WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Beryllium - A Bane to Dental Professionals.

[1]Hombesh MN, [2]Sumit Deshpande, [3]Suneel Vadavadgi, [4]Dayanand Huddar

[1]MDS, Professor, Department of Prosthodontics, College of Dental Sciences, Davanagere
[2]MDS, Professor & Head, Department of Prosthodontics, Albadar rural Dental college, Gulburga
[3]MDS, Professor, Department of Prosthodontics, SJM Dental college & Hospital, Chitradurga
[4]MDS, Professor, Department of Prosthodontics, Bharathi Vidyapeeth Dental College and Hospital, Sangli.

Introduction

Beryllium toxicity is a concern for dental professionals due to the potential exposure to beryllium in dental materials. Chronic beryllium disease (CBD) is an occupational illness that has been more prevalent among dental technicians compared to the general population.[1] Exposure to beryllium can lead to lung pathologies, such as CBD[1].Acute beryllium toxicity typically occurs after exposure levels of 25 to 100 µg/m and manifests with inflammation of the upper and lower respiratory tract, similar to other cases of chemical pneumonitis[2]. Symptoms may include cough, shortness of breath, fatigue, chest pain, hemoptysis, palpitations, decreased appetite, or other respiratory issues[2].Dental technicians are at high risk of beryllium exposure due to their occupation, as they work with various dental materials that may contain beryllium[3].

Chemistry of Beryllium

Beryllium is a lightweight, naturally occurring metallic element. It is found in rocks, coal and oil, soil and volcanic dust. The element forms a light, hard, noncorrosive metal. It is a Group II metallic element with a silver-grey-whitish color, an atomic weight of 9.01, melting point of 1,287°C, boiling point of 2,970°C, and density of 1.85 at 20°C. Its hexagonal crystalline structure makes it the lightest of all solids and chemicals, and it has a very high melting point, specific heat, heat of fusion, and strength-to-weight ratio. It is lighter than aluminium and over 40% more rigid and ca. 33% more elastic than steel. At ordinary temperatures, beryllium resists oxidation in the air and a thin layer of beryllium oxide on its surface makes it highly resistant to corrosion[4]. because of these properties of beryllium, it is more commonly used in dental casting alloys.[1]

Advantages of Beryllium alloy in dentistry

Beryllium is incorporated into dental casting alloys, such as nickel-chromium alloys, to improve their properties. It can be present in these alloys at levels up to 2.05 mass%. Beryllium reduces the melting temperature, decreases surface tension, and increases the bond strength between metals and ceramics. It also improves the castability and polishing of non-precious alloys[1]. it has below mentioned advantages

- Strength and durability: Beryllium-containing alloys are strong and durable, making them suitable for use in crowns, bridges, and partial denture frameworks.[5]
- Corrosion resistance: Beryllium alloys are resistant to corrosion, which is essential in dental applications where the materials are exposed to saliva and other fluids in the oral cavity.[6]
- Biocompatibility: Beryllium is biocompatible, meaning it is not harmful to living tissue. This is an important factor in dental applications, as the materials used in dentistry should not cause adverse reactions or health issues.[6] (however inhalation of beryllium particles and fumes is reported to be highly toxic)[1]
- Lightweight: Beryllium is a lightweight metal, which can be beneficial in dental applications where the weight of the material is a consideration, such as in the production of dental implants.[1]

Disadvantages of Beryllium alloys in dentistry

Manufacturing and processing of Be-containing materials is highly toxic, and workers are exposed to the inhalation of Be particles, fumes, or solutions. Brief exposure can lead to the development of a rare condition called acute berylliosis, while long-term contact can cause Be sensitization (BeS) and chronic Be disease (CBD), also known as chronic berylliosis.[1]

Dental laboratory technicians involved in activities such as casting, sprue cutting, grinding, polishing, and finishing of dental alloys containing beryllium are at risk of exposure. Additionally, individuals working in the dental industry, including dental technicians, may be exposed to beryllium through the use of beryllium-containing tools and equipment.[1,5]

