INTERNATIONAL JOURNAL OF CURRENT MEDICAL AND PHARMACEUTICAL RESEARCH

IJCMPR

Available Online at http://www.journalcmpr.com

REVIEW ARTICLE

BIOLOGIC WASTE MANAGEMENT: HYPE OR A CONCERN

Sathish Abraham., Krishna Ramjeet Jaiswal., Chinmaya Kumar Samantaroy., AshishKumarPatil and Shashidhar C

Department of Conservative Dentistry and Endodontics

ARTICLE INFO

Article History:

Received 16th June, 2016
Received in revised form 14th July, 2016 Accepted 16th August, 2016 Published online 28th September, 2016

Key words:

Biomedical waste management, Biomedical waste, BMW, Amalgam waste, BMW in conservative dentistry and endodontics.

ABSTRACT

Biomedical waste management has always been a crucial step in any health care set up. Unfortunately, it has not been practiced strictly universally. But with increase in the awareness among the healthcare professionals and even the general public it is now evident that every health care set up and professionals should be aware of and practice effective biomedical waste management. This not only improves the quality of the treatment furnished but also protects the environment around us. This article has reviewed the topic of biomedical waste and its management in detail from its history till its methods. In addition, the article has also discussed about biomedical waste management in conservative dentistry and endodontics in particular also.

INTRODUCTION

Healthcare waste management is a crucial step of infection control programme in our day to day healthcare settings.[1] Any waste in the form of solid or liquid which poses a threat of infection transmission is called as biomedical waste.[2] As dentist our primary goal is to promote and enhance oral health and wellbeing. Dentists use a variety of materials and equipment; among which few have the potential in being a hazardous waste that presents a challenge to the environment.[3]
Background

In 5000 B.C., Dravidians were the first to practice the essence of cleanliness. They understood and valued the importance of safe and effective sewerage systems. That is the reason, they are considered to be the pioneers of scientific waste management.[4]

According to the Bio-Medical Waste rules 1998 of India, It is defined as "*Any solid, fluid or liquid waste, including its container and any intermediate product, which is generated during the diagnosis, treatment or immunization of human beings or animals, in research pertaining to, or in production or testing of biological and animal wastes from slaughter houses or any other like establishments*".[4]

Compared to the WHO classification of biomedical waste (Table1) [5] the Ministry of environment and Forests has released the new Bio-Medical Waste rules on 21st September, 2011 under the Environment Protection Act. The Biomedical waste rules 1998 contained 10 categories of wastes which have been reduced to 8 categories by omitting Category No. 8, 9.(Table 2).[1,2,6-9]

Based on the sources from which the wastes are generated they are again classified into two categories:

1. Primary sources- Hospitals, Nursing homes, veterinary hospital, dispensaries, primary health care centres, blood banks, autopsy centres, medical and dental colleges and research centres, veterinary colleges.[1, 5, 9]
2. Secondary/Auxiliary sources - Households, industries, physicians, dental clinics, slaughterhouses, vaccination centres, funeral services, acupuncturists, psychiatrist clinic, cosmetic piercing etc.[1, 5, 9]

It is crucial for an effective management of biomedical waste in health care set ups e.g. hospitals, medical and dental colleges etc. because:[6, 9-11]

1. To prevent injuries from sharps leading to infection to all categories of hospital personal and waste handlers.
2. To prevent nosocomial infection in patients from poor infection control practices and poor waste management.
3. To prevent risk of infection outside hospital for waste handlers and general public living in the vicinity of hospitals or health centres.
4. To prevent risk associated with hazardous chemicals, drugs to persons handling wastes at all levels.

5. To prevent the sale of disposable items out of the waste by few unauthorized recyclers of waste products.
6. To prevent sale of disposed drugs to suspected buyers.
7. To prevent risk of air, water and soil pollution directly due to waste or due to defective incineration emissions and ash.
8. Steps for Bio-Medical Waste Management

The biomedical waste management is a complex procedure which involves various steps. Each step is crucial and a methodical approach to individual step leads to an effective management of the wastes. The various steps that are followed can be discussed as follows:[2,5,7,9,11-18]

Waste Survey

It is an important component of waste management method. It helps in assessment of both the type and amount of waste generated. It is significant because:

