SCOPING REVIEW

Monolithic Zirconia Vs Layered Zirconia: How to Make Right Choice

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ABSTRACT

OBJECTIVE: Monolithic and Layered Zirconia are being comparatively evaluated in this study based on clinical performance (Fracture & Abrasive Resistance, Marginal Adaptation) to help clinician's decision making process.

INTRODUCTION: Monolithic Zirconia is high strength, single block restoration whereas Layered Zirconia consists of Zirconia core covered with aesthetic porcelain. Clinical performance of Zirconia depends on parameters like Fracture & Abrasive Resistance, Marginal adaptation. In this article these parameters are evaluated.

INCLUSION CRITERIA: Population: Patient receiving Monolithic or layered Zirconia crowns, Concept: Comparison of clinical performance of two groups of patients - with Monolithic Zirconia and Layered Zirconia, Context: Manav Rachna Dental College.

METHOD: Google Scholar, PubMed databases were searched.

CONCLUSION: On evaluating the clinical performance (Fracture resistance, Abrasive resistance and Marginal adaptation) of Monolithic Zirconia and Layered Zirconia it can be concluded that Monolithic zirconia is better as compared to Layered Zirconia.

KEYWORDS: Monolithic and layered zirconia, multi-yttria-layered zirconia, Fracture resistance, Abrasive resistance, Marginal Adaptation, Clinical Performance.

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INTRODUCTION

There are various indirect restorations placed intraorally including Metal Ceramic crowns and All Ceramic Crowns. The most outstanding advantage of metal-ceramic restorations is their resistance to fracture. Another potential advantage of metal-ceramic restorations over total ceramic restorations is that less tooth structure needs to be removed to provide the proper bulk for the crown. Such designs also cause less wear of antagonist enamel than occurs when enamel is opposed by a ceramic surface. But Metal Ceramic Crowns have certain disadvantages. One of the most frequently mentioned disadvantages is the potential for metal allergy. However, such allergic reactions are very rare except possibly when nickel-containing alloys are used. A metal-ceramic crown is not the best aesthetic choice for restoring a single maxillary anterior tooth. An all-ceramic crown offers a greater

potential for success in matching the appearance of the adjacent natural tooth, especially when a relatively high degree of translucency is desired. A dark line at the facial margin of a metal-ceramic crown associated with a metal collar or metal margin is a significant aesthetic concern when gingival recession occurs. Therefore a shift towards all ceramic restorations has been done. The most frequently utilized all ceramic Restoration includes Zirconia. Under atmospheric pressure, pure zirconia can exhibit three different crystal structures. At temperatures greater than 2367 °C, Zirconia has a cubic structure, between 1167 °C and 2367 °C, Zirconia is tetragonal & below 1167 °C the structure is monoclinic.[1,6]

Zirconia can also be classified as Monolithic or Layered Zirconia. Monolithic Zirconia (Full Contour) Zirconia is fabricated from single block Zirconia shaped entirely via CAD/CAM to the final anatomical contour. Layered Zirconia consists of the durable zirconia coping that acts as a structural framework, which is then covered (layered/veneered) with porcelain to create a natural appearance.

The primary aim is to balance aesthetic demands with functional longitivity. The functional longitivity of the prosthesis can be evaluated on parameters eg; Fracture resistance, Abrasiveness potential and Marginal adaptation. Fracture resistance is the material‘s ability to withstand load induced deformation and resist the initation and propagation of cracks. Abrasive resistance is prevention of wear of the opposing enamel. According to literature Monolithic zirconia consistently exhibits higher fracture resistance as compared with the layered zirconia. The tetragonal-to monoclinic phase transition of Zirconia results in a 3% to 5% volume increase, which produces cracks in bulk zirconia samples and a reduction in strength and toughness. Monolithic zirconia is a high-strength, homogeneous dental ceramic composed primarily of zirconium dioxide, stabilized with yttria ($Y2O3$) typically classified as Y-TZP (Yttria-stabilized Tetragonal Zirconia Polycrystal). Compositions vary from 3 mol% (high strength) to 5 mol% (high translucency) yttria, directly impacting cubic phase content, translucency, and fracture toughness.[2,7]

Abrasion resistance, also known as wear resistance, describes a material's ability to withstand mechanical stress, particularly friction and surface abrasion. Longitivity of the Zirconia Crowns is directly related to abrasion resistance.

Marginal adaptation refers to the precision with which the edge of dental restoration fits against the prepared tooth surface. According to literature Monolithic zirconia offers better marginal adaptation as compared to layered zirconia due to omission of veneering porcelain , which can alter the marginal fit during sintering .

Thus in this article the parameters affecting the longitivity of the prosthesis foreg, Fracture resistance, Abrasiveness potential and Marginal Integrity of Monolithic and layered zirconia has been evaluated with the purpose of determining which crown will be suitable option for the clinician.

REVIEW QUESTION

"What is the evidence regarding the clinical performance (longevity, fracture rate, abrasive resistance, marginal fit) of monolithic zirconia compared to layered zirconia?"

