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Stainless steel crowns vs preformed zirconia crowns in primary teeth

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Abstract

Early childhood caries is a common chronic disease affecting children and often requires extensive restorative treatments. Stainless steel crowns (SSC) and preformed zirconia crowns (PZC) are two of the most widely used options in pediatric dentistry. SSC, introduced in 1950, are known for their durability, ease of placement, and low cost, although they have limited aesthetics due to their metallic appearance. In contrast, PZC offer an attractive aesthetic alternative, mimicking the natural tooth color, catering to the growing demand from parents for more aesthetic restorations. In terms of gingival health and plaque accumulation, PZC exhibit lower bacterial plaque adhesion and reduced gingival inflammation compared to SSC, due to their highly polished surface. Nevertheless, both options offer successful clinical outcomes in terms of longevity. Regarding retention, SSC excel in long-term stability and resistance, though PZC also demonstrate high retention rates, particularly during the first years of follow-up. However, PZC require greater tooth reduction for placement, which may compromise pulpal health and increase operative time. A critical aspect is the wear on opposing teeth, as PZC may cause slight wear, whereas SSC show less abrasion, making them more suitable for restorations in posterior sectors. Additionally, preparation time for PZC is longer since they do not allow adjustments after fabrication, unlike SSC. In conclusion, both crowns have advantages and disadvantages. The selection depends on clinical factors and the preferences of patients and their parents. SSC provide a durable and economical option, while PZC stand out for their aesthetics and gingival health benefits, albeit with higher costs and longer operative times.

Keywords: Stainless steel crowns, zirconia crowns, restorations, caries, childhood

1. Introduction

Early childhood caries is one of the most prevalent chronic diseases affecting children and is primarily associated with poor oral hygiene and a diet high in cariogenic foods and beverages. This condition poses a significant challenge for pediatric dental professionals due to its high prevalence and its negative impact on the quality of life of affected children ^[1]. Carious lesions that affect more than one tooth surface in primary teeth often require restorations that provide full coverage to ensure long-term protection and functionality. In this context, stainless steel crowns (SSC) have been widely used as a default solution for full coronal restoration due to their availability in preformed, pre-cut, and pre-contoured versions, offering a range of sizes and demonstrating proven clinical efficacy over time ^[2].

SSC are particularly recommended for restoring carious lesions that affect multiple tooth surfaces, as well as for generalized or localized enamel and dentin developmental defects. They are also preferred after pulp treatments and in children with high caries risk due to their ability to provide protection and durability. These prefabricated metal crowns can be effectively adapted to individual primary molars based on clinical needs ^[3]. Although modern pediatric dentistry advocates for a minimally invasive approach to caries treatment, extensive progression of the disease often necessitates more invasive interventions, such as pulp treatments followed by the placement of crowns, to preserve the tooth's integrity ^[4].

There are various options for full-coverage restorations, each with specific characteristics and challenges that can influence their use. Key considerations include functionality, aesthetics, strength, and acceptance by both patients and their parents.

Among the available options, SSC and preformed zirconia crowns (PZC) stand out as the most commonly used in pediatric patients^[5]. SSC have been a cornerstone in pediatric dentistry since their introduction in the 1950s due to their ease of placement, superior mechanical properties, and consistent durability. However, their main drawback lies in their metallic appearance, often considered unattractive by both children and their parents, prompting the search for more aesthetic alternatives^[6].

In this regard, preformed zirconia crowns (PZC) have emerged as a promising alternative to SSC, particularly in terms of aesthetics. PZC not only offer a more natural and aesthetically pleasing appearance but also exhibit high retention capacity, fracture resistance, and positive effects on gingival health, contributing to their acceptance among patients and families^[7]. The properties of PZC, such as high mechanical strength, low plaque adhesion, controlled wear behavior, and their resemblance to natural teeth, make them a viable option for the treatment of carious primary teeth^[8].

The increased demand for aesthetic solutions from parents has driven pediatric dentists to seek options that offer a combination of functionality and aesthetics. This is particularly important as more children, even as young as three years old, along with their parents, express growing concerns about dental appearance^[9]. The desire for restorations that mimic the natural color of teeth has influenced patient and family preferences toward more aesthetic options, such as PZC^[10]. In a context where appearance plays an increasingly significant role in the choice of restorative materials, PZC present themselves as an alternative that combines aesthetics and functionality. Despite the consistent and durable results provided by SSC over the years, their main disadvantage remains their metallic appearance. Therefore, the purpose of this study is to compare various clinical aspects of SSC and PZC, including plaque accumulation, gingival health, crown retention, dental wear during preparation, wear of antagonist teeth, and preparation time, to determine which option offers better comprehensive outcomes in the restoration of primary teeth.

