Noncarious Cervical Lesions: Why on the Facial? A Theory

Noncarious cervical lesions (NCCLs), also referred to as toothbrush abrasion or abfraction, occur almost exclusively on the facial surfaces of teeth. According to Khan only 2% of these lesions occur on the lingual or palatal surfaces.[1] The etiology is still controversial and much has been written in an effort to explain this phenomenon.

There are at least two plausible explanations for the noncarious loss of tooth structure at the cementoenamel junction (CEJ). One is toothpaste/brush abrasion and the other is abfraction, either of which may be hastened by the presence of an acidic environment. Abfraction is described as the loss of tooth structure primarily due to the concentration of forces particularly tensile stress. Lee and Eakle described the concept in 1984[2] and Grippo in 1991 coined the term *abfraction* meaning *to break away*.[3] Grippo further refined the idea and described a multifactorial etiology in 2004.[4] It is his belief that toothpaste abrasion in a corrosive environment can hasten the loss of tooth structure due to tensile forces concentrated at the cervical area of teeth.

Laboratory studies have demonstrated the ability to create notched lesions using a toothbrush with toothpaste but not by using a toothbrush alone.[5,6] These lesions have also been created in the lab using an acid bath and force alone.[7] In addition, the literature is replete with peer-reviewed articles supporting both theories.

Dentists who dismiss the concept of abfraction cite the fact that these notched lesions occur almost exclusively on the facial, and if forces alone were responsible, the lingual surfaces should also be affected. It is intuitive that the toothbrush can easily reach the facial but not so easily reach the lingual, thus toothbrush abrasion seems a more reasonable etiology. However, many experienced practitioners and scientists continue to believe that force plays a decisive role in the formation of NCCLs particularly when these forces result in tensile stress at the CEJ.

FIGURE 1. Premolars demonstrate facial noncarious cervical lesions whereas the canine is unaffected.

TABLE 1. Average facial and lingual bone thickness of teeth in millimeters

	Molars	Premolars	Anterior
Dentate maxilla			
Facial	2.23	1.62	1.59
Lingual	2.35	2	1.95
% Difference facial–lingual	5%	19%	18%
Dentate mandible			
Facial	1.98	1.2	0.99
Lingual	2.51	1.92	1.24
% Difference facial–lingual	21%	37%	20%

From Katranji and colleagues.[14]

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Wear facets on occlusal surfaces can be correlated with cervical notching[8,9] and NCCLs occur more than six times more frequently in patients with group function than in canine protected occlusions.[10] These lesions also occur in non-brushing populations[11] as well as subgingivally where toothbrush bristles can not reach.[12] Often one lingually positioned premolar will demonstrate these defects whereas the more facially oriented canine in the same quadrant is left undisturbed (Figure 1). These lesions have also been reported in early hominids well before the advent of the toothbrush.[13] The question remains why so few lesions occur on the lingual and so many on the facial.

A THEORY

In 2007, Katranji, Misch, and Wang studied and reported the relative thickness of bone on the facial and lingual surfaces of teeth (Table 1).[14] Their findings show that the thickness is consistently greater on the lingual