INCLUSION CRITERIA

Population: Patients receiving Zirconia Crowns (Monolithic &layered Zirconia).

Concept: Comparison of Longitivity of Monolithic Zirconia & Layered Zirconia by evaluating (Fracture resistance, Abrasive resistance & Marginal adaptation) .

Context: Manav Rachna Dental College.

TYPES OF SOURCES

Numerous experimental and quasi-experimental study designs, systematic review, original research, were considered in this scoping review. Additionally, prospective and retrospective cohort studies, analytical cross-sectional studies, case-control studies, and other analytical observational research were taken into consideration for inclusion.

SEARCH STRATEGY

In this review, a three-step search approach was applied. To find pertinent literature on the subject, a preliminary search of Google Scholar and MEDLINE (PubMed) was conducted. The index keywords used to find the articles and the key phrases in the titles and abstracts of pertinent publications were combined to create a thorough search strategy.

STUDY OR SOURCE OF EVIDENCE SELECTION

After the investigation, duplicates were eliminated, and all citations found were gathered and entered the bibliographic program. After a pilot test, two or more independent reviewers assessed the titles and abstracts to determine whether they matched the review's inclusion criteria. Two or more independent reviewers extensively evaluated the complete text of chosen publications pertaining to the inclusion criteria. The scoping review excluded full-text evidence sources that did not fall in accordance with the inclusion criteria. At every step of the selection process, the reviewers spoke or conferred with one or more additional reviewers to settle any differences that came up. The final scoping review provides a detailed report on the search and study inclusion process outcomes.

AUTHOR	YEAR OF PUBLICATION	ORIGIN OF STUDY	AIM OR PURPOSE OF STUDY	STUDY POPULATION AND SAMPLE SIZE	METHODOLOGY OR METHODS	INTERVENTION & OUTCOME MEASURES	KEY FINDING RELATED TO RESEARCH QUESTION
1.	2022	USA	Survivability and fracture resistance of monolithic and multi-yttria-layered zirconia crowns as a function of yttria content	(n = 80) were fabricated using: multi-yttria-layered 5Y-PSZ/3Y-PSZ, multi-yttria-layered 5Y-PSZ/4Y-PSZ, monolithic 4Y-PSZ, and monolithic 3Y-PSZ as control (n = 20).	Half of the samples in each group were subjected to thermo-mechanical loading under 110 N, 1.4 Hz, 1.2 million cycles with simultaneous thermocycling (10,000 cycles, 5–55C). The other half were subjected to thermocycling alone. The samples were loaded to failure to measure their fracture resistance. The data were analysed using by two-way ANOVA and Turkey's HSD post-hoc test (α = 0.05	The yttria content significantly affected the fracture resistance of the crown.	The yttria content has an inverse relationship with the fracture resistance of zirconia crowns.

2.	2024	Riyadh	Clinical Efficacy and Longevity of Monolithic VS Layered Zirconia Crowns	The procedure for choosing the articles that were searched was outlined using the PRISMA flowchart. From 112, recruited 10 studies after a comprehensive screening process	.A thorough analysis of the literature covering the years 2012 – 2023 was done, using the Science Direct, Medline, and Pub Med databases. The terms that were employed were "monolithic zirconia", "layered zirconia", "longevity", and "aesthetics".	Clinical success rate and fracture resistance were superior among monolithic zirconia crowns compared to the multi-layered ones. However, some studies revealed no significant difference between the two.	Most of the included studies suggested that the clinical success rate and fracture resistance were superior among monolithic zirconia crowns compared to the multilayered ones.
3.	2018	India	The aim of this study is to compare wear of the natural teeth against monolithic zirconia and layered zirconia with different surface finishing procedures such as	.Zirconia specimen was divided into two groups layered and monolithic which further subdivided into unpolished unglazed, polished unglazed, and polished glazed groups (n = 10)	The data were statistically analysed to compare the enamel wear against layered and monolithic zirconia with different surface finishing protocols by repeated ANOVA test	Monolithic polished unglazed zirconia showed least tooth wear. Layered unpolished unglazed zirconia showed highest tooth wear.	Within the limitations of the study, monolithic polished unglazed zirconia is wear-friendly to the opposing natural teeth, and polished surfaces in both the

			unpolished unglazed, polished unglazed, and polished glazed				groups showed less tooth wear compared to the glazed surface of zirconia specimen
4.	2023	Saudi Arabia	This in vitro study evaluated the influence of restoration design (bi-layered vs. monolithi	Mandibular second premolars and second molars were prepared as abutments in a 3-unit zirconi	MZ: Monolithic zirconia FDPs, ZL: zirconia framework veneered by the hand-layering technique, ZP: zirconia	No significant differences were found between the monolithic and bi-layered zirconia groups in terms of	The current in vitro investigation demonstrated equivalent mean values of margi

