

Dental abfractions - a literature review and hypothesis

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INTRODUCTION

Through the years the dental profession has held a variety of theories about the causes of abfractions, including chemical wasting of the teeth, the effects of tooth brushing, and lateral forces. This article reviews the literature on this topic and proposes a new hypothesis to explain which lateral forces are the primary contributing factors that produce abfractions.

REVIEW OF THE LITERATURE

Up until now, research into the causes of abfractions seems to be divided into two camps: those who argue for toothbrushes and other artificial forces as the cause, and those researchers who point to internal physiological sources as the culprit. The latter argument, while not providing a complete explanation, does offer a significant clue to the real cause of this troubling phenomenon.

Original works by W. D. Miller¹ in the late 1800s and early 1900s, seem to be the earliest review in English of the erosion-abrasion issue as it relates to tooth brushing and dentifrices. Miller discussed wasting away of the tooth at the neck as "very often taking a form as though produced by a three-cornered file (p. 2)."¹ Possible causes of wasting away mentioned in the literature at that time included: toothbrushes, alkalis, acids, friction of folds of the mucous membrane, exfoliation, acid secretions of the mucous membrane, electrolytic action, defective development, and rubbing of partial clasps, among others. Ingredients used in toothpastes at that time included: pumice, oyster shells, precipitated calcium carbonate, prepared chalk, and cigar ashes. The results of Miller's two years work on the etiology of erosion were published in 1907 when he announced his belief that erosion was caused by weak acids or gritty tooth powders, or by both, assisted by the toothbrush.

From his investigations, Miller deduced that wasting of the teeth was for the most part a purely mechanical process in which the chief and often only factor concerned was the toothbrush in conjunction with tooth-powder. He believed lingual wasting resulted from the friction of artificial plates or clasps, and he concluded that acids alone could never produce wasting. In 1914, G. V. Black,² the "Father of Modern Dentistry" who witnessed Miller's experiments, disagreed that the brush could produce the kind of wasting to the hard tissue of the teeth that Miller described. Black stated: "In some cases it has appeared as though the brush might be responsible for injury to the teeth near the gum margin, but other cases where the brush had not been used at all are so nearly like these as to show that the injury had not been done by severe brushing (p. 157)."

The works by S. C. Miller³ in 1950 appear to be the first in the literature that suggest that traumatic and lateral forces by the tongue, lips, and cheeks were contributors to gingival recession. In 1960, Fritz Mannerberg⁴ experimented by brushing freshly extracted teeth with a brush that was attached to a machine. Brushing of teeth for 10 hours under standardized conditions with distilled water produced no scratches in the tooth surface. Brushing under the same conditions except with toothpaste containing insoluble abrasives abraded the crown of the tooth

at a maximum rate of 2 to 2.5u per hour. One hour's brushing in the machine was calculated to correspond to one year's tooth brushing *in vivo*. A picture of a tooth after being brushed by a machine for 3, 5, and 10 hours shows lesions, but lesions quite dissimilar from those seen in the mouth and described here as an abfraction.

In 1965, Glickman,⁵ proposed that susceptibility to recession was influenced by many factors, such as the position of teeth in the arch, the angle of the root in the bone, and the mesio-distal curvature of the tooth surfaces. In 1972, Sognaes et al.⁶ examined a random sample of about 10,000 extracted teeth. About 1,700 teeth (18%) had typical patterns of erosion-like lesions. These authors noted that erosion patterns *did not* (emphasis added) occur exclusively on surfaces that were exposed to obvious physical factors such as the abrasive action of a toothbrush. Instead, lesions were found on the lingual surfaces of the teeth and on regions that were inaccessible to friction from tooth brushing.

In 1974 Brodie⁷ demonstrated erosion-like patterns that occurred in acrylic dentures and teeth. Brodie surmised that individuals with erosion-like lesions tended to be of the nervous type, exhibiting bruxism and tension and perhaps psychosomatic conditions. In 1975, Volpe et al.⁸ completed a long-term supervised, double-blind clinical study of abrasivity on teeth of commercially available cosmetic dentifrice, concluding that factors *other* (emphasis added) than dentifrice abrasivity played an important role in tooth wear. Sangnes and Gjermo⁹ found that of 533 patients examined, 45% had wedge-shaped defects in the cervical area of one or more teeth. Once again, it was found that the various tooth brushing techniques did not seem to influence the development of such lesions.

Yettram et al.¹⁰ used engineering principles and studied forces applied within a tooth when external loads were placed on it. Using the "Finite Mathematical Element Stress Analysis," these researchers were able to determine the stress loads on teeth during various tests. They explained why abfractions could occur even gingival to the margins of crowns. Interestingly enough, they found the amount of load placed on the teeth was the key factor.

