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ORIGINAL ARTICLE

Does a specific dental amalgam syndrome exist? A comparative study

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Abstract

Objective. The aim of this article was to investigate whether there is evidence for a specific syndrome of health problems attributed to dental amalgam. ***Material and methods.*** A secondary and retrospective analysis of two different databases was performed: (a) 90 patients (47% female, mean (SD) age 34 (6) years) of a clinical trial to remove amalgam fillings who attribute their health complaints to dental amalgam, and (b) 116 patients (62% female, mean (SD) age 37 (8) years) from an outpatient unit for environmental medicine who attribute their symptoms to environmental sources other than amalgam. ***Results.*** The samples differed in age, sex, and educational level. No statistically significant differences between either of the groups were found in overall psychological distress, intensity of the symptoms, or in numbers of self-reported symptoms in the Symptom Check List after controlling for age, sex, and education (Mean Global Severity Index 0.62 versus 0.63). Patients from the amalgam group showed mean values for private and public self-consciousness similar to the population norm, while patients from the comparison group had statistically significantly decreased mean values. While the amalgam group more frequently reported mental symptoms, patients from the comparison group had a higher prevalence of somatic symptoms. ***Conclusions.*** The results showed some differences in symptomatology, while general psychological distress was similar in both groups, indicating no strong evidence for an amalgam-specific syndrome.

Key Words: *Amalgam syndrome, dental amalgam, environmental medicine, subjective complaints, symptom check list*

Introduction

Potential health threats of mercury exposure from dental amalgam fillings have been a matter of concern for several decades. In spite of extensive research, there is ongoing debate about whether amalgam fillings are to blame for a number of chronic diseases and conditions with unspecific multisystem complaints. Whereas the clinical sequelae of higher doses of mercury are well described and universally accepted, predominantly tremor, erethism, and impaired kidney function, which are usually associated with urine mercury concentrations of 100 μg/l or higher and occur in occupational settings, possible effects of chronic low-dose exposures are discussed controversially [1].

One hypothesis is that "amalgam intolerance" is more psychosomatic than toxicogenic [2]. If this assumption is true, the symptom pattern and psychometric characteristics of amalgam patients should be congruent with those of other environmental medicine patients who attribute their complaints to *different* environmental chemicals, as well as patients with conditions such as multiple chemical sensitivity (MCS), sensitivity to electromagnetic fields, for which no toxic/organic causes can be found, but which are strongly associated with psychic distress and psychiatric illness [3]. If, on the contrary, mercury from dental amalgam fillings is the main causal factor in the elicitation of symptoms, a *specific* somatic symptom profile which is at least different from other forms of environmental illness should be expected.

In this article, two samples of environmental medicine patients are compared; one group who

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attribute their health complaints to dental amalgam fillings, and a second group who attribute their symptoms to environmental sources other than amalgam. The main question is whether there is evidence for a specific "amalgam syndrome". The objective was thus to investigate whether the two groups differ with respect to certain symptom or psychometric parameters, while the underlying statistical null hypothesis assumed no differences between the groups.

Material and methods

Data sources of this retrospective analysis were two samples of patients defined as follows.

Sample 1 (the 'amalgam group')

Ninety patients out of a randomized trial to compare the reduction of subjective complaints by three treatment regimens (conventional removal of dental amalgam, removal plus biologic detoxification, health promotion program without removal) recruited from 1999 to 2002. Inclusion in this study was possible if patients suspected that their health complaints were caused by dental amalgam, if they reported 10 symptoms at least (3 of them of strong intensity), and if age was between 20 and 50 years. Patients with complex dental situations (bridges, crowns, and/or unsuccessful endodontic treatment), severe psychotic disorders, diagnostically verified allergy, alcohol or drug abuse, pregnancy or lactation, or missing informed consent were excluded from the study [4].