			c) and manufacturing technique on the marginal discrepancy and internal fit of 3-unit zirconia fixed dental prostheses (FDPs	a bridge to develop four groups (n = 10 FDPs	framework veneered by the heat-pressed technique, and CAD-on: zirconia framework veneered by CAD/CAM lithium-disilicate glass–ceramic. All the zirconia FDPs were cemented to their corresponding die replicas using dual-cure resin cem	the marginal discrepancy. The marginal gap between monolithic and bi-layered zirconia FDPs was within the clinically acceptable range (<100 µm	nal gaps of both 3-unit monolithic and bi-layered zirconia FPDs, the use of monolithic 3-unit zirconia FPDs would be a viable alternative fabrication technique

					ent and were subjected to compressive cyclic loading at a load range for half a million cycles using a universal testing machine. FDPs were sectioned mesiodistally to measure the marginal gap and internal fit using scanning electron microscopy. The		

					measurements were taken at pre-assigned points of each abutment. Data were statistically analyzed via a Kruskal–Wallis test ($\alpha = 0.05$).		
5	2023			In the first group, 10 crowns were fabricated with the framework design followed by porcela	An ideal complete crown with a chamfer finish line was prepared on an extracted maxillary central incisor. Two prost	Monolithic prostheses having lower mean marginal gaps (31.0 and 84.0 µm).	

				in veneering, and 10 crowns were fabricated monolithically in the second group.	hesis designs, a framework and a monolithic design, and 2 marginal fit evaluation methods, the silicone replica and the triple scanning techniques, were used. In the first group, 10 crowns were fabricated with the framework design followed		

					by porcelain veneering, and 10 crowns were fabricated monolithically in the second group. The marginal gap in each group was evaluated		

DISCUSSION

The objective of this scoping review was to compare and evaluate the clinical performance (Fracture & Abrasive Resistance, Marginal Adaptation) of Monolithic and layered zirconia. In this study five articles were included, which includes original research, systemic and literature review and case study. On analysing the results, it can be concluded that Monolithic Zirconia has better clinical performance as compared to Layered Zirconia.

Ansari , et al. evaluated the Clinical Efficacy and Longevity of Monolithic VS Layered Zirconia Crowns. According to literature Monolithic zirconia consistently exhibits higher fracture resistance as compared with the layered zirconia. The tetragonal-to monoclinic phase transition of Zirconia results in a 3% to 5% volume increase, which produces cracks in bulk zirconia samples and a reduction in strength and toughness. If one modifies the composition by doping with Mg, Ca, Sc, Y, or Nd, the high-temperature tetragonal phase can be stabilized at room temperature. Another possibility for stabilizing the high-temperature tetragonal phase at room temperature is to reduce the crystal size to less

than 10 nm. The structural stabilization of zirconia by yttria results in a significant proportion of metastable tetragonal phase. The metastable tetragonal phase strengthens and toughens the structure by a localized transformation to the monoclinic Phase when tensile stresses develop at crack tips. The resulting volume expansion adjacent to the crack tips produces a high local compressive stress around the crack tips, which Increases the localized fracture toughness and inhibits the potential for crack propagation. This phenomenon is called Transformation toughening. Monolithic zirconia is a high-strength, homogeneous dental ceramic composed primarily of zirconium dioxide, stabilized with yttria ($Y2O3$) typically classified as Y-TZP (Yttria-stabilized Tetragonal Zirconia Polycrystal). Compositions vary from 3 mol% (high strength) to 5 mol% (high translucency) yttria, directly impacting cubic phase content, translucency, and fracture toughness.[3,8]

Badr et al. concluded that the yttria content significantly affected the fracture resistance of the crown, The high survival rate of the traditional monolithic 3Y-PSZ was projected. This is mainly due to the transformation toughening phenomenon.[4,9]

Gundugollu et al. compared the wear of the natural teeth against monolithic zirconia and layered zirconia with different surface finishing procedures such as unpolished unglazed, polished unglazed, and polished glazed. It could be concluded that Monolithic polished unglazed zirconia showed least tooth wear. Layered unpolished unglazed zirconia showed highest tooth wear. Monolithic polished unglazed zirconia group resulted in the least teeth wear which is attributable to the fact that no porcelain was added in the glazing process.[2]

Alsarani etal[5] evaluated the influence of restoration design (bi-layered vs. monolithic) and manufacturing technique on the marginal discrepancy and internal fit of 3-unit zirconia fixed dental prostheses. No significant differences were found between the monolithic and bi-layered zirconia groups in terms of the marginal discrepancy. A possible explanation for this finding could be the influence of the number of firing cycles. Manual veneering usually requires between four and five firing cycles, while between two and three firing cycles are needed for pressed-on and CAD-on techniques. In addition to the number of firing cycles, the coefficient of thermal expansion mismatch between the veneering material and the zirconia framework is another factor. This difference causes stresses in the veneering layer during cooling from the glass transition to room temperature. As veneering methods negatively affect the marginal adaptation of bi-layered zirconia FDPs, information regarding the influence of glazing firing on monolithic zirconia restorations is limited..

CONCLUSION

Thus it can be concluded that clinical performance (Fracture resistance, Abrasive Resistance and Marginal adaptation) of Monolithic Zirconia is better as compared to Multilayered Zirconia. Hence Monolithic Zirconia is a suitable option for clinicians .

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