

A ten-year study was made of the cracked tooth syndrome, in which 102 posterior teeth with cracks were investigated. Early diagnosis and treatment can prevent further cracking into the pulp and fracture of the tooth.

The cracked tooth syndrome: additional findings

Caryl E. Cameron, DDS, MS, Chicago

In an earlier report in March 1964, 50 instances of the cracked tooth syndrome were described.¹ That paper called attention to the syndrome to make the dentist aware of the problem so he could make the correct diagnosis. Once the diagnosis is made, further cracking into the pulp and fracture of the tooth can be prevented.

Another 102 teeth have been studied: only posterior teeth were involved, anterior teeth were not included.

■ **Diagnosis:** Discomfort in chewing is the most frequent symptom of a cracked tooth, but unexplained sensitivity to cold is often experienced by the patient. The patient complains that it hurts to bite on one side of the mouth, but he may not know which tooth is involved or whether the pain is in the mandible or maxilla. However, a crack should be suspected when the patient experiences pain when chewing on that side of the mouth, especially when chewing tough foods.

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. These cracks occur most frequently in the mandibular second molars. They are easy to diagnose if they can be seen. Food and bacteria may stain the plaque in the crack when the crack extends over the distal marginal ridge and onto the distal surface. A typical crack



Fig 1 ■ Typical crack in distal surface of mandibular second molar.

is shown in Figure 1; there is no restoration on the distal surface of the tooth and the third molar is missing.

Unfortunately, most posterior teeth that crack have been restored, thus obscuring the crack and necessitating the use of other diagnostic procedures. Diagnostic methods previously described were tapping the various cusps in different directions, wedging along a margin of the restoration with a sharp instrument, having the patient bite on a wooden toothpick, and staining.)

An additional diagnostic aid to locating the

tooth involved was suggested by Sturdevant.² He asks the patient to bite on a small sulci burlew wheel. The hole is positioned in sequence on each cusp of a suspect tooth to limit the pressure to one cusp at a time until the offender is found. Surprisingly, (the pain may occur when the biting pressure is released.)

Transillumination is another important aid in locating the crack. A bright mouth light used in a darkened room may make the crack visible. An incandescent or, better still, one of the newer fiber optic lights shone through the various surfaces will outline a crack that cannot be seen in normal direct light. This is difficult to photograph in the mouth but shows well on an extracted tooth (Fig 2).

When a crack is suspected but cannot be seen, the sharp point of a fine curved explorer will often catch in the crack interproximally or below the margin of a restoration. This is sufficient indication of a crack to warrant removal of the restoration for further inspection of the tooth.

Viener³ described a method of staining-to-locate the crack. The old restoration is removed and a dye such as methylene blue is applied. If the crack still cannot be seen, the dye is sealed in with zinc oxide and eugenol to which the same dye has been added. In two or three days, any crack is then visible. Hefferren⁴ also described a technique in which he applied a fluorescent dye that is absorbed by the plaque in the crack; the crack then may be seen under ultraviolet light.

Even after the foregoing methods are used, diagnosis may still elude the practitioner. Ingle^{5,6} said the symptoms are often bizarre and diagnosis may depend on the extent of the fracture. Stanley⁷ has described the symptoms as gradually increasing to the excruciating pain of a severe toothache.

Patient awareness led to discovery of the cracks in 25% of the 102 teeth studied here. The patients were able to make their own diagnoses because they remembered the symptoms of a previously cracked or fractured tooth. (A patient who has cracked one tooth is likely to crack another.) Of the repeat patients, 26 had had one previously cracked tooth, 7 had had two, 2 had had three, and 1 had had four.

Not all unexplained symptoms are those of cracked teeth. Teeth with old pulp cappings have been treated for suspected cracks until the restorations were removed and the old exposure uncovered. However, in the differential diagnosis of unexplained pain, the dentist must be aware that the tooth may be cracked.



Fig 2 • Crack shown by transillumination.

Hiatt⁸ reported on 100 incompletely fractured teeth in 64 patients. He also used the small burlew disk to identify the tooth and found the pain to be in both the pulpal and periodontal regions. He showed the progress of the crack into the pulp and the development of a periodontal pocket along the line of fracture. His observation that cracks occur in older age groups, and most often in mandibular molars, agrees with the pattern found in the 102 cracked teeth described here as well as those described in the previous report.

Results found in evaluation of series

Of the 102 cracked teeth, 68 were in women and 34 were in men. Thirty percent of the patients were 60 years old or older, 28% were 50 to 60, and 22% were 40 to 50; only 20% were under 40 years of age. Radiographs showed no alteration at the apex in 83 of the teeth. The pulp was found to be vital in 71 of the teeth. In 11 teeth, a crack was discovered during cavity preparation for caries when no symptoms had been present. Only five normal unrestored teeth were cracked.

