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The connection between discolored gingiva of abutment teeth and the presence of cast post

Povezanost prebojene gingive pored zuba nosača sa prisustvom livene nadogradnje

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Abstract

Background/Aim. The cause of discolored gingiva (DG) is the presence of metal in the gingival tissue. DG is a relatively common case and is caused by the deposition of amalgam material in the gingival tissue during dental application or oral surgery. The aim of this study was to determine the significance of the presence of a cast post for the appearance of DG of abutment teeth (AT) in relation to the type of alloy used to make the fixed dental prosthesis (FDP). **Methods.** The study included 327 subjects with FDP. A total of 1,585 AT were examined. The subjects were classified into four groups depending on the type of alloy used to fabricate their FDPs (silver-palladium, gold, nickel-chromium alloy, or a combination of them). The presence of a cast post was confirmed by X-ray or by inspection of the dental chart. The study was conducted over the course of one year. **Results.** DG was observed in more than one-third (37.7%) of the subjects, of which 57.3% had a cast post. In the case of AT, discoloration occurred in 14.6%. Cast post was present in 92.7% of AT with DG. **Conclusion.** DG occurred in all groups of subjects regardless of the type of alloy from which the FDP was fabricated. The presence of a cast post is of great significance for the appearance of gray-bluish discoloration of the gingiva.

Key words:
dental alloys; dental amalgam; denture, partial, fixed; gingiva.

Apstrakt

Uvod/Cilj. Uzrok promene boje gingive (*discolored gingiva* – DG) je prisustvo metala u gingivalnom tkivu. DG je relativno česta pojava, a izazvana je taloženjem amalgamskog materijala u gingivalnom tkivu tokom stomatološke primene ili oralne hirurgije. Cilj rada bio je da se utvrdi značaj prisustva livene nadogradnje za pojavu DG kod zuba nosača u odnosu na vrstu legure od koje su proizvedene fiksne zubne nadoknade (FZN). **Metode.** U studiju je bilo uključeno 327 ispitanika sa ugrađenim FZN. Ispitivano je ukupno 1 585 zuba nosača FZN. U zavisnosti od vrste legure od kojih su bile izrađene FZN (srebro-paladijum, zlato, metal-keramika ili njihova kombinacija), ispitanici su bili razvrstani u četiri grupe. Prisustvo livene nadogradnje potvrđivano je rendgenskim snimkom ili uvidom u stomatološki karton. Ispitivanje je vršeno u periodu od jedne godine. **Rezultati.** Kod više od trećine (37,7%) ispitanika uočena je DG, od kojih je 57,3% imalo izrađenu livenu nadogradnju. Kod zuba nosača, FZN prebojenost se javila kod 14,6% ispitanika. Livena nadogradnja bila je prisutna kod 92,7% zuba nosača kod kojih se javila DG. **Zaključak.** Prebojena gingiva pojavila se u svim grupama ispitanika, bez obzira na vrstu legure od koje je FZN bila izrađena. Prisustvo livene nadogradnje je od velikog značaja za pojavu sivo-plavičaste prebojenosti gingive.

Ključne reči:
legure, stomatološke; amalgam, stomatološki; zubna proteza, parcijalna, fiksna; gingiva.

Introduction

"Amalgam tattoo" is a term that refers to gray-bluish discoloration of the gingiva that has been retained due to the centuries-old use of silver amalgam as a restorative material in dentistry. The cause of discolored gingiva (DG) or "amalgam tattoo" is the presence of metal in the gingival tissue. Oral amalgam pigmentation is a relatively common clinical

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lesion in about 12% of patients and is caused by the deposition of amalgam material in the gingival tissue during the dental application or oral surgery [1].

Numerous *in vitro* and *in vivo* studies (case reports, animal models) have examined the frequency of "amalgam tattoo" [1–3]; however, there are practically no papers concerning the reasons for the appearance of DG of the abutment teeth (AT). According to some authors, DG is a consequence of the "dissolution" of amalgam as a result of galvanic corrosion. Due to the difference in the potential between different metals in the presence of saliva as an electrolyte, a galvanic current leads to corrosion, and the released metal ions can be deposited in the surrounding tissues [4]. However, some studies have shown that patients with various metal restorations do not have galvanic current and side effects, like periodontal and mucosal diseases, caries lesions, or increased concentration of metal ions in their saliva [5, 6].

