

THE BENEFITS OF ZIRCONIUM CROWNS VERSUS STAINLESS STEEL CROWNS IN PEDIATRIC DENTISTRY. A REVIEW ARTICLE

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Abstract

Objectives: This study aims to provide a current overview of the clinical outcomes and advantages of zirconia pediatric crowns compared to traditional stainless steel crowns. **Material and method:** We evaluated articles from the MedLine database, researched via PubMed, ScienceDirect and EBSCO using MeSH terms. **Results:** Stainless steel crowns have long been considered the „gold standard” for full-coverage restorations in primary molars due to their simplicity in preparation, durability, and strength. However, their primary limitation is their aesthetic appearance. In contrast, zirconia crowns, which are tooth-colored full crowns, provide an excellent aesthetic solution and are more effective in maintaining and promoting gingival health. **Conclusion:** Zirconia pediatric crowns currently represent the best restoration option, offering all the benefits of prefabricated stainless steel crowns while also providing exceptional aesthetics that fully satisfy today's beauty standards.

Keywords: stainless steel crowns, zirconia crowns, primary dentition

INTRODUCTION

Pediatric crowns have a significant history in modern dentistry, first described by Engel in 1947 and consistently used since 1950 by Humphrey in the form of stainless steel crowns (SSCs). This material provided pediatric patients with highly effective, easy-to-apply, low-cost treatments with remarkable longevity, surpassing the performance of amalgam or composite materials, according to many clinicians (Mathew MG et al., 2020).

Today, with rapid technological advancements, the improvement in quality of life, global prosperity, and easier access to medical services for many population groups, pediatric treatments now also focus on enhancing aesthetics to meet patient needs.

Between 2008 and 2010, EZ Pedo co-founders Fisher and Hansen introduced prefabricated zirconia pediatric crowns to the international dental market, offering

treatment options for all 20 temporary teeth. Zirconia is durable, biocompatible, and offers superior aesthetics compared to stainless steel, serving as an alternative for patients allergic to other metals. Since 2012, zirconia pediatric crowns have been available worldwide (Ajayakumar LP et al., 2020).

In the early years following the introduction of zirconia pediatric crowns, only a few patients had the opportunity to benefit from this technology due to the initially high costs and the inability to implement the technology on a large scale due to the necessary production equipment. Today, this barrier has been overcome, and more and more clinicians are successfully applying zirconia pediatric crown treatments for their patients (Almajed OS et al., 2024).

New comparative studies and scientific articles are constantly emerging

between traditional stainless steel crowns and zirconia crowns.

This study provides an up-to-date overview of the clinical outcomes and benefits of using zirconia pediatric crowns compared to traditional stainless steel options.

MATERIALS AND METHODS

This study is the result of a review. Thirteen articles from the period 2019-2024 were analyzed, with authors from 12 countries (Canada, United States Of America, Israel, Australia, South Korea, France, Saudi Arabia, Lebanon, United Arab Emirates, India and Turkey). The articles were selected using databases such as PubMed, ScienceDirect, and EBSCO, accessed through the "Gr. T. Popa" University of Medicine and Pharmacy Iași website.

The patients who participated in the research provided informed consent. Most of them required oral rehabilitation, primarily due to early childhood caries.

RESULTS

Statistical analysis and interpretation

In 2022, Prabhu et al. published the article „A clinical and radiographic comparative evaluation of custom-made zirconia crowns using CAD-CAM and stainless steel crowns in primary molars” which examined the clinical performance of these two types of crowns, the satisfaction levels of parents and young patients, and the measurement of interproximal bone height on X-rays one year after crown placement.