- It makes a distinction of waste types
- Enumerates the quantity of waste generated
- Identifies the points of generation and type of waste generated at each point
- Determine the altitude of generation and disinfection within the hospital
- To trace out the type of disposal carried out

Waste Segregation

It is referred to as the division of different categories of waste generated and thereby minimizing the risks as well as cost of handling and disposal. It is the most crucial step and its effectiveness ensures a correct biomedical waste management. Categorically it can separated based on four differ color coding as described in Table -3[1,5-9,19-21]

Waste Transportation

Biomedical waste should be transported within the hospital by means of a specially designed wheeled trolley, containers or cart that is not used for any other purpose. In addition, the trolley has to be cleaned daily. The vehicle helping in transportation of waste should be:

- Covered and secured against any leakage or accidental opening
- The inside of the container should be without sharp edges or corners.
- There should be arrangement for drainage and collection of any leakage.

Treatment and Disposal of biomedical waste

There are various methods of disposal of biomedical waste which are based on the category it belongs to.[1,2,9]

Incineration

It is a thermal process which employs heat at high temperature under controlled condition to convert them into inert materials and gases. Basically the incinerator has two chambers.

The primary chamber has pyrolytic conditions with temperature of 800 ± 50 ^{0}C. The secondary chamber operates under excess air conditions at about 1050 ± 50 ^{0}C. Volatiles are liberated in the first chamber and destroyed in the second one. The chimney height should be minimum 30 m above the ground level.[9,22,23]

There are three types of incinerators which are used for hospital wastes:

a) Multiple Hearth Type: In this type solid phase combustion takes place in primary chamber whereas the secondary chamber is for gas phase combustion.
b) *Rotary Kiln*: It is a cylindrical refractory lined shell that is mounted at a slight tilt to facilitate mixing and movement of the waste inside. The kiln acts as a primary solid phase chamber, which is followed by the secondary chamber for the gaseous combustion.
c) *Controlled air type*: The first chamber is operated at low air levels followed by an excess air chamber.

Auto Clave

It is a method of steam sterilisation of the biomedical wastes under pressure. It is a low heat process in which steam comes in contact with the wastes material to disinfect it. They are again of three types:[9,22,24]

a) *Gravity Type* – In this type air is evacuated with the help of gravity alone. The system operates with 121 ^{0}C and 15 psi steam pressure for 60 to 90 minutes.
b) *Pre-Vacuum Type* – Here the temperature is kept at 132 ^{0}C and the air is evacuate using vacuum pumps which reduces the time to 30 to 60 minutes.
c) *Retort Type* – It is designed to disinfect larger volumes of wastes and it operates at much higher steam temperature and pressure.

Shredder

Shredding is a method of cutting waste into smaller pieces so as to make the wastes unrecognizable. It helps in prevention of reuse of bio-medical waste and also it acts as a mark of identification that the wastes have been disinfected and are safe to dispose. [22]

Hydroclave

It is anadvanced and innovative equipment for steam sterilization process. It is a double walled container in which the steam is introduced into the outer jacket to heat the inner chamber containing the waste. Moisture in the steam evaporates and builds up the steam pressure. The system operates at 132 ^{0}C and 36 psi for 20 minutes. The unit consists of a rotating paddle which is attached to a shaft.The paddle rotates the wastes against the hot wall and ensures mixing as well as fragmenting simultaneously. This technique provides various advantages like absence of liquid discharges, non-requirement of chemicals and reduces the volume & weight of the wastes.[22]

Table - 1 WHO Classification of Biomedical waste

	category 2	**category 3**	**category 4**	**category 5**	**category 6**	**category 7**	**category 8**
General waste	Pathological	Radioactive	chemical	Infectious to potentially infectious waste	Sharps	Pharmaceuticals	Pressurized containers