Through our clinical practice, we have noticed that DG also occurs in teeth that do not have amalgam filling, such as incisors or canines (Figures 1 and 2). We also observed that, in a large number of cases, these teeth were restored by cast post, a type of dental restoration required in cases of reduced remaining tooth structure to retain the core [7]. The cast post can be made of gold, silver and palladium alloys, or base metal alloys [8].

Fig. 1 – Discolored gingiva at the metal-ceramic bridge made of nickel-chromium alloy.

Fig. 2 – Discolored gingiva and cast post after removal of the metal-ceramic bridge made of nickel-chromium alloy.

The aim of this study was to determine the significance of cast post presence on the appearance of DG of AT.

Methods

The observational study included 327 subjects of both genders with an average age of 52 ± 11.4 years, treated at the Dental Clinic, Military Medical Academy, Belgrade, Serbia. Examinees with a fixed dental prosthesis (FDP) were included in the study. Exclusion criteria were severe periodontal and other oral diseases. All study participants provided written informed consent for participating in this study. The protocol of this study was approved by the Ethics Committee of the Military Medical Academy on May 21, 2009. The data were collected within one year.

Subjects were divided into four groups according to the type of alloy from which their FDP was fabricated: group 1 – subjects with metal-acrylate FDP made of gold (Au) alloy (n = 70); group 2 – subjects with metal-acrylate FDP made of silver-palladium (Ag-Pd) alloy (n = 94); group 3 – subjects with metal-ceramic FDP made of nickel-chromium (Ni-Cr) alloy (n = 85); group 4 – subjects with two or more FDPs made of different alloys (Au or Ag-Pd or Ni-Cr) (n = 78).

The following data were recorded: type of dental restoration (type of alloy used, date of manufacture, and possible changes in the restoration); presence of cast dowels (confirmed by inspection of dental chart or X-ray imaging).

Two dentists had to confirm the presence and characteristics of DG (localization, shape, size). AT without DG were marked as non-DG (NDG).

We compared the number of subjects and AT with DG with those without DG. The number of subjects and AT with cast post were compared to those without DG as well.

All parameters are presented as percentages. Statistical processing of the results was performed using the Chi-squared (χ^2) test on the commercial statistical software SPSS-18 (USA).

Results

The percentage of the subjects with DG in relation to the type of alloy that the FDP was fabricated from is shown in Table 1. A statistically significant difference in the presence of DG among the compared examined groups was not found.

The percentage of AT with the appearance of DG in relation to the type of alloy from which the FDP was fabricated is shown in Table 2. A statistically significant difference in the presence of AT with DG among the compared examined groups was not found. The analysis of the group of examinees developing DG showed that most of them had FDPs fabricated from the combination of alloys. DG appeared in 68 subjects whose FDPs were fabricated from Ni-Cr, while 48 and 39 patients had their FDPs fabricated from Ag-Pd and Au, respectively.

The percentage of the subjects with the cast post and the presence of DG in relation to the type of FDP alloy is shown in Table 3. A statistically significant difference in the presence of DG among the compared examined groups was not found. However, it was shown that more than half of the subjects with a cast post had DG, mainly the ones whose

FDPs were fabricated using a combination of two alloys, while the smallest percentage was among those whose FDPs were fabricated from Au.

Additional analysis of the subjects with cast post and DG showed that DG occurs in 92.7% of these subjects and in a significantly smaller number of subjects without the cast post (Table 4).

The percentage of AT with cast post and the presence of DG in relation to the type of FDP alloy is shown in Table 5, showing the same trend as has been previously described. Namely, the number of AT with DG was higher in the AT group with cast post (n = 171) when compared with AT without cast post. The highest number of AT with DG was detected in the group whose FDPs were fabricated from the combination of different alloys, and the least was in the group whose FDPs were fabricated from Au. A statistically significant difference in the presence of DG between the examined groups (depending on the type of the FDP alloy) was not found.

