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RESEARCH AND EDUCATION

A comparative study of the cutting efficiency of diamond rotary instruments with different grit sizes with a low-speed electric handpiece against zirconia specimens

Ane van Aswegen, BChD, MSc,[a] Avish J. Jagathpal, BDS, PDD, MChD,[b]
Leanne M. Sykes BSc, BDS, MDent, IRENSA, Dip Forensic Path, Dip ESMEA,[a,b,c,d] and
Herman Schoeman, BSc, MSc, DSc[d]

ASBTRACT

Statement of problem. The use of zirconia in dentistry has increased. However, little attention has been given to the difficulty experienced by clinicians when cutting zirconia restorations intraorally. Evidence for which grit size and type of rotary instrument is best for cutting zirconia intraorally is lacking.

Purpose. The purpose of this in vitro study was to identify the most efficient diamond rotary instrument grit size for cutting zirconia intraorally.

Material and methods. Efficiency was measured by comparing the cutting depth of each rotary instrument into zirconia, analyzing zirconia specimens for surface damage after cutting, and measuring instrument deterioration. Thirty zirconia specimens of the same measurements were used as test specimens and cut with 30 diamond rotary instruments with different grit sizes. An electric handpiece was used with constant force (1.7 N), speed (40 000 rpm), time (1 min), and water flow rate (25 mL/min) to produce comparative data. The mean cutting efficiency values were compared by analysis, and the median values were compared by the nonparametric Kruskal-Wallis test (α=.05). Each test was followed up with pair wise comparisons of the mean or median values if significance was indicated.

Results. The greatest cutting depth was achieved with a fine-grit instrument with a mean cutting depth of 5.79 mm compared with 4.54 mm for the coarse-grit instrument (P=.032). The greatest damage to zirconia was done by the coarse- and supercoarse-grit instruments (both 33%), with no substrate damage by the superfine-, fine-, and medium-grit instruments. The greatest instrument deterioration was found on the supercoarse rotary instruments (9.05%). With only 3 exceptions, the power calculations were all sufficient and above 83%.

Conclusions. The fine grit rotary instrument (between 40 and 50 μm) was the most efficient, achieving the greatest cutting depth, with no detectable macroscopic damage to the zirconia and minimal instrument deterioration. (J Prosthet Dent 2024;131:101.e1-e8)

The use of zirconia in dentistry has increased because of its excellent mechanical properties, biocompatibility, and satisfactory esthetics.[1–8] Its popularity has led to a demand for instruments that can cut zirconia efficiently for occlusal adjustment, prepare endodontic access cavities, or section failed restorations.[1,3,4] The hardness of zirconia, approximately 1300 VHN, is much higher than for other dental ceramics, including lithium disilicate glass-ceramic and leucite glass-ceramics (L) with Vickers hardness values of below 735 VHN and 615 VHN, respectively.[1–9] In clinical practice, it is time consuming and difficult to cut zirconia, with rapid deterioration of rotary instruments, increased chair time, and discomfort for the patient.[1,3,4] Furthermore, the excessive heat and stress generated while grinding can cause the polymorphic t-phase of zirconia to become less stable and change.[4,6] Such phase changes have been reported to be influenced by the type of grinding apparatus, speed of grinding, force applied,

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[a] Postgraduate student, Department of Prosthodontics, School of Dentistry, University of Pretoria, Pretoria, South Africa.
[b] Specialty Consultant, Department of Prosthodontics, School of Dentistry, University of Pretoria, Pretoria, South Africa.
[c] Professor and Head, Department of Prosthodontics, School of Dentistry, University of Pretoria, South Africa.
[d] Professor, Mathematics and Statistics, Biostatistics, University of Pretoria, ClinStat CC, Pretoria, South Africa.

Clinical Implications

Contrary to the common perception that more abrasive rotary instruments would be more effective in cutting zirconia, the empirical findings in the present study found that fine-grit diamond rotary instruments were more effective than coarse-grit instruments for cutting zirconia intraorally. The study provided new insights into the efficient cutting of zirconia in clinical practice, ensuring maximum productivity (cutting depth) with minimum wasted time and expense (instrument deterioration and substrate fracture).

and grit size of the rotary instruments.[3,10–12] As well as phase changes, the strength of zirconia can decrease because of the formation of cracks and surface irregularities that act as stress concentration sites.[12–14] Grinding zirconia restorations may result in reduced clinical functionality and longevity.

