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Research Report

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Cutting Performance of Various Single Use Diamond Burs

Objective: To compare the bur cutting rate and visually compare SEM photos of the bur and bur cut surface of various single-use diamond burs when challenged to cut a 2-3 mm deep groove in a 5.6 mm thickness piece of plate glass.

Introduction: The study compares the cutting efficiency of single-patient use diamond burs and their durability and provides a visual SEM comparison of surface roughness of the cut surface and also of the new and used bur diamonds for each bur product evaluated. A custom bur test jig utilizing a Kavo Gentle Silence Lux 6500B handpiece and a specimen carriage which holds the plate glass specimen while the carriage with the specimen is pulled into the rotating bur was used to perform the testing. The system was driven by a universal test machine (Instron 5866) cross-head that was programmed to deliver a pulsatile force that ranges from zero to 2.0 N per cycle (cutting pulse cycle) when pulling the carriage.

Experimental Design:

Materials and Equipment:

- Diamond bur products: type 856 single-patient use ***Meisinger Singles*** *(Meisinger)* (Lot# Q41687), ***NeoDiamond*** *(Microcopy)* (Lot # 130617), and ***Premier Solo*** *(Premier Dental Products Co.)* (Lot# 07ND)
- Bur testing machine with handpiece (Kavo Gentle Silence Lux 6500B)
- Scanning electron microscope (Philips XL 30 ESEM)

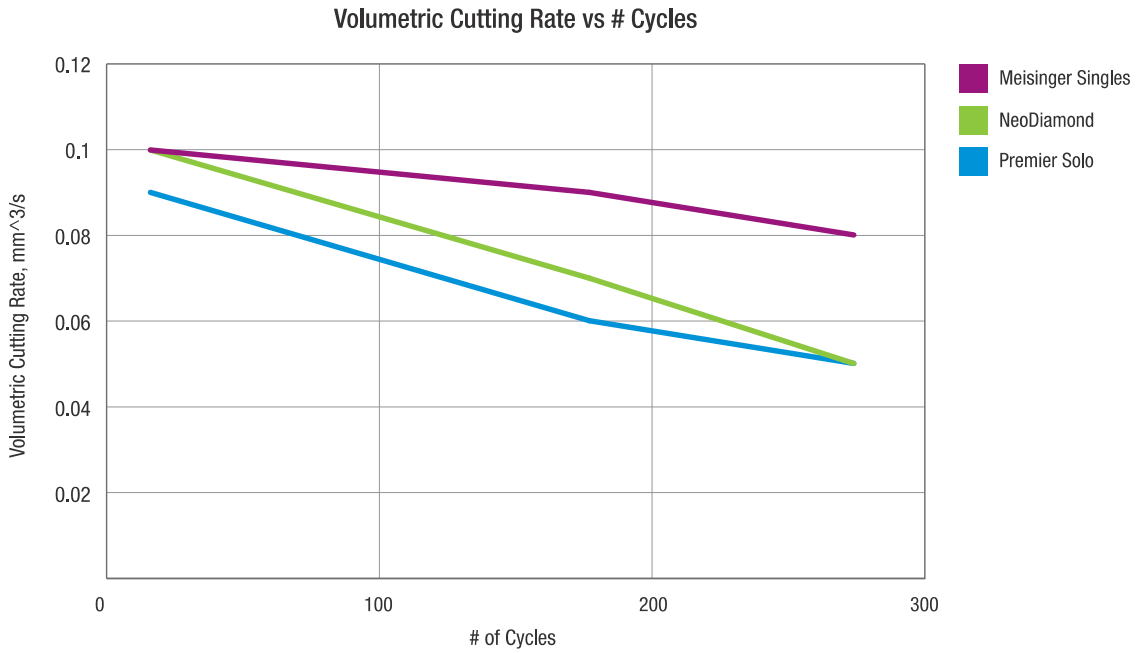
Repetitions: 5

Methods:

