

Engineering Specifics of the Periodontal Curet's Cutting Edge*

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MUCH HAS BEEN REPORTED on the qualitative, and to some degree, the quantitative effects of wear and sharpening of the periodontal curet's cutting edge. Presented here is an engineering model of the periodontal curet's cutting edge during wear and sharpening, and an estimated life of a typical periodontal curet. Although not confirmed by scientific experiments, this engineering model provides a framework for further scientific analysis. It also gives a clinical appreciation for the longevity of such periodontal instruments. *J Periodontol* 1996;67:374-378.

Key Words: Dental instruments; curets.

Periodontal curets and scalers are the basic instruments used in periodontal therapy. Treating diseased roots with periodontal instruments consists of two stages. The primary step involves the removal of large deposits of bacterial plaque and calculus from the root surfaces. The objective of the second step is to attain a smooth finish on the root. A smooth finish is believed to be necessary in reducing the likelihood of further plaque.¹

This sort of periodontal therapy results in wear of the periodontal instrument's cutting edge. As a result, the re-establishment of a sharp edge is mandatory for periodontal instruments to perform efficiently and successfully.

This paper will review the basic technical principles of a periodontal curet's cutting edge during wear and sharpening. An engineering model of the wear rate and longevity of a typical curet's edge is offered.

PRINCIPLES OF THE CUTTING EDGE

A cutting edge is established when two surfaces meet. In the case of the periodontal scaler and curet, the cutting edge is defined by the union of the lateral and facial surface (Fig. 1).²

The quality of this edge is defined by its fineness, delicacy, and durability.^{3,4}

The fineness of an edge refers to the smoothness of the forefront established by the meeting of the lateral and facial surface. In this paper, the fineness of an edge will be classified as either a fine edge, a near exact meeting of the facial and lateral surface (Fig. 2A); a burr edge, metal flakes protruding from the edge (Fig. 2B); and a beveled edge, a dull edge (Fig. 2C).

The exact effect an edge burr has on the root surface is still not fully understood. Paquette and Levin defined

two types of burr edges; a functional burr edge and non-functional burr edge.^{3,4} A burr edge is said to be functional when the metal projections of the burr are oriented parallel to the direction of the cutting action. This type of burr edge is believed to help in the cutting action, thus the so-called functional burr edge. A non-functional burr edge has its metal projections oriented at right angles to the direction of cutting. This type of burr edge may not only decrease the efficiency of cutting but may also gouge the surface.

This may sound conceptually correct, but when you take into account that these metal projections are very fragile we would expect them to dislodge from the edge after one or two strokes of cutting. Light honing with an Arkansas stone will likely be enough to remove these burrs.

The objective of sharpening is to achieve a consistently fine edge. This type of edge is the most predictable in terms of its cutting efficiency as well as its cutting quality. A burr edge is not only unpredictable in its cutting effects but may behave as a dull edge during initial cutting.

The delicacy is the angle at which the facial and lateral surfaces approach each other. Manufactured sharpened edges are usually present with a delicate angle of approximately 85°. Angles below 80° and above 90° will be less functional.⁵

The ability to keep an edge is indicative of its durability. Durability is usually a property of the hardness of the material of construction. Tal et al. demonstrated that "harder" high carbon steel curets have a more durable edge than stainless steel blades.⁶

Periodontal hand instruments need only be fine and delicate enough to efficiently scrape and remove deposits and diseased cementum from the tooth's root structure.