Diamond rotary instruments have been reported to be more effective in cutting zirconia than tungsten carbide rotary instruments.[1,15,16] Diamond rotary instruments typically have diamond particles brazed to the cutting area, and the size of the abrasive particles is referred to as the grit size[15,17] (Fig. 1). Song et al[18] reported that diamond grit size was a controlling factor in determining the degree of substrate damage, concluding that smaller grit sizes should be used to adjust dental porcelain to minimize subsurface damage. Zirconia, however, is much harder than feldspathic porcelain and much more difficult to cut.[5–8] For this reason, coarser rotary instruments have been more commonly chosen to cut zirconia because they are expected to be more effective than fine-grit rotary instruments.[17–21]

Specifically designed zirconia-cutting diamond instruments have been marketed with the claim that they avoid excessive heat and stress generation.[1,3,4,10,19] Conversely, others have reported no significant difference in cutting efficiency between the dedicated zirconia instruments and conventional diamond instruments within the first 5 minutes of cutting.[1,3,19]

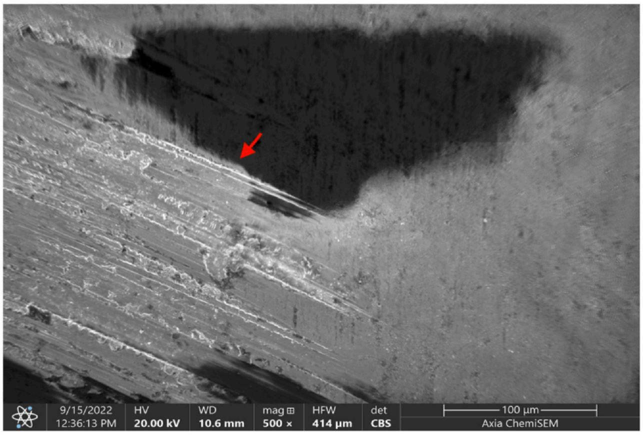

Figure 2. Scanning electron micrograph showing surface scratches (*arrow*) made on zirconia specimen by super coarse diamond rotary instrument. (Axia ChemiSEM; Thermo Fisher Scientific Inc). Original magnification ×500.

Anecdotal evidence has emerged suggesting that finer-grit rotary instruments provide more efficient cutting of zirconia because of an increased cutting surface area-to-substrate ratio.[6] Coarse rotary instruments introduced deeper surface flaws when cutting zirconia, which may result in reduced strength of the zirconia substrate.[6] (Fig. 2).

The cutting efficiency of rotary instruments with different grit sizes on zirconia has been investigated.[1,3,4,11,12,17,19,22] However, these studies have been restricted to limited comparisons of different grit sizes. The authors are unaware of studies that provided sufficient evidence on the cutting efficiency of zirconia with rotary instruments with all grit sizes.[1,3,4,11,12,17–22] Additionally, grit sizes of diamond rotary instruments are not always disclosed by manufacturers or revealed in research.[3,21] Consequently, the lack of research that included and compared all rotary instrument grit, especially smaller-grit instruments, and omission of grit sizes make it difficult to establish a specific grit size that will best cut zirconia.

