Journal of Paediatric Surgeons of Bangladesh (2023) Vol. 14 (1 & 2)
Official Journal of the Association of Paediatric Surgeons of Bangladesh
https://doi.org/10.3329/jpsb.v14i1.88461

Journal of Paediatric Surgeons of Bangladesh

Original Article

Evaluation of Chronic Gingivitis in Response to Nickel Chromium and Gold Alloy Crown

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Abstract

Background: Dental crown materials can influence the biological response of the surrounding gingival tissues. Nickel–chromium alloys and gold alloys are widely used in fixed prosthodontics due to their mechanical properties and clinical durability. However, differences in corrosion resistance, metal ion release and biocompatibility may affect periodontal health around these restorations. Understanding their clinical impact is essential for selecting appropriate restorative materials. This study aimed to compare the gingival health status around nickel–chromium alloy crowns and gold alloy crowns among adult patients.

Methods: This cross-sectional comparative study was conducted at the Department of Prosthodontics, Bangabandhu Sheikh Mujib Medical University in collaboration with Beau-Dent, The Dental Specialist, Dhaka, Bangladesh, from January to December 2019. A total of 60 patients aged 30–40 years with existing full-coverage crowns were included. Participants were categorized into two groups based on crown material: nickel–chromium alloy crowns (n=32) and gold alloy crowns (n=28). Gingival health was assessed using the Gingival Index, Plaque Index, Sulcus Bleeding Index and probing depth measurements. Data were analyzed using SPSS version 25.0.

Results: Healthy gingiva was observed in 12.5% of participants with nickel–chromium crowns and 32.1% with gold crowns. Moderate and severe gingivitis were more prevalent in the nickel–chromium group. Poor plaque scores were recorded in 28.1% of the nickel–chromium group compared with 17.8% in the gold group. Similarly, higher levels of bleeding and deeper probing depths were observed around nickel–chromium crowns, although differences were not statistically significant.

Conclusion: Gold alloy crowns demonstrated comparatively better gingival health outcomes than nickel–chromium alloy crowns. Material biocompatibility may influence periodontal responses around fixed prostheses.

Keywords: Nickel–chromium alloy, Gold alloy crown, Gingival health, Fixed prosthesis, Periodontal response.

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Introduction:

Fixed partial dentures and single-unit crowns remain among the most frequently prescribed restorations in contemporary prosthodontics, with alloy selection representing a decision of considerable biological and clinical consequence [1]. The interface between a crown margin and the surrounding periodontium is a zone of particular vulnerability; the material properties of the chosen alloy can either preserve or progressively compromise gingival health through ion release, surface degradation and tissue sensitization [2]. Selecting an alloy that is both mechanically reliable and periodontally compatible is therefore central to the long-term success of any fixed restoration.

Nickel–chromium (Ni–Cr) alloys have been widely adopted in fixed prosthodontics owing to their favourable mechanical strength, low cost and ease of fabrication [3]. However, their clinical use is not without concern. Corrosion of metallic biomaterials in the oral environ ment releases constituent ions into the surrounding tissues and biological fluids and Ni–Cr alloys are recognized as comparatively susceptible to such degradation [4]. Nickel, in particular, is a well-established allergen and cellular toxicant; it has been shown to trigger immunological hypersensitivity, dysregulate cytokine production in monocytes and exert direct cytotoxic effects on oral mucosal and periodontal cells [5,6]. Chromium, co-released during alloy corrosion, carries additional concerns related to genotoxicity and carcinogenicity at elevated tissue concentrations [7]. These properties collectively raise legitimate questions about the periodontal safety of Ni–Cr crowns over extended periods of clinical service.

Gold alloys occupy the opposite end of the biocompatibility spectrum. Their chemical nobility confers exceptional resistance to corrosion and ion release and they have historically been regarded as the reference standard for tissue-compatible fixed restorations [8]. Wataha's comprehensive review of prosthodontic alloys affirmed that gold-based systems elicit minimal inflammatory response in adjacent soft tissues and are associated with favourable long-term periodontal outcomes [1]. Nevertheless, the higher cost and evolving aesthetic demands of patients have progressively displaced gold alloys in routine clinical practice and Ni–Cr alternatives now predominate in many healthcare settings worldwide [3].