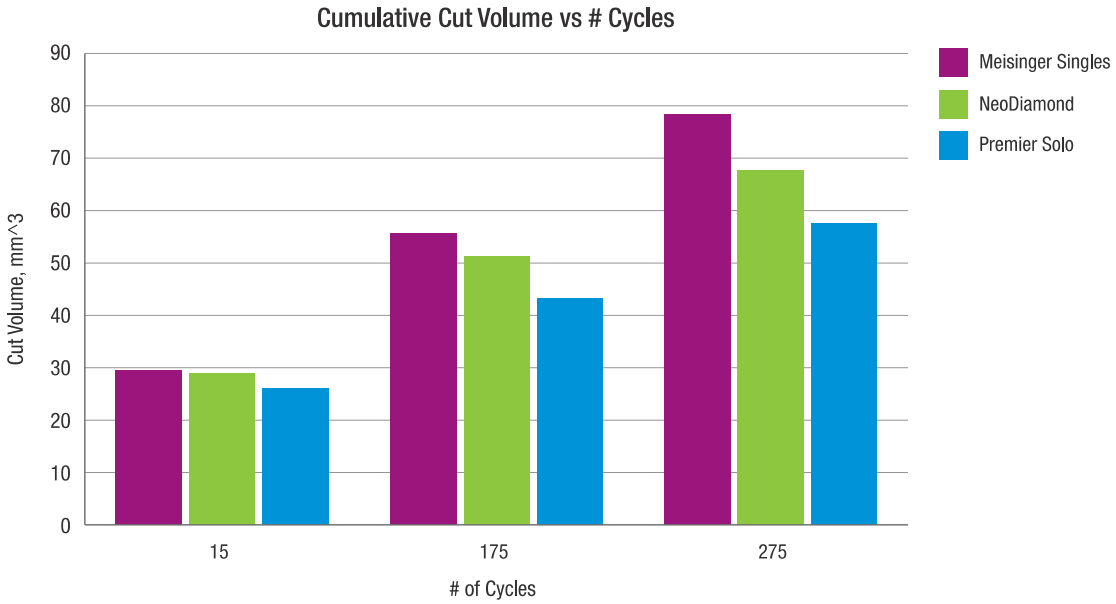
Bur Cutting Proficiency: The bur test machine is composed of a Kavo high-speed, air-driven handpiece driving the test burs while positioned over a carriage holding the plate glass test specimens (12 x 13 x 5.6 mm thick). The carriage holding the specimen was moved into the rotating bur by a cable connected between it and the cross-head of a universal test machine (Instron 5866) operated in load control. The load was pulsed from zero to 2.0 N as the test specimen was moved against the bur. The air-powered handpiece drove the burs at a 250,000 RPM (unloaded rotational speed). The dependent variable was the change in distance traveled over time to demonstrate performance and durability (longevity of cutting ability). The greater the wear of the bur, the slower its cutting progress through the plate glass specimen. Each bur test was terminated after 300 cycles. The cutting took place with the handpiece spray engaged and using tap water. Five repetitions were completed for each bur product. The pulsatile cycle rate was approximately 1 cycle per 3 seconds which gives the handpiece enough time to recover full rotational speed in between pulses. Both the volumetric cutting rate (mm^3/second) and cumulative cut volume (total mm^3 cut per number of cycles) are presented in the results. Visual analysis of SEM photos of the bur at several magnifications were performed on new unused burs and after 300 cycles of cutting to evaluate the visual physical changes that may explain why the bur performance decreased. Visual analysis of SEM photos was also performed on the cut surface of the plate glass specimens at the beginning, and at approximately 3 cm of cut length. The volumetric cutting rate (VCR) was determined by calculating the cross-sectional area of the groove and multiplying it by the length of the groove at each of the three cycle points listed below and plotting this value against number of cycles for each bur product at 15, 175, and 275 cycles.

Results:

The graph below shows the volume of material removed per second for each bur product when each was driven by a Kavo air driven handpiece with an unloaded rotational speed of 250,000 RPM. The bur was cyclically loaded to 2.0 N and unloaded to 0.0 N to simulate clinical use. The period of each cycle was approximately 3 seconds which was just enough time to allow the handpiece to return to its maximum rotational speed before the next cycle would begin.

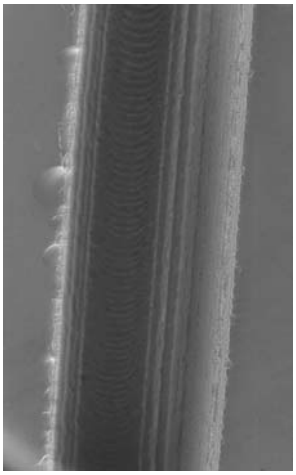


The bar chart below shows the cumulative volume of glass cut for 15, 175 and 275 cutting pulse cycles

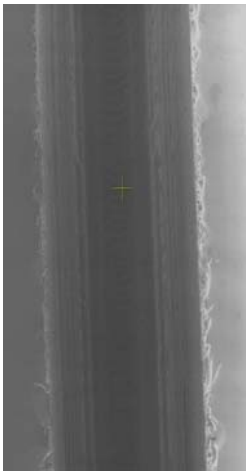


Results (cont):