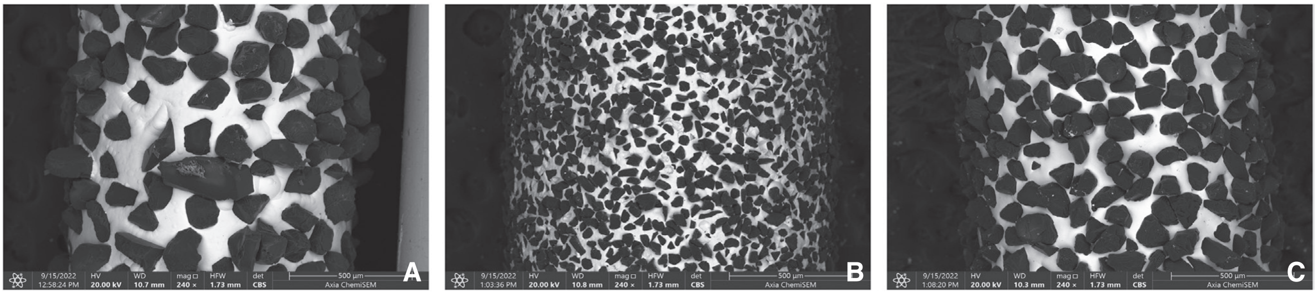

Figure 1. Scanning electron micrograph showing different diamond grit of diamond rotary instruments. (Axia ChemiSEM; Thermo Fisher Scientific Inc). A, Coarse rotary instrument. B, Fine rotary instrument. C, Medium rotary instrument. Original magnification ×240.

Electric motor handpieces operate at many fewer revolutions per minute (rpm) than air turbines, reducing stress and heat to zirconia and decreasing trauma to the dental pulp if restorations are cut intraorally.[3,16,19,20] Furthermore, electric handpieces may enhance cutting efficiency on ceramic specimens compared with air turbines owing to their consistent torque, which is absent in air turbines.[16]

Increased cutting force has been reported to increase zirconia surface damage and rotary instrument wear.[3] The present study used the 1.7-N cutting force recommended by Chung et al, reported to be sufficient to cut zirconia without causing unnecessary damage to the rotary instrument or substrate.[23]

When considering the cutting efficiency of a rotary instrument, both the substrate and the instrument itself should be examined. For this reason, cutting depth into zirconia, damage to the cut zirconia, and extent of rotary instrument deterioration were assessed. The null hypothesis was that no significant difference would be found between the cutting efficiency of diamond rotary instruments with different grit sizes on zirconia.

MATERIAL AND METHODS

An electric handpiece (Ti-Max Z95L; NSK) was used to cut zirconia specimens with constant force (1.7 N), speed (40 000 rpm), coolant feed rate (25 mL/min), and time (1 min).[1] These specifications have been reported to provide optimum conditions for cutting zirconia with diamond instruments.[1,3,21] A pilot study was performed to confirm and standardize all parameters.

Table 1 shows the 5 diamond instrument groups that were evaluated. Thirty 1.5×10×14-mm translucent sintered zirconia (Zolid HT+; Amann Girrbach AG) specimens were prepared and assigned to 1 of 5 grit size groups (n=6). The surface of each specimen was examined with ×3.5 magnification loupes (SLE binocular loupes; Zumax Medical) under back-lighting to exclude flawed specimens before cutting (Fig. 3). Apart from superficial surface irregularities, no macroscopic damage was detected.

Thirty commercially available cylindrical diamond rotary instruments (Horico Dental Hopf; Ringleb & Co GmbH & Cie) with similar diameters and profiles were used according to a computer-generated randomized drilling sequence. Figure 4 illustrates the difference in the diamond particle size of different grit size groups. Grinding was repeated 6 times for each group using 1 rotary instrument for each specimen. The sample size of 6 was chosen, as it is the minimum number of replications required to perform an analysis of variance (ANOVA) test. The diameter of each rotary instrument was measured with digital calipers (Whitworth Electronic Digital Caliper; Tork Craft) before cutting (Table 2).

Table 1. Standard parameters of diamond rotary instruments (Horico Dental Hopf; Ringleb & Co GmbH & Cie)

Description	Code	Grit Size (µm)	Color
Super Fine	SF	20–30	Yellow
Fine	F	40–50	Red
Medium	M	107–120	Blue/Clear
Coarse	C	150–180	Green
Super Coarse	SC	180–250	Black

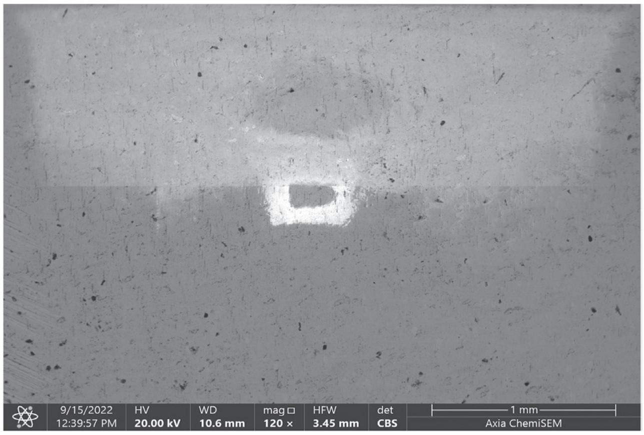

Figure 3. Scanning electron micrograph of zirconia specimen showing no microfractures. Original magnification ×120.