The methods used in this study involved the careful selection of patients and the choice of primary molars suitable for fixed prosthodontics. The molars were

prepared according to the indications for the crowns that were subsequently applied. For the zirconia crowns manufactured using CAD-CAM technology, both dental arches—upper and lower—were scanned using an intraoral scanner. The crowns were cemented using glass ionomer cement (for stainless steel crowns) and resin-modified glass ionomer cement (for zirconia crowns). After crown placement, both patients and their parents were surveyed about their satisfaction, considering the duration of the treatment, comfort, cost of the crowns, their appearance, etc. Additionally, an X-ray of the treated teeth was taken, and patients were monitored every 3 months for 1 year to assess retention loss, interproximal contact loss, gingival inflammation, antagonist tooth wear, and marginal integrity. After one year, a radiographic reevaluation was conducted to observe the condition of the interproximal bone. A total of 30 zirconia crowns and 30 stainless steel crowns were studied.

The results showed that, one year after crown placement, both zirconia and stainless steel crowns performed well based on evaluations. However, zirconia crowns were more effective in maintaining and promoting gingival health. Stainless steel crowns caused less wear on antagonist teeth and adapted better at the gingival margin. Both patients and their parents preferred the appearance of zirconia crowns. Prabhu D et al. found that zirconia is at least as good as stainless steel for restoring primary molars, offering improved overall gingival health and a more aesthetically pleasing appearance (Prabhu D et al., 2022).

In 2019, Go H. et al., in their article titled „Effect of various polishing burs on surface roughness and bacterial adhesion in pediatric zirconia crowns” highlighted the importance of the surface conditions of crowns applied to primary teeth in terms of

the risk of adhesion and development of pathogenic microorganisms in the oral cavity.

The materials and methods used in this study were similar to the fabrication and modeling techniques for zirconia pediatric crowns manufactured by NuSmile. The materials were transformed into zirconia discs using the pressing method, resulting in discs with diameters of 8.0 mm and thicknesses of 2.0 mm, which were then sintered at 1500°C for 2 hours. To confirm the similarity between the surfaces of the discs and NuSmile crowns, an electron microscope was used. A total of 40 zirconia specimens in the form of discs were studied, divided into five groups: the first group was the control, the second was polished with a single bur, and the last three groups were polished with three different burs. The burs used were fine diamond burs (53-63 µm particle size) attached to a turbine for 30 seconds in a single direction.

The study concluded that there is a positive correlation between surface roughness and bacterial adhesion for zirconia pediatric crowns, but only when the roughness exceeded 0.2 µm. Compared to other materials, zirconia did not show different results in these aspects. The authors note certain limitations of the study, as the in vitro environment does not fully correspond to the oral cavity (Go H et al., 2019).

The article „Evaluation of the Clinical Performance of NuSmile Pedodontics Zirconia Crowns in Pulp-Treated Primary Teeth—2 Years Follow-Up Study” published in 2022 by Alamoudi R. A. et al. aimed to gather information on the longevity of prefabricated crowns applied to primary teeth. The study focused on the success rate of NuSmile zirconia crowns for primary anterior and posterior teeth over a

two-year period, evaluating gingival health, plaque levels, restorative failures, and marginal integrity.

The study assessed the clinical performance of 232 NuSmile zirconia crowns (172 for primary incisors and 60 for primary molars – teeth treated endodontically).

The results and conclusions indicated that the gingival and plaque index for teeth restored with NuSmile zirconia crowns showed no significant differences compared to antagonist teeth (used as controls). The Kaplan-Meier chart confirmed that only 34% of the crowns applied to incisors and 86% of the crowns applied to molars survived at the end of the 24-month period. Of the 172 crowns placed on incisors, only 82 teeth survived after two years. The Kaplan-Meier chart also showed that more than two-thirds of the crowns (90% of incisors and 76% of molars) maintained good marginal integrity at the end of the 24 months. Thus, NuSmile zirconia pediatric crowns preserve and maintain good gingival health, provide good retention and marginal integrity, and indirectly protect teeth from secondary caries (Alamoudi R A et al., 2023).

In 2020, Kang H. Y. et al. published the article titled „Feasibility of 3-Dimensional Visual Guides for Preparing Pediatric Zirconia Crowns: An In Vitro Study” which evaluated the difficulty of tooth preparation for zirconia pediatric crowns and the need for a 3D guide in this process.

