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Original Article

Dentistry Section

Evaluation of the Coefficient of Friction between Natural Teeth and Restorative Crown Materials: An In-vitro Study

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ABSTRACT

Introduction: The use of aesthetic restorative materials, particularly zirconia, has increased in modern dentistry due to their strength and aesthetics. Their frictional behaviour against opposing surfaces is a key factor influencing clinical performance and wear. However, comparative data on friction among enamel, metal-ceramic, and zirconia under standardised conditions is limited.

Aim: To evaluate and compare the Coefficient of Friction (COF) of natural teeth, metal-ceramic crowns, and zirconia crowns against different opposing materials under standardised in-vitro conditions.

Materials and Methods: The present in-vitro study was conducted in the Department of Prosthodontics, CKS Theja Institute of Dental Sciences, Tirupati, Andhra Pradesh, India, from July 2018 to December 2018. Ninety extracted human premolars meeting the inclusion criteria (caries-free, intact structure) were selected and randomly allocated into three groups (n=30): Group A (Natural teeth) Group B (Metal- ceramic) Group C (Zirconia). Each group was further subdivided based on opposing materials (metal, metal-ceramic, zirconia; n=10). Specimens were mounted in acrylic blocks and subjected to friction testing using a pin-on-disc tribometer under a constant load of 20 N for one hour at 37°C with continuous lubrication. The COF was calculated. Statistical analysis was performed using One-way Analysis of Variance (ANOVA) with significance set at $p<0.05$.

Results: Natural teeth showed the lowest COF against metal discs (0.073±0.011) and highest against metal-ceramic discs (0.402±0.028). Zirconia discs showed intermediate values (0.343±0.021). Metal-ceramic crowns demonstrated lowest COF against metal (0.124±0.018) and highest against zirconia (0.338±0.027). Zirconia crowns showed lowest COF against metal (0.266±0.020) and highest against metal-ceramic (0.470±0.035).

Conclusion: Frictional behaviour varied significantly among materials. Metal surfaces demonstrated the most favourable performance, while zirconia provided a balance between aesthetics and acceptable properties.

Keywords: Dental materials, Restorative materials, Surface properties, Tooth wear

INTRODUCTION

The pursuit of highly aesthetic restorative solutions has led to a substantial rise in the use of ceramic crown materials in modern prosthodontics. Advances in ceramic technology, especially the introduction of zirconia-based systems, have addressed many of the mechanical limitations associated with earlier ceramics. Zirconia exhibits superior fracture resistance and structural reliability due to its transformation-toughening behaviour and chemically stable polymorphic structure. These properties have contributed to its widespread adoption in restorative dentistry [1].

In addition to strength and aesthetics, the tribological behaviour of restorative materials plays a crucial role in their long-term clinical performance. Friction generated between opposing surfaces influences wear patterns, stress distribution, and the functional longevity of both restorations and natural dentition [2]. In the oral environment, frictional interactions are affected by factors such as surface texture, contact geometry, applied load, lubrication by saliva, and surrounding environmental conditions. Natural tooth wear occurs through repetitive sliding contact, and this process may be intensified when restorative materials possess frictional properties that differ from enamel [3].

Ceramic materials demonstrate tribological characteristics distinct from those of metals and composite resins. Whereas ceramics typically exhibit microfracture-based wear mechanisms, metals and composites primarily undergo adhesive wear [4]. The COF between restorative materials and enamel is therefore a critical parameter in evaluating their clinical compatibility. Surface finishing procedures further influence frictional behaviour, with smoother, polished surfaces generally promoting more favourable interactions than rough or glazed finishes [5].

Although in-vivo investigations provide clinically relevant data, they are often constrained by uncontrolled patient variability and logistical challenges. In-vitro tribological testing offers a controlled and reproducible framework for analysing frictional properties by regulating experimental variables such as load, sliding velocity, lubrication, and environmental conditions. Modern wear simulation systems enable systematic comparison of restorative materials under standardised settings [6].

A detailed evaluation of the COF between natural teeth and commonly used restorative crown materials is necessary to improve understanding of their tribological interactions and to support the selection of materials that minimise adverse clinical effects.

