ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 07, pp.55086-55088, July, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

EVALUATION OF ELEMENTAL COMPOSITION OF THE DIFFERENT DENTAL BURS: AN ENERGY DISPERSIVE SPECTROSCOPY STUDY

[1,*]Dr. Nilesh Rathi, [2]Dr. Manoj Chandak and [3]Dr. Manohar Bhat

[1]Reader, Department of Pedodontics & Preventive Dentistry, Sharad Pawar Dental College, Datta Meghe Institute of Medical Sciences, Sawangi (M), Wardha, Maharashta, India
[2]Professor & Head, Department of Conservative & Endodontics, Sharad Pawar Dental College, Datta Meghe Institute of Medical Sciences Sawangi (M), Wardha, Maharashtra, India
[3]Principal, Jaipur Dental College, Jaipur, Rajasthan

ARTICLE INFO

Article History:
Received 10th April, 2017
Received in revised form
11th May, 2017
Accepted 25th June, 2017
Published online 31st July, 2017

Key words:

Dental Burs,
Trace Elements,
Copper, Sintered Burs,
Energy Dispersive Spectroscopy.

ABSTRACT

Objective: Recurrent caries is the one of the commonest reason for the failure of restoration. The microgap created at the tooth restoration interface lead to the formation of secondary caries. Cavity disinfection, chelation or fluoridation of the smear of the cavity did not prevent caries formation.
Study Design: Five galvanic burs and sintered burs each are selected and cleaned with absolute alcohol. The elemental compositions of the burswere assessed by energy dispersive X-ray spectroscopy. Scanning electron microscope was used to examine the changes of the burs before and after preparation of tooth.
Result: EDS of the galvanic burs (G) (Matrix) detected the presence of Nickel ions in the range of the 69.94 to 75.09 atomic%, carbon from 20.21 to 97.53 atomic % and oxygen from 1.38 to 6.31 atomic % in all the burs. The EDS of sintered burs (Matrix) copper ion concentration ranged from 27.58 to 46.21 atomic % with the mean concentration of 36.17±3.28 SD
Conclusion: The copper ions and the nickel ions were the major constituents of the binder of the sintered and galvanic burs respectively

Citation: Dr. Nilesh Rathi, Dr. Manoj Chandak and Dr. Manohar Bhat. 2017. "Evaluation of elemental composition of the different dental burs: An energy dispersive spectroscopy study", *International Journal of Current Research* 9, (07), 55086-55088.

INTRODUCTION

Dental caries has now become a pandemic disease and is increasing at an alarming rate. The caries is most commonly found in people from the low socioeconomic group, immigrants, and children. (Feng, 2014) The traditional rotary air motor or air rotors use various kinds of bur for preparation of the teeth. (Siegel and Von Fraunhofer, 1998) The diamond burs are manufactured by various methods like electrodeposition, micro brazing with sintering and sintering with abinder. The electrodeposition method is considered as simplest which includes deposition of single or multiple layers of diamond particles on the steel shank into a nickel sulfate bath with a diamond point. (Siegel and Von Fraunhofer, 1998) The Vacuum sintered burs are manufactured in a graphite mold of the desired shape by heating diamond points with a copper binder at 1000^0C and high pressure in a vacuum. This causesgood cohesion of diamond particles with metallic binder (Borges *et al*., 1999). The smear layer is always formed on the tooth surfaces and it consists of dentinal debris, microorganism, saliva, bur binder and diamond particles.(Landuyt *et al*., 2005) Secondary caries is one of the most common causes of the failure of restoration and it essentially requires retreatment in 70% of the cases.(Murray *et al*., 2002) The invasion of cariogenic flora from the superficial biofilm extends into the micro-gaps of the tooth restoration interface and cause secondary caries. (Totiam *et al*., 2007) The bactericidal and cariostatic properties of copper is well known. (Thneibat *et al*., 2008) The aim of the study was to evaluate the composition and structure of the different dentalburs. The null hypothesis was that there is no difference between the elemental compositions of two different burs.

Corresponding author:* **Dr. Nilesh Rathi,
Reader, Department of Pedodontics & Preventive Dentistry, Sharad Pawar Dental College, Sawangi (M), Wardha, Maharashta, India.

MATERIALS AND METHODS

The study was conducted after the approval from Institutional Ethical Committee, DattaMeghe Institute of Medical Sciences, at Department of Pedodontics and Preventive Dentistry, Sharad Pawar Dental College, Sawangi, Wardha. The two types of dental burs selected for the study were- Galvanic burs (Group A) and Sintered burs (Group B). Five burs of each group of same ISO specifications were obtained. Group A consists of galvanic burs (Mani, Japan) of specification 805.314.110. 534.016 and Group B consist of sintered burs (Varenkor, SA) of specification 807.314.111.512.016.

All the burs were cleaned with acetone and subject to scanning electron microscope at Department of Mechanical engineering, Visvesvaraya National Institute of Technology, Nagpur. Images were obtained at different magnifications. The same burs were subject to energy dispersive spectroscopy for elemental assessment of binder at three different sites and at two different sites on diamond points. Results were obtained and categorized.