Table 1

Percentage of subjects with discolored gingiva in relation to the type of alloy used to fabricate the fixed dental prosthesis

Group	Type of alloy	Subjects with FDP (n)		Percentage
		DG	NDG	
1 (n = 70)	Au	23	47	32.9
2 (n = 94)	Ag-Pd	30	64	31.9
3 (n = 85)	Ni-Cr	34	51	40.0
4 (n = 78)	different alloys[#]	36	42	46.2
Total (n = 327)		123	204	37.7

DG – discolored gingiva; NDG – non-discolored gingiva; FDP – fixed dental prosthesis; Au – gold; Ag – silver; PD – palladium; Ni – nickel; Cr – chromium; n – number. [#]Au and/or Ag-Pd and/or Ni-Cr.

Table 2

Presence of abutment teeth (AT) with discolored gingiva in relation to the type of alloy used to fabricate the fixed dental prosthesis

Group	Type of alloy	AT (n)		AT with DG
		DG	NDG	%
1 (n = 263)	Au	39	224	14.8
2 (n = 370)	Ag-Pd	49	321	13.2
3 (n = 440)	Ni-Cr	68	372	15.5
4 (n = 512)	different alloys[#]	76	436	14.8
Total (n = 1,585)		232	1353	14.6

For abbreviations, see Table 1. [#]Au and/or Ag-Pd and/or Ni-Cr.

Table 3

Presence of discolored gingiva in subjects with a cast post in relation to the type of alloy used to fabricate the fixed dental prosthesis

Group	Type of alloy	Subjects with cast post (n)		Percentage
		DG	NDG	
1 (n = 28)	Au	19	9	67.8
2 (n = 51)	Ag-Pd	28	23	54.9
3 (n = 61)	Ni-Cr	31	30	50.8
4 (n = 59)	different alloys[#]	36	23	61.0
Total (n = 199)		114	85	57.3

For abbreviations, see Table 1. [#]Au and/or Ag-Pd and/or Ni-Cr.

Table 4

Frequency of subjects with a cast post in the group of subjects experiencing discolored gingiva

Group	Type of alloy	Subjects with cast post	Subjects without cast post
1	Au	19 (82.6)	4 (17.4)
2	Ag-Pd	28 (93.3)	2 (6.7)
3	Ni-Cr	31 (91.2)	3 (8.8)
4	different alloys[#]	36 (100)	0 (0)
Total		114	9***

For abbreviations, see Table 1. All values are expressed as numbers (percentages). [#]Au and/or Ag-Pd and/or Ni-Cr; ***$p < 0.005$ compared to subjects with cast post.

Table 5

Presence of discolored gingiva in abutment teeth (AT) with a cast post in relation to the type of alloy used to fabricate the fixed dental prosthesis

Group	Type of alloy	AT with DG (n)		AT with cast post %
		with cast post	without cast post	
1 (n = 39)	Au	29	10	74.4
2 (n = 49)	Ag-Pd	38	11	77.6
3 (n = 68)	Ni-Cr	47	21	69.1
4 (n = 76)	different alloys[#]	57	19	75.0
Total (n = 232)		171	61	73.7

For abbreviations, see Table 1. [#]Au and/or Ag-Pd and/or Ni-Cr.

The size, shape, and intensity of coloring were very inconsistent, even in the same subject/tooth, with no connection between these characteristics and the type of alloy used to fabricate the FDP. Discoloration occurred on the free and attached gingiva as well as the interdental gingiva. It was of various sizes (1–12 mm^2), and in some instances, it included a 3 mm wide gingiva around the tooth. The DG was present in the form of one or more dots but most often in the form of lines that followed the shape of the free gingiva.

Subjects with FDP made of Au alloy (the oldest one created) had the lowest percentage of DG in the presence of cast post. Moreover, DG was observed in subjects whose FDP was cemented just before this research.

Discussion

Regardless of the carefully made FDP, side effects can occur, most often on soft tissues. They can appear in the form of inflammation, recession, or DG. In contrast to the red coloration of the gingiva, which develops as a consequence of inflammation, characteristic grey-bluish discoloration that frequently appears is not a consequence of inflammation [9, 10].