The degree of wear on all teeth in mouths of patients with a cracked tooth was tabulated as none, moderate, or severe. The teeth in 92% of the patients were moderately worn, those in 4% were severely worn, and the teeth in the other patients showed no wear. Wear was moderate in 81% of the cracked teeth and severe in 15%; the other cracked teeth showed no wear.

Table ■ Cracked surfaces and materials involved in restoring those surfaces.

Restorations	Amalgam	Gold inlays	Total
Occlusal	21	7	28
Mesioclusal	8	15	23
Distoclusal	7	4	11
MOD	18.5	14.5	33
Other			2
None			5
Total	54.5	40.5	102

Two thirds of the 102 cracked teeth were mandibular molars; mandibular first molars numbered 30 and mandibular second molars, 38. Of maxillary cracked teeth, 10 were premolars, 9 were first molars, 13 were second molars, and 2 were third molars.

The types of restorative materials found in the cracked teeth and the surfaces involved are shown in the Table. (In many MOD restorations, half the filling was amalgam, the other half was a gold inlay.) The restorations in more than half of all the cracked teeth were amalgams. Cement bases were evident radiographically in 32 of the teeth.

According to the patients' recollections, only four of the restorations had been placed within the past five years, 40 had been in place five to ten years, and 47 had been in place for more than ten years. No data were available for the others.

At the time that the cracked tooth was discovered, 72 of the patients complained about pain on chewing, 68 mentioned sensitivity to pressure, 47 gave sensitivity to cold, 27 mentioned sensitivity to tapping, 27 gave sensitivity to heat, 19 mentioned sensitivity to wedging, 7 indicated sensitivity to sweet, 21 mentioned toothache, and 4 mentioned the symptom of swelling. Most patients listed a combination of several symptoms. Those who experienced toothache or swelling were candidates for endodontic treatment or extraction; this was also true for about half of those who complained that the teeth were sensitive to heat. In the other heat-sensitive teeth, and even though the symptoms were minor, the possibility of the crack invading the pulp was suspected, even if the pulp was vital.

Endurance of patients is amazing. According to available information, 24 patients had experienced the symptoms for more than a year, 14 had been uncomfortable for more than six months, and 20 for more than a month. Only 17 had sought treatment, with the condition diagnosed within the first month.

An estimate of biting pressure was made by the patients and the author. A third of the pa-



Fig 3 ■ Crack following lines of dentinal tubules.

tients exerted average pressure, two thirds exerted hard pressure and were strong biters or clenchers.)

Histologic sections of a typical cracked tooth showed that the crack follows the lines of the dentinal tubules in a general though irregular direction. There are no clear-cut lines of tubules for the crack to follow through the secondary dentin. Shadows or stains along the crack indicated it had been there a long time, perhaps progressing slowly before symptoms appeared (Fig 3). Almost all the cracks extended in a mesiodistal direction and differed only in degree of depth and length. Only two cracks were unusual in that they extended buccolingually.

Treatment

One suggested treatment is that the fragments be wedged apart and the fracture site restored. Superficially cracked cusps usually fracture and are removed in the restorative process. However, if the fragments are wedged apart, deeper and more centrally located cracks lead into the pulp; this necessitates endodontic treatment or extraction. The closer the crack is to the pulp, the poorer is the prognosis.

Further cracking should be prevented before

symptoms approach those of a pulpitis. An onlay with reverse bevels or a crown provides much better treatment than endodontics or extraction.

Two patients whose cracked teeth were evaluated in this series had such severe pain that they were being treated for trigeminal neuralgia by their physicians; one patient was being given Tegretol medication and brain surgery was being considered for the other. Their conditions disappeared after the diagnosis of a cracked tooth had been made and treatment completed; one patient underwent an extraction procedure and the other endodontic treatment.

Pruden⁹ classified various cracks and fractures and described their treatment. He pointed out the stapling effect inlays should have to protect and prevent further cracking. In this series, endodontic treatment or extraction was required for 25% of the teeth with cracks. Another 25% had enough supporting dentin to warrant an onlay with reverse bevels over the cusps to hold the tooth together and resist the forces widening the crack. Fifty percent of the teeth received crowns. During the ten-year study I have concluded that full coverage is the best protection.

A cusp might fly off during preparation since the vibration of the bur or stone under high speed might complete the fracture. In a few instances, a cusp or part of the preparation would come off in the temporary crown when it was removed.

Restorative treatment was attempted in a few instances in the hope that the pulp would survive. These were borderline instances in which a mild pulpitis was present or the teeth were sensitive to heat. The crown was cemented with a nonirritating cement. Pulpal treatment could be done through the crown if the pulp did not remain vital. This in no way contraindicates protecting a tooth that might be suspected of having a crack.