RESULTS

Energy dispersive X-ray spectroscopy of the burs

EDS of the galvanic burs (Matrix) detected the presence of Nickel ions in the range of the 69.94 to 75.09 atomic%, carbon from 20.21 to 97.53 atomic % and oxygen from 1.38 to 6.31 atomic % in all the burs. In few burs, sodium ion concentration was 0.32 to 1.65 at % and aluminum 0.04 to 1.92atomic %. The mean of Fluoride concentration was 1.08±0.35 SD while the mean of nickel was 68.23±7.96 SD (Table 2). However, EDS of the galvanic burs(diamond) showed the mean atomic concentration of nickel in the range of 0.02to 0.28 with a mean of 0.11±0.10 SD, while the atomic concentration of fluoride was 0.09±0.00 SD (Table 4). The EDS of sintered burs (Matrix) copper ion concentration ranged from 27.58 to 46.21 atomic % with the mean concentration of 36.17±3.28 SD (Table 1),

Table 1. Elemental composition of the sintered burs at matrix

Element	Mean ± SD
Copper	36.17±3.28
Cobalt	0.58±0.15

Table 2. Elemental composition of the Galvanic burs at matrix

Element	Mean ± SD
Nickel	68.23±7.96
Fluoride	1.08±0.35

Table 3. Elemental composition of the Sintered burs at diamond points

Element	Mean ± SD
Copper	0.56± 0.50
Cobalt	---

Table 4. Elemental composition of the Galvanic burs at diamond points

Element	Mean ± SD
Nickel	0.11±0.10
Fluoride	0.09±0.00

Figure 1. Sintered bur and Galvanic Bur

carbon ranged from 38.28 to 49.18 atomic%, tin ranged from 1.71 to 5.79 % and oxygen ranged from 6.78 to 18.43 atomic % in all the burs. Aluminum concentration ranges from 0.60 to 0.84 atomic %, cobalt from 0.40 to 0.98 atomic % with a mean of 0.58±0.15, silicon from 0.4 to 2.74 at % in few burs and iron 0.48 at% in only one bur. However, EDS of the sintered burs (diamond) showed a concentration of copper in the range of 0.08 to 1.36 and the mean was 0.56± 0.50 (Table 3) and there was no presence of cobalt.

DISCUSSION

There is a surge in the incidence of dental caries, especially in the developing countries. The employment of preventive and restorative strategies still demands the maintenance of the treated teeth. This demands to revisit the restorative procedure and pursue a method for improving the longevity of restoration against the occurrence of secondary caries. The cutting debris formed after preparing tooth harbors the bacteria especially Mutans Streptococci and lactobacilli which result in secondary caries and disintegration of the hybrid layer of the composite restorations. (Kermanshahi *et al*., 2010) On preparation of the teeth, the cutting debris is accumulated on the surfaces of teeth and burs. (Fraunhofer *et al*., 2005) This tend to change the elemental composition of both substrate teeth and the burs.

The galvanic bur (G) contains nickel ions as a major component followed by carbon and oxygen in all the burs followed by fluoride and aluminum in few burs. The nickel ions were present in galvanic burs manufactured by electrodeposition of the diamond particle initially flashplated in nickel chloride bath followed by nickel sulfamate. The elements of aluminum are inert to caries and fluoride is cariostatic in nature. (Shashikiran *et al*., 2007) Nickel ions is mild cariogenic (Ghazal *et al*., 2015) and maypromote secondary caries. Streptococcus Mutans causes lactose generation and glucose metabolism in anaerobic conditions (Rymovicz *et al*., 2013). The sintered diamond burs (S) are formed by compressing the binder containing themajority of copper and diamond particles at high temperature and pressure. However, atrace amount of carbon, tin, aluminum, cobalt, silicon and rarely iron are found. To our knowledge, perhaps there are no studies which have reported the contents of the dental burs for their biological implications. Copper is a known bactericidal and mild cariostatic agent.

It has implications for prevention of the progression of the carious process. (Harris *et al*., 2008) It has antibacterial property in both aerobic and anaerobic condition. (Bundy *et al*., 1980) It prevents the growth of Streptococcus Mutans and actinomycetes. (Duguld, 1983) Although sintered bur contains the silicon, mild cariogenic element; copper has high resistance to remineralization of the tooth. (Brookes *et al*., 2003) Cobalt has a potent antibacterial activity in both aerobic and anaerobic condition even at low concentration.(Bundy *et al*., 1980) The weight percentage of the elements are considered regularly to estimate the biological effect of the alloy. But the actual effect of the alloy is dependent on the atomic percentage of the alloy as a lighter element will be weighing less than its actual volume in the alloy which will determine the property on the tissue. (Wataha, 2000) Further researches are required to potentiate the utilization of the elements of the burs to modify the smear layer for improving the restorations.

Conclusion

The galvanic and sintered burs are mainly composed of nickel and copper respectively. The other trace elements of the burs may influence the tooth restoration interface.

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