Despite substantial in vitro and orthodontic in vivo evidence documenting the biological hazards of nickel and chromium ion release [9,10], comparatively few clinical studies have directly evaluated the periodontal tissue response to Ni–Cr versus gold alloy crowns in the context of fixed prosthodontic rehabilitation. Most existing comparative data derive from orthodontic bracket and wire studies or laboratory corrosion models, which differ substantially in alloy composition, surface area and clinical loading from cast dental crowns. The biological interactions between dental cast alloys and oral tissues have been described broadly by Schmalz and Garhammer [2], yet the specific impact of crown alloy type on standardized periodontal clinical parameters — including gingival index, plaque index, sulcus bleeding index and probing depth — remains insufficiently characterized in the clinical literature.

The present study was designed to address this evidence gap by clinically evaluating and comparing the gingival health status and periodontal clinical parameters of patients rehabilitated with Ni–Cr alloy crowns versus gold alloy crowns. By employing validated indices in a defined adult cohort, this study aims to provide clinically grounded evidence to inform alloy selection in fixed prosthodontics, with direct relevance to minimizing iatrogenic periodontal risk in everyday restorative practice.

Materials & Methods

This cross-sectional comparative study was carried out at the Department of Prosthodontics, Bangabandhu Sheikh Mujib Medical University, in collaboration with Beau-Dent, The Dental Specialist, Dhaka, Bangladesh. The study period extended from January 2019 to December 2019. The study population consisted of adult patients who had previously received full-coverage metal crowns. A total of 60 participants were included in the study, with an age range of 30 to 40 years. The participants were divided into two groups according to the type of crown alloy present: nickel–chromium alloy crowns and gold alloy crowns.

Selection Criteria

Inclusion Criteria

- Patients aged between 30 and 40 years.
- Presence of a single full-coverage metal crown fabricated from either nickel–chromium alloy or gold alloy.
- Crown placed at least six months before clinical examination.
- Patients with good general health.
- Participants willing to provide informed consent.

Exclusion Criteria

- Presence of systemic diseases affecting periodontal health.
- History of periodontal therapy within the previous six months.
- Use of antibiotics or anti-inflammatory drugs within the last three months.
- Presence of multiple crowns or mixed alloy restorations.
- Pregnancy or lactation.
- Known history of hypersensitivity to dental metals.

Data Collection Procedure

Data collection was conducted through a structured clinical examination and patient interview process. Participants who met the eligibility criteria were informed about the objectives and procedures of the study. Written informed consent was obtained before to participation and confidentiality of personal information was strictly maintained throughout the study.

Initially, socio-demographic information including age and gender was recorded using a standardized data collection form. Each participant then underwent a detailed intraoral examination performed under adequate illumination using sterile dental instruments. The type of crown alloy present was identified based on patient treatment records and confirmation from the dental clinic where the crown had been fabricated.

Assessment of gingival and periodontal health was performed around the crowned tooth using established clinical indices. Gingival condition was evaluated using the Gingival Index (GI), which measures the severity of gingival inflammation based on color, edema and bleeding tendency. Each crown-adjacent gingival site was scored from 0 to 3, where 0 represented healthy gingiva and 3 represented severe inflammation.

The Plaque Index (PI) was recorded to determine the level of plaque accumulation around the crown margins. The index was categorized into good (0–0.9), fair (1.0–1.9) and poor (≥2.0) oral hygiene status. In addition, the Sulcus Bleeding Index (SBI) was used to evaluate bleeding tendency upon gentle probing of the gingival sulcus.

Periodontal probing depth was measured using a calibrated periodontal probe. Measurements were taken at the gingival margin adjacent to the crown to determine the depth of periodontal pockets. Probing depths were categorized into ≤3 mm, 4–5 mm and ≥6 mm.