To ensure constant, reproducible results while drilling, a custom device was constructed in the Mechanical Engineering Department of the University of Pretoria[1,3] (Fig. 5). The device consisted of a low-friction track and cart incorporated into a vertical pulley system. A slot for the zirconia specimens was mounted atop the cart. A vertical frame was fixed over the tracks with a custom-made screw clamp fixed to it. The screw clamp fit the electric handpiece precisely, ensuring that the handpiece was secured throughout the study.

A measured weight of 170 g was attached to the cart with a low-friction string (Builders line; Marshal) and suspended vertically from the device. Frictional interference was decreased by using bearings for the trolley and incorporating a wheel in the pulley system. A saliva ejector (Dental Saliva Ejector; BMS Dental) was used to remove water and grinding debris from the system. The weight generated a vertical force which resulted in the desired horizontal force of 1.7 N.[21] Each diamond rotary instrument was placed in the handpiece with the respective zirconia specimen secured in its slot. Upon releasing the weight, the trolley with the specimen moved down the tracks towards the drill at a right angle until it contacted the diamond rotary instrument, resulting in the cutting of the specimen at a constant force of 1.7 N (Fig. 6). A stopwatch was started when the rotary instrument contacted the zirconia specimen. Cutting commenced and continued for 1 minute, after which the specimen was removed, wiped, and marked with its specimen number along with the relevant rotary instrument. This process was repeated for each instrument

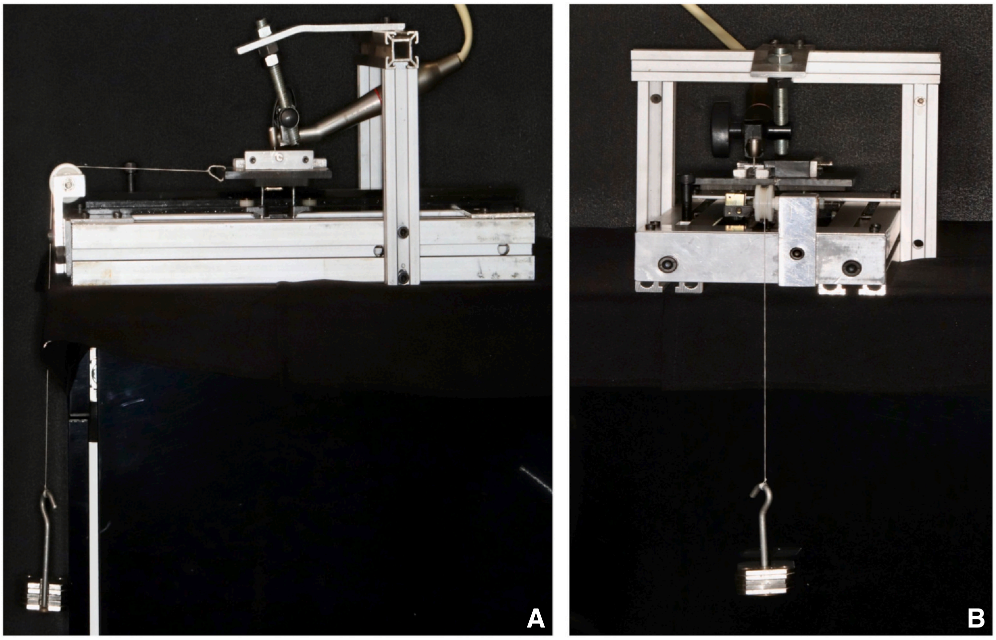

Figure 4. Assembled dental drilling simulator with weight of 170 g and electric handpiece. A, Lateral view. B, Frontal view.