Table -2 Categories of Biomedical Waste based on Bio-Medical Waste Rules, 2011

Category Number	Waste Content	Components	Methods Of Treatment and Disposal
01	Human Anatomical waste	Human tissues, organs, body parts	Incineration, deep burial
02	Animal waste	All types of animal tissues, organs, body parts, carcasses, bleeding parts etc. generated by different health sectors	Incineration, deep burial
03	Microbiology and Biotechnology waste	Wastes from laboratory cultures, stocks or specimens of micro-organisms used in research	Local autoclaving, micro waving/incineration
04	Sharp Wastes	Needles, syringes, scalpels, blades glass etc.	Disinfection (Chemical treatment autoclaving, microwaving)
05	Discarded medicines	Outdated, contaminated and discarded medicines	Incineration, destruction and disposal in secured landfills
06	Soiled wastes	Cotton dressings, soiled plaster casts, beddings contaminated with blood	Incineration, autoclaving, micro-waving
07	Solid wastes	Disposable items other than sharp wastes e.g. catheters, tabbing, intra-venous sets	Chemical treatment autoclaving, microwaving and mutilation shredding
08	Chemical wastes	Chemicals used in production of biological waste , chemicals used in disinfection as insecticides etc.	Chemical treatment and discharge into drains for liquids and secured landfills for solids.

Table-3 Colour coding for various biomedical waste based on its categories

Colour coding	Type of container	Waste category
Yellow	Plastic bag	Category 1 , 2 ,3 , 6 (human anatomical waste, animal waste, microbiology & biotechnology waste , solid waste)
Red	Disinfected container / Plastic bag	Category 3,6,7 (microbiology & biotechnology waste ,solid waste)
Blue/white tranlucent	Plastic bag/puncture proof container	Category 4,7 (waste sharps ,solid waste)
Black	Plastic bag	Category 5,9,10 (discarded medicine and cytotoxic drugs, incineration ash,chemicals)

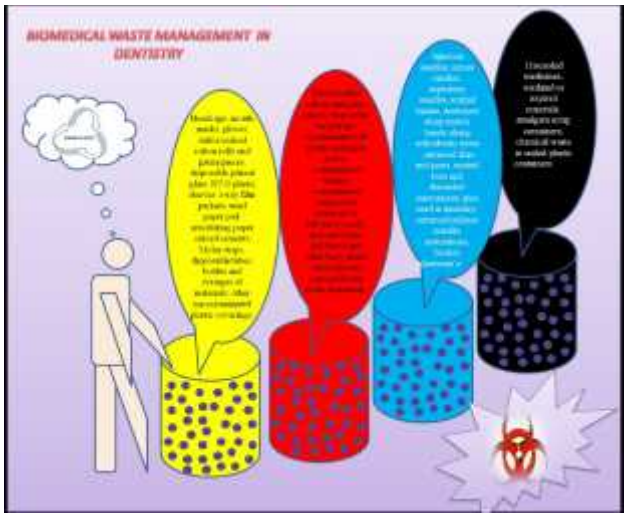

Figure -1 Categorically biomedical waste management in operative dentistry and endodontics

Micro-wave treatment

It is an example of wet thermal disinfection technology which heats the targeted material from inside out. The waste is first placed in a shredder. The shredded material is then introduced to a treatment chamber where it is moistened with steam at high temperature. The material is then carried by a screw conveyor beneath a series of micro-wave generators which heat the material to 95 to 100 ^{0}C and uniformly disinfect the material for 50 minutes. A second shredder fragments the material further into unrecognisable particles which can be later landfilled. Advantages of this method are absence of emission of harmful gases and liquids, requirement of no chemicals, reduced volume of waste and operator safety. The only drawback of this method is that the investment cost is too high.[22,25]

Chemical disinfection

This treatment is recommended for sharp wastes, solids and liquid wastes as well as chemical wastes. Chemical treatment involves use of at least 1 % hypochlorite solution with a minimum contact period of 30 minutes. Other reagents used are phenolic compounds, iodine alcohol or formaldehyde alcohol combination etc.[22,26]

Sanitary and secured landfilling

- Deep burial of human anatomical waste– secured land fill
- Disposal of autoclaved/hydroclaved/ microwaved waste – Sanitary land fills
- Disposal of incinerated ash – Sanitary land fills
- Disposal of biomedical waste till proper treatment and disposalfacility is available – Secured land fill
- Disposal of sharp pit/ Encapsulation –

A sharp pit or a facility for sharp encapsulation shall be provided for treatment of sharp objects. Sharp objects should be encapsulated and subjected to secured landfill[22]

Plasma Pyrolysis

Plasma pyrolysis is a newer environmental friendly technology for safe disposal of medical waste. It converts organic waste into by-products which are commercially useful. The heat generated by the plasma enables it to dispose all types of wastes in a safe and reliable manner. Medical waste is pyrolysed into Carbon Monoxide, Hydrogen, and hydrocarbons when it comes in contact with the plasma-arc. [9,27]