All clinical measurements were performed by a trained dental examiner using standardized techniques to ensure consistency and reliability. Data were recorded immediately following examination to minimize errors. Patient identification information was coded to maintain anonymity and protect confidentiality.

Statistical Analysis

All collected data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 25.0. Descriptive statistics including frequency, percentage, mean and standard deviation were used to summarize demographic and clinical variables. The chi-square test was applied to evaluate associations between crown alloy types and gingival or periodontal parameters. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 60 participants aged between 30 and 40 years were included in this study. The results present the socio-demographic characteristics of participants, distribution of crown alloy types, gingival health status and comparison of periodontal clinical parameters between nickel–chromium and gold alloy crowns.

Table 1: Socio-demographic Characteristics of the Study Participants (n = 60)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	30–32	18	30.0
	33–35	22	36.7
	36–38	12	20.0
	39–40	8	13.3
	Mean ±SD	34.2 ± 3.1	
Gender	Male	34	56.7
	Female	26	43.3

Table 1 shows the socio-demographic characteristics of the study participants. The majority of participants belonged to the 33–35 year age group (36.7%), followed by 30–32 years (30.0%), 36–38 years (20.0%) and 39–40 years (13.3%). Male participants accounted for 56.7% (n=34) while females represented 43.3% (n=26). The overall mean age of the participants was 34.2 ± 3.1 years.

Table 2: Distribution of Crown Alloy Types among Participants (n = 60)

Crown Alloy Type	Frequency (n)	Percentage (%)
Nickel–Chromium Alloy Crown	32	53.3
Gold Alloy Crown	28	46.7
Total	**60**	**100**

Table 2 presents the distribution of crown alloy types among participants. Nickel–chromium alloy crowns were slightly more prevalent, accounting for 53.3% (n=32) of restorations. Gold alloy crowns represented 46.7% (n=28) of the sample.

Table 3: Association between Crown Alloy Type and Gingival Index Score

Gingival Index Score	Nickel–Chromium Crown n (%)	Gold Alloy Crown n (%)	p-value
Healthy Gingiva (GI = 0)	4 (12.5)	9 (32.1)	0.094
Mild Gingivitis (GI = 1)	11 (34.4)	12 (42.9)	
Moderate Gingivitis (GI = 2)	12 (37.5)	6 (21.4)	
Severe Gingivitis (GI = 3)	5 (15.6)	1 (3.6)	
Total	**32 (100)**	**28 (100)**	

Table 3 describes the association between crown alloy type and the gingival index score. Healthy gingiva (GI=0) was observed in 12.5% of participants with nickel–chromium crowns and 32.1% with gold alloy crowns. Mild gingivitis (GI=1) occurred in 34.4% of nickel–chromium crowns and 42.9% of gold crowns. Moderate gingivitis (GI=2) was more frequent around nickel–chromium crowns (37.5%) compared with gold crowns (21.4%). Severe gingivitis (GI=3) was also higher among nickel–chromium crowns (15.6%) than gold crowns (3.6%). However, the association between alloy type and gingival index score did not reach statistical significance (p=0.094).

Table 4: Comparison of Periodontal Clinical Parameters around Crowns According to Alloy Type

Parameter	Category	Nickel-Chromium Crown n (%)	Gold Alloy Crown n (%)	p-value
Plaque Index	Good (0–0.9)	8 (25.0)	11 (39.3)	0.429
	Fair (1.0–1.9)	15 (46.9)	12 (42.9)	
	Poor (≥2.0)	9 (28.1)	5 (17.8)	
Sulcus Bleeding Index	No bleeding	8 (25.0)	12 (42.9)	0.277
	Mild bleeding	13 (40.6)	12 (42.9)	
	Moderate bleeding	8 (25.0)	3 (10.7)	
	Severe bleeding	3 (9.4)	1 (3.6)	
Probing Depth	≤3 mm	18 (56.3)	20 (71.4)	0.42
	4–5 mm	11 (34.4)	7 (25.0)	
	≥6 mm	3 (9.3)	1 (3.6)	