Table 2. Rotary instrument deterioration measurements and calculations

Rotary Instrument	Replicas					
	1	2	3	4	5	6
Super Fine						
Specimen ID	1	2	3	4	5	6
First reading (mm)	1.33	1.33	1.33	1.33	1.33	1.33
Second reading (mm)	1.29	1.31	1.30	1.29	1.31	1.32
Deterioration (%)	3.0	1.5	2.26	3.0	1.5	0.75
Fine						
Specimen ID	7	8	9	10	11	12
First reading (mm)	1.43	1.43	1.43	1.43	1.40	1.43
Second reading (mm)	1.38	1.36	1.38	1.37	1.36	1.36
Deterioration (%)	3.5	4.9	3.5	4.2	2.86	4.9
Medium						
Specimen ID	13	14	15	16	17	18
First reading (mm)	1.35	1.35	1.35	1.35	1.35	1.35
Second reading (mm)	1.32	1.29	1.31	1.32	1.31	1.32
Deterioration (%)	2.22	4.44	2.96	2.22	2.96	2.22
Course						
Specimen ID	19	20	21	22	23	24
First reading (mm)	1.35	1.35	1.33	1.35	1.35	1.35
Second reading (mm)	1.24	1.22	1.22	1.26	1.28	1.29
Deterioration (%)	8.15	9.63	8.27	6.67	5.19	4.44
Super Course						
Specimen ID	25	26	27	28	29	30
First reading (mm)	1.33	1.35	1.33	1.35	1.35	1.35
Second reading (mm)	1.21	1.22	1.23	1.28	1.20	1.19
Deterioration (%)	9.02	9.63	7.52	5.19	11.11	11.85

and zirconia specimen in each grit size group in 6 sessions of 5 repetitions according to the randomized drilling sequence (Table 2).

The depth that was cut into the zirconia specimens was measured to the nearest 0.01 mm with the calipers and noted on the relevant data collection sheet (Table 3). The incidence of surface damage on the zirconia specimens was assessed with ×3.5 magnification loupes with back lighting. Any surface damage was reported as either present (Y) or absent (N) for each specimen (Table 4). The diameters of the rotary instruments were measured before and after cutting with the calipers.[1,3] After cutting, measurements were made at the area of most wear, where the rotary instrument contacted the zirconia specimens (Table 5). The difference in initial diameter and final diameter was calculated and used to determine a mean percentage (%) of deterioration. All measurements were made by the primary researcher (A.V.A.) and confirmed by the research supervisor (A.J.). Descriptive and inferential statistical analyses were

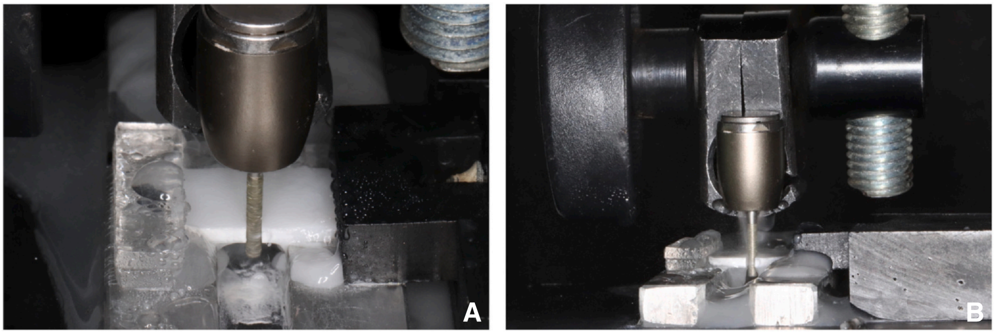

Figure 5. Rotary instrument and handpiece positioned in drilling simulator cutting zirconia specimen.

Figure 6. Zirconia specimens after being cut.

made with a statistical software program (SAS/STAT 15.3; SAS Institute Inc).

RESULTS

Table 6 represents the mean, median, minimum, and maximum depths (mm) cut into the zirconia specimens of each rotary instrument group. ANOVA for comparison of the mean values showed that the minimum

Table 4. Presence of surface damage

Rotary Instrument	Replicas					
	1	2	3	4	5	6
Super Fine						
Specimen ID	1	2	3	4	5	6
Surface damage: Y/N	N	N	N	N	N	N
Fine						
Specimen ID	7	8	9	10	11	12
Surface damage: Y/N	N	N	N	N	N	N
Medium						
Specimen ID	13	14	15	16	17	18
Surface damage: Y/N	N	N	N	N	N	N
Course						
Specimen ID	19	20	21	22	23	24
Surface damage: Y/N	N	Y	N	Y	N	N
Super Course						
Specimen ID	25	26	27	28	29	30
Surface damage: Y/N	Y	N	N	N	Y	N