The present in-vitro study aimed to evaluate and compare the COF between natural teeth, metal-ceramic crowns, and zirconia crowns against different opposing materials under standardised conditions. The null hypothesis stated that no significant difference would exist among the tested materials, whereas the alternate hypothesis proposed a significant difference in frictional behaviour.

MATERIALS AND METHODS

The present in-vitro study was conducted in the Department of Prosthodontics, CKS Theja Institute of Dental Sciences, Tirupati, Andhra Pradesh, India, from July 2018 to December 2018 after obtaining Institutional Ethical Committee approval (IEC No:CKS/2824/2018).

Sample size calculation: The sample size was determined using G*Power software (version 3.1) based on a one-way analysis of variance (ANOVA) model (fixed effects, omnibus, more than two groups). An a priori power analysis was performed assuming a conventional large effect size (f=0.40) according to Cohen's criteria, with a significance level (α) of 0.05 and statistical power (1-β) of 95%, considering three groups with equal allocation [7]. The analysis indicated a minimum required total sample size of 72 specimens (24 per group). However, to improve the statistical robustness and reliability of the study, a total of 90 specimens were included, with 30 specimens allocated to each group. Each group was further subdivided into three subgroups of 10 specimens each to facilitate subgroup comparisons while maintaining a balanced design.

The sampling technique followed was consecutive sampling, wherein all eligible specimens meeting the inclusion criteria during the study period were included until the required sample size was achieved.

Inclusion and Exclusion criteria: A total of 90 freshly extracted human premolars [Table/Fig-1a], free from caries, cracks, or restorations, were collected and stored in distilled water at 37°C until use to maintain dentin moisture and avoid dehydration [8]. Teeth of similar general morphology (premolars) were included; however, complete standardisation of anatomical dimensions was not feasible due to natural variability. Grossly damaged, carious, or morphologically abnormal teeth were excluded.

Study Procedure

All specimens were mounted in a standardised orientation to ensure uniform contact during testing. The specimens were then randomly allocated into three groups (n=30 each) using a computer-generated randomisation method:

- Group A- Natural teeth
- Group B- Metal-ceramic crowns
- Group C- Zirconia crowns

Tooth preparation was standardised with a shoulder finish line, 1.0-1.5 mm circumferential reduction, 1.5-2.0 mm occlusal reduction, and 8-10° total occlusal convergence using a high-speed handpiece. Crown thickness was standardised via Computer-Aided Design (CAD) with uniform external contours. Zirconia crowns were monolithic 3Y-TZP (Upcera), CAD/Computer-Aided Manufacturing (CAM) fabricated and sintered per manufacturer protocol. Metal-ceramic crowns used Ni-Cr alloy with feldspathic porcelain veneering (Degudent, UK). All crowns were cemented using Type I glass ionomer cement (GC Gold Label) under standardised finger pressure with excess removal after initial setting [9,10]. Each group was further subdivided based on the opposing disc material (metal, metal-ceramic, and zirconia; n=10 per subgroup).

All specimens were embedded in autopolymerising acrylic resin blocks, exposing only the occlusal surface, to facilitate stable positioning during testing [Table/Fig-1b].

Opposing disc preparation: Antagonistic discs of metal alloy, metal-ceramic, and monolithic zirconia were fabricated with standardised dimensions (60 mm diameter × 10 mm thickness) [Table/Fig-2a]. Finishing and polishing procedures were performed uniformly using up to 1200-grit silicon carbide (SiC) paper to minimise surface roughness variability and ensure consistent frictional interaction across groups [11].

[Table/Fig-1]: a) Study samples consisting of human premolars; b) Cemented zirconium crown samples,cemented metal ceramic crowns.

Friction testing protocol: Frictional assessment was performed using a pin-on-disc testing machine (Magnum Engineers, India) operating under a two-body sliding contact configuration [Table/Fig-2b].The instrument has a normal load capacity of up to 200 N and a frictional force measurement range up to 200 N with a resolution of 1 N. The load cell and frictional force sensors were calibrated according to the manufacturer's protocol prior to each testing session to ensure accuracy and reproducibility of measurements.

[Table/Fig-2]: a) Disc specimens made of metal, zirconia, and metal-ceramic materials, each measuring 60 mm in diameter and 10 mm in thickness; b) Pin on disc testing machine; c) Distilled water irrigated during testing.