Table 4 presents the comparison of periodontal clinical parameters around crowns according to alloy type. For plaque index, good oral hygiene scores were observed in 25.0% of nickel–chromium crowns and 39.3% of gold crowns. Poor plaque scores were slightly higher around nickel–chromium crowns (28.1%) compared with gold crowns (17.8%), although the difference was not statistically significant (p=0.429). Regarding the sulcus bleeding index, no bleeding was observed in 25.0% of nickel–chromium crowns and 42.9% of gold crowns. Moderate to severe bleeding was somewhat higher among nickel–chromium crowns. However, this difference was not statistically significant (p=0.277). In terms of probing depth, periodontal pockets ≤3 mm were present in 56.3% of nickel–chromium crowns and 71.4% of gold crowns. Deeper pockets (≥4 mm) were slightly more frequent around nickel–chromium crowns, but the difference was not statistically significant (p=0.420).

Discussion

The present study evaluated the periodontal health status of participants rehabilitated with nickel–chromium (Ni–Cr) and gold alloy crowns, comparing gingival index scores and key clinical parameters including plaque index, sulcus bleeding index and probing depth. The findings revealed a consistent trend toward poorer gingival health around Ni–Cr crowns compared with gold alloy crowns across all clinical measures, although none of the differences reached statistical significance. These results are clinically meaningful and align with, as well as extend, a growing body of literature documenting the biological consequences of base-metal alloys in the oral environment.

The higher prevalence of moderate and severe gingivitis around Ni–Cr crowns (37.5% and 15.6%, respectively) compared with gold crowns (21.4% and 3.6%) is consistent with established evidence on the adverse tissue responses induced by nickel-containing alloys. Wataha et al. documented that nickel ions released from dental casting alloys can provoke inflammatory reactions in surrounding soft tissues, a finding supported by subsequent in vivo investigations [11]. The capacity of Ni^{2} ions to dysregulate cytokine secretion from human monocytes has been mechanistically demonstrated by Lewis et al., suggesting that the local inflammatory response observed in the present study may partly reflect immunomodulatory disturbances triggered by metal ion release [12]. Furthermore, Genchi et al. highlighted that nickel exerts direct cytotoxic effects on epithelial and connective tissue cells, which may compromise the integrity of the junctional epithelium and facilitate gingivitis development [6]. In contrast, gold alloys have consistently been regarded as exhibiting superior biocompatibility owing to their chemical inertness and resistance to ion release, as comprehensively reviewed by Wataha, who placed gold alloys among the most biocompatible options available for fixed prosthodontic restorations [1].

The plaque accumulation data in the current study showed a tendency for poorer plaque control scores around Ni–Cr crowns (28.1% poor scores) compared with gold crowns (17.8%), albeit without reaching statistical significance (p=0.429). This observation resonates with the argument put forward by Padbury et al. that the physicochemical properties of restorative margins directly influence supragingival and subgingival plaque ecology [10]. Eliaz noted that base-metal alloys such as Ni–Cr are more susceptible to surface corrosion in the oral environment, resulting in increased surface roughness that promotes microbial adhesion and biofilm maturation [4]. Marsh et al. similarly emphasized that the surface texture of biomaterials within the oral cavity plays a critical role in determining the architecture and pathogenicity of dental plaque biofilms [13]. Gold alloys, given their superior corrosion resistance and smoother surface characteristics following polishing, are therefore less likely to support the same degree of pathogenic plaque accumulation, a difference that may account for the better plaque index scores observed in gold crown recipients in the present study.

