RESEARCH

RELATIONSHIP BETWEEN THE AMOUNT OF AMALGAM FILLING AND COGNITION IN OLDER ADULTS

Turkish Journal of Geriatrics
DOI: 10.29400/tjgeri.2023.334
2023; 26(1):91–99

Savaş ÖZARSLANTÜRK[1]
Mehmet İlkin NAHARCI[2]
Numan AYDIN[3]
Serpil KARAOĞLANOĞLU[3]
Elif Aybala OKTAY[3]

CORRESPONDANCE

[1]Savaş ÖZARSLANTÜRK

Phone : +905057050920
e-mail : savasozarslanturk@yahoo.com

Received : Sep 28, 2022
Accepted : Feb 07, 2023

[1] University of Health Sciences, Gulhane Faculty of Dentistry, Department of Dentomaxillofacial Radiology, Ankara, Turkey

[2] University of Health Sciences, Gulhane Faculty of Medicine & Gulhane Training and Research Hospital, Division of Geriatrics, Ankara, Turkey

[3] University of Health Sciences, Gulhane Faculty of Dentistry, Department of Restorative Dental Treatment, Ankara, Turkey

Abstract

Introduction: This study aimed to evaluate the relationship between dental amalgam filling and cognition in older adults.

Materials and Methods: A total of 169 patients aged 65 years and above were recruited from a geriatric outpatient clinic. Their socio-demographic and chronic disease data were recorded. All patients underwent oral examinations. Amalgam filling index scores were calculated for individuals with amalgam fillings. The participants were divided into a study group [amalgam (+)] and a control group [amalgam (–)] based on their amalgam-filling statuses. For sub-analysis, the amalgam-filled group was categorised according to high (≥4.191) and low (<4.191) mean index scores. Standardised mini-mental test, clock drawing test and Lawton–Brody instrumental activities of daily living scale were conducted for all patients.

Results: About 46.2% (n=78) of participants were female, mean age was 69.6 ± 6.3 years and 53.7% (n=89) had amalgam fillings. There was no significant difference in the standardised mini-mental test, clock drawing test and Lawton–Brody instrumental activities of daily living scale scores between the study and control groups (all p>0.05), or in all test scores between participants with high and low amalgam scores in the group with amalgam fillings.

Conclusions: This study showed that dental amalgam fillings were not associated with cognitive decline in older adults.

Keywords: Aged; Cognitive Dysfunction; Dental Amalgam.

INTRODUCTION

Dental amalgam has been used in dentistry for 150 years because of its low cost, ease of application, durability and bacteriostatic effects (1). It is formed by combining approximately 50% mercury as a liquid with a mixture of powdered silver, copper, zinc and tin (2). The popularity of amalgam has decreased in recent years, especially because of the harmful effects of mercury on health, environmental pollution and aesthetic concerns (3). Mercury exposure from amalgam depends on both the number of amalgam fillings present and the total surface area of the exposed amalgam (4). Mercury vapour released from amalgam fillings increases with oral functions, such as chewing, taking hot drinks and brushing (5). Most inhaled mercury vapour passes into the circulatory system and is excreted from the body, but some accumulates in the brain, kidneys and other body tissues (6). The blood mercury level in individuals with amalgam fillings is approximately 3–5 times higher in urine and 2–12 times higher in body tissues than in individuals without amalgam fillings (7). The half-life of mercury in the brain can also extend up to 18 years (8).

Because of its lipophilic property, mercury crosses the blood-brain barrier into the brain and central nervous system. This chemical element can cause demyelination, autonomic dysfunction, sensory nerve conduction delay, abnormal neuronal migration and abnormal cell division in the central nervous system (6). Some studies have examined the relationship between Alzheimer's disease (AD), a neurodegenerative disorder and the most common cause of dementia, and mercury (9). Although a cross-sectional study showed that amalgam filling increases the risk of AD in older females, there is also a contrary finding in another report showing no relationship (10). Blood mercury levels were also found to be high in Parkinson's disease, another neurodegenerative disease (11).