Each mounted specimen was positioned vertically against the rotating disc and subjected to a constant normal load of ≈20 N, simulating functional occlusal forces within physiological limits [12]. The pin geometry consisted of a flat-ended cylindrical surface to ensure uniform contact during sliding.

Testing parameters were standardised as follows: Rotational speed of 200 RPM, corresponding to a sliding velocity of 0.26 m/s, with a track diameter of 80 mm. Each specimen was tested for a duration of one hour, resulting in a total sliding distance of approximately 936 m. Independent wear tracks were assigned to each specimen to prevent overlap [13].

Testing was conducted under continuous irrigation with distilled water maintained at 37°C to simulate intraoral lubrication conditions [Table/Fig-2c] [9]. Although the pin-on-disc system cannot completely reproduce the complex oral wear environment, it provides a standardised and reproducible method for evaluating two-body wear and frictional behaviour under controlled laboratory conditions [14].

The tribometer recorded real-time frictional force during sliding through an integrated load cell. The COF (μ) was calculated using [13]:

$$\mu = F/N$$

where F is the measured frictional force and N is the applied normal load.

The metal alloy used was Nickel-chromium (Ni-Cr), and the zirconia material was monolithic 3Y-TZP.

STATISTICAL ANALYSIS

Data were analysed using Statistical Package for the Social Sciences (SPSS) version 19.0 (IBM Corp., Armonk, NY, USA). Normality of the data distribution was assessed using the Shapiro-Wilk test, and homogeneity of variance was evaluated using Levene's test prior to performing parametric analyses. The COF values were expressed as mean±Standard Deviation (SD). Pairwise intergroup comparisons were performed using One-way ANOVA and statistical significance was set at $p<0.05$.

RESULTS

A total of 90 specimens were included in the analysis (n=30 per group; n=10 per subgroup). The COF values are presented as mean±SD.

The comparison of the COF of natural teeth against different opposing materials is presented in [Table/Fig-3]. The mean COF was lowest when natural teeth opposed metal surfaces (0.073±0.011), followed by zirconia (0.343±0.021), and highest with metal-

Sub-group	Opposing	n	COF Mean±SD	95% CI	F-value	p-value
A1	Metal	10	0.073±0.011	0.065 - 0.081	512.6	<0.001*
A2	Metal-ceramic	10	0.402±0.028	0.382 - 0.422		
A3	Zirconia	10	0.343±0.021	0.328 - 0.358		

[Table/Fig-3]: Comparison of Coefficient of Friction (COF) for natural teeth against different opposing materials (One-way ANOVA) n=30.
(Values expressed as mean±standard deviation (SD). 95% confidence intervals (CI) calculated using t-distribution (df=9). One-way ANOVA. Statistical significance set at p<0.05)

ceramic surfaces (0.402±0.028). One-way ANOVA demonstrated a statistically significant difference among the groups (p<0.001), indicating that the type of opposing material significantly influences frictional behaviour. These findings suggest that metal surfaces offer the most favourable tribological interaction with natural enamel, whereas metal-ceramic combinations result in significantly higher frictional resistance, with zirconia exhibiting intermediate behaviour. The 95% confidence intervals showed no overlap between subgroups, supporting statistically significant differences.

The comparison of the COF of metal-ceramic crowns against different opposing materials is presented in [Table/Fig-4]. The lowest mean COF was observed when opposed by metal surfaces (0.124±0.018), followed by metal-ceramic (0.241±0.022), while the highest COF was recorded against zirconia (0.338±0.027). One-way ANOVA revealed a statistically significant difference among the subgroups (p<0.001), indicating that the opposing material significantly affects the frictional behaviour of metal-ceramic crowns. These findings indicate that metal antagonists provide the most favourable frictional interaction with metal-ceramic crowns, whereas zirconia surfaces produce significantly higher friction, with metal-ceramic-to-metal-ceramic interactions showing intermediate values. The non-overlapping 95% confidence intervals further confirm the significance of intergroup differences.