Sample 2 (the 'other group')

Our database of 309 environmental outpatients existing from the years 1998 to 2000 was screened for patients' causal attributions for their complaints; 211 patients were identified attributing their complaints to diverse environmental chemicals such as solvents, pesticides, or timber preservatives, but not mercury from dental restorations. In order to match age distribution of this group with the other sample, 116 patients aged between 20 and 50 years and complete data sets were selected for analysis.

The following data were available in both data sets:

(a) Patient questionnaire "Symptom Check List SCL-90-R" [5], German version by Franke 1995, providing a profile of nine primary symptom dimensions (somatization SOM; obsessive-compulsiveness O-C; interpersonal sensitivity I-S; depression DEP; anxiety ANX; hostility HOS; phobic anxiety PHOB; paranoid ideation PAR; and psychoticism PSY). There are three global indices as well: global severity index (GSI); positive symptom distress index (PSDI); and positive symptom total (PST). Raw scores were transformed to a standard T-scale controlling for age and sex of the normal population. According to the convention to define a case of "psychiatric" disorder, the frequency of patients with T-scores for the Global Severity Index ≥ 63 and/or for at least two scales ≥ 63 was specified. The SCL-90-R is frequently used in clinical and research applications demonstrating sufficient reliability and validity.

(b) The SAM questionnaire is a modified German version of the Self-Consciousness Scale [6] and was designed to assess individual differences in the tendency to focus one's attention on oneself (self-attentiveness, self-awareness). It includes two subscores for "private" (e.g. emotional state, opinions, and insights) and "public" (e.g. outer appearance) self-consciousness with a total of 27 items. Both features have been found to be stable over the years. Internal consistency is regarded as satisfactory and validity is supported by factorial representation of both subscores.

(c) Documentation of symptoms and complaints: In sample 1, a 50-item-list was presented to the patients to estimate the intensity of symptoms by a 4 categories scale (inexistent, slight, moderate, and severe). The selection of symptoms has been proved by previous studies. In sample 2, the "SOMS" questionnaire [7] was used. SOMS is a patient-administered method to screen for somatoform disorders consisting of 53 different complaints. Patients are instructed to report those symptoms having no other medical reasons and strongly affecting their well-being. Since SOMS items are binary-coded (yes or no), the items from the ad-hoc symptom list were subsequently dichotomized (inexistent or only slight/moderate or severe) to achieve comparable categories for symptoms' prevalence in both instruments. In addition, the free-field specifications of complaints reported in medical anamnesis were checked to edit the statements in SOMS, if indicated. Fifteen matching symptoms from both questionnaires were selected for comparative analysis (supplemented by the symptom 'metallic taste').

Subject to analysis were the findings before treatment or documented during the first visit at the outpatient centre, respectively.

All data were analyzed descriptively; mean values with standard deviations, and percentages were provided. Distributions of nominal-scaled variables were checked for differences between both samples by chi-squared tests. For continuously distributed measures, *t*-tests for independent samples were

Table I. Basic description of the patient samples.

	Amalgam ($n=90$)		Other causes ($n=116$)		
	n	%	*n*	%	*p*
Sex					
Female	42	46.7	72	62.1	<0.05
Male	48	53.3	44	37.9	
Age					
Years mean (SD) [range]	34.4 (6.1) [22–50]		37.5 (7.9) [18–50]		<0.01
Marital status					
Single	52	57.8	50	43.1	<0.05
Married	36	40.0	56	48.3	
Divorced/widowed/separate	2	2.2	10	8.6	
Household					
One-person household	30	33.3	25	21.6	0.06
With partner	60	66.7	91	78.4	
Educational level					
>12 school years	45	50.0	36	31.0	<0.01
Employment	78	86.7	93	80.2	0.22
Amalgam surfaces					
	21.6 (10.6) [1–45]		§		

§Data not available.

applied. Additionally, analyses of covariance were performed to adjust for covariates in the case of unequal sample structures. According to the explorative character of the analysis we did not control for α-adjustment due to multiple testing.

