

An Evaluation of the Effects of Bio-fluid Dynamism and Temperature Fluctuation on the Leaching of Mercury, Copper and Silver Ions from Amalgam Filling of Tooth into Bio-Fluids



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INTRODUCTION

- Dental caries, also known as tooth decay is one of the most common diseases throughout the world; it is an infection that results from the production of acid by bacterial fermentation of the food debris that accumulate on the tooth surface (Fergusson, 1990).
- Restorative materials include dental amalgam, composite resin, porcelain and gold. Composite restorations are not as strong as dental amalgam and gold (Smith *et al.*, 1996; Morgan and Morgan, 1998).
- Dental amalgam has been used for more than 150 years in hundreds of millions of patients. Dental amalgam is an alloy that results when mercury (50%) is combined with amalgam alloy - silver (34%), tin (9%) and copper (6%) and sometimes zinc (1%) (Lorscheider, 2005).

- But inside the oral cavity, implants are exposed to the influence of biological, thermal, mechanical, electrical and chemical factors that negate on the functional and aesthetic characteristics of dental works, diminishing their longevity (Vimy, 1998).



Figure 1: An amalgam used as a restorative material in a tooth

STATEMENT OF RESEARCH PROBLEM

- The World Health Organization states that "No level of exposure to mercury can be considered harmless".
- Despite the use of dental amalgam for many years, its use has always generated some concerns due to the mercury content being around 40–55%.
- The filling is bathed by an electrolyte at fluctuating temperatures during meals, enhancing the corrosion process that takes place on the metallic prostheses.

OBJECTIVES OF THE RESEARCH

- To mimic the *in vivo* situations of temperature fluctuation between body temperature (37°C) and warm-coffee-sipping (60°C); and that of salivary/buccal dynamism, and relate these factors to the levels of released anticipated corrosion products of dental amalgam filling of human tooth into simulated saliva (SS) and Hank's solution (HS) at 1, 4 and 12 weeks of immersion.

METHODS

Dental amalgam filling

- A total of 48 extracted human teeth were filled with zinc free dental amalgam (Dispersalloy[®] brand) by the professional dentists at Kaduna Dental Centre, Kaduna – Nigeria, between March and April 2013.

Bio-fluids for the study

1. Simulated saliva (SS) – 0.720 g of KCl, 0.220 g CaCl_2 , 0.600 g NaCl, 0.866 g of potassium phosphate dibasic, 1.500 g of K_2CO_3 and 0.030 g of citric acid dissolved 1000 cm^3 distilled water. The pH of the solution was 9.33 (Duffo and Gastillo, 2004).
- 2. Hank's solution (HS) - to simulate extra-cellular body fluids - This was prepared according to Table 1. It has a pH of 7.3.

- **Table 1: Ion concentration of Hank's solution** (Lori and Hanawa, 2001)

<u>Ion</u>	<u>Concentration (molL⁻¹)</u>
Na ⁺	1.42 x 10 ⁻¹
K ⁺	5.81 x 10 ⁻³
Mg ²⁺	8.11 x 10 ⁻⁴
Ca ²⁺	1.26 x 10 ⁻³
Cl ⁻	1.45 x10 ⁻¹
HPO ₄ ²⁻	7.78 x 10 ⁻⁴
SO ₄ ²⁻	8.11 x 10 ⁻⁴
CO ₃ ²⁻	4.17 x 10 ⁻³

Statistical analysis

- The results were compared using two-way ANOVA using Duncan Multiple Range Test at $P < 0.05$.

Results

- The amalgam contained: mercury (50%), silver (34%), tin (9%) and copper (7%). The mean % recovery of the AAS was 79.8 ± 0.33 to 90.7 ± 0.51 .