2. Methodology

A comprehensive literature review was conducted using the PubMed database with the aim of gathering and analyzing relevant studies comparing stainless steel crowns (SSC) and preformed zirconia crowns (PZC) in the restoration of primary teeth. To ensure a precise and specific search, keywords such as "Stainless steel crowns," "Preformed zirconia crowns", "Gingival health", "Tooth wear", "Antagonist tooth wear", among other related combinations, were utilized. Articles published in recent years were included, encompassing systematic reviews, clinical trials, experimental studies, and ex vivo studies.

The article selection process involved several phases. First, all potentially relevant articles were identified based on the mentioned keywords. Subsequently, an analysis of titles and abstracts was performed to exclude irrelevant studies, duplicates, or those that did not directly address the comparison between SSC and PZC. Next, the selected articles were thoroughly reviewed to confirm their relevance and methodological quality, ensuring that the included studies met internal validity criteria, such as appropriate design and clinically significant outcomes.

Multiple comparison variables were considered to ensure a comprehensive evaluation of both crown types, The

analyzed variables included

- **Plaque accumulation and gingival health:** Evaluation of periodontal inflammation, biofilm accumulation, and bacterial adhesion such as *S. mutans*.
- **Crown retention:** Analysis of short- and long-term stability, marginal integrity, and survival rates.
- **Tooth wear during preparation:** Comparison of the degree of tooth reduction required for each crown type.
- **Wear of antagonist teeth:** Impact of each crown type on the abrasion of opposing teeth.
- **Preparation time:** Operative time required for the placement of each crown type.

In addition to clinical variables, studies evaluating patient and family satisfaction, as well as complications reported during follow-up, were included. The review was supplemented with critical commentary on relevant findings in each area, analyzing the strengths and limitations of the selected studies to provide a clear view of the advantages and disadvantages of each type of restoration.

This approach enabled an objective and detailed comparison between SSC and PZC, offering relevant information to guide clinical decision-making in pediatric dentistry.

3. Results

3.1 Plaque Accumulation and Gingival Health

Preformed Zirconia Crowns (PZC) have demonstrated a significant reduction in the adhesion of *Streptococcus mutans* to their surface, resulting in lower plaque accumulation around the crown and reduced gingival inflammation compared to conventional stainless steel crowns (SSC)^[11]. Due to their low microbial adhesion, PZC offer a potential advantage in reducing the risk of secondary caries and other complications related to microbial colonization^[12]. This is attributed to the highly polished surface of PZC, which presents a less favorable environment for plaque deposition compared to other restorative materials^[13].

The ability of PZC to preserve and maintain gingival health is evidenced by their high long-term survival rates, along with good retention and marginal integrity^[14]. Various studies have highlighted that PZC outperform SSC in terms of plaque accumulation and gingival health^[15]. PZC have been associated with lower plaque accumulation and better gingival health, whereas SSC have shown a systematic tendency to cause mild gingival inflammation^[16].

However, some studies have reported less conclusive results regarding the comparison of both crowns. In particular, it has been noted that although SSC exhibit good crown retention, marginal integrity, and relatively low plaque accumulation, these results do not reach a statistically significant level of superiority over PZC^[17]. Regarding biofilm formation, SSC stand out for having one of the lowest levels compared to other restorative materials. Nevertheless, ion-releasing materials do not necessarily show better antimicrobial activity than conventional materials^[18].

Both types of crowns, SSC and PZC, have shown 100% clinical success in comparative studies^[19]. While SSC tend to exhibit lower plaque accumulation in some cases, PZC have a smoother surface that reduces plaque biofilm adhesion, resulting in generally better gingival health compared to SSC. Despite these differences, it is important to emphasize that overall gingival health success largely depends on proper tooth brushing and daily oral hygiene, regardless of the type of restorative material used.

3.2 Crown Retention

Studies comparing the retention of stainless steel crowns (SSC) with other restorative methods have concluded that SSC exhibit superior longevity and durability, making them a preferred option in many clinical scenarios^[20]. This high clinical performance of SSC is attributed to their durability, ability to maintain the morphological shape of the tooth, and minimal technical sensitivity during placement. These characteristics provide stability and reduce procedure-related complications, contributing to their popularity among pediatric dentists^[21].

