"ADVERSE REACTIONS TO PROSTHODONTIC MATERIALS A SYSTEMATIC REVIEW"

Dr. Rampal Niraj vsm
BDS, MDS, Principal & Head

Dr. Shukla Prasoon
BDS, MDS, Senior Lecturer

Dr. Pawah Salil
BDS, MDS , Professor

Dr. Malik Kanika
BDS

Department of Prosthodontics, Sudha Rustagi College of Dental Sciences and Research, Kheri More, Faridabad

INTRODUCTION

Prosthodontic restorations and appliances consist of many designs including conventional and implant-supported crowns, fixed prostheses (dental bridges) and removable prostheses or dentures. Some are fixed using precision attachment and screws or cemented to teeth or implants with minimal contacts with gingival or other oral soft tissues. Others are either fully supported by the oral mucosa and are removable or resting on both hard tissues of teeth and soft tissues.

Different materials, including metals, polymeric materials, ceramics and several types of cements are used when fabricating and fitting prosthodontic appliances for patients. For the purpose of this review, prosthodontics materials are defined as those used in the making of indirect restorations. These restorations are constructed in the dental laboratory on casts obtained from impressions and other chair-side recordings.

TESTING FOR BIOCOMPATIBILITY

Many preclinical biocompatibility tests are available to minimize the risk of adverse reactions to dental materials.1,2 These tests are categorized on the basis of their applicability levels.

Initial tests include cell culture tests, hemolytic tests, systemic toxicity tests, and tests estimating teratogenic and carcinogenic potential. Secondary tests cover implantation tests, skin and mucous membrane irritation tests and sensitization tests. Usage tests take into account the manner in which the materials are intended to be used in clinical practice.

Oral mucosa tests based on reactions to materials in contact with the hamster-cheek pouch is considered to be a standard short-term usage test for prosthodontic materials and relatively less invasive and traumatic. Plaque accumulation around the test specimen will also affect the reactions. Specially designed appliances for testing prosthodontic materials have not received widespread use, probably because of the inherent problems with the test or the cost involved.2,3

A number of factors need to be taken into account when estimating adverse biological reactions to prosthodontic materials. Among these include; the type, form, contour, extent of the prosthesis, any medication used by the patient, salivary flow rate, xerostomia, oral hygiene, quality of fit and function of the prosthesis. All these conditions may affect local reactions in addition to those caused by the materials per se. Biological films, 'pellicles', of salivary origin will also accumulate on the materials.4,5

SIDE EFFECTS OF MATERIALS

Unexpected biological side effects to prosthodontic materials may occur as a result of their direct contact with soft or mineralized tissues, or by exposure to leachable components resulting from corrosion and degradation products. Alloys of different composition will tend to enhance the corrosion caused by galvanic action. Since these components may be ingested, both local and systemic reactions may occur. Prosthodontic materials and their corrosion degradation products comprise components that are known to be allergenic, toxic and carcinogenic in specific situations.6 Local mechanical irritation due to an overhang on a crown or an overextended denture must also be considered as adverse effects.

It should be kept in mind that prosthodontic materials are manufactured with the aim of being inert and insoluble, thus the amounts of leachable components are small, which make toxic reactions unlikely to occur. However, the initiation of an allergic reac- tion in a sensitised individual requires minimal amounts of the allergen to be present. Contact allergic reactions (type IV reactions) are the most common side-effects to prosthodontic materials.

INCIDENCE OF SIDE-EFFECTS

Overall incidences of side-effects to dental materials of one per 700 patients, or of one patient per approximately 3.5 years of practice, as reported by Kallus and Mjor.7 In this study over 13000 patients were examined for acute and long-standing adverse effects during a 2-week period. Many types of dental materials were involved, but the incidence for individual materials, or even groups of materials, was too low to establish an incidence rate. Lichenoid reactions in the oral mucosa related directly to a restorative material were the most commonly reported side-effects. Many of these were asymptomatic and were not noted by the patient.

A questionnaire survey among Prosthodontists by Hensten-Pettersen and Jacobsen indicated adverse patient reactions in one out of 300 patients or one patient in approximately 2 years per prosthodontist.8

ADVERSE REACTIONS TO PROSTHODONTIC MATERIALS

Due to the low incidence of side effects to prosthodontic materials, it will be pertinent to limit this discussion to groups of materials rather than specific types of materials including polymeric materials, alloys, implant

materials, and cements. Ceramic materials are generally regarded as inert, but dust particles of these materials arising during when handling, manipulating and adjusting and finishing the fabrication represent a potential problem, both for the laboratory and clinical personnel as well as patients.9

Polymer Materials

Resin-based materials made from liquid methacrylate monomers mixed with polymethacrylate powder are the most commonly used polymers in prosthodontics. Apart from containing accelerators (amines), they contain co-polymers, such as butyl-meth-acrylate (BMA), plasticizing agents such as di-butyl-phtalate, and inhibitor such as hydroquinone. In addition, cadmium salt-based colouring agents are also added. These ingredients as well as the added cadmium salts are not considered to represent any problems for patients but they may pose potential hazard to technicians routinely grinding and finishing prostheses made in resin-based materials.10 In fact, about half of all reported side effects to prosthodontic materials have been associated with polymeric materials.

MMA monomer may result in toxic reactions and allergic responses in previously sensitized individuals, especially in under cured appliances.11 The clinical manifestation presents with redness and swelling of the affected mucosa. The consequent diffused or localized burning sensation in the mouth because of direct mucosal irritation may be erroneously taken for the entity of "Burning Mouth Syndrome (BMS). Differential diagnosis of fungal infections & physical trauma caused by overextended or poorly fitting dentures must also be made

Heat-cured acrylics are well tolerated by the gingival tissues, while cold-curing acrylic resins may result in gingival reactions.12 This has been attributed to the presence, in higher concentration, of the residual monomer in cold-cured resins as compared to heat-cured acrylics.