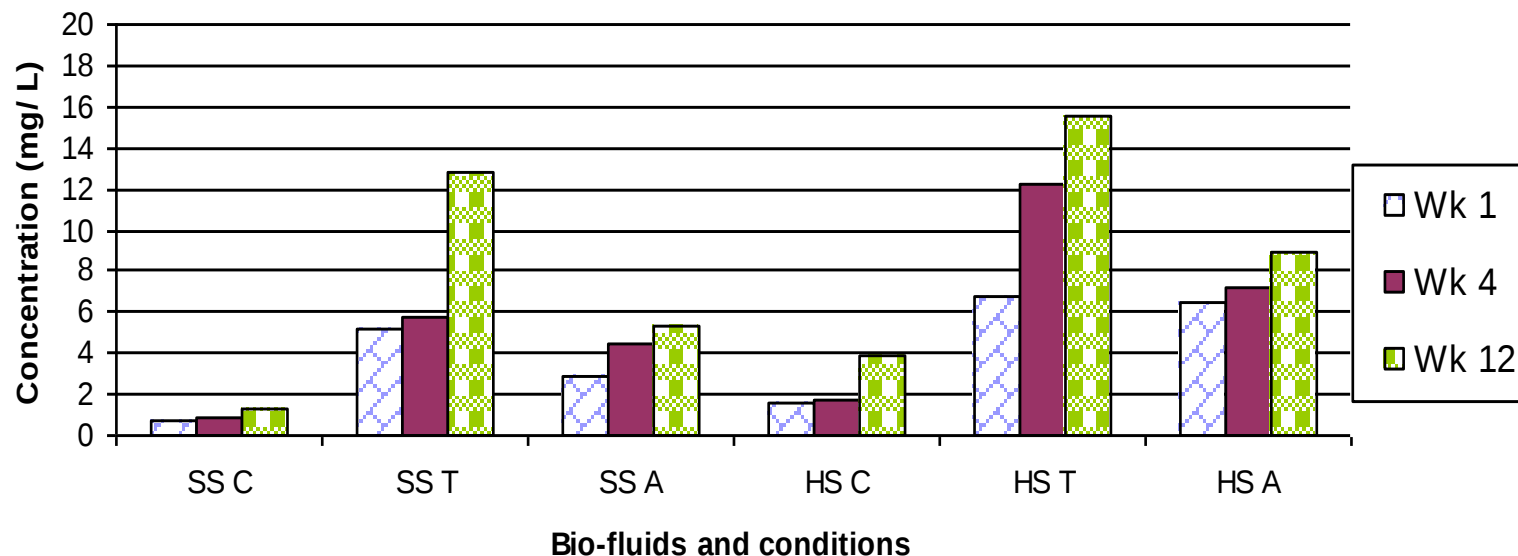


Fig. 2: Levels of mercury ion released from dental amalgam filled tooth into bio-fluids under agitation and heat

Key to bio-fluids and conditions:

SSC – Simulated saliva control

SST- Simulated saliva temperature change

SSA - Simulated saliva agitated

HSC - Hank's solution control

HST- Hank's solution temperature change

HSA - Hank's solution agitated

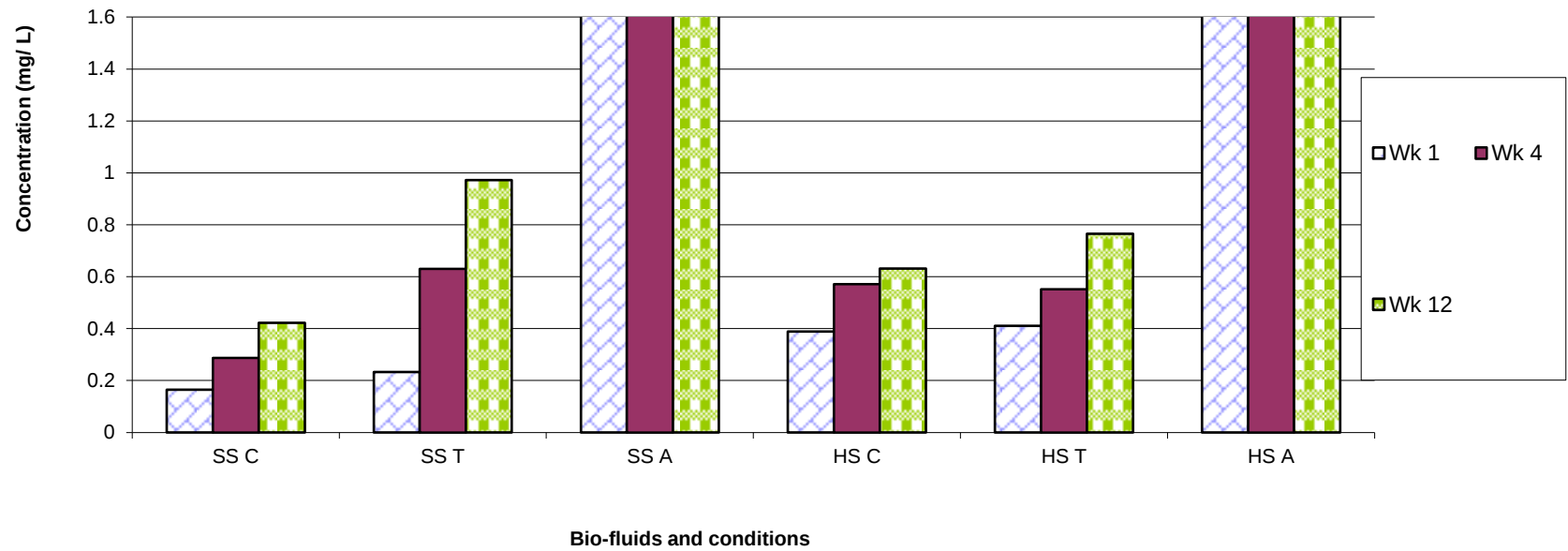


Fig. 3: Levels of copper ion released from dental amalgam filled tooth into bio-fluids under agitation and heat

