



Prevalence of cracked tooth in a group of patients at the Faculty of Dentistry, Mahidol University

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Abstract

Objective: The purpose of this study was to investigate the prevalence of cracked tooth and associated behavioral factors in a group of patients at the Faculty of Dentistry, Mahidol University.

Materials and methods: A group of patients who attended the Advanced General Dentistry or Special clinics were invited to participate in this study. Two hundred patients (43 males and 157 females) were enrolled. Informed consent was reviewed and signed by each patient. Medical history and associated risk behaviors which can induce cracked tooth were recorded. Subsequently, all the remaining teeth of each patient were examined. Cracked tooth was defined as a tooth having either craze or cracked line(s) or both. Prevalence rates of cracked tooth according to the number of patients and the number of teeth were reported.

Results: The age of the subjects ranged from 12-80 years old (mean 40.9 years). Out of 200 patients, 194 (97%) patients had at least one cracked tooth. In addition, out of 5,096 teeth investigated, 1,932 (37.9%) teeth had either craze or cracked line(s) or both. The most common cracked teeth found on both arches were first permanent molars. The most common associated risk behavior was accidental biting of hard objects.

Conclusion: This study showed a high prevalence of at least one cracked tooth in a group of patients at the Faculty of Dentistry, Mahidol University. Dental professionals should be aware of this common problem and advise patients about prevention and proper treatment of cracked tooth.

Key words: cracked tooth, prevalence of cracked tooth, craze line, behavior, risk factors of cracked tooth, tooth fractured

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Introduction

Dental tissues respond biologically to stresses and strains imposed during mastication. The stresses on these teeth may lead to the formation of microcracks in the dentine and enamel which can propagate, causing symptoms in vital teeth possibly leading to tooth fracture. Cameron in 1964 first used the term “cracked tooth syndrome” (CTS) to describe this phenomenon, which has been defined as “an incomplete fracture of a vital posterior teeth involving the dentine and possibly dental pulp”¹. Discomfort when chewing is the most frequent symptom of a cracked tooth. Patient complains that it hurts when biting on one side of the mouth, especially when chewing hard food. The dentist should be suspicious that the tooth is cracked if no caries or sensitive cementum is found and the tooth structures appear normal in the radiograph.

The incidence and prevalence of cracked lines has been reported in many studies. In a study conducted by Hyatt, it was found that 25% of cases occurred in teeth without restorations and 39% occurred in teeth with Class I restorations. In only 26% of cases was there Class II restorations². The most commonly affected teeth were the lower molars³. Because mandibular first molars are the first permanent teeth to erupt, they show the highest incidence of carious lesions and restorations. Variables such as the presence of a Class I or II restoration and the presence of excursive interferences were shown to significantly increase the chances of a crack being present⁴. In addition, combination of both interferences and restoration also increased more chances of cracked tooth⁴.

Regarding the age of the patients with cracked tooth, results in the dental literature are contradictory as to whether tooth fracture is related to age⁵. It has been suggested that

fractures are more prevalent in middle-age and above. Cameron determined that predominantly persons older than 50 years suffer from a cracked tooth syndrome¹, whereas Hiatt² and Talim⁶ reported the maximum number of split teeth to be in patients between the ages of 40 and 49.

Associated risk behaviors which can induce cracked tooth are tremendously important in the diagnosis and management of cracked tooth. Patients should be asked whether they have any risk behavior or habit such as tendency to eat hard food, accidental trauma, inappropriate use of teeth and bruxism or clenching. It has been reported that the most common cause for an incomplete fracture is masticatory or accidental trauma⁷. Unintentional biting with physiologic masticatory force on a small and very hard object, such as a seed, may suddenly generate an excessive load due to the very small contact area⁸. As a consequence, the loaded tooth may split or fracture. It has been suggested that one of the steps to identify a crack or fracture is to ask the patient if they remember accidentally biting a hard object and any damaging habit, such as clenching or grinding the teeth, or chewing on ice, pens, hard candy or other objects⁹. Such incidents and habits may correspond to a sudden onset or pain. Interestingly, one article reported a tooth injury in a 28-year-old male patient who liked to chew a soft drink can’s ring⁹. Intra-oral examination revealed a chipping of the enamel layer of the buccal cusp, attrition and craze lines on the left first upper premolar where he liked to chew on it. Generalized attrition and vertical craze lines were observed in his whole dentition. Lurie and colleagues also reported the high prevalence of teeth attrition in a group of military aircrews as well as officers on commando units¹⁰. Dental fracture, enamel chipping and dental attrition are also well

documented complications of intra-oral metal ornament wearing¹¹. Brennan and colleagues described a case of multiple dental chipping and fractures caused by 1 year of metal tongue ornament flicking¹¹. Therefore, dental practitioners should ask patients about their lifestyles and habits after the occurrences of such complications.