Results

We found several noticeable and statistically significant differences between both samples with respect to demographic variables (Table I). Patients suspecting their health problems to amalgam were more frequently male (53% versus 38% in the other group) and living in a single household (33% versus 22% in the other group). School education was higher (more than 12 years in 50% versus 31% in the other group), and age was slightly lower compared to the patients attributing their symptoms to other sources (34.4 versus 37.5 years).

The profiles of the nine primary symptom dimensions of the SCL-90-R for both samples are presented in Figure 1. The mean values are displayed in terms of normalized T scores with a normal range between 40 and 60 (mean ± 1 SD). Mean values of 50 represent the healthy reference population by definition of the standard scale. Both groups demonstrated similar profile patterns with no statistically significant differences in either of the symptom dimensions. The predominant factor in both groups was 'Somatization', which reflects distress arising from perceptions of bodily dysfunction (mean *t* scores >60). *T* scores of all other factors were, on average, located within the upper normal range (50 to 60). Slightly elevated mean scores in the amalgam group could be observed related to the dimensions 'Obsessive compulsiveness' and 'Interpersonal Sensitivity'. The three global distress indices did not differ between groups. The Global Severity Index as a measure of the overall psychological distress revealed mean *t* scores in both groups (about 57) being very close to each other. In the 'amalgam group', 47% of patients complied with the definition of a "psychiatric disorder" according to Derogatis's proposal, compared to 51% in the 'other group'.

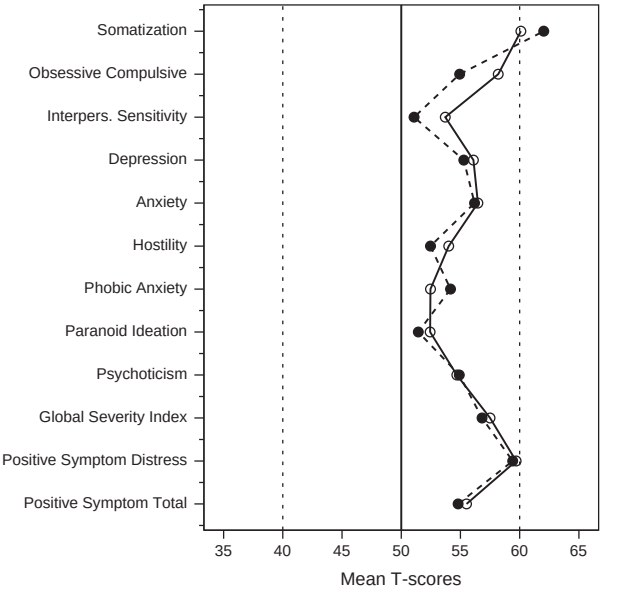

Figure 1. SCL-90-R: Mean T-scores adjusted for age and sex according to manual (normal population is defined to have a mean T-score of 50 with standard deviation of 10). Solid line: patients with symptom attribution to amalgam ($n=90$); dotted line: patients with symptom attribution to other toxic substances ($n=116$).

Table II. Mean raw scores in the Symptom Check List and for assessment of self-consciousness.

	Amalgam ($n=90$)		Other causes ($n=116$)			
	Mean	SD	Mean	SD	p^1	p adj^2
SCL-90-R						
Somatization	0.85	0.55	0.96	0.68	0.22	0.76
Obsessive compulsiveness	0.88	0.70	0.78	0.67	0.31	0.29
Interpersonal sensitivity	0.62	0.61	0.55	0.61	0.37	0.38
Depression	0.71	0.67	0.73	0.74	0.79	0.96
Anxiety	0.55	0.47	0.64	0.65	0.26	0.50
Hostility	0.55	0.54	0.48	0.59	0.40	0.28
Phobic anxiety	0.25	0.34	0.32	0.50	0.20	0.43
Paranoid ideation	0.57	0.57	0.48	0.58	0.27	0.10
Psychoticism	0.31	0.35	0.35	0.40	0.47	0.44
Global Severity Index	0.62	0.41	0.63	0.52	0.84	0.86
Positive Symptom Distress Index	1.69	0.44	1.59	0.45	0.11	0.12
Positive symptom total	31.4	16.9	31.9	19.8	0.85	0.74
SAM						
Private self-consciousness	45.5	6.3	40.3	8.3	<0.001	<0.001
Public self-consciousness	44.4	7.6	38.7	8.8	<0.001	<0.001

[1] p for differences between groups (t-test).
[2] p for differences between groups adjusted for age, sex, education.