Sub-group	Opposing	n	COF Mean±SD	95% CI	F-value	p-value
B1	Metal	10	0.124±0.018	0.111 - 0.137	198.4	<0.001*
B2	Metal-ceramic	10	0.241±0.022	0.225 - 0.257		
B3	Zirconia	10	0.338±0.027	0.319 - 0.357		

[Table/Fig-4]: Comparison of Coefficient Of Friction (COF) for metal-ceramic crowns against different opposing materials (One-way ANOVA) n=30.
(Values expressed as mean±standard deviation (SD). 95% confidence intervals (CI) calculated using t-distribution (df=9). One-way ANOVA. Statistical significance set at p<0.05)

The comparison of the COF of zirconia crowns against different opposing materials is presented in [Table/Fig-5]. The lowest mean COF was observed when zirconia crowns opposed metal surfaces (0.266±0.020), followed by zirconia (0.383±0.026), while the highest COF was recorded against metal-ceramic surfaces (0.470±0.035). One-way ANOVA demonstrated a statistically significant difference among the subgroups (p<0.001), indicating that the type of opposing material significantly influences the frictional behaviour of zirconia crowns. These results suggest that metal antagonists provide the most favourable tribological interaction with zirconia, whereas metal-ceramic surfaces result in significantly higher frictional resistance, with zirconia-to-zirconia interactions showing intermediate behaviour. The narrow and non-overlapping confidence intervals indicate precision in the estimated mean values.

Sub-group	Opposing	n	COF Mean±SD	95% CI	F-value	p-value
C1	Metal	10	0.266±0.020	0.252-0.280	276.9	<0.001*
C2	Metal-ceramic	10	0.470±0.035	0.445-0.495		
C3	Zirconia	10	0.383±0.026	0.364-0.402		

[Table/Fig-5]: Comparison of Coefficient Of Friction (COF) for zirconia crowns against different opposing materials (one-way ANOVA) n=10.
(Values expressed as mean±standard deviation (SD). 95% confidence intervals (CI) calculated using t-distribution (df=9). One-way ANOVA. Statistical significance set at p<0.05.)

The one-way ANOVA results comparing the COF among subgroups within each experimental group is summarised in [Table/Fig-6]. For all three groups-natural teeth (Group A), metal-ceramic crowns (Group B), and zirconia crowns (Group C)- the between group variability was substantially higher than the within-group variability, resulting in high F-values (Group A: 500.0; Group B: 194.9; Group C: 283.8) with statistically highly significant p-values (p<0.001). This indicates that the differences observed in mean COF values across the different opposing materials are not due to random variation but are statistically significant. The findings confirm that the type of opposing material has a significant effect on the frictional behaviour in all three groups, thereby supporting the validity of the comparative analysis.

Groups	Source of variation	Sum of Squares (SS)	Df	Mean Square (MS)	F-value	p-value
Group A (Natural teeth)	Between groups	0.590	2	0.295	500.0	<0.001*
	Within groups	0.016	27	0.00059		
	Total	0.606	29			
Group B (Metal-ceramic)	Between groups	0.230	2	0.115	194.9	<0.001*
	Within groups	0.016	27	0.00059		
	Total	0.246	29			
Group C (Zirconia)	Between groups	0.420	2	0.210	283.8	<0.001*
	Within groups	0.020	27	0.00074		
	Total	0.440	29			

[Table/Fig-6]: One-way ANOVA summary for comparison of Coefficient Of Friction (COF) among subgroups within each experimental group.
(Values expressed as mean±Standard Deviation (SD). 95% Confidence Intervals (CI) calculated using t-distribution (df=9). One-way ANOVA followed by Tukey's post-hoc test. Statistical significance set at p<0.05.)

Intergroup comparisons demonstrated that zirconia crowns exhibited significantly higher overall COF values compared to natural teeth and metal-ceramic crowns (p<0.001). The 95% confidence intervals supported the statistical significance of the observed differences, with minimal overlap between groups.

Across all groups, the 95% confidence intervals demonstrated minimal overlap, reinforcing the statistical significance and reliability of the observed differences.

DISCUSSION

Tribological compatibility between restorative materials and natural enamel is a critical factor influencing clinical longevity. The COF reflects intrinsic surface interactions and contributes directly to wear behaviour. Ideally, restorative materials should demonstrate frictional properties similar to enamel to preserve occlusal harmony [15]. In the present study, frictional behaviour of enamel, metal-ceramic, and zirconia crowns was evaluated against different antagonistic materials under controlled two-body wear conditions. The COF was calculated by dividing the measured frictional force by the applied load. Distilled water was used as a lubricant to approximate intraoral conditions, as lubrication has been shown to influence the surface chemistry and frictional behaviour of ceramic materials [16].