However, studies on the effects of mercury on the cognitive state of healthy individuals are limited. Investigating this relationship in healthy individuals with amalgam fillings before possible mercury-induced cognitive impairment may add value to the current literature. This study aimed to examine the relationship between dental amalgam filling and cognitive status in cognitively intact older adults.

MATERIALS AND METHODS

Subjects who visited the geriatric outpatient clinic between February 2020 and June 2021 were prospectively included in this study. The inclusion criteria were as follows: age ≥ 65 years, must be literate, absence of dementia, absence of any psychiatric disease and volunteering for the study. The exclusion criteria were visual and/or hearing impairment and total tooth deficiency. In this study performed in accordance with the principles of the Declaration of Helsinki, all patients provided written informed consent and the local ethics committee approved the study (2019/99).

Data collection

Age, gender, educational status, current smoking and alcohol use and existing chronic diseases (cardiovascular diseases, diabetes, hypertension, chronic obstructive pulmonary disease, liver diseases, kidney diseases, stomach diseases, cancer and AIDS) were recorded using case data follow-up forms. The individual's burden of disease was measured using the modified Charlson comorbidity index (MCCI), which assigned a weighted score to each of 19 comorbid conditions based on the relative risk of 1-year mortality (12).

Amalgam-filling score evaluation

Each tooth containing an amalgam restoration was evaluated according to the location and number of filling surfaces, with reference to the "location index scores" section in the "criteria for

dental amalgam index scores" table in Saxe et al. (9). The location index score was calculated by the same dentist who performed the oral examinations. The location and surface number of amalgam fillings in existing amalgam-filled teeth were included in the evaluation. The occlusal surfaces scored higher than the surfaces other than the occlusal surface. The occlusal amalgam restorations in molars scored higher than those in premolars because the molars had larger surface areas.

Subjects (n = 80; 47%) who did not have amalgam fillings in their teeth, who declared that they had not had an amalgam filling in the last 10 years or who had an amalgam-filled tooth extracted (n = 80; 47%) were included in the control group. All participants were divided into a study group, amalgam (+) and a control group, amalgam (–), based on their amalgam-filling statuses. For further analysis, the amalgam-filled group was divided into two categories after the mean amalgam score was determined (high: ≥ 4.191; low < 4.191).

Cognitive and functional assessments

The standardised mini-mental test (SMMT), clock drawing test (CDT) and Lawton–Brody instrumental activities of daily living (IADL) scale scores were administered to both groups by the same geriatrician.

SMMT is a universal, short, useful and standardised neuropsychological tool for measuring cognitive domains, including orientation, registration, attention and calculation, recall and language (13). Total scores on the SMMT range from 0 to 30, with lower scores indicating worse cognitive statuses.

CDT is a simple and fast applicable test for evaluating the cognitive abilities of comprehension, visual memory, executive function, planning, numerical sequencing, knowledge and abstract thinking (14, 15). Its reliability in detecting the early stages of cognitive dysfunction is high (15). In scoring out of six points, a low score indicates a poor cognitive status (16).

Lawton–Brody IADL assesses independent daily living skills in eight areas: using the phone, shopping, preparing meals, cleaning the house, washing laundry, travelling, accepting responsibility for taking medication and coping with financial affairs (17). Total IADL scores range from 0 to 8, with a lower score indicating a functional disability (17).

Statistics

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) 22.0 (IBM SPSS Inc., Chicago, IL) software. Results were presented as absolute numbers, percentages and mean ± standard deviation, as appropriate. Categorical variables between amalgam (+) and amalgam (-) groups were compared using chi-square tests. After testing for normality of distribution of continuous variables via the Kolmogorov-Smirnov test, Student's t-test and Mann–Whitney U-test were used for normally distributed and non-normally distributed data, respectively. To make a comparison based on the amount of amalgam filling within the amalgam (+) group, an amalgam filling average ($\bar{x}$ = 4.191) was taken and this value was accepted as "normal". Then, the amalgam-filled group was divided into two categories; "low" for those below the amalgam-filling average and "high" for those equal to or above the average.