Using an intraoral scanner, 3D data was obtained regarding the surfaces of maxillary first primary molars from first quadrant and mandibular second primary molars from fourth quadrant. These data were then used to create preparation guides

for zirconia pediatric crowns. Twenty patients were recruited for treatment, and parameters such as preparation time and the degree of tooth reduction were evaluated.

The study concluded that the use of 3D guides reduced preparation time and the extent of tooth reduction. The treatment speed increased, and the quality of care improved by better preserving dental structures. In the future, it is believed that these 3D guides will become a standard tool in dental clinics (Kang H Y et al. , 2020).

Ellan El Hayek J et al. released in 2022 the article titled „Fracture strength of preformed zirconia crown and new custom-made zirconia crown for the restoration of deciduous molars: in vitro study” which investigated the efficiency of zirconia alternatives for temporary tooth crowns compared to widely used stainless steel crowns.

The study evaluated and compared the forces required to fracture two types of pediatric posterior zirconia crowns: a prefabricated zirconia crown and a CAD-CAM custom-made zirconia crown—both applied to primary molars immediately after extraction.

Thirty primary molars were used and divided into two crown groups. All crowns were cemented using glass ionomer. Compressive forces were applied using a Universal Testing Machine until crown fracture occurred, and the forces required for this process were measured.

The results of the study showed that the average force required for fracture was significantly higher for CAD-CAM fabricated zirconia crowns compared to prefabricated zirconia NuSmile crowns (Elian El Hayek J et al., 2022).

Alrashdi M. et al. published in 2022 the article „Zirconia crowns fro children: A systematic review”. The aim of the study was to summarize the clinical outcomes of prefabricated zirconia crowns applied to primary dentition, including the degree of wear on opposing teeth, retention, fracture resistance, parental satisfaction, gingival health and cementation materials.

Using databases such as PubMed, Google Scholar, Web of Science and Cochrane Library, the authors selected 166 references, of which 14 studies were qualitative analyses.

All included and analyzed studies indicated that the use of prefabricated zirconia crowns for primary teeth is not associated with a higher degree of wear on opposing teeth, that these crowns are highly retentive, have a high resistance to fracture, are compatible with gingival health and that parental satisfaction is very high. Prefabricated zirconia crowns are an excellent alternative to traditional stainless steel crowns for primary teeth (Alrashdi M et al., 2022).

In 2021, the article titled „Zirconia crown performance in primary maxillary anterior teeth: a retrospective photographic and radiographic cohort study” was published by Yanover L. et al.. This retrospective cohort study assessed the overall satisfaction of parents and dentists after 131 zirconia crowns were applied to the maxillary primary anterior teeth of 37 children aged between 25.8 and 62.2 months, who had at least one follow-up visit at a minimum of 6 months post-treatment. Color, contour, and durability were evaluated in comparison with photographs taken immediately after crown cementation.

Parental satisfaction was rated at 100%, crown retention scored 99.7%, color

match was satisfactory in 97% of cases by parents and 37% by dentists and crown contour was rated as good by 97% of parents and 55% of dentists. The time elapsed from cementation to follow-up did not affect the color and contour of the crowns. Thus, zirconia crowns are an outstanding aesthetic and durable option for restoring primary anterior maxillary teeth. Parents were significantly less critical than the dentists (Yanover L. et al, 2021)

Shin et al. delivered in 2022 the article titled „Surface Roughness of Prefabricated Pediatric Zirconia Crowns Following Simulated Toothbrushing” analyzing the behavior of three different brands of prefabricated zirconia crowns for primary dentition after brushing with various toothpastes.

The study used 96 prefabricated zirconia crowns applied to the primary maxillary central incisors in second quadrant (32 crowns for each brand—Kinder Krowns, NuSmile, Sprig). These crowns were then brushed under identical conditions, using the same amounts of different types of toothpaste.