Since there was no study regarding the prevalence of cracked tooth and associated behavioral factors in patients at the Faculty of Dentistry, Mahidol University, the objective of this study was to investigate the prevalence of cracked tooth in a group of these patients at the Faculty of Dentistry, Mahidol University, Thailand.

Materials and methods

Two hundred subjects were included in this study. All the subjects attended the Advanced General Dentistry or Special clinics, Faculty of Dentistry, Mahidol University, Thailand. Inclusion criteria were patients aged older than 12 years old with permanent dentition. Exclusion criteria were patients without natural teeth in the oral cavity, patients with orthodontic treatment, with crowns in all remaining teeth, with communication problems or patients who did not want to participate in the study.

This study was approved by the Committee on Human Rights Related to Human Experimentation of the Mahidol University (MU-IRB 2008/258.2312). All the subjects signed the informed consent form. Patient history was retrieved from each subject. Patients were asked about their general information including age, sex, date of birth, occupation, and past dental history.

Patients were interviewed on whether they had risk behaviors that can induce cracked tooth. These risk behaviors included 1) accidental biting on hard objects, 2) tendency

for chewing or eating hard food such as ice, bone, cartilage, etc., 3) accidental trauma, 4) thermal stress from food such as drinking hot drink immediately followed by cold drink, 5) having stress, 6) parafunctional habits including bruxism, clenching and grinding, and 7) unilateral chewing.

Intra-oral examination included the use of mouth mirror and sharp explorer to examine any crack. Only one investigator (SS) performed the intra-oral examination in all patients. If there was any suspicious lesion which cannot be identified by naked eye, a light curing unit with the wave length of 300-500 nm was used to explore craze or cracked line. The crack was categorized as enamel crack or dentine crack. Enamel crack included only craze or cracked line that cannot be caught by explorer. Dentine crack included line that can be caught by explorer or line that can be seen that involved dentine or line with visible color. Crack-involved pulp included tooth with spontaneous pain with no reasons except crack. If that patient could not indicate which tooth induced pain, tooth slooth was used. Electrical pulp test was also performed in cases when vitality of the tooth was questioned.

The simplified surface and position (S&P) crack classification proposed by Tatum (1998) was used in this study¹². This classification system categorized cracks according to the depth and the position of crack which included 1) enamel cracks (craze lines), 2) dentine cracks, 3) pulpal involved cracks, 4) cuspal cracks, 5) coronal cracks, 6) marginal ridge cracks, 7) grooves and fissure cracks, 8) cervical area cracks, and 9) midtooth buckling cracks (abfractions). Examples of these types of crack are shown in Figure 1.

Although there are some other classifications of cracked tooth such as the comprehensive directional crack propagation (DCP) classification system, the longitudinal