On the other hand, preformed zirconia crowns (PZC) have also demonstrated notable retention rates. In three-year studies, PZC have shown retention rates ranging from 76% to 94%, supporting their viability as a long-lasting restorative option^[22]. Additionally, carious teeth restored with PZC following pulp treatments have shown good retention and aesthetic outcomes over a 30-month period, highlighting their ability to maintain both functionality and aesthetic appeal^[23]. PZC are known for their high retention and biocompatibility, although they may cause a low degree of abrasion to the opposing natural dentition, as evidenced in six-month follow-up studies^[24]. However, a one-year follow-up revealed statistically significant differences in the frequency of crown retention between PZC and SSC. Retention criteria after cementation and the preservation of anatomical shape indicated a preference for SSC^[25]. This finding suggests that, within the limitations of *ex vivo* studies, the statistically superior retention of SSC makes them the preferred option for full-coverage restorations^[26].

Nevertheless, it has been noted that PZC may have slightly lower retention and, in some cases, require excessive tooth reduction during preparation, which can be a significant disadvantage in terms of preserving dental tissue^[27]. The success of PZC retention depends largely on the cementation material used, as, unlike SSC, PZC cannot be precisely adjusted to the tooth, necessitating tooth adaptation to the crown. This underscores the importance of selecting an appropriate cement to ensure their stability. Despite both types of crowns exhibiting high retention rates, studies indicate that SSC tend to offer higher success rates both in the short and long term.

3.3 Dental wear during preparation

Preformed zirconia crowns (PZC) require greater reduction of tooth structure compared to stainless steel crowns (SSC) in both anterior and posterior primary teeth. This is due to the structural characteristics of PZC, which are significantly thicker than SSC^[28]. The greater mass and lack of flexibility of PZC necessitate a more aggressive tooth preparation for proper placement, increasing the risk of pulp exposure and potentially compromising the integrity of the treated tooth^[29]. To achieve the passive fit required for PZC, dentists must perform more extensive tooth preparation, which can result in reduced long-term retention due to the greater amount of sacrificed tooth structure^[30]. Unlike SSC, PZC cannot be compressed or adjusted to fit the tooth's shape. Instead, the tooth must be prepared to fit the crown, necessitating more extensive reduction of surrounding dental tissue^[13]. Dental preparations for PZC are often significantly deeper, particularly in the occlusal and mesiobuccal areas of deciduous molars, compared to SSC^[31].

Variations in preparation depth for PZC can be considerable, reflecting the complexity of the procedure and individual differences in dental anatomy^[32]. However, wear is not

limited to the prepared tooth; increased wear on the opposing tooth has also been reported in cases of PZC restorations, posing a potential long-term concern^[33]. The need for extensive reduction is due to the inherent inflexibility and thickness of PZC, characteristics that limit their ability to be adjusted compared to SSC^[34].

In contrast, SSC offer greater adaptability and allow for specific adjustments to achieve a better fit, thereby reducing the amount of tooth structure that needs to be removed. This less invasive approach to tooth preparation is one of the reasons why SSC may be preferred in certain cases, especially when preserving as much tooth structure as possible is a priority. Therefore, although PZC offer significant aesthetic benefits, their thickness and lack of modifiability make preparation more demanding, requiring exhaustive dental adjustments to ensure proper placement.

3.4 Wear on Opposing Teeth

Preformed zirconia crowns (PZC) have demonstrated a tendency to cause greater wear on opposing primary teeth compared to other restorative options^[35]. Although PZC are known for their high retention and gingival compatibility, they is that the have been observed to produce minor abrasion on opposing teeth. However, this abrasion is often considered clinically insignificant, depending on the context^[36]. Another notable finding mean bite force in the PZC group was higher compared to the stainless steel crown (SSC) group, which may be related to the structural properties of PZC^[37].

On the other hand, some studies have reported that none of the PZC samples exhibited wear on opposing teeth, open margins, or recurrent caries during the evaluation period, highlighting their potential for providing satisfactory clinical outcomes in certain situations^[38]. Additionally, both SSC and PZC have demonstrated the ability to establish good proximal contact and have not shown significant wear on opposing teeth throughout the study period^[17]. However, SSC have shown to have a lesser impact on the wear of the enamel of opposing teeth compared to PZC, which can be relevant in terms of preserving the integrity of the patient's natural dentition^[39].