RESULTS

A total of 169 participants were included in the study (mean age 69.6 ± 6.3 years; females 53.8%; mean MCCI score 4.3 ± 1.6). About 52.7% (n = 89) of the sample had amalgam fillings in their teeth (Table 1). Since we did not have enough cases aged 85 and over, we formed two age groups, 65-74 and 75 and over. When we compared these two age groups according to whether or not they

Table 1. Comparison of cognition and function according to amalgam-filling statuses.

Tests	Amalgam (+) (n = 89)	Amalgam (-) (n = 80)	T/U	p
Age (years)	69.2 ± 5.9	70.0 ± 6.7	-0.885	0.377
65-74 years	76 (53.5)	66 (46.5)	0.263	0.608
+75 years	13 (48.1)	14 (51.9)		
Gender (female)	42 (47.2)	49 (61.3)	3.351	0.067
Current smokers, n (%)	7 (7.9)	10 (12.5)	1.000	0.317
Current alcohol users, n (%)	5 (5.6)	5 (5.3)	0.030	0.862
MCCI, mean ± SD	4.2 ± 1.6	4.2 ± 1.6	-0.924	0.357
SMMT	26.7 ± 3.5	27.1 ± 3.0	3326.50	0.456
CDT	4.4 ± 1.7	4.5 ± 1.5	-0.28	0.779
IADLs	7.33 ± 1.45	7.39 ± 1.35	3549	0.966

*MCCI: Modified Charlson comorbidity index, CDT, clock drawing test; SMMT, standardised mini-mental test; IADLs, Lawton–Brody instrumental activities of daily living scale. Values given in bold indicate statistically significant results ($p < 0.05$).

Table 2. Comparison of cognition and function according to amalgam-filling statuses at different education levels.

Education	Tests	Amalgam (+)	Amalgam (-)	T/U	p
Illiterate		N = 8	N = 5		
	SMMT	24.8 ± 3.0	25.40 ± 1.34	18.00	0.833
	CDT	2.13 ± 1.81	2.60 ± 1.34	16.00	0.622
	IADLs	6.25 ± 2.61	6.60 ± 1.14	17.50	0.724
Primary/Middle school		n = 39	n = 49		
	SMMT	25.7 ± 4.5	26.9 ± 2.3	843	0.338
	CDT	4.15 ± 1.83	4.55 ± 1.37	-1.17	0.247
	IADLs	7.13 ± 1.66	7.53 ± 0.79	903	0.596
High school		n = 24	n = 21		
	SMMT	27.54 ± 2.0	27.3 ± 4.6	192.50	0.167
	CDT	4.7 ± 1.2	4.5 ± 1.7	0.33	0.743
	IADLs	7.5 ± 0.7	7.1 ± 2.2	251.50	0.981
University		N = 18	N = 5		
	SMMT	28.6 ± 1.0	29.4 ± 0.9	-1.62	0.120
	CDT	5.61 ± 0.7	5.4 ± 0.9	0.57	0.578
	IADLs	7.9 ± 0.4	8.0 ± 0.0	42.50	0.857

*CDT, clock drawing test; SMMT, standardised mini-mental test; IADLs, Lawton–Brody instrumental activities of daily living scale. Values given in bold indicate statistically significant results ($p < 0.05$).

had amalgam fillings, there was no significant difference. (p = 0.608) (Table 1). No difference was found between the amalgam (+) and amalgam (–) groups in terms of demographic and clinical data. The SMMT, CDT and Lawton–Brody IADL scores did not differ significantly between the groups (p = 0.779, p = 0.456 and p = 0.966, respectively) (Table 1).

When all participants were grouped according to their educational levels and compared according to their amalgam-filling statuses at an equal educational level, SMMT, CDT and Lawton–Brody IADL scores were similar (all p > 0.05) (Table 2).

