IK type, 0.56 mm in the V type, and 0.53 mm in the U type. Deep and narrow fissures (e.g., IK and I types) are relatively more prone to caries formation than wide fissures (U or V type) (21). In a study conducted by Konig (5), enamel decalcifications were found to be common at or near the deepest point of the fissures formed by angles smaller than about 70°. Although the fissure pattern has been proven to affect caries formation, the occlusal angle, enamel thickness, and depth and width of the fissure can also play a crucial role therein (22).

Another factor that affects caries progression in deep and narrow fissures is the closeness of these fissures to the dentinoenamel junction (DEJ). The distance between the deepest part of the fissure and the DEJ affects the progression of caries (23). Consequently, fissure caries can easily initiate and involve dentin. To prevent caries formation, the implementation of preventive dentistry is of critical importance. Fissure sealant application is a preventive MID approach that provides a physical barrier that keeps bacteria away from their nutrient sources (24). However, it is known that occlusal fissure depth and morphology are limiting factors for fissure sealant penetration (25). Studies have shown that U- and V-type fissures display the most favorable conditions for sealant application (6, 26). Consequently, it is important to know the fissure patterns in the selection of the preventive method to be applied.

The pit and fissure systems of molars are more complex than those of premolars, which makes it difficult to determine the fissure pattern in molars. To avoid possible bias in the present study, all sections of the molars were created from the deepest part of the

central fossa. However, it should be noted that due to morphological variations, it is not always possible to categorize a tooth as having only one type of fissure (27).

Within the limitations of the present study, the reported prevalence of I- and IK-type fissures was probably lower than their actual prevalence because non-carious teeth were included in the study. As narrow-angle fissures (I and IK types) are more prone to caries, to determine their actual prevalence and to establish their relationship with caries more clearly, further studies with a larger sample size are needed.

Conclusions

The variety in the morphology of pits and fissures obstructs their self-cleaning mechanism, making them more susceptible to caries than flat surfaces. Therefore, fissure caries may easily develop unnoticed, progress rapidly, and eventually involve the pulp. In addition, the determination of risky fissure patterns before caries initiation has gained popularity. Identifying the risk factors and detecting caries as early as possible can allow dentists to implement preventive strategies and provide health education for patients.

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