Discussion

Two thirds of the cracked teeth occurred in women; this is hard to understand. Whether women bite harder or more often or whether they have more caries so that their teeth are weakened by restorations was not determined. It was noticed that the men involved seemed to have short square faces with muscular jaws.

The frequency with which mandibular molars crack is an indication of the "nutcracker" effect of the jaws. The lingual cusps of the maxillary

molar wedge the cusps of the mandibular molar apart, either by excessive force or constant hammering.

Wear is nearly always present on the occlusal surfaces of all teeth with cracks in older patients. It is not an important diagnostic factor unless the wear is deep and at a steep angle to the cusps. Biting pressure and frequency of contact seem to be more important factors. Expansion of amalgam or insertion of an inlay does not explain the syndrome since almost half of the restorations had been in the cracked teeth for more than ten years.

An encouraging finding was that 75% of the teeth had vital pulps and were preserved. Also, those teeth that could have endodontic treatment were retained. These observations show the importance of early diagnosis.

There is a direct relationship between the size of the restorations and the number of teeth cracked. Naturally, the teeth in which three surfaces were involved were weakest. The more extensive and the deeper the restoration, the less tooth there is remaining to support the load. Silvestri¹⁰ in describing the syndrome of split roots illustrates how the depth of an MOD cavity preparation is an important factor weakening tooth structure. His review of the literature shows the deleterious effects of high-speed instrumentation, insertion of pins, and thermal cycling; all cause internal stresses and strains leading to crazing and cracking.

Patients will tolerate discomfort and learn to favor a painful tooth or side of the mouth for months. The crack always becomes worse under occlusal forces until a clear break or an intolerable toothache develops. Patients frequently procrastinate even after the diagnosis is made. Although temporary relief may be obtained by occlusal adjustment, the symptoms and cracking eventually return and progress.

After evaluating the symptoms, the dentist should have confidence in his diagnosis. Even if there is some doubt, the cusps must be protected in any large or deep restoration. An onlay with reverse bevels over the cusps or a crown is necessary. Such protective measures will prevent or stop further cracking.

Textbooks of dental anatomy seldom describe the developmental fissures over the marginal ridges of mandibular molars, yet many cracks are found in such fissures. Sturdevant² also observed this occurrence and pointed out that a dividing force in the resultant weak plane readily splits the tooth.

Summary

The results of this study add to the previous findings on the cracked tooth syndrome. Treatment to prevent further cracking is a must. Dentists should be aware of the syndrome and, after making the diagnosis, initiate necessary treatment.

Dr. Cameron is associate professor, oral diagnosis at Northwestern University Dental School. His address is 670 N Michigan Ave, Chicago, 60611.

1. Cameron, C.E. Cracked tooth syndrome. JADA 68:405 March 1964.

2. Sturdevant, C.M.; Barton, H.E.; and Brauer, J.C., ed. The art and science of operative dentistry. New York, McGraw-Hill Book Co., 1968, p 57.

3. Viener, A.E. Fractured teeth: a cause of odontalgia. Oral Surg 20:594 Nov 1965.

4. Hefferren, J.J. Council on Dental Materials and Devices. A review of approaches to the detection of dental caries. JADA 86: 1358 June 1973.

5. Ingle, J.I. Endodontics. Philadelphia, Lea & Febiger, 1965, p 270.

6. Ingle, J.I. Endodontics. Philadelphia, Lea & Febiger, 1965, p 434.

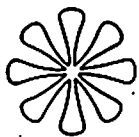
7. Stanley, H.R. The cracked tooth syndrome. J Am Acad Gold Foil Oper 11:36 Sept 1968.

8. Hiatt, W.H. Incomplete crown-root fracture in pulpal-periodontal disease. J Periodontol 44:369 June 1973.

9. Pruden, W.H. Treatment of the cracked tooth. J NJ Dent Assoc 42:22 March-April 1971.

10. Silvestri, A.R. The undiagnosed split-root syndrome. JADA 92:930 May 1976.

Foley's Footnotes



Through the long travail of the centuries, man has devised many punishments involving the oral cavity. An alert curiosity has enabled me to collect references to a parcel of these oral mechanisms. In this note I shall mention only two of them.

Two methods used by American schoolmasters to punish troublesome students exemplify in the 19th century the practice of oral punishment.

In the 1830s, after Captain Joseph Brown had retired from sea voyaging, he taught school in Newburyport, Mass. The stern Captain asserted his authority by a strong system of discipline, one of his methods of punishment being to place upon the tongue of any lad who lied or swore a cleft stick which he kept soaking in a bottle of pepper sauce.

In the 1870s, Charles T. Harris, superintendent of schools in St. Louis, periodically warned his teachers not to flog, pull ears, cuff, or have a pupil stand in a corner holding a piece of wood in his mouth. As the chip of wood was inserted perpendicularly between the child's teeth, this mode of punishment may have affected the teeth and their adnexa.

Gardner P. H. Foley