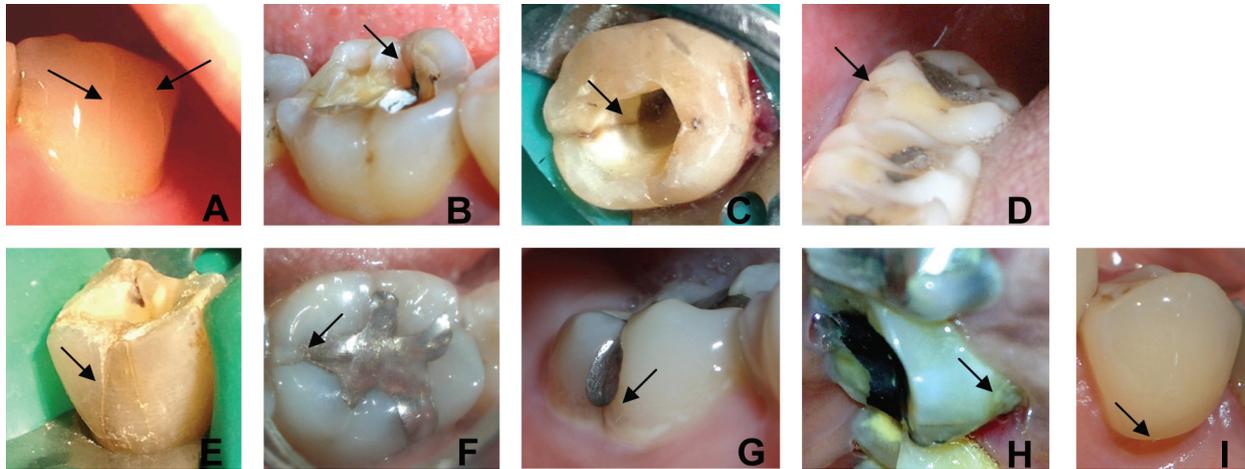


Figure 1 Demonstration of each type of crack according to the surface and position (S&P) crack classification proposed by Tatum (1998). A) enamel cracks (craze lines), B) dentine cracks, C) pulpal involved cracks, D) cuspal cracks, E) coronal cracks, F) marginal ridge cracks, G) grooves and fissure cracks, H) cervical area cracks, and I) midtooth buckling cracks (abfractions).

tooth fractures classification system proposed by the American Association of Endodontists and the cracked tooth classification system proposed by Talim and Gohil, we preferred to use the simplified surface and position (S&P) system since this system classified cracks according to the position and the depth of the cracks so it is easy to remember and to explain to the patient. It is also simple to keep a record and investigate the progression of the crack when the patient came back in the future.

In this study, the prevalence of cracked tooth according to the number of patients and the number of teeth are reported. In addition, the associated risk behaviors are also presented.

Results

Patient characteristics

Two hundred patients, 43 male and 157 female, were recruited in this study. The range of the age of the patients was between 12-80 years old with the average of 40.92 years old. (Table 1)

Associated risk behaviors

According to the interviews, the most frequent associated behavior was accidental biting of hard objects, followed by the tendency for chewing or eating hard food and unilateral chewing (Figure 2).

Prevalence of cracked tooth

Out of the 200 patients, 194 (97%) patients had cracked tooth. The distribution of patients with cracked tooth stratified with the age and the gender of the patients is presented in Table 1. It was found that the prevalence of cracked tooth increased with the age of the patient and all of the patients older than 41 years old had at least one cracked tooth.

In addition, out of the 5,096 teeth investigated, 1,932 (37.9%) teeth had either craze or cracked line(s) or both. The distribution of cracked tooth in the upper and low arches is presented in Tables 2. The distribution of cracked tooth in each quadrant is presented in Table 3. In quadrant 1, the most frequent cracked teeth found were canines. In quadrants 2, 3 and 4, the most frequent cracked teeth found were first permanent molars.

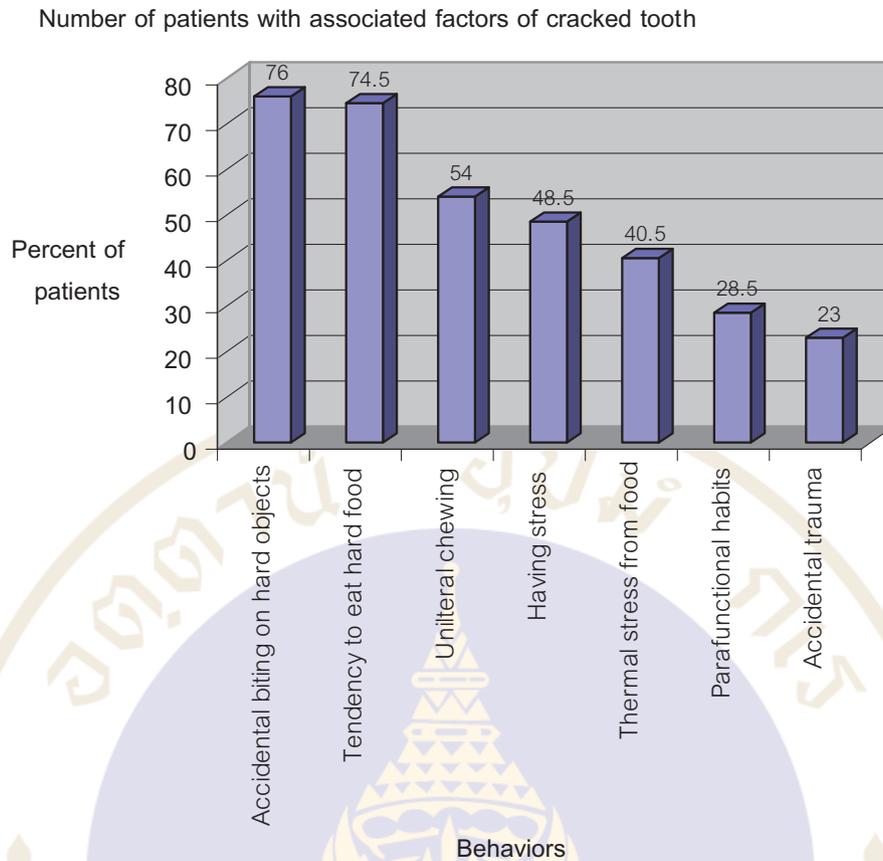


Figure 2 The percentage of associated factors of cracked tooth

Table 1 Distribution of patients with cracked tooth according to the age and gender of patients