The efficiency of the cutting action is dependent on the

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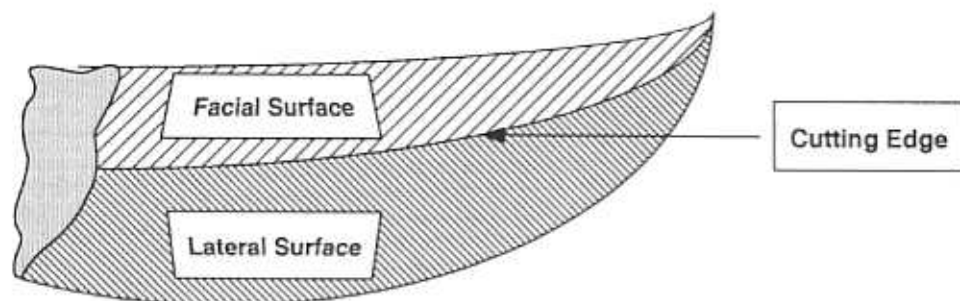


Figure 1. The cutting edge is defined by the union of the lateral and facial surfaces.

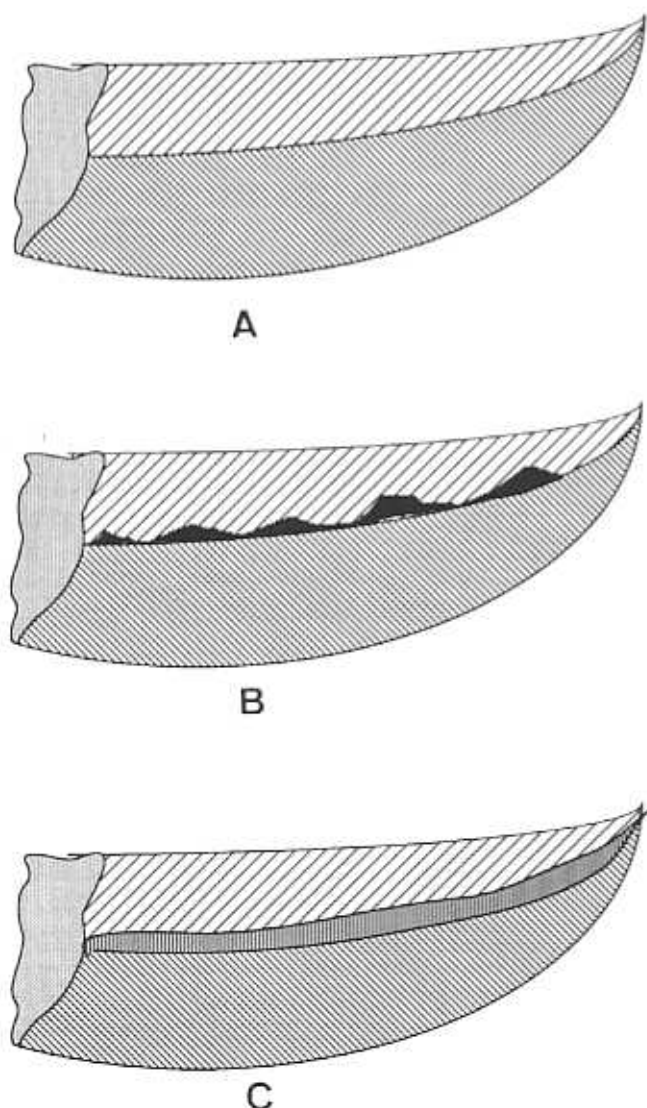


Figure 2. Quality of cutting edges: A. fine edge; B. burr edge; and C. beveled edge.

blade's rake angle and clearance angle (Fig. 3). The rake angle is the angle formed between the facial surfaces of the special plane perpendicular to the root surface. An angle measured above and below the referred special

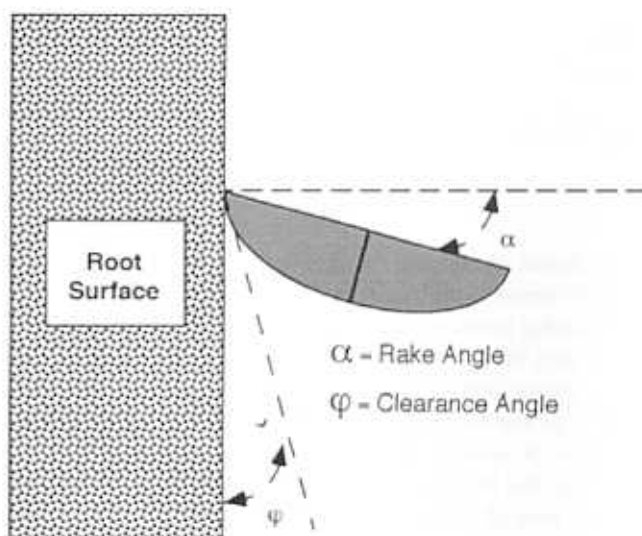


Figure 3. Rake and clearance angles.