Burning sensation may result from the intra-oral manipulation of resin or because of the presence of residual monomer. Consequently, this may elicit either an allergic response or cause direct irritation of the mucosa by the monomer or by the heat generated during its curing in the mouth.13

Allergic reactions to an ethylene amine activator used in several polymeric materials, including impression materials and temporary crown materials are one of two most commonly reported adverse effects to prosthodontic materials.14

Prosthodontic Alloys

Some of the metals used in dental alloys are known to be biologically active or potentially hazardous, such as nickel, chromium, cobalt, cadmium and beryllium. About one in four reactions to materials used in prosthodontic treatments are related to metals, especially chromium, cobalt, nickel, and gold alloys used for metal ceramic restorations.14

Nickel is the most common metal to cause contact dermatitis, with more cases of allergic reactions than all the other metals combined. Kerosuo et al found the prevalence of nickel allergy in Finnish adolescents to be 30 per cent in girls and 3 per cent in boys. This is thought to be due to ear piercing being a major cause of sensitization to nickel, as the prevalence in subjects with pierced ears was 31 per cent and those without pierced ears 2 per cent. It has been suggested that a threshold concentration of approximately 30 ppm of nickel may be sufficient to elicit a cytotoxic response. The lesions of contact stomatitis may be variable and may be barely visible. Itching is not a common feature of contact stomatitis (table 1) and extra-oral reactions are more common than intra-oral reactions.15,16

Interestingly literature indicates that allergic reactions to gold-based restorations were also common.17, 18 Gingivitis and stomatitis were the most common clinical symptoms, but remote reactions occurred in almost 25% patients. Palladium alloys are generally better tolerated than base-metal alloys or gold alloys for metal-ceramic restorations, although they tend to tarnish more than other casting alloys. However, palladium alloys have also been reported to cause adverse reactions, and palladium may be linked to a cross-reactivity with nickel.19,20

Casting alloys used frequently nowadays are base metal alloys which do have berrylium in trace amounts. Beryllium was-initially believed to be nontoxic; however, reports of illness among workers handling beryllium began appearing after 1930.21 It is now generally recognized that the primary routes of acquiring beryllium disease are by inhalation of or direct skin contact with fumes or dust of beryllium. Acute beryllium disease involves symptoms that persist "for less than one year. The clinical manifestations of acute beryllium disease vary from contact dermatitis and a mild inflammation of the respiratory tract to a severe chemical pneumonitis which can be fatal.21 Chronic beryllium disease may not express itself for a number of years following exposure but it is characterized by nonnecrotizing granulomatous inflammation in the lungs and several other organs.22

Implant Materials

A wide variety of materials have been used in dental implants, including polymeric materials, alloys, ceramics, and synthetic hydroxy-apatite. Numerous investigations have been performed to assess the biological properties of dental implants. The concept of 'osseointegration' associated with titanium implants, as demonstrated by Bránemark, has provided much of the biological basis for modern implantology 23.

So far our understanding is clear regarding the inert nature of pure titanium implants, which is in tremendous use now days. Recently clinical reports have started appearing with suspected association of an allergic reaction with titanium dental implants. The rare occurance of such a response to titanium materials in clinical dentistry should, therefore, be further discussed and investigated.24

Cements

Zinc-phosphate cement has been, and still is,

frequently used luting agent for crowns and bridges. Pulpal reactions initially occurring in deep cavities usually subside over the time. Uncertainty has also existed about glassionomer cements, because clinical reports have indicated a high frequency of post-luting sensitivity. Pulp studies generally indicate slight reactions, but somewhat more to the luting type than to the restorative type of glassionomer materials.25 A recent clinical study of pulp sensitivity following cementation with zinc phosphate and glass-ionomer cements showed less sensitivity to zinc phosphate than to glass ionomer during the first 2 weeks, but after 3 months, there were no differences.26 The pressure on the dentine exerted during cementation was thought to play a possible role on the observation. Modern resin-based luting cements are also well tolerated by the pulp.

The importance of establishing a hermetic seal by the cements has been stressed.

Zinc oxide eugenol is used extensively in temporary cements, and it also forms the basis for certain impression materials. The relatively short-term use of these materials calls for attention to allergic reactions, but chronic toxic reactions are unlikely.

CONCLUSION

The efficacy of fixed and removable restorations is well established. Many potential problems exist, but few documented adverse reactions have been published. Extensive clinical experience with nickel containing alloys in prosthodontic practice calls for a reevaluation of their use. Future evaluation of dental materials, including those used in prosthodontics, will include more attention to biological and clinical properties. It is expected that one requirement will be for clinicians and manufacturers to report biological side effects associated with use of the materials to certifying bodies or health authorities.

With the low incidence of adverse effects of the materials in present use, this will satisfy the needs of the patients and those handling the materials. On rare occasion when side effects occur, the use of alternative materials will be the treatment of choice.

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Table 1 Signs and symptoms of nickel allergy

Intra-Oral	Extra-Oral
Stomatitis from Mild to Serve Erythema	Generalized Urticaria
Papula Peri-Oral Rash	Widespread Eczema
Loss of taste or metallic taste	Flare-up of allergic dermatitis
Numbness	
Burning Sensation	Exacerbation of pre-existing eczema
Soreness at side of the tongue	
Angular cheilitis	
Severe gingivitis in the absence of plaque	