Table 5. Presence or absence of surface damage on zirconia specimens

Instrument Grit Size Group	Presence of Surface Damage	
	Yes	No
Super fine (SF)	-	6 (100%)
Fine (F)	-	6 (100%)
Medium (M)	-	6 (100%)
Coarse (C)	2 (33.3%)	4 (66.7%)
Super course (SC)	2 (33.3%)	4.(66.7%)

Table 3. Drilling depth measurements

Rotary Instrument	Replicas					
	1	2	3	4	5	6
Super Fine (SF)						
Specimen ID	1	2	3	4	5	6
Drilling depth (mm)	2.05	1.30	2.01	0.99	1.03	0.93
Fine (F)						
Specimen ID	7	8	9	10	11	12
Drilling depth (mm)	3.64	4.90	6.50	5.23	7.08	7.38
Medium (M)						
Specimen ID	13	14	15	16	17	18
Drilling depth (mm)	4.92	5.22	4.51	4.57	4.48	5.47
Course (C)						
Specimen ID	19	20	21	22	23	24
Drilling depth (mm)	4.58	6.49	4.28	4.84	4.33	2.70
Super Course (SC)						
Specimen ID	25	26	27	28	29	30
Drilling depth (mm)	5.33	4.41	5.43	4.66	5.44	3.54

Table 6. Cutting depth (mm) of diamond rotary instruments into zirconia specimens

Instrument Grit Size Group		**Cutting Depth (mm)**		
Rotary Instrument	**n**	**Mean ±Standard Deviation**	**Median**	**Minimum / Maximum**
Super fine (SF)	6	1.39 ±0.52	1.17	0.93 / 2.05
Fine (F)	6	5.79 ±1.44	5.87	3.64 / 7.38
Medium (M)	6	4.86 ±0.41	4.75	4.48 / 5.47
Coarse (C)	6	4.54 ±1.22	4.46	2.70 / 6.49
Super coarse (SC)	6	4.80 ±0.75	5.00	3.54 / 5.44

Table 7. Rotary instrument deterioration values of each instrument grit size group

Rotary Instrument Grit	**n**	**Instrument Diameter (mm) and Deterioration (%)**		
		Mean ±Standard Deviation	**Median**	***P****
Super fine (SF)				
First reading (mm)	6	1.33 ±0.00	1.33	
Second reading (mm)	6	1.30 ±0.01	1.31	
Deterioration (%)	6	2.01 ±0.91	1.88	.003 /.031
Fine (F)				
First reading (mm)	6	1.43 ±0.01	1.43	
Second reading (mm)	6	1.37 ±0.01	1.37	
Deterioration (%)	6	3.97 ±0.83	3.85	<.001 /.031
Medium (M)				
First reading (mm)	6	1.35 ±0.00	1.35	
Second reading (mm)	6	1.31 ±0.01	1.32	
Deterioration (%)	6	2.84 ±0.87	2.59	.001 /.031
Coarse (C)				
First reading (mm)	6	1.35 ±0.01	1.35	
Second reading (mm)	6	1.25 ±0.03	1.25	
Deterioration (%)	6	7.06 ±1.99	7.41	<.001 /.031
Super coarse (SC)				
First reading (mm)	6	1.34 ±0.01	1.35	
Second reading (mm)	6	1.22 ±0.03	1.22	
Deterioration (%)	6	9.05 ±2.44	9.33	<.001 /.031

* *P*-values: *t* test/sign test

mean cutting depth was achieved with the SF instrument (1.39 mm) and that the maximum mean depth was achieved with the F rotary instrument (5.79 mm). The mean cutting depth with the F rotary instrument (5.79 mm) and the C rotary instrument (4.54 mm) differed significantly (*P*=.032). A nonparametric analysis of variance (Kruskal-Wallis) for comparison of the median values showed that the minimum median cutting depth was achieved with the SF rotary instrument (1.17 mm), and the maximum median depth was achieved with the F rotary instrument (5.87 mm).

Table 5 shows the number and percentage of zirconia specimens with surface damage after cutting. Surface damage was found on only 4 of the zirconia specimens: 2 cut with the C rotary instruments (33.3%), and 2 cut with SC instruments (33.3%).