plane is defined as a negative and positive rake angle respectively (Fig. 4). For efficient cutting, the rake angle should preferably be zero degrees (0°) although positive rake angles are acceptable. A negative rake angle should be avoided since this type of cutting angle tends to cause the blade to ride over the surface rather than cutting it.

The clearance angle is the angle measured between the lateral surface of the blade and the root surface. "Proper clearance is essential if the edge is to make contact with enough pressure and precision to take full advantage of rake and fineness."⁷ The clearance is dependent on both the rake angle and the quality of the cutting edge. Since wear of periodontal instruments results in a loss of clearance, proper periodical sharpening is necessary for the re-establishment of an effective clearance angle.

ENGINEERING MODEL OF EDGE WEAR RATE AND INSTRUMENT LONGEVITY

Wearing of the sharp edge is the consequence of root planing. Tal et al. reported that 15 strokes of root planing resulted in a narrow bevel of less than $15 \mu\text{m}$, while heavily root planing a surface with 45 strokes of a curet resulted in a wide bevel of greater than $15 \mu\text{m}$.⁷

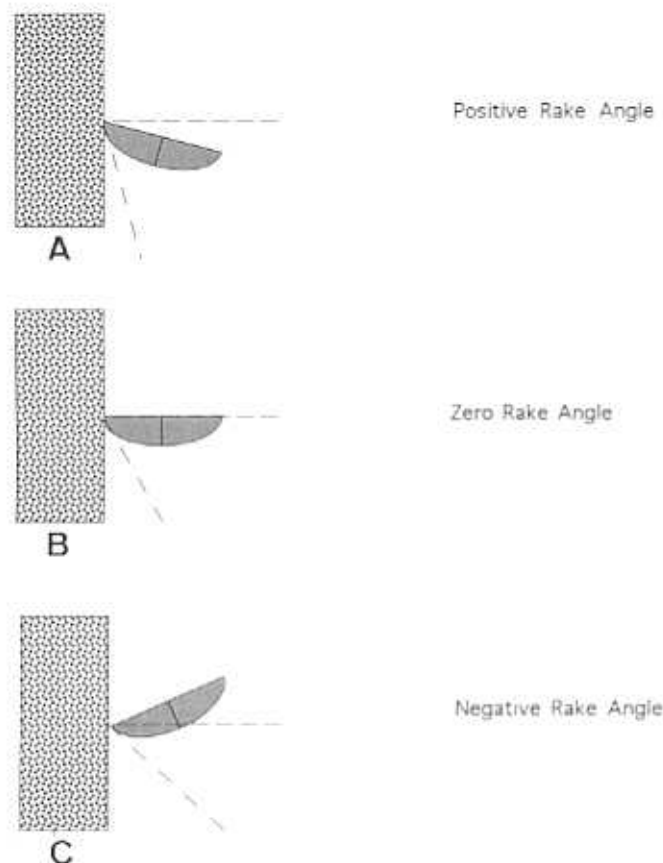


Figure 4. Rake angles: A, positive; B, zero; C, negative.

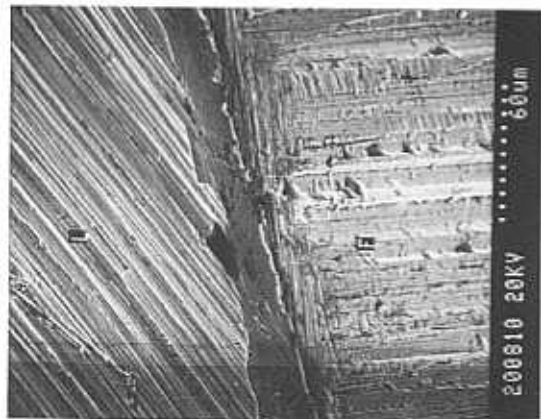


Figure 5. Beveled edge of approximately 33 μm after 40 strokes (original magnification $\times 500$).