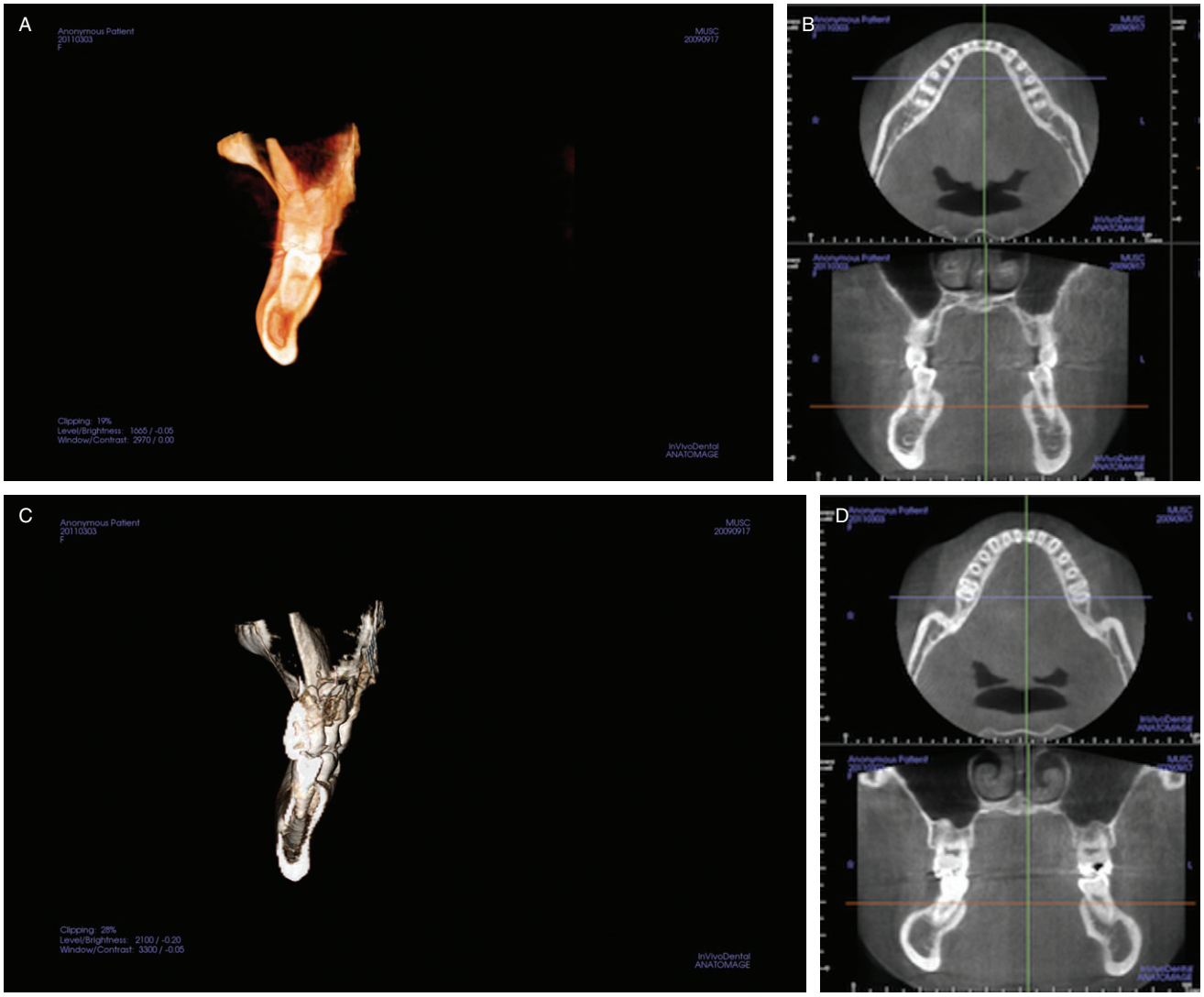

FIGURE 2. A, First molar in cross-section (cone beam computed tomography [CT], courtesy of Dr. Richard Duncan). B, Second premolar, multiplanar (cone beam CT, courtesy of Dr. Richard Duncan). C, Second premolar, cross-section, bone window (cone beam CT, courtesy of Dr. Richard Duncan). D, First molar, near cementoenamel junction, multiplanar (cone beam CT, courtesy of Dr. Richard Duncan).

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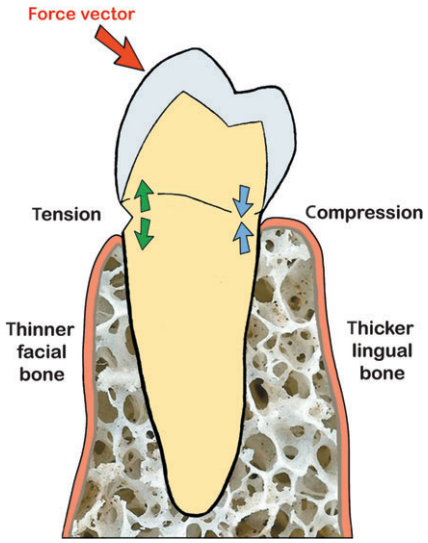

FIGURE 3. Lingual bone creates a fulcrum at the cementoenamel junction (CEJ) when the force is from a facial to a lingual direction placing the facial CEJ under tension (drawing courtesy of Dr. Eddie Collins).

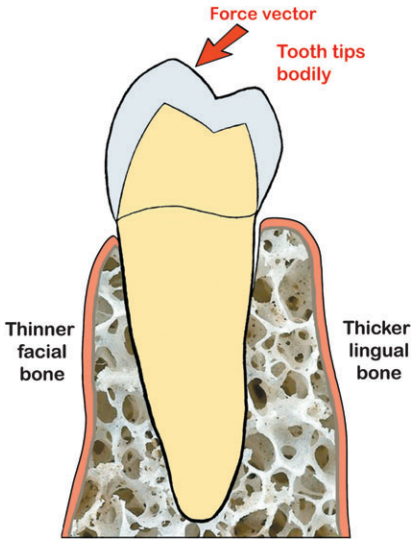

FIGURE 4. Facial bone allows tooth to tip bodily when force is from a lingual to a facial direction dissipating tensile load at the lingual cementoenamel junction (drawing courtesy of Dr. Eddie Collins).

or palatal surfaces. This can also be clearly demonstrated on cone beam computed tomography images (Figures 2A–D).