Pathophysiology and symptoms of Beryllium toxicity

Absorption of beryllium occurs through inhalation. Beryllium deposited in lungs moves into pulmonary circulation. During the natural clearing of the throat and cilliary mucus clearance, beryllium may enter the mouth and may get ingested. It becomes protein-bound and deposits over a long period in the liver, spleen, and skeleton despite a portion being excreted by the kidneys. In chronic conditions, lesion appears like sarcoid-like granulomata mainly in the lungs and is occasionally subcutaneous. Lung lesions may result in interstitial fibrosis with hilar lymphadenopathy with resultant cor pulmonale. Beryllium is a likely candidate as a lung carcinogen. Beryllium compounds cause genetic transformations in cultured mammalian cells resulting from binding of ionic beryllium to nucleic acids, resulting in infidelity of DNA replication. Lung cancer is likely during exposure with an excess relative risk of exposure. Acute Beryllium toxicity with high dose is associated with lung cancer.[4] Symptoms of chronic Beryllium disease include cough, shortness of breath, fatigue, weight loss, fevers and night sweats. even this disease can remain latent for upto thirty years.[7]

Investigations

Beryllium toxicity can be detected through various lab tests. The beryllium lymphocyte proliferation test (BeLPT) is the test of choice to identify beryllium workers who develop beryllium sensitization or chronic beryllium disease (CBD). The test involves exposing peripheral blood mononuclear cells in vitro to beryllium salts at varying concentrations. Cell proliferation in the presence of beryllium indicates a positive test result. Other tests for beryllium sensitization or CBD severity include patch testing, pulmonary function tests, measurement of DLCO, and exercise capacity testing. Suspected chronic beryllium disease (CBD) is a clinical indication for bronchoscopy. The bronchoalveolar lavage (BAL) fluid from a patient with CBD typically reveals evidence of lung indicated by an elevated white blood cell count with an increased number of lymphocytes. Lung histopathology reveals interstitial infiltration with mononuclear cells. If beryllium exposure is suspected, the respiratory tract and skin should be examined carefully. Initial evaluation of a patient with a history of beryllium exposure should include a thorough medical history and physical examination.[3,9,10]

Treatment

In the case of acute beryllium exposure, removal from the source of exposure is crucial, along with symptomatic treatment and stabilization of any abnormal vital signs. Inhaled corticosteroids and short-acting bronchodilators can be used for symptomatic relief. For chronic beryllium disease, the primary treatment is typically prednisone, with the response to therapy assessed regularly. However, it's important to note that once pulmonary fibrosis has developed, corticosteroid therapy cannot reverse the damage. Despite treatment, progressive decline in pulmonary function and fibrosis is possible, and some patients may require lifelong immunosuppressant treatment. Due to the potential side effects of long-term steroid use, the use of steroid-sparing therapies may be considered in patients experiencing notable side effects. The mainstay of management of chronic beryllium disease involves cessation of beryllium exposure and the use of systemic corticosteroids.[2,8,9,10]

Discussion

Dental professionals may be exposed to beryllium through various sources, including dental prostheses manufacturing, orthodontic appliances, and materials for temporomandibular joint disorders. Beryllium can be present in dental materials such as porcelain, base metal alloys, and some dental implant surface coatings. Exposure can occur during activities like grinding, sandblasting, or melting of beryllium compounds, which can produce hazardous fibers or dust. This airborne dust can be inhaled or ingested, leading to potential health risks over time, such as chronic beryllium disease (CBD)[1,4]. While most manufacturers state that dental materials are beryllium-free, the prevalence of CBD among dental technicians raises questions about the presence of beryllium traces in these materials[1]. It is important for dental professionals to be aware of these potential sources of exposure and to implement prevention methods to mitigate the risks.