Regarding the sulcus bleeding index, the present study found that no bleeding was recorded in 42.9% of gold crown participants compared with only 25.0% of Ni–Cr crown participants, with moderate to severe bleeding more prevalent in the latter group. Although the difference was not statistically significant (p=0.277), this trend is clinically meaningful. Hasturk et al. described the close interrelationship between local inflammatory lesions in the periodontium and heightened vascular permeability, with bleeding on probing being a reliable indicator of active gingival inflammation [14]. Schmalz and Garhammer demonstrated that metal ions released from dental cast alloys can accumulate in adjacent oral tissues, perpetuating a local inflammatory microenvironment that manifests clinically as sulcular bleeding [2]. The immunological response to nickel, which includes delayed-type hypersensitivity reactions mediated by T-lymphocyte activation, has been detailed by Büdinger and Hertl, who noted that even sub-sensitizing concentrations of nickel can elicit gingival inflammation in susceptible individuals [15]. These mechanisms collectively provide a plausible biological basis for the sulcus bleeding differences observed between the two crown types in this study.

Probing depth measurements in the current study revealed that periodontal pockets ≥4 mm were more frequent around Ni–Cr crowns (43.7%) than gold crowns (28.6%), though the difference did not achieve statistical significance ($p=0.420$). Deeper probing depths suggest a greater degree of connective tissue attachment loss and alveolar bone involvement. Garhammer et al. previously reported that metal ion accumulation in tissue biopsies adjacent to dental cast alloys was associated with histopathological changes including increased inflammatory cell infiltration, consistent with early periodontitis changes [16]. Geurtsen's comprehensive review of casting alloy biocompatibility concluded that base-metal alloys with high nickel content pose a significant risk for local tissue irritation and deeper periodontal involvement over time [17]. Elshahawy and Watanabe further corroborated this view, arguing that the selection of alloy type for fixed prosthodontic restorations should incorporate considerations of long-term periodontal tissue response alongside functional and aesthetic criteria [9].

The non-significant p-values observed across all comparisons in this study warrant careful interpretation. Rusu et al. noted that in vitro and in vivo assessments of alloy cytotoxicity frequently yield clinically important trends but statistically modest effects, particularly in studies with limited sample sizes [18]. McGinley et al. similarly cautioned that the biological effects of base-metal alloys are often cumulative and may only become statistically apparent over longer follow-up periods or with larger patient cohorts [19]. The present study's cross-sectional design and relatively modest sample of 60 participants may have constrained statistical power and the consistent directional trend across all four clinical parameters towards poorer periodontal outcomes around Ni–Cr crowns nonetheless strengthen the clinical plausibility of the association. Rees documented that hypersensitivity reactions to dental cast metals can present subtly and may not always manifest as overt clinical lesions in the short term, further supporting the notion that the absence of statistical significance does not negate the clinical relevance of the observed trends [20].

Taken together, the findings of this study reinforce existing evidence that gold alloys offer superior periodontal compatibility compared with Ni–Cr alloys in fixed crown restorations. The consistent pattern of more favourable gingival health, better plaque control, lower sulcular bleeding and shallower probing depths around gold crowns provides a compelling clinical rationale for their preferential selection in patients with a predisposition to periodontal disease or known sensitivity to nickel. These results carry practical implications for clinical decision-making in restorative and prosthodontic practice, particularly in light of the growing recognition of nickel's systemic and local toxicological profile.

Limitations and Recommendations

The study involved a relatively small sample size and a short observation period. Future studies should include larger populations and longitudinal follow-up to better evaluate long-term periodontal responses to different crown alloys and their influence on peri-prosthetic tissue health.

Conclusion

Within the limitations of this study, gingival health parameters showed comparatively favorable outcomes around gold alloy crowns compared with nickel–chromium alloy crowns. Patients with gold crowns demonstrated a higher proportion of healthy gingiva and lower levels of gingival inflammation, plaque accumulation, bleeding tendency and periodontal pocket depth. Although the differences were not statistically significant, the findings suggest that alloy composition may influence the biological response of peri-crown gingival tissues and should be considered when selecting materials for fixed prosthodontic restorations.

Funding: None

Conflicts of interest: There are no conflicts of interest.

