Cracked Tooth Syndrome: Characteristics and Distribution among Adults in a Nigerian Teaching Hospital

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Abstract

This study highlighted the characteristics and distribution of cracked tooth syndrome (CTS) and the associated factors in adult attendees in the University of Nigeria Teaching Hospital. Three hundred seventy patients aged 18 years to 77 years with CTS-like conditions were included and studied over 12 months. The following information was recorded: suspected tooth and the dental arch, restorative status of the tooth, age and sex of the patient, results of bite test and transillumination, and the pulpal and periapical status of the tooth. CTS was seen most often in the 41 to 50 years age band (36.4%), in molars (63.6%), and in the maxillary arch (51.5%). Also, it was more frequent in men (55.8%). About 82% of CTS occurred in amalgam-restored teeth. All cases had a positive response to the bite test and a normal response to the electric pulp test. Only 10% gave a positive history of masticatory accident as against none with history of bruxism habits. It was concluded that patients with unexplained pain in a vital, amalgam-restored tooth (especially in maxillary molars), with or without a history of a masticatory accident, may have a cracked or fractured tooth. *(J Endod 2009;35:334–336)*

Key Words

Associated factors, bite test, cracked tooth syndrome

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The term "cracked tooth syndrome" (CTS) was first used by Cameron (1), although other researchers had reported on the condition 7 years earlier (2). It may be defined as a fracture plane of unknown depth initiated from the crown passing through the tooth structure and extending subgingivally, which may progress to communicate with the pulp space and/or periodontal ligament. The fracture may be extended through either or both of the marginal ridges and also through the proximal surfaces of the tooth (3, 4).

CTS often evolves from a cracked tooth, and the latter does not always induce pain (5). Some workers believe that CTS is limited to vital posterior teeth (6), but it can also present in nonvital teeth (7). However, a true cracked tooth cannot be found among anterior teeth (4).

A relationship between CTS and restorative status of the teeth has been reported (1). Other predisposing factors are some morphologic and physical factors such as deep fissures and pronounced intraoral temperature fluctuation, iatrogenic factors (such as poor cavity design and wrong selection of restorative materials), heavy occlusal forces, masticatory accidents, and bruxism habits. The pain of CTS is elicited by releasing a clenching pressure. It is also worsened by extreme temperature, especially cold (4, 8, 9). The complications of CTS include the involvement of pulpal tissue and/or periodontal ligament, cuspal fracture, and tooth mortality (10).

The occurrence of CTS is unknown, but an incidence of 34% to 74% has been cited (1, 10). It occurs more frequently in the 30- to 50-year-old patients (3), and it has predilection for females (5). The CTS is most frequently observed in the mandibular second molar followed closely by the first molars and then by either maxillary premolars or maxillary second molars (4, 10, 11).

The clinical importance of CTS lies in difficulties in its diagnostic procedures and frustration faced by both the patient and the dentist. Cameron (1) drew the attention of the dentistry world to the symptoms of the patient. All dentists should be aware that cracks are expectable in all cases. The cracks generally shear toward the buccal or lingual side toward one root surface, usually the lingual surface. Because the crack begins on the occlusal surface, it grows from this area toward the cervical surface and down the root. The application of wedging forces produces no separable segments that would indicate complete fracture, as with a split tooth (4).

Sharp acute pain on chewing hard objects may be observed in this situation. In fact, the patients experience some intermittent episodes of acute pain radiating over the entire side of the face. A sharp short-duration pain may also be observed by cold stimuli. These cases may present with a variety of symptoms ranging from mild to very severe spontaneous pain consistent with pulp necrosis, irreversible pulpitis, or even an apical periodontitis. Both cracked and crazed teeth are considered incomplete tooth fractures, but a challenging form is CTS. The fracture line of a cracked tooth usually runs mesiodistally, whereas the craze line is limited to the enamel tissue (4, 12, 13).

It should be remembered that the symptoms and signs in CTS are highly variable so the signs and symptoms are not the same in all cases of CTS (4). The recognition of patient symptoms, early diagnosis, and suitable treatment are important factors to salvaging a cracked tooth. The purposes of this prospective clinical study were to investigate the characteristics and distribution of CTS among Nigerians and to highlight any other associated factors, including age and sex.

Materials and Methods

A total of 370 attendees aged 18 years to 77 years presenting with suspected cracks and/or unexplained sharp pain in a vital tooth were examined at The University of Nigeria Teaching Hospital and followed up for 12 months. The symptoms included pain upon chewing or upon alleviating on release as well as mild pain with cold stimulation.

After careful isolation of the tooth with cotton rolls, it was visually examined with the naked eye for restorative status, cracks, and displaceable fractured cusps using a sharp explorer and a mouth mirror. Mobility and percussive tests were also performed, whereas pockets were assessed with a WHO probe (Hahnenkratt, Königsbach-Stein, Germany).