Patient's Age	All patients (persons)			Patients with cracked tooth (persons)			%
	Male	Female	Total	Male	Female	Total	
12-20	1	14	15	0	12	12	80 (12/15)
21-30	11	36	47	11	34	45	95.74 (45/47)
31-40	10	27	37	9	27	36	97.29 (36/37)
41-50	12	35	47	12	35	47	100 (47/47)
51-60	5	26	31	5	26	31	100 (31/31)
61-70	2	12	14	2	12	14	100 (14/14)
71-80	2	7	9	2	7	9	100 (9/9)
Total	43	157	200	41	153	194	97 (194/200)

Characteristics of cracked tooth

According to the classification of Tatum (1998) the distribution of cracks is presented in Tables 4 and 5. Regarding the depth of the cracks, enamel cracks were the most prevalent cracks found (98.18%) followed by dentine

(1.6%) and pulpal involved cracks (0.2%), respectively. Moreover, the most frequent position of cracked tooth was coronal cracks (83.06%) followed by groove and fissure cracks and marginal ridge cracks.

Table 2 Distribution of cracked tooth in the upper and lower arches.

Tooth type	Total number of teeth	Number of teeth with cracks	%
Upper third molars (teeth 18 and 28)	118	13	11.02 (13/100)
Upper second molars	339	113	33.33 (113/339)
Upper first molars	310	194	62.58 (194/310)
Upper second premolars	348	136	39.08 (136/348)
Upper first premolars	323	129	39.94 (129/323)
Upper canines	371	214	57.68 (214/371)
Upper lateral incisors	359	97	27.02 (97/359)
Upper central incisors	347	110	31.70 (110/347)
Lower third molars	136	29	21.32 (29/136)
Lower second molars	300	109	36.33 (109/300)
Lower first molars	261	155	59.38 (155/261)
Lower second premolars	354	138	38.98 (138/354)
Lower first premolars	355	141	39.71 (141/355)
Lower canines	394	101	25.63 (101/394)
Lower lateral incisors	388	108	27.83 (108/388)
Lower central incisors	393	145	36.90 (145/393)
Total number of teeth	5,096	1,932	37.9 (1932/5096)

Discussion

In this study, 97% of 200 patients had at least one cracked tooth. This prevalence rate was high since we included enamel cracks or teeth with craze lines in this study. The reason we included teeth with craze line was because it has been suggested that craze lines can develop into cracks¹³. Hence this prevalence rate may be higher compared to other studies^{14,15}. Since we included patients who attended regular dental check up at the Advanced General Dentistry or Special clinic, the population can partly represent only a group of patients at the Faculty of Dentistry, Mahidol University. If we chose to look at the patients at other departments, such as, the Emergency or Endodontic clinics of the faculty, more patients with cracked tooth with symptoms might be found.

The most prevalent behavioral factor

which could induce cracked tooth found in this study was accidental biting on hard objects (Figure 2). Thai people usually eat rice and the most prevalent object found in the accidental biting was small stones in rice. Approximately 75% of the patients like to eat hard food and the majority of them did not know that hard food can induce cracked tooth. A lot of patients like to chew on ice, hard candies, nuts and tamarind seeds. Moreover, 40% of the patients did not know that drinking or eating hot food immediately followed by cold food can cause craze or cracked line of the tooth^{16,17}. Some patients drink hot coffee immediately followed by cold drink and they did not know that this can jeopardize their teeth. This result indicated that more knowledge regarding the cause of cracked tooth should be given to the patients so that cracked tooth can be prevented.

Table 3 Distribution of cracked tooth according to quadrant

Tooth type	Total (Teeth)	Crack (Teeth)	%	Tooth type	Total (Teeth)	Crack (Teeth)	%
18	59	8	13.55	28	59	5	8.47
17	176	54	30.68	27	163	59	36.20
16	156	97	62.17	26	154	97	62.99
15	174	70	40.22	25	174	66	37.93
14	168	74	44.04	24	155	55	35.48
13	185	118	63.78	23	186	96	51.61
12	179	54	30.16	22	180	43	23.89
11	171	55	32.16	21	176	55	31.25
Total	1,268	530	41.80	Total	1,247	476	38.17