The results indicated no significant differences between the three brands of prefabricated pediatric zirconia crowns, confirming that dentists can use these options for treating primary teeth without encountering issues (Shin BW et al., 2022).

The article „Stress distribution in pediatric zirconia crowns depending on different tooth preparation and cement type: a finite element analysis” written in 2022 by Chung et al. aimed to evaluate the biomechanical behavior of prefabricated zirconia crowns for primary dentition following different clinical preparations.

The methods involved using 3D models of prefabricated pediatric zirconia

crowns, cement and teeth with six simulated conditions for primary first molars, with cement thicknesses of 100, 500 and 1000 μm , using resin-modified glass ionomer and resin cement. A force of 200 N was applied to the occlusal surface of the crowns, both vertically and obliquely.

The overall stress on the teeth increased with the expansion of the cement space during the application of oblique forces. The conclusions were that the von Mises stress values of the resin cements were significantly higher than those of the resin-modified glass ionomer cements for all cement thicknesses. Choosing the right type of cement for prefabricated zirconia crowns in primary dentition can improve treatment outcomes. (Chung S-Y, 2022).

Lopez-Cazaux S et al. published in 2019 the article titled „Preformed pediatric zirconia crown versus preformed pediatric metal crown: study protocol for a randomized clinical trial” aiming to analyze the efficacy of the two materials used for treatment.

The study involved 101 pediatric patients who presented with primary molars needing restorations using prefabricated metal crowns and prefabricated zirconia crowns. Temporary molars from two different quadrants were used. The first set received prefabricated metal crowns, and after 1-2 weeks, the paired molars were covered with prefabricated zirconia crowns. Treatment was considered successful if there was no clinical or radiological failure (e.g., pain, endodontic involvement, dental abscess, periradicular pathology). Additionally, retention rate, fracture rate, gingival conditions, wear on opposing teeth, as well as the satisfaction levels of parents and children were evaluated. The evaluation took place 2 years after the crowns were applied.

The conclusion of the study is that dentists can consider prefabricated zirconia crowns a very good alternative for treating severely affected primary molars. The results indicate that this therapeutic option is superior to prefabricated metal crowns, particularly in terms of superior aesthetics and a high degree of patient and parent satisfaction (Lopez-Cazaux S, 2019).

Yanover L. et al. published in 2021 the article titled „Parental and Dentist Satisfaction with Primary Anterior Zirconia Crowns: A Case Series Analysis” The study evaluated the marginal integrity, gingival health and aesthetics of zirconia crowns applied to primary maxillary anterior teeth, with a follow-up ranging from 6 to 30 months.

A total of 131 zirconia crowns were applied to 36 children aged between 24.8 and 62.2 months, each of whom had a follow-up visit at least 6 months after cementation. Marginal integrity was highly evident in 82.4% of the teeth. The absence of gingivitis was observed in 35% of the teeth, mild gingivitis in 58% of cases and moderate gingivitis in 7% of the teeth. The color and contour of the crowns were rated as very satisfactory in 55% of the cases. Gingival health and marginal integrity varied depending on how the crowns were applied (with or without general anesthesia). Teeth that underwent endodontic treatment showed a lower satisfaction level concerning color.

The conclusions indicate that zirconia crown therapy for primary teeth provides a sufficiently satisfactory solution for primary maxillary incisors, generally yielding good results in terms of marginal integrity, gingival health, and aesthetics (Yanover L et al, 2021).

Foster M. et al. published in 2024 the article titled „Survival of pre-formed zirconia crowns in primary teeth: a prospective practice-based cohort study” involving 155 children treated between 2012 and 2020 under general anesthesia by a single dentist.

The study included 319 primary teeth with prefabricated zirconia crowns, followed over a period ranging from 12 to 78 months. Among the 319 applied crowns, 5 failures were observed in 3 patients, necessitating extraction. Other complications included fractures (3), over-contouring (3), internal resorption (5) and 24% of the crowns displayed radiographic changes over time. The age at treatment, tooth type and the need for pulp therapy were not statistically associated with clinical success.