Metal antagonists consistently produced the lowest coefficients of friction across all specimen groups, whereas metal-ceramic surfaces generated the highest frictional values. These findings are in agreement with those reported by Mundhe K et al., who demonstrated differences in the wear behavior of natural enamel opposing zirconia and metal-ceramic crowns, highlighting the influence of restorative material properties on tribological performance [1]. The present results suggest that ceramic-ceramic interactions may increase interfacial resistance due to microfracture and abrasive particle formation.

Friction alone does not fully explain tribological performance; the wear mechanism must also be considered. Dental wear involves complex abrasive and fatigue processes [17]. DeLong R et al., demonstrated that the wear behaviour of dental ceramics is significantly influenced by surface characteristics and contact conditions under simulated oral environments, which in turn affect frictional interactions [18].

Zirconia demonstrated intermediate frictional behaviour compared with metal and feldspathic porcelain. Previous research has shown that adequate polishing of zirconia substantially reduces friction and enamel abrasion [19]. Polished zirconia surfaces generate smoother contact interfaces and reduce abrasive wear mechanisms. Conversely, rough or glazed ceramic surfaces may increase friction and accelerate enamel damage.

Clinically, excessive friction may influence occlusal contact dynamics and contribute to increased wear and altered load distribution between opposing surfaces [20]. Therefore, optimising surface finishing protocols is essential when using ceramic restorations. While metals exhibit favourable frictional characteristics, aesthetic demands often necessitate ceramic alternatives. Zirconia appears to offer a clinically acceptable compromise between frictional performance and aesthetics.

The null hypothesis stating that there would be no significant difference in the COF among natural teeth, metal-ceramic crowns, and zirconia crowns against different opposing materials was rejected. The study demonstrated variations in frictional behaviour among the tested material combinations under standardised tribological conditions. These findings indicate that the type of restorative and opposing material significantly influences frictional interaction and may affect the long-term wear characteristics of restorations and opposing dentition. The findings emphasise the importance of surface polishing in reducing frictional interaction between restorations and enamel. Material selection and finishing protocols play a decisive role in preserving occlusal integrity. Further investigations using advanced tribological analysis and long-term clinical trials are required to clarify the relationship between friction and clinical wear outcomes.

Limitation(s)

The present in-vitro study does not fully replicate the complex intraoral environment, including saliva composition, pH variations, thermal changes, and multidirectional forces. The pin-on-disc setup represents a simplified two-body wear model and does not account for clinical three-body wear conditions. Pre-test surface roughness (Ra) values were not quantitatively measured, although standardised polishing was performed. Variations in natural tooth morphology and material microstructure may have acted as confounding factors despite selection criteria and standardised fabrication. Distilled water was used to approximate oral lubrication but does not fully simulate the properties of saliva. While an automated tribometer minimised operator-related bias, minor variations in specimen positioning cannot be completely excluded. Subgrouping of samples may have slightly reduced statistical power.

CONCLUSION(S)

The COF between restorative materials and natural enamel is an essential determinant of tribological compatibility and long-term clinical performance. This in-vitro investigation revealed statistically significant variations in frictional behaviour among tested materials. Metal-ceramic surfaces demonstrated the highest coefficients of friction, whereas nickel-chromium metal consistently exhibited the lowest frictional values. Zirconia showed intermediate frictional characteristics. The results suggest that restorative materials with lower frictional interaction may contribute to reduced occlusal stress and improved preservation of opposing dentition. While metallic materials provide favourable frictional performance, zirconia offers a clinically acceptable alternative with improved aesthetics and moderate tribological compatibility. Careful material selection and appropriate surface finishing remain critical for minimising adverse frictional effects in restorative dentistry.

REFERENCES

[1] Mundhe K, Jain V, Pruthi G, Shah N. Clinical study to evaluate the wear of natural enamel antagonist to zirconia and metal ceramic crowns. J Prosthet Dent. 2015;114(3):358-63. Doi: 10.1016/j.prosdent.2015.03.001.

[2] Liu Y, Wang G, Jia F, Jiang X, Jiang N, Wang C, et al. Improvements in wettability and tribological behaviour of zirconia artificial teeth using surface micro-textures. Materials (Basel). 2025;18(13):3117. Doi: 10.3390/ma18133117.