Tooth type	Total (Teeth)	Crack (Teeth)	%	Tooth type	Total (Teeth)	Crack (Teeth)	%
38	66	14	21.21	48	70	15	21.42
37	152	52	34.21	47	148	57	38.51
36	129	74	57.36	46	132	81	61.36
35	176	68	38.64	45	178	70	39.32
34	182	75	41.2	44	173	66	38.15
33	197	45	22.84	43	197	56	28.42
32	194	49	25.26	42	194	59	30.41
31	196	70	35.71	41	187	76	40.64
Total	1,292	447	34.60	Total	1,289	479	37.16

Table 4 Distribution of cracked tooth according to the depth of the cracks

Characteristics of cracked tooth	Number of teeth	%
Surface		
Enamel	1897	98.18 (1897/1936)
Dentin	31	1.60 (31/1936)
Pulp	4	0.20 (4/1936)

Table 5 Distribution of cracked tooth according to position

Characteristics of cracked tooth	Number of teeth	%
Position		
Cuspal cracks	9	0.45 (9/1936)
Coronal cracks	1643	83.06 (1643/1936)
Marginal ridge cracks	91	4.60 (91/1936)
Grooves and fissure cracks	210	10.61 (210/1936)
Cervical area cracks	0	0
Mid tooth buckling (abfraction)	19	0.96 (19/1936)

Regarding the age of the patients, all patients older than 40 years old had cracked tooth. Hiatt reported that the occurrence of incomplete tooth fractures requiring treatment was not noted before age of 26². In his study, 100 incomplete tooth fractures from 64 patients responding to pulpal-periodontal symptoms are distributed according to the age of the patients. It was found that fractures occurred in the patients at ages between 26-29, 30-39, 40-49, 50-59, and 60-68 were <5%, 15%, 30%, 14% and <5%, respectively. A sharp increase was apparent during the two decades of life (between 30-49 years old). The rapid decline in such fracture beginning at age 50 is interpreted as being the result of teeth loss in that age group as well as the presence of restorations which protect the tooth from fracture. Comparing to our study, even in young patients at the age of 21-30, more than 90% had at least one cracked tooth. This may be due to the criteria for the diagnosis of cracked tooth in our study which also included tooth with craze lines. Therefore, if this is excluded, the lower prevalence of cracked tooth may be found.

The literature has discussed age changes that may influence tooth fracture predisposition. Early theories proposed that teeth become more brittle and fracture more easily with age¹. In addition, the post-eruptive maturation of enamel may be responsible for fractures in the advanced age groups⁶. Dentine is also subjected to age changes, namely progressive sclerosis and physiologic secondary dentine deposition¹⁸. The teeth of older persons may be predisposed to fracture from other factors including increased numbers and size of restorations, increased prevalence of endodontically treated teeth, and long-term fatigue problem associated with thermal stress¹⁶. Another consideration is that the teeth lost throughout life reduce the number of functional units

which leads to the increase of load per tooth. Therefore, more fractured and cracked teeth could be found in the older age group¹⁶.

In this study, it was found that in quadrants 2, 3 and 4, the most prevalent teeth with cracked or craze lines were first permanent molars (Table 3). This is consistent with a study which reported that the first permanent molars were frequently subjected to cracks³. However, this is in contrast to another study which found that second permanent molars were the most frequent teeth presented with cracks¹⁹. Interestingly, we found that in quadrant 1 the most prevalent teeth with craze or cracked line were canines. This might be due to the inclusion criteria of teeth with craze lines in this study. However, the second most frequent teeth with cracked or craze lines in this quadrant were the first permanent molars. It should be interesting to further investigate in patients with craze or cracked line on canines whether these patients had canine guidance or not. Since the association of occlusal scheme and the area of cracked tooth has never been reported.

In this study, very few patients had pulpal symptoms associated with cracked tooth (Table 4). However, when patients come with symptoms of cracked tooth, thorough investigation should be initiated since there may be more than one tooth with cracks. In addition, most cracks found in this study were coronal cracks which should be visible, therefore, the detection of cracked tooth should not be difficult.

The result from this study indicated that most of the patients had risk behaviors that can induce cracked tooth. According to the interviews, most patients did not know that these behaviors such as frequent eating hard food or abrupt changes of the temperature in the mouth can induce cracked tooth¹⁶. More education should be given to the patients

regarding the causes of cracked tooth, especially with regards to associated behavioral risk factors. Dentists should be cautious if their patients have several craze or cracked lines on their teeth. Associated behavioral risk factors should be asked in these patients. Patients should be informed that he or she has multiple craze or cracked lines and those associated risk behaviors should be reduced or stopped to prevent further cracks of these teeth.

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