Table 7 shows the mean and the median values of 2 consecutive rotary instrument diameter measurements together with the instrument deterioration calculated as the percentage loss in the overall rotary instrument diameter. A significant deterioration was found with each rotary instrument as measured by the mean and the median values. The least deterioration was found with the SF instrument (mean=2.01% and median=1.88%). The greatest deterioration was found with the SC instrument (mean=9.05% and median=9.33%). ANOVA was performed for comparison of the mean deterioration values, followed by pairwise comparisons of the percentages, shown in Table 8. The mean deterioration percentages for rotary instruments M and F in Category II (2.84% and 3.97%) did not differ significantly from each other (*P*=.220) but differed significantly from rotary instruments C and SC (*P* <.002).

Table 8. Mean rotary instrument deterioration values (%)

Rotary Instrument	**SF**	**M**	**F**	**C**	**SC**
Mean	2.01	2.84	3.97	7.06	9.05
Category	I	II		III	

Table 9. Median rotary instrument deterioration values (%)

Rotary Instrument	**SF**	**M**	**F**	**C**	**SC**
Median	1.88	2.59	3.85	7.41	9.33
Category	I	II		III	

The Kruskal-Wallis analysis was performed for comparison of the median deterioration values, followed by pairwise comparisons of the percentages (Table 9). The power for comparison of the mean cutting depth for instruments F and C (5.79% and 4.54% respectively) was 30%. The power for all the other comparisons was above 90%. The power for comparison of the mean deterioration percentages for instruments SF and M (2.01% and 2.84% respectively) was 29% and for comparison of instruments C and SC (7.06% and 9.05% respectively) was 27%. With only 3 exceptions, the power calculations were all sufficient and above 83%.

DISCUSSION

According to the results obtained from this study, the null hypothesis that no significant difference would be found between the cutting efficiency of diamond rotary instruments with different grit sizes on zirconia was rejected, as cutting efficiency was significantly increased with the F rotary instrument group.

The first objective was to identify the rotary instrument that achieved the greatest cutting depth. Interestingly, the maximum mean cutting depth and maximum median cutting depth was achieved by the F instrument group with grit sizes between 40 and 50 µm. This is contrary to previous studies that reported that coarser rotary instruments were more capable of achieving greater cutting depths in zirconia than finer rotary instruments.[1,3,17–21,24] However, most of these studies[1,3,20,21,24,25] only investigated rotary instruments with M to SC grit sizes (107 to 250 µm) and omitted finer rotary instruments (< 100 µm). Two studies[17,19] included finer instruments but omitted other rotary instrument grit. A probable explanation for the F instrument being more successful than the coarser rotary instruments is the increased cutting surface area-to-substrate ratio with the F instrument, associated with more diamond particles on the F rotary instrument, resulting in more effective cutting.

The present study was not consistent with that of Alexander,[16] who concluded that SC, C, and M grit sizes were more efficient in cutting 3Y-TZP zirconia than F rotary instruments. Likewise, Alenezi[20] used similar cutting parameters to Alexander[16] and reached the same conclusions. The difference with the present study was most likely due to the difference in cutting parameters. Cutting efficiency greatly depends on diamond particle size, cutting time, and cutting force, and the relationship between these variables has been reported to be complex.[3,16,20] The present study used a greater cutting force (1.7 N), a decreased cutting speed (40 000 rpm), and reduced cutting time (1 min) compared with that of Alexander and Alenezi.[16,20] Longer cutting time (> 5 min) leads to more wear of abrasive particles, which results in different cutting outcomes for different grit sizes than a shorter cutting time.[16,20]

No significant difference was found between the mean cutting depths of the M (4.86 mm), C (4.54 mm), and SC (4.80 mm) instruments. The similarity might have been due to the short cutting time that was used in the present study. Alexander[16] suggested that M, C, and SC diamond rotary instruments might have comparable cutting depths over a short period of time but that C and SC instruments might show improved efficiency over longer cutting periods (> 5 min) than M instruments because of larger abrasive particles and a higher grit load on the substrate.[16,17] This outcome also suggests that there is a threshold below which the surface area of the abrasive particles of the rotary instrument cease to make a significant difference in cutting efficiency. To investigate whether these speculations are plausible, future evaluations of cutting efficiency with shorter (1 min) and longer (> 5 min) cutting times should be carried out with M, C, and SC rotary instruments on zirconia. The SF rotary instrument achieved the smallest cutting depth, which is primarily related to the small diamond particles that represent the abrasive grit of the SF instrument (20–30 µm) and that are too small to have any significant effect on the hard zirconia substrate.[17]