The findings of the SCL-90-R were additionally analyzed in terms of raw scores. Neither the simple group comparisons nor the analyses of covariance controlling for age, sex, and education revealed any statistically significant difference between groups (Table II). There was only one dimension (paranoid ideation) where amalgam patients tended to show slightly higher mean scores.

Regarding the SAM questionnaire, "sample 2" patients showed lower mean raw values for both subscores of private and public self-consciousness than patients of the amalgam group (Table II). Simple group comparisons as well as adjustments concerning age, sex, and education resulted in statistically significant differences ($p<0.001$). In terms of standard T-values (related to a norm sample of healthy subjects), the patients of the amalgam group showed means for private and public self-consciousness of 49 and 47, respectively, while means for the 'other group' were 42 and 43, respectively. The reference population is represented by a mean (SD) T-value of 50 [10].

With respect to the selected symptoms, amalgam patients reported statistically significantly fewer symptoms on average than patients suspecting their complaints to other causes, also after controlling for age, sex, and education. Out of the predefined list of 16 symptoms, the mean (SD) sum of existing symptoms was 3.3 (2.1), while the 'other group' showed a mean (SD) of 5.3 (3.1) symptoms. With respect to the symptoms 'sweating', 'skin reactions', 'frequent toilet urge', 'memory disturbance', and 'shortness of breath', there was no statistically significant difference between either group in prevalence adjusted for age, sex, and education (Figure 2). Patients of the amalgam group reported 'metallic taste' significantly more often, while all other complaints showed markedly higher prevalence in the other patient group.

Besides these comparable items, patients reported many other symptoms listed in the questionnaires (Table III). The most frequent ones in the amalgam group were 'general faintness' (57%), 'susceptibility to stress' and 'susceptibility to infections' (47% each). Patients from the other group stated 'painful menorrhea' (40% of all women), 'pain in extremities' (40%), 'nausea', 'tongue coating', and 'paresthesia' (37% each).

Discussion

The question of a specific amalgam syndrome is closely related to the question of causal relationship between mercury burden released by amalgam fillings and health problems reported by patients.

Several reviews [8–11] come to the conclusion that there is no convincing evidence of any adverse health effects attributable to dental amalgam, with the exception of the rare contact sensitization with a positive patch test. However, in a recent review, it has been concluded that epidemiologic data to establish the safety of amalgam fillings are still inadequate and the need for further investigation is emphasized, especially with regard to neurodegenerative diseases and effects on children [12]. No evidence of hazards from amalgam fillings could be found on neuropsychological performance in children [13], on cognitive functioning in older women [14], or on clinical neurological signs [15].

Several studies found no correlation between symptom prevalence or intensity and number of amalgam fillings [16–18]. The fact that symptomatic