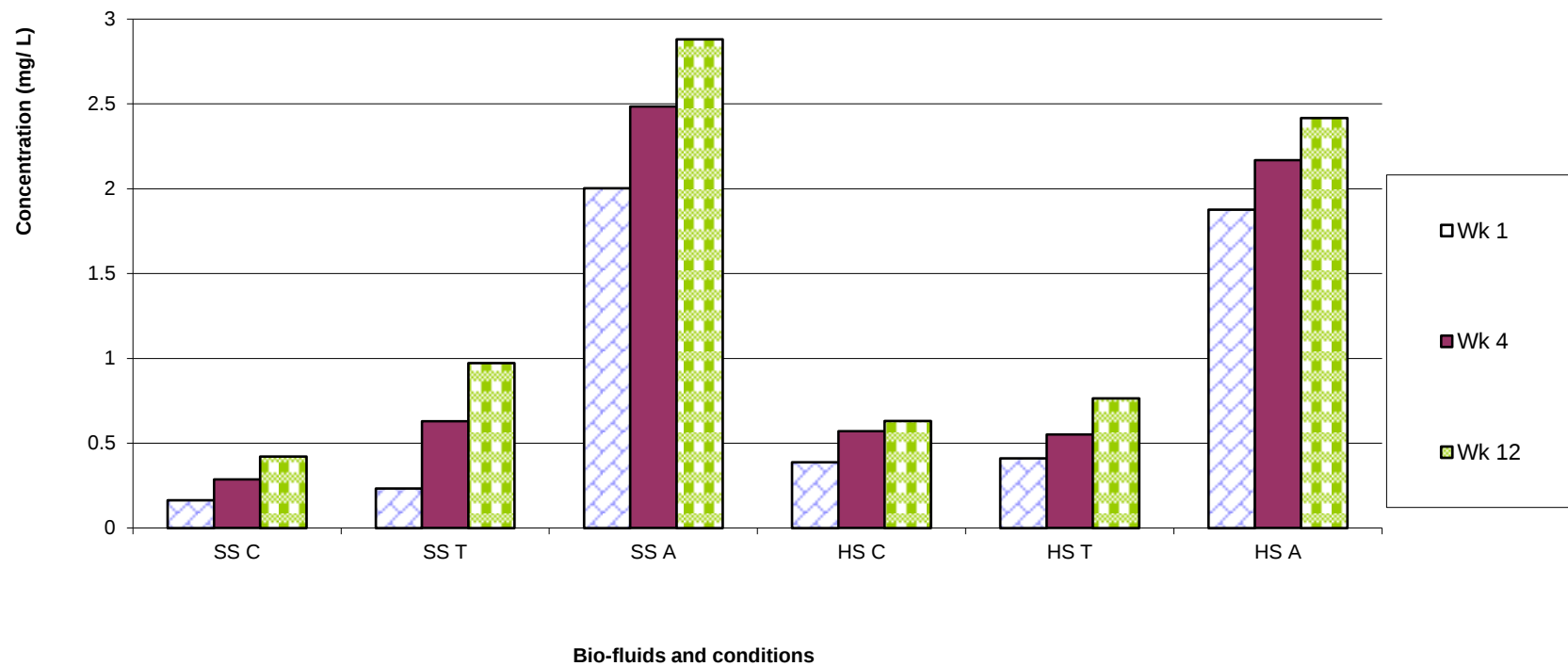


Fig. 4: Levels of silver ion released from dental amalgam filled tooth into bio-fluids under agitation and heat

CONCLUSION

- There was low level of released Cu and Ag ions from dental amalgam filled human teeth when immersed in Hank's solution and simulated saliva, under agitation and temperature fluctuation; however the study indicated that the mean level of Hg ion released into simulated saliva (control group) at the long term of 12 weeks was 0.105 mg/L per week; 0.325 mg/L per week for Hank's solution (control group).
- The effect of temperature fluctuation occasionally from 37°C to 60°C resulted to making the rate of release of Hg ion from the amalgam filling into SS to become ten-fold, while the effect of temperature fluctuation, resulted to making the rate of release of Hg ion from the filling into HS to become five-fold.
- Agitation of the bio-fluid medium resulted to making the rate of release of Hg ion into SS to become four-fold; this was three-fold when the medium was HS.
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- The total concentration of the released ions from the amalgam filling was in the order $\text{Hg} > \text{Ag} > \text{Cu}$. This trend follows the percentage composition of the dental alloy.
- Though, the levels of the released Cu and Ag were below the daily human dietary intake of the metals. However, concern results from the levels of Hg ions released from the 1 week time point.
- Attention is drawn from the fold elevation of the amount of Hg released due to temperatures increase during meals and the dynamic setting of the buccal cavity.

References

- (1) Holloway, P.J.; Moore, W.J. *J. dentist.* **1983**, 1(3), 189–213.
- (2) Hardie, J.M. *Dental Update.* **2002**, 9 (4), 199–200, 202–4, 206–8.
- (3) Rogers, A.H. Caister Academic Press. **2008**, 978-1.
- (4) American Dental Association (ADA). **2006**. www.ada.org. Accessed 16th August, 2013.
- (5) Richie, S.K. The New York Times. **2011**. Pp. 23.
- (6) Disease Control Priorities Project (DCPP). Aspects of treatment of cavities and of caries diseases. www.dcp2.org. Accessed 15th August, 2013.
- (7) Robert, G.C.; Williams, J.O.; John, M.P. Dental materials properties and manipulation second edition. **1979**. Pp. 73-75.
- (8) Scientific Committee on Emerging and Newly Identified Health Risk (SCENIHR). Dental Amalgam. **2012**. Pp.15.
- (9) Case C.P.; Langkamer, V.G.; James, C.; Palmer, M.R.; Kemp, A.J.; Heap, P.F.; Solomon, L. *J. Bone Joint Surg.* **1994**, 76(5), 701-712.

“ULTIMATELY, ALMOST EVERY HUMAN IN
TECHNOLOGICALLY ADVANCED
SOCIETIES WILL HOST A BIOMATERIAL”
(DAVID, 2003)

THANK YOU FOR LISTENING