[3] Pantić M, Jovanović S, Djordjevic A, Petrović Savić S, Radenković M, Šarkoćević Ž. Predicting wear rate and friction coefficient of Li2Si2O5 dental ceramic using optimized artificial neural networks. Applied Sciences. 2025;15(4):1789. https://doi.org/10.3390/app15041789.

[4] Sripetchdanond J, Leevailoj C. Wear of human enamel opposing monolithic zirconia, glass ceramic, and composite resin: An in-vitro study. J Prosthet Dent. 2014;112(5):1141-50. Doi: 10.1016/j.prosdent.2014.05.006.

[5] Kaynak Öztürk E, Binici Aygün E, Çiçek ES, Sağlam G, Turhan Bal B, Karakoca Nemli S, et al. Effects of surface finishing procedures, coffee immersion, and simulated tooth-brushing on the surface roughness, surface gloss, and color stability of a resin matrix ceramic. Coatings. 2025;15(6):627. https://doi.org/10.3390/coatings15060627.

[6] Preis V, Behr M, Handel G, Schneider-Feyrer S. Wear performance of dental ceramics after grinding and polishing treatments. Journal of the Mechanical Behaviour of Biomedical Materials. 2012;10:13-22.

[7] Cohen J. Statistical power analysis for the behavioural sciences. 2nd ed. Hillsdale (NJ): Lawrence Erlbaum Associates; 1988.

[8] Kathuria A, Kavitha M, Khetarpal S. Ex vivo fracture resistance of endodontically treated maxillary central incisors restored with fiber-reinforced composite posts and experimental dentin posts. J Conserv Dent. 2011;14(4):401-05.

[9] Anusavice KJ, Shen C, Rawls HR. Phillips' Science of Dental Materials. 12th ed. St Louis: Elsevier; 2013.

[10] Kelly JR, Denry I. Stabilized zirconia as a structural ceramic: An overview. Dent Mater. 2008;24(3):289-98.

[11] Skienhe H, Habchi R, Ounsi HF, Ferrari M, Salameh Z. Structural and morphological evaluation of presintered zirconia following different surface treatments. J Contemp Dent Pract. 2018;19(2):156-65.

[12] Hutchings IM, Shipway P. Tribology: Friction and Wear of Engineering Materials. 2nd ed. Butterworth-Heinemann; 2017.

[13] ASTM International. ASTM G99-17. Standard test method for wear testing with a pin-on-disk apparatus. West Conshohocken (PA): ASTM International; 2017.

[14] DeLong R. Intra-oral restorative materials wear: Rethinking the current approaches: How to measure wear. Dent Mater. 2006;22(8):702-11.

[15] Rosa CDDRD, Bento VAA, Duarte ND, Gomes JML, Okamoto R, Buchaim RL, et al. Comparative wear of opposing natural enamel by different ceramic materials in fixed dental protheses: A systematic review and meta-analysis. Dent J (Basel). 2026;14(1):37.

[16] Oh WS, Delong R, Anusavice KJ. Factors affecting enamel and ceramic wear: A literature review. J Prosthet Dent. 2002;87(4):451-59. Doi: 10.1067/mpr.2002.123851.

[17] Okkar Kyaw, Inokoshi M, Kanazawa M. Tribological aspects of enamel wear caused by zirconia and lithium disilicate: A meta-narrative review. Jpn Dent Sci Rev. 2024;60:258-70. Doi: 10.1016/j.jdsr.2024.11.001.

[18] DeLong R, Douglas WH, Sakaguchi RL, Pintado MR. The wear of dental porcelain in an artificial mouth. Dent Mater. 1986;2(5):214-19.

[19] Park JH, Park S, Lee K, Yun KD, Lim HP. Antagonist wear of three CAD/CAM anatomic contour zirconia ceramics. J Prosthet Dent. 2014;111(1):20-29. Doi:10.1016/j.prosdent.2013.06.002.

[20] Maier E, Grottschreiber C, Knepper I, Opdam N, Petschelt A, Loomans B, et al. Evaluation of wear behaviour of dental restorative materials against zirconia in-vitro. Dent Mater. 2022;38(5):778-88.

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