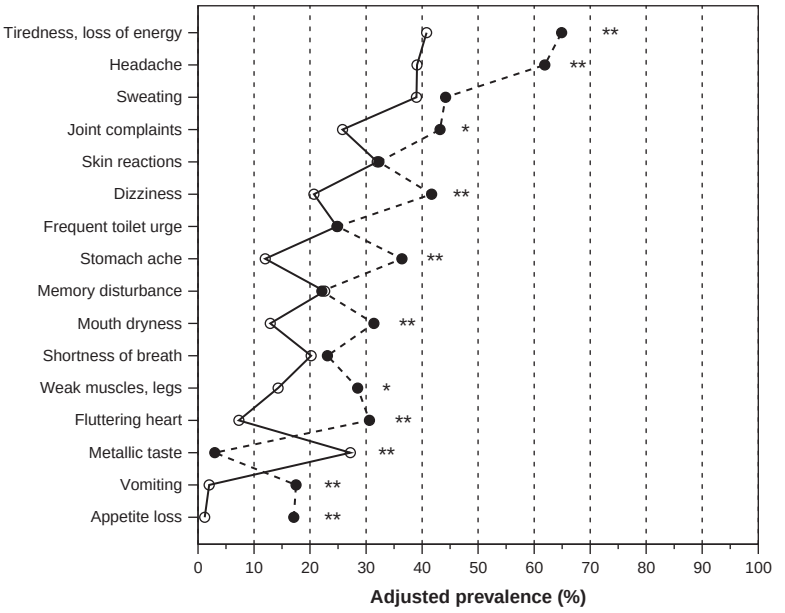

Figure 2. Prevalence of symptoms and complaints in moderate to strong intensity, adjusted for age, sex, and education, descending order of total prevalence. Solid line: patients with symptom attribution to amalgam ($n=90$); dotted line: patients with symptom attribution to other toxic substances ($n=116$); $^{\star}p<0.05$ $^{\star\star}p<0.01$ between groups.

amalgam patients with a high prevalence of psychiatric disorders and control groups of amalgam bearers without subjective complaints do not differ with respect to their objective mercury burden [19–21] leads most of the authors to the conclusion that there is no causal relationship between mercury body burden and mental disorders [2,22]. Furthermore, several therapeutic studies with different approaches question a causal relationship between amalgam fillings and the patients' complaints [23–25].

The secondary analysis presented in this article is intended to investigate whether there is evidence for a specific 'amalgam syndrome' in terms of psychological or physical symptom patterns.

We compared 90 patients who suspected that their health complaints were caused by dental amalgam with a sample of 116 patients of an outpatient unit of environmental medicine who attributed their complaints to noxious substances other than amalgam. In summary, we found no differences in overall psychological distress, intensity of the symptoms, or in numbers of self-reported symptoms between groups. Patients from the amalgam group showed mean values for private and public self-consciousness similar to the population norm, while patients from the other group had statistically significantly decreased mean values. All patients complied with the concept of 'medically unexplained symptoms' [26], which means that patients with known diseases presumably causing the presented complaints were excluded from our samples. About 45% of patients had to be excluded prior to randomization due to inclusion/exclusion criteria to finally result in the group of amalgam patients under investigation here [4]. Patients of both groups actively sought advice and treatment, either by participating in a clinical trial to investigate the effects of removal of amalgam fillings (with a chance of fillings not been removed) or by visiting a specialized unit of a university hospital. This kind of selection entertains some doubt that the samples do not represent the population of people being convinced to suffer from

Table III. Other symptoms in moderate to strong intensity, 10 with highest prevalence in each group.

Amalgam group (symptom list)	%	Other causes group (SOMS)	%
General faintness	56.7	Painful menorrhea	40.3*
Susceptibility to stress	47.2	Pain in extremities	39.7
Susceptibility to infections	46.7	Nausea	37.1
Restlessness/acathisia	40.0	Tongue coating	37.1
Lack of concentration	37.8	Paresthesia	37.1
Allergic reactions	37.1	Back pain	36.2
Testiness	35.6	Feeling stuffed	34.5
Nervousness	34.4	Hot flashes	31.0
Itching	33.7	Irritable bowel	25.0
Indecisiveness	30.3	Food intolerances	25.0

*Related to 72 women.

amalgam or other toxic agents. Furthermore, to agree to participate in a randomized trial may underlie motives such as financial advantages or being less convinced of amalgam fillings as the exclusive cause of the reported health problems.

The groups differed in basic demographic variables. The amalgam group showed a smaller percentage of women (47 vs 62%), a lower age on average (34 vs 37 years) despite a common upper age limit, and a higher degree of school education (>12 years: 50 vs 31%). Since these differences were statistically significant, we controlled the group comparisons for these covariates by regression analysis, although some findings were of minor clinical relevance. A weakness of this analysis is its retrospective approach, meaning that some essential data were not available due to different methods of data collection.