When the effect of gender status on the results was evaluated, there was no significant difference between SMMT, CDT and IADL scores for female (p = 0.403, p = 0.653, p = 0.866, respectively) and male participants (p = 0.785, p = 0.227, p = 0.551, respectively) according to whether or not they had amalgam fillings (Table 3).

Tablo 3. Comparison of cognition and function according to gender.

Gender	Tests	Group	n	$\bar{X}$	S	Sd	T/U	P
Female	SMMT	Amalgam (+)	47	26.04	3.75	76	647.50	.403
		Amalgam (-)	31	26.48	3.64			
	CDT	Amalgam (+)	47	3.81	1.93	76	-.45	.653
		Amalgam (-)	31	4.00	1.67			
	IADLs	Amalgam (+)	47	7.00	1.79	76	713.50	.866
		Amalgam (-)	31	7.13	1.41			
Male	SMMT	Amalgam (+)	42	27.48	3.11	89	995.50	.785
		Amalgam (-)	49	27.43	2.57			
	CDT	Amalgam (+)	42	5.07	1.20	89	885.50	.227
		Amalgam (-)	49	4.78	1.31			
	IADLs	Amalgam (+)	42	7.69	.81	89	977.00	.551
		Amalgam (-)	49	7.55	1.29			

CDT, clock drawing test; SMMT, standardized mini-mental test; IADLs, Lawton–Brody instrumental activities of daily living scale. Values given in bold indicate statistically significant results (p < 0.05).

Table 4. Comparison of cognition and function according to amalgam-filling scores among patients with amalgam-fillings.

Tests	Low score (n = 57)	High score (n = 32)	T/U	p
SMMT	27.6 ± 2.0	25.1 ± 4.9	570	0.920
CDT	6.3 ± 4.1	5.9 ± 4.1	861.50	0.619
IADLs	4.8 ± 1.5	3.7 ± 1.9	2.91	0.632

*CDT, clock drawing test; SMMT, standardised mini-mental test; IADLs, Lawton–Brody instrumental activities of daily living scale. Values given in bold indicate statistically significant results ($p < 0.05$).

When we compared the amalgam (+) cases according to their amalgam-filling scores, no significant differences were found between those with "low" amalgam-filling scores and those with "high" amalgam-filling scores for the SMMT, CDT and Lawton–Brody IADL scores ($p = 0.920$, $p = 0.619$ and $p = 0.632$, respectively) (Table 4).

DISCUSSION

This study, which focused on the neurotoxic effects of mercury-containing amalgam fillings, found that the presence of amalgam fillings in the teeth of older adults was not associated with cognitive or functional changes. Gender status and educational level did not play a role in these relationships. In addition, higher scores in amalgam-filled patients were not associated with cognitive or functional decline. This finding is original and deserves attention in several ways. Our findings provide additional insights into understanding cognitive functions in older adults with amalgam fillings, emphasising that the need for an amalgam-filling replacement in this population may be unnecessary except it is in a particularly poor condition.

In recent years, there has been growing interest in investigating the effect of amalgam filling on functionality. Our study shows that amalgam restorations are not associated with cognitive and physical functions in older adults. Consistent with our results, no significant side effects of amalgam restorations were found in a study on the effects of amalgam on mental health involving 129 individuals aged ≥ 75 years (18). In another study involving 587 participants, researchers analysed the relationships between the number of surfaces restored with dental amalgams and indices predicting somatic health, mental health and memory functions. They found no adverse effects of dental amalgam on physical or mental health (19). However, a recent study conversely reported that amalgam fillings caused a significant increase in serum mercury and plasma microRNA (124–3p, 125–5p and 127–3p) levels. The increase in microRNA levels, a possible biomarker of different neurodegenerative diseases (AD and Parkinson's), might be due to amalgam filling–induced mercury exposure, which increases susceptibility to neurological diseases (20). Likewise, another study described the neurobehavioral effects of exposure to low levels of mercury from dental amalgams (21). More research is needed to determine the effect of amalgam on neurocognitive functions.