The study concluded that prefabricated zirconia crowns represent an aesthetic and long-lasting solution for children with early childhood caries. The study demonstrated a very high success rate and durability of up to 78 months for prefabricated zirconia crowns applied to primary teeth under general anesthesia (Foster M et al., 2024).

Güçlü ZA et al. published in 2021 the article titled „Can zirconia crowns be the first restorative choice after endodontic treatment of primary teeth?” which evaluated the success rate of zirconia crowns compared to other types of crowns for deciduous teeth with pulp therapy.

A total of 45 patients under 10 years of age presented with primary molars and anterior teeth requiring endodontic treatment. Stainless steel crowns, zirconia crowns and celluloid crowns were used to treat these teeth and clinical and radiological outcomes were analyzed over a

6-month period. Parents were asked to complete a questionnaire at 1 week and 6 months to assess satisfaction levels.

After 6 months, it was concluded that there were no significant negative differences between stainless steel crowns, zirconia crowns or celluloid crowns regarding clinical success. There were also no differences in the level of satisfaction among parents and children based on the treatment methods used (Güçlü ZA et al., 2021).

DISCUSSIONS

Pediatric crowns are dental solutions used for children to restore primary teeth affected by cavities or other trauma. There are several criteria that differentiate stainless steel pediatric crowns from zirconia pediatric crowns (Agrawal R. et al., 2022).

The study conducted by Lopez-Cazaux S et al., in agreement with other research on the use of stainless steel and zirconia crowns, found that stainless steel crowns are affordable, easy to apply, durable and predominantly used for restoring molars, providing excellent protection against cavities and fractures. However, their disadvantage lies in their unsatisfactory aesthetic appearance (Lopez-Cazaux S et al., 2019, Maciel R et al., 2017).

Zirconia pediatric crowns, on the other hand, are more expensive and more difficult to fabricate and adjust in the dental office but offer the best balance between durability and aesthetics. They fully meet the aesthetic requirements of any tooth in the arch (Lopez-Cazaux S et al., 2019, Yanover L et al., 2021).

According to Prabhu D et al., when comparing opposing tooth wear between preformed stainless steel crowns and

custom-made zirconia crowns, all crowns in the SSC group received a score of 0, reflecting no wear on the opposing tooth. In contrast, 25% of the zirconia crowns exhibited a score of 1, indicating minimal wear on the opposing tooth. (Prabhu D, et al., 2022). Mathewson RJ et al. and Stober T et al. have also reported that zirconia crowns tend to cause more wear on opposing enamel compared to natural teeth or stainless steel crowns (Mathewson RJ et al., 1995, Stober T et al., 2014).

The study by Go H et al., along with other previous research, has reported that zirconia crown restorations help reduce plaque formation and improve the gingival index (Go H et al., 2019, Yanover L et al., 2021, Walia T. et al., 2014, Bremer F et al., 2011).

An in vitro study by Kang H Y et al. showed that the use of the guide significantly shortened tooth preparation time and minimized unnecessary tooth reduction for zirconia crown. However, additional studies are required to further improve the clinical applicability of the tooth preparation guide (Kang H Y et al., 2020).

CONCLUSIONS

The restoration stage in pediatric dentistry is an absolutely necessary step in fixed prosthodontics, in line with the requirements of modern dental medicine. Therefore, prefabricated stainless steel or zirconia crowns represent ideal treatment options for achieving a minimally invasive, quick pediatric treatment with an increasingly high success rate. They provide dental treatment with a refined touch, allowing the patient to resume daily activities immediately after leaving the clinic.

Zirconia pediatric crowns currently represent the best restoration option, offering all the benefits of prefabricated metal crowns while also providing exceptional aesthetics that fully satisfy

today's beauty standards. The technological advancements of recent years and accelerated economic growth will increasingly facilitate global access to such pediatric treatments.

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