That can compromise the entire dental prosthetic work. The gray-blue discoloration is in great contrast with the color of the teeth and the coral-pink color of the gingiva. It significantly reduces the aesthetic appearance of the patient. Such DG raises suspicion in both the patient and the dentist that more serious pathological changes are occurring in the tissue. If the indication for making an artificial crown was aesthetic, then the goal of therapy is completely unfulfilled, with high costs and wasted time. In addition, it has been noticed that DG is a long-standing problem, and no noninvasive therapy could remove it [11].

According to some theories, DG is a consequence of the "dissolution" of the dental amalgam, cast post, and crown made of Ag alloy due to the occurrence of galvanic corrosion between all groups of materials and Ag-Pd alloys [12]. This theoretical explanation of the appearance of DG is not acceptable for several reasons. Firstly, the cast post on which the FDP is made is practically covered and protected in the mouth from the influence of the external environment. Secondly, if DG is caused by ion release, this discoloration will appear gradually and increase with time. Thirdly, if that is the case, there would be cases of DG around the teeth with the cast post before grinding.

In our study, the lowest incidence of DG was observed in patients with fixed Ag-Pd alloy restorations (31.9%) and only one percent more in Au alloys (32.9%). These results and the absence of a statistically significant difference in the occurrence of DG in relation to the type of alloy that the FDPs were fabricated from suggested that galvanic corrosion, which can occur between cast post and FDP, has no big effect on gingival discoloration.

We could not determine the composition of each cast post; however, based on the time of their creation, we concluded that in that period, in our department, the cast posts and FDPs were made mainly of Ag-Pd alloy.

In previous *in vitro* studies, Ag-Pd alloys showed higher ion release and stronger biological interaction due to poor corrosion resistance [13]. In contrast, we found the lowest incidence of DG in teeth with Ag-Pd restorations. That indicates that the increased release of ions from Ag-Pd alloys caused by corrosion does not significantly affect the appearance of DG. The small influence of galvanic corrosion on the occurrence of DG is also shown by our results which showed that the largest number of AT with DG was in the group of subjects with restorations made of Ni-Cr alloy (15.5%). In metal-ceramic restorations, the metal alloy is completely covered with a ceramic that is resistant to corrosion and thus protects the metal core. However, the use of metal-ceramic systems requires more extensive grinding of the AT with and without cast post than other tested materials (Au and Ag-Pd) [14].

The highest percentage (100%) of patients with cast post and DG in group 4 could be explained by perennial therapy and a large number of different dental restorations carried out in these patients. Over time, a greater number of indications (secondary caries, devitalization of teeth) and repeated therapy with various restorations (crown, bridge, combined prosthesis) may lead to a greater need for making a cast post [7].

The observed high frequency of DG during our examinations is not in line with the findings of other researchers. Garhammer et al. [15] analyzed 86 out of 250 patients with possible side effects caused by dental alloys, selected from a population of one million citizens, and reported that 12% of research subjects had DG. The authors attributed it to a non-irritating "amalgam tattoo" based on earlier descriptions of such changes in the literature. None of the patients had other subjective problems; apparently, DG was the only reason to be included in the research. It was not noted which teeth DG occurred on (anterior or lateral), which alloys were used for the dental restorations, and whether a cast post had been present.

Therefore, the reason for a high frequency (37.7%) of DG in our subjects could be the consequence of frequent caries destruction of the teeth with an indication for making a cast post. The appearance of discoloration can also be a consequence of inadequate modeling of the cast post by acrylate, additional preparation of cast post after cementation, and the use of feather edge demarcation, which often leads to injury of the gingiva [16, 17].

Fig. 3 – Metal powder on oral mucosa during the preparation of tooth with amalgam filling for fixed dental prosthesis.

Among our subjects with DG, 92.7% had a cast post. Furthermore, our results show that a large number (73.7%) of AT with cast post had DG. The presence of a cast post in a high percentage of AT with DG clearly shows its significant role in the appearance of DG. It should be emphasized that we were unable to find a similar study in the literature. All other AT with DG, without cast post, are premolars and molars, except one. In our population, these teeth are often treated with amalgam filling, and its preparation creates a large amount of metal powder (Figure 3). Most powders can be washed out easily, whereas metal powder could adhere to the injured gingiva. As the gingiva heals, the powder remains in the tissue and, with its gray color, causes a change in the color of the gingiva.