In this study, we focused on an almost unstudied clinical exploration: the potential effect of amalgam

load on cognitive function in cognitively intact older adults. Our findings indicate that dental amalgam filling or high-filling scores may not be associated with decreased cognitive functions in older adults. The lack of changes in cognitive functions accompanying the stability of activities of daily living also shows that our findings are consistent. Given the aforementioned cognitive stability, our results might be useful in future studies to develop strategies for amalgam-filling replacements to improve the quality of life in older adults.

Many studies in different age groups have shown that amalgam restorations do not cause cognitive dysfunction or that no significant relationships exist between cognitive impairments and amalgam restorations (11,22). However, methodological errors have drawn attention in most studies (8). For example, in a study by Björkman et al. (19), people who were completely edentulous or who had other dental treatments were classified as amalgam free. What seems to have been overlooked is that amalgam-free individuals (toothless or with crowns and bridges) may have had amalgam fillings in the past, with correspondingly longer exposures than individuals with amalgam fillings. Likewise, methodological errors were made by Ahlqwist et al. (23). They did not use a truly amalgam-free group as a control, because that group's past amalgam exposures were not taken into account. The amalgam-filled group was also physically and psychologically healthier than the amalgam-free group (23).

With these results, whether the participants have amalgam fillings or not according to gender does not make a significant difference at these three test levels. In our study, SMMT, CDT and IADL scores of women exposed to amalgam fillings were lower than those who were not exposed, but this was not statistically significant. Sun et al (24) found that women exposed to amalgam fillings were 1,132 times more likely to develop Alzheimer's disease than those who were not exposed. On the other hand, Kukull et al (25) reported that there was no association between gender and the onset of Alzheimer's disease.

This study had several limitations and strengths. Because of its cross-sectional design, our study and findings do not reveal a causal relationship. Since we collected cases in geriatric outpatient clinics, our findings cannot be generalised to older adults living in the whole community. Moreover, it is possible that incomplete or inaccurate information may have been provided by participants without amalgam fillings regarding not receiving an amalgam filling in the last 10 years or not receiving extractions of amalgam-filled teeth. The self-reported recall might have led to the underreporting of dental histories in older adults but using medical records to confirm the information minimised selection bias.

On the other hand, the dental examination of the cases was performed by the same dentist, the geriatric evaluation was performed by the same geriatrician, and the accuracy and completeness of the recorded data are the strengths of our study.

CONCLUSION

Our study shows that the presence and amount of dental amalgam filling are not associated with cognitive dysfunction in older adults. Although it has not been fully proven that amalgam fillings cause damage to neurological, immunological and other organs, it is surmised that their mercury content may cause these problems. Despite its cost-effective use and long history in dentistry, the safety of amalgam as a restorative material is still debatable. Evaluation of the risk-benefit balance of other filling materials such as directly placed composite, composite/ceramic inlays or glass ionomer cements, which can be alternatives to amalgam could be new promising area of interest. More detailed research on these alternatives and amalgam filling is required.