Ideally, re-sharpening should remove a minimum amount of material from the blade while establishing a perfectly sharp edge. Using the Tal et al. study as a guideline, allow the assumption that most practitioners probably re-sharpen their instruments after 20 to 40 strokes of root planing.⁷ This extent of root planing results in a beveled edge of about 30 μm (Fig. 5). Now the question is how much of the blade must be removed to re-establish

a fine edge each time as well as estimating the expectant life of a typical periodontal curet.

To approach this problem, we can assume that the cross-section of a typical curet is semilunar with a cutting delicacy of 80° (Fig. 6A). Assuming a zero rake-angle of cutting, the beveled edge would be expected to be only in the vertical direction. Therefore, wear in cross-section can be viewed as being a right-angled triangle. Assuming a typical bevel of 30 μm occurring only in the vertical direction, by simple trigonometry it can be calculated that 5.29 mm of material is lost from the facial surface during standard root planing (Fig. 6B).

To re-establish a similar fine edge with an 80° angle between the lateral and facial surface (Fig. 6C), either 5.21 mm of material is removed from the lateral surface, or 30 mm of material is removed from the facial surface. It appears that since less material is removed by lateral surface grinding it would be the preferred surface to grind during re-sharpening.

Also, the average facial width of a curet blade is approximately 1 μm . Assume that at least half of this width is necessary to maintain the usefulness of the blade; then, also assuming that the lateral surface grinding removes approximately 5.21 mm of metal, it can be estimated that the maximum life of a curet blade is about 96 sharpening sessions (Fig. 6D).

SHARPENING GUIDELINES

Sharpening periodontal curets and scalers necessitates the removal of a minimum amount of metal from the lateral or facial surface.

Antonini et al. found that hand sharpening with an Arkansas stone on the lateral surface resulted most often with a finer edge than sharpening with a rotary grinder.⁸ Also, grinding too much of the blade will decrease the life of the instrument. Therefore, procedures reported in the literature should not recommend the use of rotary sharpening instruments or machine sharpeners after standardized root planing.^{3,4,9,10}

Wehymer offered a simple sharpening technique using a tapered Arkansas stone.⁵ He suggested that once the proper stroke angle is reached between the surface of the instrument and the flat surface of the sharpening stone (i.e., 75° to 85°), then 6 to 10 successive downward strokes of the curet's blade against the stone are carried out. He then goes on to say that the "... instrument should then be tested for sharpness and the process should be repeated if necessary." Light sharpening with an Arkansas stone as recommended by Wehymer may be effective at establishing a fine sharp edge with minimal removal of metal.

Conclusion

Efficient instrumentation requires the use of an effective sharp edge with an overall long life of use. Much has



Figure 6A. Quantitative analysis of the cutting edge. Typical sharp edge with an edge angle of 80° .