Despite the fact that SSC have a greater tendency to accumulate plaque and may be associated with mild gingival inflammation, PZC have been linked to relatively greater wear and chipping of opposing teeth^[40]. This suggests that while PZC offer aesthetic and retentive benefits, their impact on opposing teeth must be carefully considered, especially in posterior areas. SSC, on the other hand, exhibit wear behavior more similar to that of a natural tooth, making them a preferred option for certain restorations^[41]. In general, the wear and chipping caused by PZC may be mild, but their impact should be evaluated on an individual basis before opting for their placement^[42].

The wear that PZC can cause on opposing teeth is considered minimal in many cases but remains an important variable to consider. Before deciding to place a PZC, a thorough patient evaluation should be conducted to ensure that it is the most suitable option in terms of functionality and dental preservation. In contrast, SSC tend not to cause significant wear on opposing teeth, making them an option worth considering, especially when enamel preservation and occlusal functionality are key factors.

3.5 Preparation Time Required

Stainless steel crowns (SSC) offer a significant advantage due to their reasonable costs and reduced technical sensitivity

during placement. This translates into faster and simpler procedures, especially when compared to preformed zirconia crowns (PZC) [20]. However, PZC present some important clinical limitations, as they require more aggressive tooth reduction to achieve proper fit, which results in significantly longer operative times [20].

The difference in clinical time needed for the preparation and placement of PZC is notable, with PZC procedures often taking nearly twice as long as SSC procedures [43]. Unlike SSC, PZC cannot be compressed or adjusted during the procedure. Consequently, the clinician must prepare the tooth to fit the pre-defined dimensions of the zirconia crown. (Lee JH. 2018) [44]. This means that the tooth must be significantly reduced to accommodate the selected crown size and shape, a process that prolongs treatment time [9].

Dental preparation for PZC not only involves more extensive reduction but also requires significant reductions on the occlusal surface, as well as on axial surfaces and gingival margins [45]. This level of precision and depth of preparation further contributes to the increased operative time [46]. Furthermore, both anterior and posterior primary teeth require significantly more reduction when preparing for PZC compared to SSC [28].

On the other hand, the technique for preparing SSC is quick, efficient, and less invasive [47]. Due to the thickness and predefined shape of PZC, which cannot be adjusted during placement, extensive preparation of the tooth is necessary prior to fitting, resulting in longer operative times. Conversely, SSC allow for more conservative preparation, leading to a much faster and simpler placement process without the need for significant tooth reduction.

This difference in the required preparation and placement time for each type of crown is a critical factor to consider when selecting the most appropriate restorative material for each patient. While PZC offer aesthetic advantages, the treatment time and amount of tooth structure that must be removed may be limiting factors, especially for children with higher sensitivity or in clinical situations where minimizing operative time is essential.

4. Conclusions

Both stainless steel crowns (SSC) and preformed zirconia crowns (PZC) offer effective solutions for the restoration of primary teeth, although they each present particular advantages and limitations that must be considered when selecting the most appropriate treatment. SSC remain a preferred option in pediatric dentistry due to their durability, ease of placement, low technical sensitivity, and shorter operative times. Their ability to quickly and efficiently adapt to various clinical conditions makes them an ideal choice for cases where functionality takes precedence over aesthetics, especially in posterior sectors. However, their metallic appearance is a notable aesthetic limitation for many parents and patients.

On the other hand, PZC provide a superior aesthetic alternative due to their natural appearance and tooth-like color, addressing the growing demand for more aesthetic restorations in young children. These crowns not only offer a high level of aesthetic satisfaction but also help maintain better gingival health by preventing bacterial plaque accumulation. Nevertheless, their placement poses technical challenges due to their rigidity, requiring greater tooth reduction and, consequently, longer treatment times. Additionally, PZC may cause mild wear on opposing teeth, though it is not clinically significant.

In terms of retention, both SSC and PZC show good results, although SSC tend to be more stable in the long term. The selection between these types of crowns should be based on a comprehensive evaluation of the clinical case, taking into account factors such as the patient's oral health status, the aesthetic expectations of the parents, and the functional needs of the tooth, and the child's tolerance for lengthy or complex procedures.

In conclusion, both crowns represent viable options for the restoration of primary teeth. SSC offer a quick, cost-effective, and efficient solution, while PZC provide a more aesthetically pleasing option that meets current expectations, albeit at a higher cost and with greater technical demands. The choice between SSC and PZC should be based on a personalized clinical approach that considers both functional needs and aesthetic preferences, ensuring the best outcomes for each patient and their family

Conflict of Interest

Not available

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