Management of few hazardous products generated in a dental office

In our day to day dental practice we come across few dental materials which require certain care while disposal:[4,6,8,28,29,30,31]

Dental Amalgam

Dental amalgam has a proven history of being a durable cost effective and long lasting restorative material. It has various constituents but among them, mercury is the one that concerns the environment. However; studies have proven that dental

amalgam is not responsible for adverse health effects because the forms of mercury associated with dental amalgam are elemental and inorganic. These forms are less toxic than organic mercury.[4,6,8]

Dental amalgam waste products: During the amalgam condensation and removal of dental amalgam restorations, a variety of waste products are generated:

- Elemental mercury vapour –from dental amalgam alloy
- Dental amalgam scrap – the amalgam particles that have not come in contact with thepatient.
- Amalgam waste – the particles that have come in contact with secretions of patients
- Amalgam sludge – the finer particles present in dental office waste water, commonlytrapped in chair-side traps and vacuum filters.

Elemental mercury waste management

It is managed by storing unused elemental mercury in a tightly sealed container. By using a mercury spill kit if there is a spill of elemental mercury. And also by reacting unused elemental mercury with silver alloy to form scrap amalgam.[3,4,6,8,33-36]

Scrap amalgam waste management

It is performed by using a specialized container which are commercially available to store the scrap amalgam. Use of amalgam separator on the suction lines removes over 95% of contact amalgam and use of disposal suction traps in dental units.[3,4,6,8,33-36]

Amalgam sludge management

Amalgam mixed in the dental office waste water should be separated by the process of sedimentation using specialized units called amalgam separators[3,4,6,8,33-36]

According to ADA – The module action for management of amalgam waste is "**GRIT**" by dentists and dental students to prevent mercury pollution.

G – Grey bag it; **R** – Recycle it; **I**- Install an amalgam separator; **T** – Teach it.[10,37]

Silver containing wastes

Spent X-ray Fixer Management: The fixer solution used in the dental set up to developx-rays is a hazardous material and so should not be simply rinsed to the drain. Spent fixer solution contains approximately 4000 mg of silver per litre. A Silver recovery unit should be used to recapture the silver from the fixer and once the container is full, contact a Certified Waste Carrier for recycling or disposal. The de-silvered fixer solution can be mixed with developer and water and disposed of down the sewer or septic system. Spent developer is permitted to be discharged into the sewer or septic systems provided it is diluted with water.[3,4,6,28,39- 43]

Undeveloped Film Management - Undeveloped film contains a high level of silver and so must be treated as a hazardous waste. Silver can contaminate the soil and groundwater if it is sent to a landfill. This is the reason that unused film should be recycled rather than being placed into the waste.[3,4,6,28,39- 43]

Lead containing wastes (Lead apron, Lead foil in radiograph film)

Lead aprons and lead foils present on the backside of a radiographic film should not be thrown intothe regular garbage since the lead cancontaminate soil and groundwater via the landfills. Therefore these wastes should be handed over to a certified waste carrier to recycle or dispose off unwanted lead aprons and the lead foils.[3,4,6,27,34,38 – 42, 44 - 47]

Biomedical waste management in Operative dentistry and Endodontics

As professionals from the field of operative dentistry and endodontics; in our day to day practice we deal with various dental materials and products. These materials following their use have the potential to transmit infections to other patients and health staffs in the set up. In addition, few materials pose a threat to the surrounding environment if mishandled or disposed without care. e.g. amalgam wastes and silver and lead containing wastes. So, a thorough detailing on biomedical waste and its management is the need of the hour among our fraternity which will ensure a safe environment around us and enable a healthy clinical practice. Figure 1 illustrates the disposal of variouswastes generated during practice of operative dentistry and endodontics based on standardised colour coding.