The second objective was to identify surface damage on the zirconia specimens after cutting. Edge retention at restoration margins and the achievement of close dimensional adaptation to teeth are important factors in the success rate of a zirconia restoration.[2,17] Any surface damage resulting from cutting zirconia may lead to bacterial colonization, restoration leakage, reduced structural durability, and overall reduced longevity of the zirconia restoration.[2,17] No surface damage was detected on any of the specimens cut with the SF, F, or M rotary instruments. However, damage was detected on 2 of the specimens cut in the C instrument group (33.3%) and the SC group (33.3%). This agrees with current evidence that coarser rotary instruments tend to generate more subsurface cracks, with concomitant strength degradation and decreased restoration longevity.[17] Higher grit load causes increased grit penetration into the substrate, which results in a higher removal rate and increased generation of substrate damage.[17,20]

The final objective was to measure the extent of rotary instrument deterioration after cutting, associated with the cost-effectiveness of individual instruments. The overall efficiency of the rotary instrument decreases with the increased rate of deterioration, as instrument replacement becomes more frequent, resulting in increased costs of the procedure. The present study found that the rate of rotary instrument deterioration was, with the exception of the F and M instrument groups, directly related to the coarseness of the rotary instrument. Thus, the coarser the instrument, the more deterioration was observed, presumably because coarser rotary instruments have larger yet fewer abrasive particles than finer instruments.[1,3] The decreased abrasive surface area results in an increased rate of deterioration, as the abrasive particles are lost more quickly, resulting in a greater overall material loss.[1,3,25] Furthermore, finer diamond particles are generally stronger than larger particles due to the lower flaw population in finer rotary instruments.[16] The original flaws in the larger particles have been eliminated by crushing the coarse diamond particles when finer grits were made.[17] The F instrument with finer grit particles, however, underwent more deterioration (3.97%) than the coarser M instrument (2.84%). The reason for this contradictory result is related to the cutting efficiency of the F instrument. This rotary instrument cut deeper into the zirconia specimen than other rotary instruments after 1 minute, resulting in more damage.

Limitations of the present study included the small sample size, and future studies should have larger sample sizes. Furthermore, in the clinical setting, materials are cut using multiple contacts of the rotary instrument. The present study was limited to single point contact to the zirconia specimen with constant force. Although this was necessary to ensure standardization, it does not completely reflect clinical practice. A natural progression of this work would be to analyze cutting efficiency in vivo. Additionally, the present study was limited to only 1 brand of zirconia (Zolid HT+; Straumann) and 1 brand of diamond rotary instruments (Horico Dental Hopf; Ringleb & Co GmbH & Cie). Further research using different brands and translucencies of zirconia and diamond rotary instruments should be undertaken to obtain more extensive scientific information.

CONCLUSIONS

Based on the findings of the present study, the following conclusions were drawn:

1. The greatest cutting depth was achieved with the F rotary instrument (40–50 µm).
2. The most damage to zirconia was done by the C and SC rotary instruments, with no damage to the SF, F, and M rotary instruments.
3. The least amount of rotary instrument deterioration was found on the SF instruments, with the most amount of deterioration on the SC rotary instruments.

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Corresponding author:
Dr Ane van Aswegen
Department of Prosthodontics
University of Witwatersrand
Johannesburg
SOUTH AFRICA
Email: vanaswegenane@gmail.com

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CRediT authorship contribution statement

Ane van Aswegen: Formal analysis, Investigation, Methodology, Resources, Data curation, Writing - original draft, Visualization, Project administration, Funding acquisition. **Avish J Jagathpal**: Conceptualization, Methodology, Validation, Resources, Writing - review and editing, Supervision. **Leanne M Sykes**: Writing - review and editing, Supervision. **Herman Schoeman**: Formal analysis, Validation, Data Curation.

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