

Metal release from cobalt-chromium partial dentures in the mouth

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The amounts of cobalt and chromium released to the saliva in individuals wearing cobalt-chromium partial dentures have been measured. Saliva was collected during a 5-min period, both with and without dentures in the mouth, and the two samples compared. More than 80% of the 30 cases showed increased amounts of metals with the denture in the mouth. Newer and larger dentures liberated more than did older and smaller ones. The median increase in chromium was approximately twice that of cobalt. □ *Dental alloys; corrosion*

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Common alloys for partial denture frameworks contain 60–65% cobalt, 27–30% chromium, and 5–6% molybdenum (5, 10). The nickel content is usually lower than 0.5%, but in some products the percentage may exceed 10% (10).

There are several reports on sensitivity to partial denture alloys. Both generalized skin reactions and local reactions related to the dentures have been described (2–4, 8, 11, 12). In most instances skin patch testing of the patients revealed positive reactions to constituents of the alloy, especially nickel and chromium (2, 4, 11). Moreover, both sensitivity to cobalt (3, 4, 8) and reactions to the alloy itself have been found (12).

Orthopedic implants containing nickel,

chromium or cobalt may give rise to both clinical symptoms and positive reactions in blood tests for metal sensitivity (9).

In vitro dissolution studies on some cobalt-chromium alloys have shown that only minor amounts (less than 0.2 ppm) are liberated to an artificial saliva over a 2-month period (5). The aim of the present investigation was to establish whether cobalt-chromium dentures consistently release measurable amounts of cobalt and chromium to the saliva of patients.

Materials and methods

Thirty patients with partial dentures attend-

Laboratory procedure

Acid-clean and weigh test tubes

SALIVA SAMPLING

Find total mass of saliva

Add water if mass is less than 0.5 g

Take out 0.5 ml for analyzing

Add 0.15 ml of concentrated HCl*

Heat at 80°C for 8 h

Atomic absorption analyzing procedure

Calculate the concentrations of metals in saliva

Calculate the differences in masses of metals between the A and B sample

Patient procedure

Remove denture

Wash the mouth with distilled water for 1 min

Collect saliva for 5 min (A sample)

Insert denture

Collect saliva for 5 min (B sample)

* Suprapur, Merck, W. Germany

Fig. 1. Procedures for sampling and analyzing saliva samples.

ing the prosthodontic departments at the schools of dentistry in Lisbon, Portugal, and Bergen, Norway, were asked to participate in the study. Saliva was sampled during five minutes with the mouth closed. Two samples were taken from each patient, one with the denture inserted and another without (Fig. 1). Plastic containers (NUNC No. 01880) were used to store the saliva. The samples were frozen until they could be analyzed.

Information on the age (in months) and size of the exposed metal parts of the dentures were recorded. Size was classified as small ('1'), medium ('2'), or large ('3'). The patients were asked if they had felt any metallic taste related to the dentures.

Most patients included in the investigation wore dentures that had been in service for 3 days to several years. For comparison some patients with new dentures (inserted some minutes before the saliva sampling) were included.

The dental laboratories in which the dentures were made stated that they used products containing less than 0.5% nickel. However, at least two cases from Portugal were old dentures of unknown composition.

The saliva samples were treated as described in Fig. 1. The chemical analyses were done by electrothermal atomic absorption spectrophotometry (Model 372, Perkin-Elmer Corp., USA; HGA 76B Graphite furnace, Bodenseewerk Perkin-Elmer & Co. GmbH, W. Germany). Unspecific absorption was corrected by a deuterium background corrector. The analytical lines used were cobalt, 240.7 nm, and chromium, 232.0 nm.

A test of the accuracy of the test method was performed by carrying saliva samples with known amounts of cobalt and chromium added through the complete analyzing procedure. Between 70% and 80% of the metals were retrieved, chromium showing the highest percentage of retrieval.

Statistical evaluation was done by the Wilcoxon sign rank test, and correlation between variables was assessed by the Spearman rank correlation coefficients.

Results

The saliva concentrations of cobalt and chromium showed large variations between patients (Table 1). In addition, different saliva secretion rates tended to obscure effects caused by the dentures.

The differences in total masses of metals in the saliva samples taken with and without the denture inserted (Table 2) revealed that in more than 80% of the patients, amounts of cobalt and chromium increased when the dentures were present. Chromium showed the highest median increase, approximately twice that of cobalt.

New dentures gave 3–6 times higher median values than older ones. For dentures which had been in service for some time the increase in cobalt and chromium was correlated with both age and size of the metal parts of the dentures (Table 3). Older and larger dentures released less than did newer and larger ones.

No patients reported metallic taste related to their partial dentures.

Table 1. Saliva concentrations of cobalt and chromium, as well as saliva masses obtained with and without cobalt-chromium dentures present in the mouth. Patients with both old and new dentures are included

	Without denture		With denture		No. of patients
	Median	Range	Median	Range	
Cobalt (ng/g)	3	0–569	6	0–225 000	29
Chromium (ng/g)	6	1–196	10	3–1710	30
Saliva mass (g)	1.4	0.2–3.4	1.7	0.1–4.5	30

Table 2. Increase in absolute amounts of metals in the presence of cobalt-chromium dentures. 'Old dentures' are plates which have been in use for more than 3 days

	Median	Maximum	Minimum	No. of patients
Cobalt increase (ng)				
Old dentures	3‡	493	-8	22
New dentures	103*	740 000	2	6
Chromium increase (ng)				
Old dentures	6‡	198	-7	23
New dentures	37†	534	-9	7

Levels of statistical significance: * $p \leq 0.05$, † $p \leq 0.01$, ‡ $p \leq 0.005$.

Discussion

This investigation demonstrates that release of metals from cobalt-chromium dentures is readily detected in a short-time, in vivo experiment. We assume that at least the greater amount of the metals originates from the metal parts of the dentures.

The inverse relationship between metal release and age of the denture indicates that the alloys become more strongly passivated with time and/or are covered by deposits which reduce the corrosion.

From the results for increase in metals it is not possible to ascertain at what rate the corrosion continues beyond the 5-min test period. However, abrasion during mastication may tend to increase the release of metals compared to the stagnant experimental situation of this test.

The corrosion rate found in this study may appear high compared to the results found in an in vitro test (5). On the other hand, it has been demonstrated that corrosion of

a cobalt-chromium alloy placed in the oral cavity was several times higher than that found under in vitro conditions (7).

A recent epidemiological study indicates that cobalt, chromium, and nickel are the most frequent constituents of dental materials causing hypersensitivity reactions (6). Since it is established that only minor amounts are needed to bring about reactions in sensitive subjects, it can be suspected that partial denture alloys may release sufficient amounts of metals to cause reactions.

The metals may also be stored in the oral tissues, or transported to target organs as has been demonstrated for nickel from non-noble dental casting alloys implanted in mice (1).

In conclusion, the present results demonstrate that metal release is a consistent feature of cobalt-chromium dentures.

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Table 3. Correlation coefficients related to the increase in absolute amounts of saliva metals in the presence of cobalt-chromium dentures. Only dentures which had been in use for more than 3 days are included

	Age of denture	Area of exposed metal	Cobalt, increase
Cobalt, increase	-0.55*	0.26	—
Chromium, increase	-0.33	0.54*	0.55*

* Values which are statistically discernible from zero at $p < 0.01$ level of significance.

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