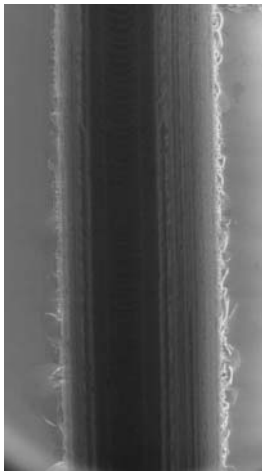
SEM Photos of Top-down View of Grooves Cut in Plate Glass and New and Used Burs



Meisinger Singles initial cut

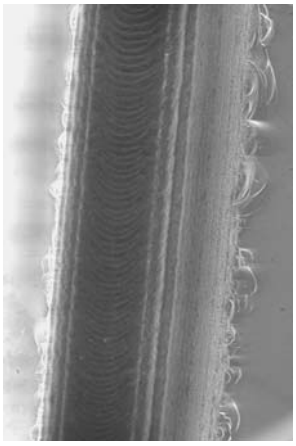


NeoDiamond initial cut

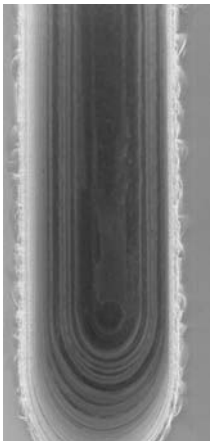


Premier Solo initial cut

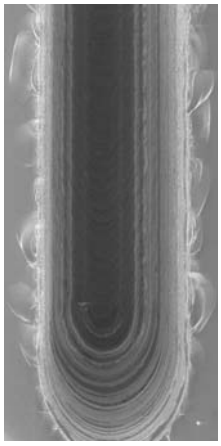
Note: The right edge of the groove is much less distressed for the Meisinger Singles Bur signaling a smoother cut for the new burs and especially the Meisinger bur.



Meisinger Singles
200-300 cycles



NeoDiamond
200-300 cycles



Premier Solo
200-300 cycles

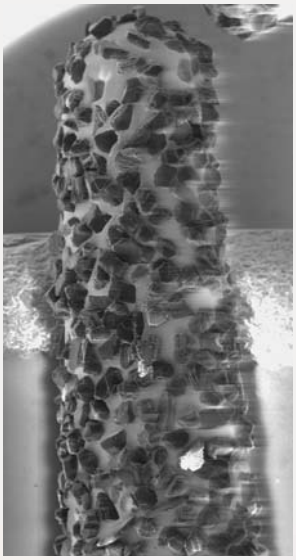
Note: At the end of the testing, the edge of the groove is considerably more distressed than at the beginning signaling that the burs are all worn. The ***Meisinger Singles*** and ***NeoDiamond*** bur cut groove edges look less distressed than the ***Premier Solo*** bur cut groove edge.

Results (cont):

New Burs

Unused Meisinger Single

Unused NeoDiamond

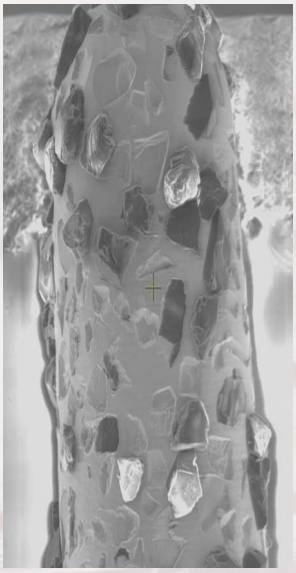


Unused Premier Solo

Used Burs

Used Meisinger Single

Used NeoDiamond



Used Premier Solo

Conclusions:

The volumetric cutting rate of the ***Meisinger Singles*** bur was the same as the ***NeoDiamond*** bur and 11% greater than the ***Premier Solo*** bur when measured during the first 15 cycles of use. At 275 cycles, the cutting rate of the ***Meisinger Singles*** bur was 60% greater than that of the ***NeoDiamond*** and ***Premier Solo*** burs and 20% less than when it was unused. The cumulative volume cut by the ***Meisinger Singles*** bur was 16% greater than that cut by the *NeoDiamond* bur and 36% greater than that cut by the ***Premier Solo*** bur at the completion of 275 cycles. The SEM analysis of the burs corroborated that the condition of the diamonds appears less worn on the ***Meisinger Singles*** product than for the other two products for 300 pulse cycles.

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