Radentz et al.¹¹ discerned that there was no relationship between cervical abrasion and tooth brushing technique, tooth brushing frequency, brand of dentifrice, brand of toothbrush, and/or salivary pH. In addition, they found no relationship between the prevalence of cervical abrasion and other factors such as race or hand dexterity. Alexander's¹² research, like that of Mannerberg, was based on attaching toothbrushes to a machine. It was concluded that brush design, brushing frequency, and brushing pressure all affect the degree of cervical abrasion on patients with good oral hygiene habits. 1983, McCoy¹³, on the other hand proposed that bruxing produced most of the destructive forces on tooth structure, and discussed occlusal equilibration as a way to reduce lateral forces. The article also illustrated Lines of Luder, which indicate material fatigue, in both amalgam and acrylic. In 1995, McCoy¹⁴ discussed vertical and horizontal forces as related to "Dental Compression Syndrome." McCoy stated that vertical forces were less harmful because they provided axial stimulation to the teeth and bone. Horizontal forces, however, were extremely damaging, because they subjected teeth and bone to torquing and off-loading.

Finally, in 1984, Lee and Eakle¹⁵ described lateral forces as the cause of the breakdown of tooth structure. Their illustration (Fig. #1) was the first and perhaps

best representation of the effects of lateral force loading. Grippo¹⁶, in 1991, originated the term *abfraction* to describe the pathologic loss of both enamel and dentin caused by biomechanical loading forces. He stated that the forces could be static, such as those produced by swallowing and clenching; or cyclic, as in those generated during chewing action. The abfractional lesions were caused by flexure and ultimate material fatigue of susceptible teeth at locations away from the point of loading. The breakdown was dependent on the magnitude, duration, direction, frequency, and location of the forces.

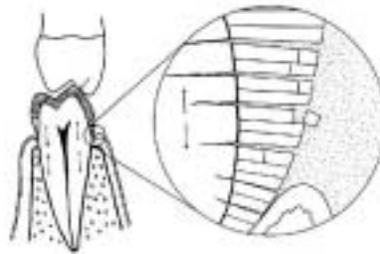


Fig 1 - Lee and Eakle illustration - J Prosthetic Dept., Sept 84, Vol 52, No 3, pp374-380

DISCUSSION and HYPOTHESIS

Much of the research described above suggests that traumatic physiological forces are the cause of the cervical erosion on teeth. This author uses this literature as support for a new hypothesis developed from having observed abfractional lesions that had different angulations of grooves or notches within the same tooth or mouth (Fig #2a), abfractional lesions that were subgingival (Fig #3 and 4), significant abfractional lesions on one tooth but not on adjacent tooth or teeth, lesions on difficult to reach lingual surfaces, and odd shaped lesions that a toothbrush could not have possibly caused.



Fig 2a - Abfractional lesions with different "slants." Note poor home care.



Fig 3 - Abfractional tooth of patient + only known tooth with an abfraction at the Smithsonian in 1996. Note identifying "pit."



Fig 4 - Tooth in mouth - Note identifying "pit" + tongue thrust (1993).

This author agrees that lateral forces are the causative factors of abfraction, as proposed in part by the works of S. C. Miller, Glickman, Brodie, Sognnaes et al., Yettram et al., Radentz et al., Lee and Eakle, Grippo, and McCoy. However, this author's hypothesis adds a significant component to past research by offering a suggestion as to the source of the lateral forces (forces secondary to malocclusions and abnormal tongue activity). These lateral forces result from oral cavity changes in the infant, changes associated with bottle-feeding and use of pacifiers, as substitutes for breastfeeding.

Damaging lateral forces caused by occlusion.

Dawson¹⁷ described the requirements for a stable occlusion. These included: 1) Having stable stops on all teeth when the condyles were in centric relation, 2) Having anterior guidance in harmony with border movements of the envelope of function, and 3) Disclusion of all posterior teeth in protrusive and excursive movements, including posterior teeth on the non-working (balancing) and working side. If a tooth has an abfraction, the occlusal loading on the tooth can be tested in centric occlusion and in excursive movements with occlusal marking paper. There is a good chance that the tooth with the abfraction will have a heavy marking on one of the inclines of a cusp. This damaging lateral force produces stress lines in the tooth and results in tooth breakdown as described by Lee and Eakle.¹⁵ McCoy¹³ suggested that to resolve the problem, the tooth needed to be reshaped. To prevent Class V abfraction restorations from falling out, however, one needs to treat the cause of the abfraction before restoring it. Not surprisingly, Heyman et al.¹⁸ found a statistically significant association in retention failure of restorations when related to tooth flexure.

Damaging lateral force caused by abnormal tongue activity.