Other assessments included pulp vitality test using an electric pulp tester (Digitest; Parkell, New York, NY), illumination of all teeth with a pen touch under a darkened background, and a bite test using a cotton roll. The patient was asked to clench on a cotton roll placed directly over the suspected tooth. The feeling of sharp pain on sudden release of clenching pressure is considered a hallmark of CTS.

The restorative, pulpal, and periapical status were assessed with bitewing and periapical radiography at both baseline and recall visits. Other information recorded included age and sex of the patient, type of tooth and dental arch, and histories of masticatory accidents and habits. Masticatory accidents included reports about a cracking sound followed by an unpleasant sensation during the eating of hard foods. Habits included bruxism and clenching.

The patients were followed up at 1, 3, 6, 9, and 12 months for frank CTS and to rule out other sources of pain that may mimic CTS. After proving the CTS in each case, depending on the nature of cracks, all CTS cases received appropriate treatment. Some of these teeth needed only restorative treatment, and a few required root canal therapy.

Inclusive criteria were both unrestored and amalgam-restored teeth (not composite or glass ionomer–restored teeth), with or without pain of unidentifiable source and cases without percussive pain of periapical origin. The relationship of composite resin and glass ionomer–restored teeth with CTS forms a separate ongoing work. Also, the patients were aged $\geq$18 years. The teeth with spontaneous pain, patients less than 18 years old, non–amalgam-restored teeth, endodontically treated teeth, and crazed teeth were excluded from the study.

The data were analyzed with SPSS, version 6 (SPSS Inc, Chicago, IL). The association between categoric variables was compared with the chi-square test. The critical level of significance was set at <0.05.

Results

The ages and sex of the patients (male = 152 or 41%, female = 218 or 58.9%) ranged from 18 to 77 years. The mean age was 34.78 $\pm$ 14.52. The CTS occurred 33 (8.9%) times in the population (men = 19 or 12.5% and women = 14 or 6.4%). CTS occurred more often in the 41 to 50 years age band (36.4%), followed by 51+ years band (27.3%), 31 to 40 years band (24.2%), and 18 to 30 years band (12.1%).

Of the 137 (37%) restored teeth, 27 (19.7%) had CTS, whereas all teeth (100% or 33) with CTS transilluminated, and 18 (54.5%) had detectable cracks. Both baseline and recall films revealed neither periapical nor pocket abnormalities.

CTS was more frequent in the molar (63.6%) than in the premolars (36.4%). In the molars, CTS occurred in the following order: second molars (27.3%) and then first molars (9.1%). For premolars, the order was second premolars (21.2%) and then first premolars (18.2%). The men (19 or 55.8%) suffered more often than women (14 or 41.2%) ($p = 0.91$) (Table 1).

CTS occurred more often in the maxillary arch (17 or 51.5%) than in the mandibular arch (16 or 48.5%) ($p = 0.39$). The order of occurrence in the former was first molars (6 or 35.2%), first premolars (4 or 23.5%), second premolar and molars (3 or 17.6%, respectively), and the third molars (1 or 5.9%), whereas the order in the mandible was second molars (6 or 37.5%), second premolars (4 or 25%), first premolars, and third molars (2 or 12.5%, respectively). CTS occurred in 27 (81.8%) amalgam-restored teeth compared with 6 (18.2%) in unrestored teeth ($p = 0.89$). Among restored teeth, CTS was most frequent in the second molars (29.6%), followed by second premolars and first molars (22.2%), first premolars (18.5%), and third molars (7.4%). In the unrestored teeth, the following order was observed: first molars (33.4%), first and second premolars, and then second and third molars (16.7%, respectively) (Table 2).

The 33 (100%) patients with CTS not only had a positive bite test but also responded to electric pulp testing at normal threshold levels, whereas of 23 (6.2%) patients with a history of masticatory accidents, 10 (2.7%) had CTS relative to bruxism for which no patient had a positive habit history.

In most cases, symptoms were relieved immediately after diagnosis was made. For those with symptoms of an unexplained source, symptomatic alleviation was effected. Such cases were followed up for evidence of cracks and to rule out other possible causes.

Discussion

The age at which CTS occurred in the current study agrees with previous reports (2, 3). Ellis et al (3) reported CTS more frequently in the 30 to 50 years age range, whereas other reports recorded the CTS more often in the middle- and older-aged patients (8). The susceptibility of these patients to CTS may be because of the less elasticity of dentin and less pliable supporting tissues usually seen with increasing age (14).