CONCLUSION

The importance of efficient management of biomedical waste is now understood by the government, health professionals and organizations. This has resulted in visualising this issue in a whole new approach with latest equipments and methods being introduced which ensures better and effective biomedical waste disposal. Safe and effective management of bio medical waste is not only a legal obligation but also a social necessity. It is a team work and primarily requires communication and awareness among the health care professionals and the assistant staff about the hazards of biomedical waste. As dental professionals, we should not only aim in promoting human health and well-being but also protect our environment. A proactive initiative towards effective biomedical waste management will allow our profession to be successful in providing good dental services and a healthy environment around.[3,41,48,52]

References

1. Babu. B.R., Parande A.K., Rajalakshmi R., Suriyakala P., Volga M. Management of Biomedical Waste in India and Other Countries: A Review. *J. Int. Environmental Application & Science* 2009;4(1):65-78.
2. Sunil K.V., Manjunatha M., Badami V., Pradeep P.R.Biomedical Waste Management:
3. A Review.*J Oral Health Comm Dent* 2012;6(3):141-144.
4. Hiltz M. The Environmental Impact of Dentistry. Journal Of Canadian dental Association 2007;73(1):59-62.
5. Agarwal B., Kumar M., Agarwal S., Singh A., ShekharA.Bio Medical Waste And Dentistry. Oral Health Comm Dent 2011;5(3):153-155.
6. Garg K.N. et al .An insight on bio medical waste management: A review. *International Journal of Biological & Pharmaceutical Research* 2015;6(2):144-149.

7. Makkar M, Kaur KA. Management of Wastes in Dental Offices-A Review. *J Adv Med Dent Scie Res* 2015;3(3):65-68.
8. Singh H, Rehman R, Bumb SS. Management of biomedical waste: a review. *Int J Dent Med Res* 2014;1(1):14-20.
9. Nayak A, Chopra R, Kaur R. Biomedical Waste Management: A Review. *J Adv Med Dent Scie Res* 2015;3(1):130-133.
10. Mathur P., Patan S., Anand S. Shobhawat. Need of Biomedical Waste Management System in Hospitals - An Emerging issue - A Review. Current World Environment 2012*;* 7(1):117-124.
11. Thota M.M., Bathala L. R., Theruru K., Shaik S., Jupidi B., Rayapati S. "There's plenty of room at the bottom":The biomedical waste management in dentistry. *Journal of Dr. NTR University of Health Sciences* 2014;3(3):149-155.
12. Biomedical waste management, pdf. www.proudtobedentist.com.
13. Gordon JG, Rein Hardt PA, Denys GA Medical waste management. In: Mayhall CG (ed).
14. Hospital epidemiology and infection control.3rd edition. Lippincott Williams and Wilkins publication 2004: 1773-85.
15. Manual for control of hospital associated infection: Standard operative procedures. National AIDS control organization: Delhi 1999:50-66.
16. Laboratory diagnosis, biosafety and quality control. National institute of communicable diseases and national AIDS control organization: Delhi: 26-4. BiomedicalWasteManagement.html. http://www.ndcnihfw.org/html/Legislations/
17. Bio-medical waste management self learning document for doctors, superintendents and administrators. Environment protection training and research institute Gachibowli, Hyderabad, Andhra Pradesh.
18. NK Das, Sushant Prasad, K Jayaram. ATGM approach to implementation of handling and management of hospital waste in Tata main hospital.
19. Anu G Agrawal, Ratna Singh. Understanding and simplifying biomedical waste management A training manual for trainers. Toxics Link, January 2005.
20. Biomedical Waste Management Rules, 1998; notified by the Government of India.
21. Arora R, Agrawal A, Singh D, Reddy *J. Management of Dental* Waste in Private
22. Clinics in Chhattisgarh State, India – A Cross Sectional Study. *Journal of Dental and Medical Sciences*.2014;13(1):53-6.
23. Hegde V, Kulkarni R D, Ajantha G S. Biomedical waste management. *Journal of Oral and Maxillo Facial Pathology* 2007;11(1)5-9.
24. Pasupathi P. , Sindhu S. , Ponnusha B.S. , Ambika A. Biomedical waste management for
25. health care industry. *International Journal of Biological & Medical Research* 2011; 2(1): 472-486.
26. Gravers PD. Management of Hospital Wastes- An overview. Proceedings of National workshop on Management of Hospital Waste, (1998).
27. Thornton J., Tally MC, Orris P., Wentreg *J. Hospitals and plastics Dioxin prevention and Medical Waste Incineration*; Public Health Reports. 1996;1:299-313.
28. Nobel J J.Waste Disposal Units: Paediatrics Emergency Care.1995; 2: 118-120.
29. Acharya DB.The Book of Hospital Waste Management. 2000;1:92-96.
30. Surjit S. Katoch Biomedical Waste Classification and Prevailing Management Strategies, Proceedings of the International Conference on Sustainable Solid Waste Management 2007:169-175.
31. Singh H., BhaskarD.J.,Dalai D.R., Rehman R., Khan M. Dental Biomedical Waste Management. *International Journal of Scientific* 2014; 2(4):66-68.
32. Guidelines to Amalgam Waste Management November 2013. Australian dental Association Inc. www.ada.org.au
33. Naik R., Chandra B.S., Hegde S., Damda A., Malik M.Best management practices for hazardous dental waste disposal. Endodontology: 108-113.
34. Horsted-Bindslev P. Amalgam toxicity-environmental and occupational hazards. *J Dent* 2004;32(5):359-65.
35. Clifton JC 2nd. Mercury exposure and public health.Pediatric Clinics of North America. 2007;54(2):237-e1.
36. Horsted P. B.Amalgamtoxicity - environmental and occupationalhazards. *J Dentist* 2004;32:359-65.
37. Fan PL, Bindslev DA, Schmalz G, Halbach S, Berendsen H. Environmental issues indentistry - mercury. *Int Dental J* 1997;47:105-109.
38. Condrin AK. The use of CDA best management practices and amalgam separators to improve the management of dental wastewater. *J CalifDentAssoc* 2004;32(7):583–592.
39. Best management practices for amalgam waste. In A–Z topics. [Website of the AmericanDentalAssociation].AvailablefromURL:www. ada.org/prof/resources/topics/amalgam_bmp.asp (accessed December 2006).30. Best management practices for hazardous dental waste disposal.
40. Mercuryindentalamalgam.Availablefrom:http://www.epa.gov/hg/Dentalamalgam.html#bmps. [Last accessed on 2011 Aug 8].
41. Availablefrom:http://www3.uwm.edu/dept/shwer/publication/cabinet/pdk/guidefordentist.pdf.Available from: http://www.p2pays.orgret/01/00020htm for more information.
42. Singh RD, Jurel SK, TripathiS,Agarwal KK, KumariR. Mercury and Other Biomedical Waste Management Practices among Dental Practitioners in India. Bio Med Research International 2014;1-6.
43. Anderson K. Creating an environmentally friendly dental practice. *CDS Rev* 1999; 12–18.
44. Best management practices for hazardous dental waste disposal. [Website of the Nova Scotia Dental Association]. Available from URL: www.nsdental.org/hazardous.htm (accessed December 2006).
45. Bhaskar Agarwal, SaumyendraVikram Singh, SumitBhansali, SrishtiAgarwal. Waste Management in Dental Office. *Indian journal of community medicine:* official publication of Indian Association of Preventive & Social Medicine 2012;37(3): 201.
46. Gidlow DA. Lead Toxicity.Occup Med (Lond) 2004;54:76-81.
47. Swanson RL, Roethel FJ, Bauer H. Reuse of lead from dental X-rays. *N Y State Dent J* 1999; 65(3):34–36.