A significant limitation of this study was the fact that the patients did not undergo sampling for histological examination of DG. In our future work, we shall focus on identifying the pathohistological characteristics of DG.

Conclusion

Cast post was present in 123 (37.7%) subjects and 232 (14.6%) AT with DG. If the artificial crown is not left with sufficient space during the modeling, the reduction of the volume of the cast post in the mouth leads to the creation of a large amount of metal powder that can be adhered to the injured gingiva. It is necessary to perform periodontal treatment, appropriate modeling of the cast post, and careful preparation of the cast post to avoid the appearance of discolored gingiva.

REFERENCES

1. *McCullough MJ, Tyas MJ*. Local adverse effects of amalgam restorations. Int Dent J 2008; 58(1): 3–9.
2. *Martín JM, Nagore E, Cremades A, Botella-Estrada R, Sanmartín O, Sevila A,* et al. An amalgam tattoo on the oral mucosa related to a dental prosthesis. J Eur Acad Dermatol Venereol 2005; 19(1): 90–2.
3. *Hassona Y, Sawair F, Al-Karadsheh O, Scully C*. Prevalence and clinical features of pigmented oral lesions. Int J Dermatol 2016; 55(9): 1005–13.
4. *Pigatto PD, Brambilla L, Guzzi G*. Amalgam tattoo: a close-up view. J Eur Acad Dermatol Venereol 2006; 20(10): 1352–3.
5. *Nilner K*. Studies of electrochemical action in the oral cavity. Swed Dent J Suppl 1981; (9): 1–42.
6. *Johansson BI, Stenman E, Bergman M*. Clinical registration of charge transfer between dental metallic materials in patients with disorders and/or discomfort allegedly caused by corrosion. Scand J Dent Res 1986; 94(4): 357–63.
7. *Dangra Z, Gandhewar M*. All about Dowels - A Review Part I. Considerations before Cementation. J Clin Diagn Res 2017; 11(8): ZG06–11.
8. *Hayashi M, Takahashi Y, Imazato S, Ebisu S*. Fracture resistance of pulpless teeth restored with post-cores and crowns. Dent Mater 2006; 22(5): 477–85.
9. *Knoernschild KL, Campbell SD*. Periodontal tissue responses after insertion of artificial crowns and fixed partial dentures. J Prosthet Dent 2000; 84(5): 492–8.
10. *Ristic Lj, Dakovic D, Postic S, Lazic Z, Bacevic M, Vucevic D*. Clinical characteristics of abutment teeth with gingival discoloration. J Prosthodont 2019; 28(1): e45–50.
11. *Aguirre-Zorzano LA, García-De-La-Fuente AM, Estefanía-Fresco R*. Treatment of amalgam tattoo with a new technique: mucoabrasion and free connective tissue graft. Clin Adv Periodontics 2019; 9(3): 120–4.
12. *Joska L, Venclikova Z, Poddana M, Benada O*. The mechanism of gingiva metallic pigmentations formation. Clin Oral Investig 2009; 13(1): 1–7.
13. *Wataha JC, Lockwood PE, Nelson SK*. Initial versus subsequent release of elements from dental casting alloys. J Oral Rehabil 1999; 26(10): 798–803.
14. *Goodacre CJ*. Designing tooth preparations for optimal success. Dent Clin North Am 2004; 48(2): 359–85.
15. *Garhammer P, Schmalz G, Hiller KA, Reitinger T, Stolz W*. Patients with local adverse effects from dental alloys: frequency, complaints, symptoms, allergy. Clin Oral Investig 2001; 5(4): 240–9.
16. *Cagidiaco EF, Discepoli N, Goracci C, Carboncini F, Vigolo P, Ferrari M*. Randomized Clinical Trial on Single Zirconia Crowns with Feather-Edge vs Chamfer Finish Lines: Four-Year Results. Int J Periodontics Restorative Dent 2019; 39(6): 817–26.
17. *Dangra Z, Gandhewar M*. All About Dowels - A Review Part II Considerations After Cementation. J Clin Diagn Res 2017; 11(10): ZE06–11.

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