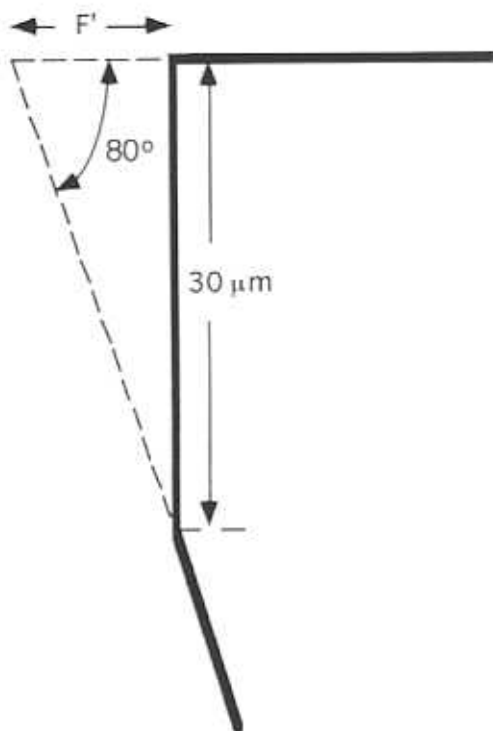


Figure 6B. Quantitative analysis of the cutting edge. Assuming the beveled edge is vertical then the loss in the facial surface, F' , is calculated as follows: $F' = 30 \mu\text{m}/\tan(88^\circ)$; $F' = 5.29 \mu\text{m}$.

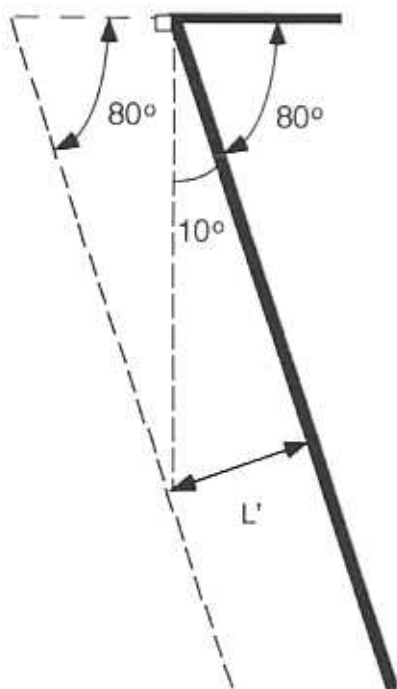


Figure 6C. Quantitative analysis of the cutting edge. Sharpening along the lateral surface while maintaining an 80° edge angle, the amount of lateral surface removed, L' , during sharpening is calculated as follows: $L' = 30 \mu\text{m} \sin(10^\circ)$; $L' = 5.21 \mu\text{m}$.

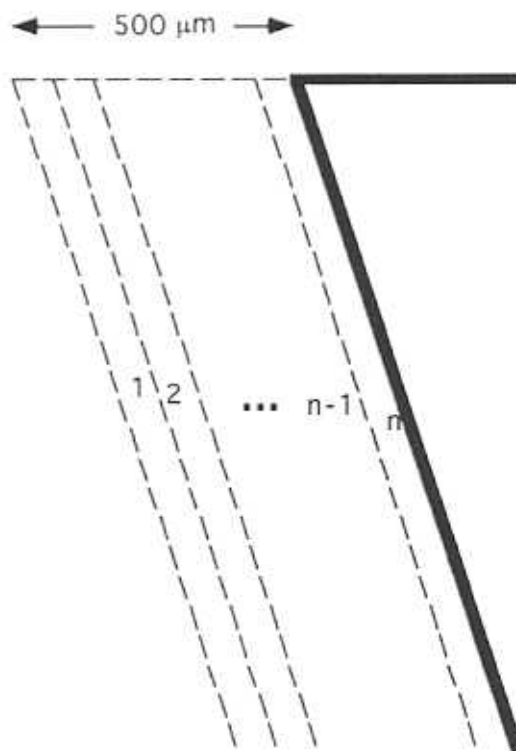


Figure 6D. Quantitative analysis of the cutting edge. Assuming the life of a curet is determined when the facial width is half its original length (i.e., 0.5 mm), then the number of sharpening sessions during the life of a curet, n , is calculated as follows: $n = 500 \mu\text{m}/5.21 \mu\text{m}$; $n = 95.97$ (approximately 96 sessions).

been reported on the qualitative, and to some degree, the quantitative effects of wear and sharpening of the periodontal curet's cutting edge. But this report is the first published engineering model of the periodontal curet's cutting edge. Although not confirmed by scientific experiments, this engineering model provides a framework for further scientific analysis. It also gives a clinical appreciation for the longevity of such periodontal instruments.

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