To prevent beryllium toxicity among dental professionals, the following methods can be employed:

Elimination or Substitution: Use viable, less toxic alternatives to beryllium-containing materials.[11,12]

1. industries should stop manufacturing beryllium containg dental alloys, also should stop marketing metal to dental industry.
2. apex bodies safegaurding the dentistry should bring immediate ban on beryllium containing dental alloys.
3. dentists should stop ordering these beryllium containing materials
4. dental laboratories should use alternative metals which are devoid of beryllium.
5. even all dental related industries should start marketing the alternative metals which are devoid of beryllium.[7]

Administrative and Work-Practice Controls: Limit work time, use HEPA vacuuming and wet mopping, and provide proper respiratory protection and protective clothing[11]

Personal Protective Equipment (PPE): Wear appropriate respiratory protection and protective clothing to limit exposure to beryllium.[11]

Early Identification and Treatment: Implement an interprofessional team-based approach for early identification and management of beryllium toxicity.[11]

Training and Education: Educate dental professionals, occupational physicians, and safety officers on the health effects of beryllium exposure and the necessary preventive measures.[11]

Compliance with Regulations: Follow the guidelines provided in the Material Safety Data Sheets (MSDS) for dental alloys containing beryllium[13,14] and these should be displayed in dental labs.

By implementing these measures, dental professionals can minimize the risk of beryllium toxicity and maintain a safe working environment.

References

1. Burkhardt, F., Pieralli, S., Bergfeldt, T. et al. Elemental analysis of contemporary dental materials regarding potential beryllium content. Sci Rep 12, 19119 (2022). https://doi.org/10.1038/s41598-022-21068-9.

2. Stearney ER, Jakubowski JA, Regina AC. Beryllium Toxicity. [Updated 2023 Aug 21]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK585042/.

3. Fireman E, Kramer MR, Priel I, Lerman Y. Chronic beryllium disease among dental technicians in Israel. Sarcoidosis Vasc Diffuse Lung Dis. 2006 Oct;23(3):215-21. PMID: 18038921

4. Ross G. Cooper, Adrian P. Harrison.The uses and adverse effects of beryllium on health Indian J Occup Environ Med. 2009 Aug; 13(2): 65–76.

5. Proper use of beryllium-containing alloys. ADA council on Scientific affairs. JADA.Volume 134, Issue 4, P476-478, April 2003.

6. About Beryllium.. Office of Environment, Health, Safety & Security. (Internet)

Available at - https://www.energy.gov/ehss/about-beryllium

7. Amy Ryder. Citizens policy center. Ban Beryllium in dentistry 2021. Cloudfront.net. (internet)

8. Sood A. Current treatment of chronic beryllium disease. J Occup Environ Hyg. 2009 Dec;6(12):762-5. doi: 10.1080/15459620903158698. PMID: 19894178; PMCID: PMC2774897.

9. Beryllium toxicity Treatment. Environmental health and medical education. Agency for toxic substances and disease registry. (Internet)

Available at - https://www.atsdr.cdc.gov/csem/beryllium/treatment.html

10. Beryllium disease. Cleveland clinic.(internet).

Available at- https://my.clevelandclinic.org/health/diseases/13807-beryllium-disease.

11. Stark M, Lerman Y, Kapel A, Pardo A, Schwarz Y, Newman L, Maier L, Fireman E. Biological exposure metrics of beryllium-exposed dental technicians. Arch Environ Occup Health. 2014;69(2):89-99. doi: 10.1080/19338244.2012.744736. PMID: 24205960; PMCID: PMC4347856.

12. Berylium - Health Effects. Diseases, Disorders and Injuries. Canadian centre for occupational health and safety. (internet).

Available at- https://www.ccohs.ca/oshanswers/diseases/beryllium.html#shr-pg-pnl2.

13.NIOSH Alert: Preventing Beryllium Sensitization & Chronic Beryllium DiseasePreventing Sensitization and Disease from Beryllium Exposure. The National Institute for Occupational Safety and Health. Centers for disease control and prevention. DHHS (NIOSH) Publication Number 2011-107

14. Preventing Adverse Health Effects from Exposure to Beryllium in Dental Laboratories OSHA Hazard Information Bulletin, HIB 02-04-19 (rev. 5-14-02). Available at www.osha.gov/dts/hib/hib_data/hib20020419.pdf. U.S. Department of Labor, Occupational Safety andHealth Administration, Washington, DC,