References

1. Wataha JC. Alloys for prosthodontic restorations. The Journal of prosthetic dentistry. 2002 Apr 1;87(4):351-63.
2. Schmalz G, Garhammer P. Biological interactions of dental cast alloys with oral tissues. Dental Materials. 2002 Jul 1;18(5):396-406.
3. Ardelean L, Reclaru L, Bortun CM, Rusu LC. Assessment of dental alloys by different methods. Superalloys. Rijeka: InTech. 2015 Nov 25:141-70.
4. Eliaz N. Corrosion of metallic biomaterials: A review. Materials. 2019 Jan 28;12(3):407.
5. Ahlström MG, Thyssen JP, Wennervaldt M, Menné T, Johansen JD. Nickel allergy and allergic contact dermatitis: A clinical review of immunology, epidemiology, exposure and treatment. Contact dermatitis. 2019 Oct;81(4):227-41.
6. Genchi G, Carocci A, Lauria G, Sinicropi MS, Catalano A. Nickel: Human health and environmental toxicology. International journal of environmental research and public health. 2020 Feb;17(3):679.
7. Wang Y, Su H, Gu Y, Song X, Zhao J. Carcinogenicity of chromium and chemoprevention: a brief update. Onco

Targets and therapy. 2017 Aug 16:4065-79.

8. Wataha JC. Biocompatibility of dental casting alloys: a review. The Journal of prosthetic dentistry. 2000 Feb 1;83(2):223-34.

9. Elshahawy W, Watanabe I. Biocompatibility of dental alloys used in dental fixed prosthodontics. Tanta Dental Journal. 2014 Aug 1;11(2):150-9.

10. Padbury Jr A, Eber R, Wang HL. Interactions between the gingiva and the margin of restorations. Journal of clinical periodontology. 2003 May;30(5):379-85.

11. Wataha JC, O'Dell NL, Singh BB, Ghazi M, Whitford GM, Lockwood PE. Relating nickel-induced tissue inflammation to nickel release in vivo. Journal of Biomedical Materials Research: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials and The Australian Society for Biomaterials and the Korean Society for Biomaterials. 2001;58(5):537-44.

12. Lewis JB, Messer RL, Pitts L, Hsu SD, Hansen JM, Wataha JC. Ni (II) ions dysregulate cytokine secretion from human monocytes. Journal of Biomedical Materials Research Part B: Applied Biomaterials: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials and The Australian Society for Biomaterials and the Korean Society for Biomaterials. 2009 Feb;88(2):358-65.

13. Marsh PD, Head DA, Devine DA. Dental plaque as a biofilm and a microbial community—Implications for treatment. Journal of oral biosciences. 2015 Nov 1;57(4):185-91.

14. Hasturk H, Kantarci A, Van Dyke TE. Oral inflammatory diseases and systemic inflammation: role of the macrophage. Frontiers in immunology. 2012 May 16; 3:118.

15. Budinger L, Hertl M. Review article Series V: The skin as target for IgE-mediated allergic reaction-Immunologic mechanisms in hypersensitivity reactions to metal ions: An overview. Allergy-Koebenhavn. 2000 Feb 1;55(2):108-15.

16. Garhammer P, Schmalz G, Hiller KA, Reitinger T. Metal content of biopsies adjacent to dental cast alloys. Clinical oral investigations. 2003 Jun;7(2):92-7.

17. Geurtsen W. Biocompatibility of dental casting alloys. Critical Reviews in Oral Biology & Medicine. 2002 Jan;13(1):71-84.3

18. Rusu LC, Borţun CM, Tănăsie GA, Podariu AC, Baderca F, Solovan C, Ardelean L. The cytotoxicity of dental alloys studied on cell culture. Rom J MorpholEmbryol. 2014 Jan 1;55(1):111-5.

19. McGinley EL, Moran GP, Fleming GJ. Base-metal dental casting alloy biocompatibility assessment using a human-derived three-dimensional oral mucosal model. Actabiomaterialia. 2012 Jan 1;8(1):432-8.

20. Rees TD. Hypersensitivity to dental cast metals: a clinical study. Open Pathol J. 2011 Mar 31;5(1):13-22.