REFERENCES

1. Berry TG, Summit JB, Chung AK, Osborne JW. Amalgam at the new millennium. J Am Dent Assoc 1998; 129:1547-56. (PMID: 9818572).
2. Shenoy A. Is it the end of the road for dental amalgam? A critical review. J Conserv Dent 2008;11(3):99-107. (PMID: 20142895).
3. Dunne SM, Gainsford ID, Wilson NH. Current materials and techniques for direct restorations in posterior teeth. Part 1: Silver amalgam. Int Dent J 1997; 47:123-36. (PMID: 9448798).
4. Brownawell AM, Berent S, Brent RL et al. The potential adverse health effects of dental amalgam. Toxicological Reviews 2005;24(1):1-10. (PMID: 16042501).
5. Svare CW, Peterson LC, Reinhardt JW et al. The effect of dental amalgams on mercury levels in expired air. J Dent Res 1981;60(9):68-71. (PMID: 6943160).
6. Clarkson TW. The three modern faces of mercury. Environ Health Perspect 2002;110 (Suppl. 1):11-23. (PMID: 11834460).
7. Kingman A, Albertini T, Brown LJ. Mercury concentrations in urine and whole blood associated with amalgam exposure in a US military population. J Dent Res 1998; 77:461-71. (PMID: 9496919).
8. Mutter J, Naumann J, Walach H, Daschner F. Amalgam risk assessment with coverage of references up to 2005, Review. Gesundheitswesen. German 2005;67(3):204-16. (PMID: 15789284).
9. Saxe SR, Wekstein MW, Kryscio RJ et al. Alzheimer's disease, dental amalgam and mercury. JADA 1999; 130:191-9. (PMID: 10036842).
10. Fung YK, Meade AG, Rack EP, Blotcky AJ. Brain mercury in neurodegenerative disorders. J Toxicol Clin Toxicol 1997; 35:49-54. (PMID: 9022652).
11. Dantzig PI. Parkinson's disease, macular degeneration and cutaneous signs of mercury toxicity. J Occup Environ Med 2006; 48:656. (PMID: 16832218).
12. Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index, J Clin Epidemiol 1994;47(11): 1245-51. (PMID: 7722560).
13. Folstein MF, Folstein S, Mc Hugh PR: "Mini Mental State" A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975; 12:189-98. (PMID: 1202204).
14. Amodeo S, Mainland BJ, Herrmann N, Shulman KI. The times they are a-Changin': Clock drawing and prediction of dementia. J Geriatr Psychiatry Neurol 2015;28(2):145-55. (PMID: 25319477).
15. Rakusa M, Jensterle J, Mlakar J. Clock drawing test: a simple scoring system for the accurate screening of cognitive impairment in patients with mild cognitive impairment and dementia. Dement Geriatr Cogn Disord 2018;45(5-6):326-34. (PMID: 30036864).
16. Shulman KI: Clock-drawing: is it the ideal cognitive screening test? Int J Geriatr Psychiatry 2000; 15: 548–61. (PMID: 10861923).
17. Lawton MP, Brody EH. Instrumental activities of daily living (IADL) scale: original observer-rated version. Psychopharmacol Bull 1988; 24:785-91. (PMID: 3249785).
18. Saxe SR, Snowdon DA, Wekstein MW et al. Dental amalgam, and cognitive function in older women: Findings from the nun study. JADA 1995;126(11):1495-501. (PMID: 7499646).
19. Björkman L, Pedersen NL, Lichtenstein P. Physical and mental health related to dental amalgam fillings in Swedish twins. Community Dentistry and Oral Epidemiology 1996;24(4):260-7. (PMID: (8711034).
20. Tunçdemir MT, Yerlikaya FH. The Relationship Between Plasma MicroRNAs and Serum Mercury Levels in Patients with Amalgam Filling and Dentists. Selcuk Dent J 2021; 8:736-43. (DOI: 10.15311/selcukdentj.800489).
21. Echeverria D, Aposhian HV, Woods JS et al. Neurobehavioral effects from exposure to dental amalgam Hg(o): New distinctions between recent exposure and Hg body burden. FASEB. J.1998;12: 971-80. (PMID: 9707169).
22. DeRouen TA, Martin MD, Leroux BG et al. Neurobehavioral effects of dental amalgam in children: A randomized clinical trial. JADA 2006; 295(15):1784-92. (PMID: 16622140).
23. Ahlqwist M, Bengtsson C, Lapidus L, Gergdahl IA, Schutz A. Serum mercury concentration in relation to survival, symptoms, and diseases: results from the prospective population study of women in Gothenburg, Sweden. Acta Odontol Scand 1999; 57:168-74. (PMID: 10480284).

24. Sun YH, Nfor ON, Huang JY, Liaw YP. Association between dental amalgam fillings and Alzheimer's disease: a population-based cross-sectional study in Taiwan. Alzheimer's Research & Therapy 2015; 7(1):65. (PMID: 26560125).

25. Kukull WA, Higdon R, Bowen JD et al. Dementia and Alzheimer disease incidence: a prospective cohort study. Arch Neurol. 2002; 59:1737-46. (PMID: 12433261).