In the Symptom Check List, we found no statistically relevant differences with regard to the three general indices between groups. This demonstrates that overall psychological distress, intensity of the symptoms, and numbers of self-reported symptoms were quite similar. Age and sex adjusted mean T-values in the range between 55 and 60 indicated a clearly elevated level of distress compared to adequate population norms. About one-half of patients in each group were classified as 'case' with a mental diagnosis in the sense of a screening procedure where a comprehensive psycho-diagnostic clarification should follow. The mean profiles of the 9 primary symptom dimensions showed a similar pattern in both groups, with 'somatization' as the dominating dimension. No statistically significant differences between groups could be observed. However, mean values of 'obsessive compulsiveness' and 'interpersonal sensitivity' were slightly higher in patients of the amalgam group, while showing less 'somatization'. The SCL-90-R is widely used to describe psychological symptom pattern in various populations, and empirical data show our patients as clearly less impaired compared to psychotherapy patients. However, Dalen et al. [27] found elevated scores on psychasthenia and schizophrenia scales in persons with self-reported reactions to dental amalgam, reflecting an increased prevalence of psychological and somatic complaints compared to a control group without amalgam-related symptoms.

Self-consciousness as related to the concept of self-awareness includes the faculty to focus on oneself as an object and to use this information as motivation for actions. It refers to cognitions and meta-cognitions regarding the private (e.g. 'It is important for me to know my needs') and public self-consciousness, which refers to perceiving oneself as regarding to others (e.g. 'I take care to present myself well'). Both components represent aspects of dispositional self-directed attention, and are elevated in patients with social phobia [28] and decreased in patients with somatoform disorders [29]. For the amalgam group, we found no divergence to the population norm for either private or public self-consciousness (corresponding to T-values of about 48). However, mean values were significantly lower in patients with other attributions for their complaints (corresponding to T-values of about 43). Related to the concept of 'alexithymia', it has been hypothesized that patients with a strong affinity to somatic aspects ("somatizers") show a decreased capability to perceive and describe intrapsychic processes such as emotions [29]. In conclusion, the amalgam patients in our study largely shared their psychological symptom pattern with other environmental patients, but seemed to have better access to their self.

Different assessment methods for self-reported symptoms and complaints in both samples make interpretation of the findings here difficult. The list of comparable symptoms displays only part of the diversity of symptoms covered by the two questionnaires in use. The comparison showed that patients with attributions other than amalgam more frequently reported somatic oriented symptoms. On the other hand, patients of the amalgam group presented more so-called pseudo-neurological symptoms like 'faintness', 'susceptibility to stress', 'nervousness', or 'testiness'. Complaints like these do not appear in the SOMS questionnaire, which focuses primarily on somatic symptoms to assess 'somatization'. Since the patients of the 'other group' did not report pseudo-neurological symptoms in similar frequency during the basic exploration, we may hypothesize that the 'amalgam syndrome' is characterized more by mental symptoms. Accordingly, we found a little bit lower mean level of SCL-90 dimension 'Somatization', which is represented rather by symptoms such as pain, nausea, or numbness. On the other hand, most studies of patients with "environmental illnesses", such as MCS or Sick Building Syndrome, generally report a leading role of pseudo-neurological symptoms in these conditions, too [30–32]. Metallic taste and bleeding of the gums could be observed more frequently in the amalgam group, while other intra-oral symptoms like burning sensation at the tongue were likewise rare in both groups.

As a conclusion, our findings indicate a somewhat different symptomatology in patients attributing their health complaints to dental amalgam. Mental symptoms appear to be the main complaints, in contrast to somatic symptoms which could be found in higher frequency in patients who suspected reasons other than amalgam to be responsible for their health problems. Apart from some differences in self-consciousness, psychological symptom patterns and total distress were similar. From our analyses in subjects who subjectively attributed their health problems to amalgam and did not suffer from

manifest diseases, there is no strong evidence for an amalgam-specific syndrome.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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