48. Agarwal B, Kumar M, Agarwal S, Singh A, Shekhar A. Bio Medical Waste And Dentistry. *Journal of Oral Health and Community Dentistry* 2011;5(3):153-155.
49. Singh RD, Jurel SK, TripathiS, Agarwal KK, Kumari R. Mercury and Other Biomedical Waste Management Practices among Dental Practitioners in India. BioMed Research International 2014;1-6.
50. Westman JF, Tuominen T. Amalgam waste management. Issues and answers.*N Y State Dent J* 2000; 66(8):20–24.
51. Chilibeck R. Mercury pollution in dental office waste water [Letter]. *J Can Dent Assoc2000*; 66(4):174–175.
52. Trip L. Canada-wide standards: a pollution prevention program for dental amalgam waste. *J Can Dent Assoc*2001; 67(5):270–3. Availablefrom URL: http://www.cda-adc.ca/jcda/vol-67/issue-5/270.pdf (accessed December 2006).
53. Nova Scotia Dental Association. Best management practices for hazardous dental waste disposal. [Website of the Nova Scotia Dental Association].Available from URL: http://www.nsdental.org/hazardous.HTM#mercu (accessedDecember 2006).
54. Balfry G. Green dentistry [Letter]. *Br Dent J* 2001; 191(7):356.