If the patient does not have heavy markings on the inclines, then the patient may have abnormal activity of the tongue. For the purpose of this article, a "normal swallow" is a swallow that is initiated with the tip of the tongue starting in the area of the maxillary anterior papilla, that continues with a peristaltic-like action, pressing up against the roof of the maxilla, forcing the bolus (saliva or food) posteriorly and finally down the throat. The tip of the tongue remains in the area of the anterior papilla during the entire swallow. Within the context of this article, any other swallow is considered to be the result of abnormal tongue activity. The tongue should not press with any force into, against, or between any teeth during the swallow. A visual examination of the area of the abfraction with the patient's teeth together and lips slightly parted, can reveal whether the tongue is pushing into the tooth, or if salivary bubbles are visible coming between the interproximal spaces (also a sign of abnormal tongue activity). Note the abnormal position of the tongue during swallowing in figures 2c and 4a. Tongue thrusting can also be the result of large tongues and congested or obstructed airways.



Fig 2c - Note force of tongue thrust against teeth.



Fig 4a - Tooth in mouth - Note identifying "pit" + tongue thrust (1993).

Reputed American orthodontist, Harry W. Tepper¹⁹, appreciated and understood the importance of the action of the tongue in treating orthodontic cases. Tepper treated several thousands of patients over 40 years of practice. He stated that the major causes for malocclusion, like narrow arches, crowded bites and maxillary protrusions,

were usually brought about by an interference of the normal swallowing process by the use of artificial nursing. Tepper explained that the initial insertion of the large and elongated rubber nipple was a basic cause for tongue malfunction. This author agrees with that statement.

If the key requirements of occlusion are not met, or if lateral tongue forces traumatize teeth, then a number of events deleterious to dental health can occur:

- 1) Abfractions
- 2) Sensitive teeth
- 3) Loosening of teeth
- 4) Excessive wear of teeth
- 5) Change in alignment of teeth
- 6) Bone breakdown and bone loss
- 7) Broken or destroyed restorations
- 8) Non-bacterial, non-plaque related gingival recession
- 9) Opening of contacts



Fig 2b - Abfraction ultimately led to fracture of tooth.

Depending on varying conditions, any or all of the above can occur over time. Factors such as the over-all health of the individual, the health of the surrounding bone and tissue, oral hygiene habits, personality of the individual, stress level of the individual, strength of masticatory and peri-oral musculature, et cetera, all contribute to the degree of the response and subsequent breakdown. Not all teeth respond in the same way, but with time, teeth may even fracture (Fig. #2b).

The hypothesis is basically simple, and easily tested in any dental office. Abfractions are not generally found on teeth of calm, non-stressed individuals with a natural and ideal (non-crowded, non-ortho) Class I occlusion. These individuals with a non-crowded natural Class I occlusion will normally have a good cuspid rise during lateral excursions. With cuspid rise, the loading forces of the excursive movement will be directed onto the cuspid. Abfractions are frequently found, however, on cases where mal-aligned cuspids cause initial lateral guidance forces to be exerted on the lingual incline of the buccal cusp of the first maxillary bicuspid (or whichever tooth bears the initial lateral guiding force of excursion). An abfraction can be commonly found on any tooth that has an exceptionally heavy occlusal marking on an inclined plane. Abfractions are also found quite frequently on patients with slight anterior open bites for the same reason -- guidance coming from the bicuspids, rather than the cuspid. The open bite is usually the result of an abnormal motor action of the tongue. If damaging lateral forces are not obvious during excursive motions, then one needs to evaluate the position and motion of the tongue as described above.



Fig 3 - Abfraction tooth of patient + only known tooth with an abfraction at the Smithsonian in 1996. Note identifying "pit."

Abfractions are rarely seen on teeth from prehistoric cultures (Fig. #3), and lesions that are found can usually be explained by the customs of that culture. Examples include interproximal notching or grooving from a cultural custom of passing sinew between the teeth; smooth wear facets on the buccal surface on the first mandibular molar of some Eskimo teeth (due to the custom of placing a bone through the cheek, which rubbed on the molar); pointed teeth resulting from the custom of some African cultures of filing their teeth. McEvoy et al.²⁰ noted cervical lesions in two prehistoric populations. These authors, however,

stated the ancient lesions were smaller and had rougher surfaces than the modern lesions under discussion. This study did not examine either the customs or the diet of the two populations.

CONCLUSION

Toothbrushes cannot get much softer than they already are, yet people continue to develop notches on their teeth, despite instructions from dentists to lighten the forces and to brush in a circular manner. Such instructions reflect the early and inaccurate findings of 100-year-old research. This author hypothesizes, however, that abfractions do not result from brushing at all, but rather from traumatic lateral forces placed on the teeth as a result of a malocclusion or abnormal tongue activity, both of which stem from feeding conditions and training of the oral muscles begun during infancy. By embracing the findings and clear implications of current research, dental practitioners can do much to assure that the serious dental health issues related to the symptoms of abfractions will be more adequately addressed in the future.

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