If this is true, then the bone may deflect the load differently on the facial surfaces than on the lingual sufaces of teeth. This can be termed osteo-deflection (from "osteo" meaning bone and "deflection" being the displacement of a structural element under load). When a lateral force vector from a facial to a lingual direction begins to tip the tooth lingually, the tooth cannot move bodily due to the thickness of the bone, but rather must bend at the fulcrum. In doing so this places the lingual CEJ area under *compression* and the facial CEJ area under *tension* (Figure 3). It is postulated that this tensile load is far more damaging than compressive load. Conversely, if the force vector comes from a lingual to a facial direction the tooth can more likely tip bodily because of lesser bone volume/thickness on the facial thus not concentrating as much tensile stress at the lingual CEJ (Figure 4).

Toothbrushes with sharp tipped bristles can promote gingival recession.[15,16] This recession is much more common on the facial and is generally accompanied by loss of vertical bone as well.[17,18] This loss of bone on the

FIGURE 5. A, Original noncarious cervical lesion (NCCL) is at the crown margin of the premolar. B, As facial bone was lost and the fulcrum changed, the NCCL migrated apically (Photo courtesy of Dr. Bob Holmes).

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facial allows the tooth to tip bodily in a facial direction even more, further reducing the tensile stress at the lingual CEJ. Conversely, forces that tend to move the tooth lingually are resisted by the lingual bone and the stresses at the facial CEJ can shift location. This change in the location of the fulcrum may cause the cervical notches to migrate incisally/occlusally or apically depending on the new site of the fulcrum (Figure 5).

One other observation can be made from the data presented in Table 1. The difference in bone thickness from facial to lingual is greatest among premolars. Coincidently, premolars are also the teeth most affected by NCCLs.[19]

In order to manage these destructive lesions properly, it is helpful to know the etiology. This theory may help explain one inconsistency in the understanding of stress-induced NCCLs.

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REFERENCES

1. Khan F, Young WG, Shahabi S, Daley TJ. Dental cervical lesions associated with occlusal erosion and attrition. Aust Dent J 1999;44:176–86.
2. Lee WC, Eakle WS. Possible role of tensile stress in the etiology of cervical erosive lesions of teeth. J Prosthet Dent 1984;52:374–9.
3. Grippo J. Abfractions: a new classification of hard tissue lesions of teeth. J Esthet Dent 1991;13:14–8.
4. Grippo JO, Simring M, Schreiner S. Attrition, abrasion, corrosion and abfraction revisited. J Am Dent Assoc 2004;135(8):1109–18.
5. Dzakovich JJ, Oslak RR. In vitro reproduction of noncarious cervical lesions. J Prosthet Dent 2008;100(1):1–10.
6. Mannerberg F. Appearance of tooth surface as observed in shadowed replicas in various age groups, in long-term studies, after toothbrushing, in cases of erosion and after exposure to citrus fruit juice. Odontol Rev 1960;11 (6 suppl):70–86.
7. Whitehead SA, Wilson NH, Watts DC. Development of noncarious cervical notch lesions in vitro. J Esthet Dent 1999;11(6):332–7.
8. Xhonga FA. Bruxism and its effect on the teeth. J Oral Rehabil 1977;4(1):65–76.
9. Pegoraro LF, Scolaro JM, Conti PC, et al. Noncarious cervical lesions in adults. J Am Dent Assoc 2005;136(12):1694–700.
10. Marion LR, Bayne SC, Shugars DA, et al. Effects of occlusion type and wear on cervical lesion frequency. J Dent Res 1997;76:309 (Abstr).
11. Babacar F, Kane AW, Sarr M, et al. Noncarious cervical lesions among a non-toothbrushing population with Hansen's disease (Leprosy): initial findings. Quintessence Int 2006;37:613–9.
12. Heymann H. Abfractions: myth or reality? J Esthet Restor Dent 2003;5:259–60.
13. Ritter AV, Grippo JO, Coleman TA, Morgan ME. Prevalence of carious and non-carious cervical lesions in archaeological populations from North America and Europe. J Esthet Restor Dent 2009;21(5):324–34.
14. Katranji A, Misch K, Wang H. Cortical bone thickness in dentate and edentulous human cadavers. J Periodontol 2007;78(5):874–8.
15. Alexander JF, Saffir AJ, Gold W. The measurement of the effect of toothbrushes on soft tissue abrasion. J Dent Res 1977;56:722–7.
16. Silverstone M, Featherstone M. A scanning electron microscope study of the end rounding of bristles in eight toothbrush types. Quintessence Int 1988;19:87–107.
17. Dowell PD, Addy M, Dummer PMH. Dentin hypersensitivity. Aetiology, differential diagnosis and management. Br Dent J 1985;158:92–6.
18. Addy M, Mostafa P, Newcombe RG. Dentine hypersensitivity: the distribution of recession, sensitivity and plaque. J Dent 1987;5:242–8.
19. Borcic J, Anic I, Urek MM, Ferreri S. The prevalence of non-carious cervical lesions in permanent dentition. J Oral Rehabil 2004;31(2):117–23.

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