The susceptibility of males to CTS in the current study disagrees with other reports (5, 12). Some authors found that males and females are equally affected (5), whereas others reported that females are affected more often (12) because of their better dental attendance behaviors. The reason why more males are affected may be because

TABLE 1. Cracked Tooth Syndrome by Age and Sex

Tooth type	Age (y)				Sex*	
	18 - 30 n = 4 (12.1%)	31 - 40 n = 8 (24.2%)	41 - 50 n = 12 (36.4%)	51^{+} n = 9 (27.3%)	Women n = 14 (41.2%)	Men n =19 (55.8%)
First premolar	0 (0.0)	1 (12.5)	1 (8.3)	4 (44.4)	2 (14.3)	4 (28.6)
Second premolar	1 (25.0)	2 (25.0)	1 (8.3)	3 (33.3)	4 (28.6)	3 (15.8)
First molar	2 (50.09)	1 (12.5)	3 (25.0)	2 (20.2)	3 (21.4)	5 (26.3)
Second molar	1 (25.0)	3 (37.5)	5 (41.7)	0 (0.0)	4 (28.6)	5 (26.3)
Third molar	0 (0.0)	1 (12.5)	2 (16.7)	0 (0.0)	1 (7.1)	2 (14.3)
Total	4	8	12	9	14	19

*$\chi^2_4 = 1.02$, $p = 0.91$.

TABLE 2. Cracked Tooth Syndrome by Arch and Restorative Status

Variables		CTS (%)				
		First Premolar	Second Premolar	First Molar	Second Molar	Third Molar
Dental arch	Mandible (48.5%)	12.5	25	12.5	37.5	12.5
	Maxilla (51.5%)	23.5	17.6	35.2	17.6	5.9
Restorative status	Unfilled (18.2%)	16.7	16.7	33.4	16.7	16.7
	Filled (81.8%)	18.5	22.2	22.2	29.6	7.4

of the higher masticatory forces exerted by males than females. It should be noted that 81.8% of teeth with CTS were amalgam restored, and they lacked any manner of protective covering. The average biting forces exerted by males and females are 448 N and 357 N, respectively (15).

The pattern of occurrence of CTS among tooth types in the present work agrees with the findings of previous reports (11, 16). The high frequency of occurrence in the molars is suggested to be caused by the proximity of molars to the temporomandibular joint (11). Arnold (17) reported that the force ratio on molars, premolars, and incisors is 4:2:1, with far heavier forces on the most posterior teeth.

The predilection of amalgam-restored teeth to CTS in the present study agrees with the report of Cameron (18) but not with others (8, 19). The predilection may be because their heavily restored status compromises the teeth, and they become progressively weaker with a tendency for microfracture under stress (18). Thermal cycling and damaging horizontal forces are mentioned as predisposing factors. How cracks form in a restored tooth is not completely clear. Perhaps when cusps flex under normal loading, high stresses are induced at the internal line angles of the cavity, producing microcracks that may propagate to cause fatigue fracture (20). The presence of a class I or II restoration has been shown to significantly increase the chances of a crack being present (21). It has been claimed that teeth having class I restorations (especially molar teeth) have the same incidence of CTS as compared with teeth with class II restorations (4).

The result of the bite test in the present study agrees with earlier findings (22). A positive bite test is diagnostic of CTS. In a bite test, pain is felt when clenching pressure is released. The pain is caused by fluid within the crack moving toward the pulp (23). Thus, the fluid stimulates mechanoreceptors very close to the odontoblast cell body, resulting in the activation of A-delta fibers, which gives rise to sharp pain of a few seconds duration. Pain of CTS is usually sharp, moderate, and lasts for a very short duration and it is localizable by the patient (10). The shortcoming of bite test is the difficulty in positioning the test material over a specific cusp of the tooth.

Because of the difficulty in detecting cracks, the study used both periapical and bitewing films (13). However, this study like many other studies has some limitations. An important limitation was nonusage of staining agent to delineate crack lines. Classically, the fracture lines may not be visible to the naked eye and the tooth should be isolated under rubber dam; the offending tooth should then be stained and viewed under the operating microscope. Restorations should be removed to visualize and stain the fracture line (24). Also, transillumination is a beneficial aid in these situations (23). Another limitation was using the cotton roll instead of the tooth slooth. The slooth can make the results more precise compared with cotton rolls (13). Also, optical coherence tomography, which is a promising nondestructive imaging method for the diagnosis of vertical root fractures (25), may be another diagnostic aid.

The use of fiber posts in endodontically treated teeth increases their resistance to fracture and improves the prognosis in case of fracture (26). Also, using a direct bonded composite resin restoration has been proposed as a successful treatment in this situation (27). If a marginal ridge crack is identified early enough in teeth with reversible pulpitis and a full crown restoration is placed, endodontic treatment will be necessary in only 20% of these cases within a 6-month period (28).

Conclusion

Patients with unexplained pain in a vital, amalgam-restored tooth, with or without a history of a masticatory accident, may have a cracked or fractured tooth. The most instances of CTS in this study involved the maxillary first molar teeth followed by the mandibular second molars.

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