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CLINICAL REVIEW

Hazards and Compatibility of Dental Materials

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ABSTRACT

Dental materials including noble and base metal alloys have evolved with time to evaluate biocompatibility. Materials and techniques employed in dentistry have been developed, revised, and improved with time to reduce toxic effects on biological functions. This study investigated the performance of 18 dental materials present in the market following explicit instructions of the manufacturer with a slight variance in the technique and time intervals to obtain an effective response. These findings were confirmed on human tissues, but in a modified form, to demonstrate traits in different age groups *In vivo* conditions. The study indicates that many such materials could have deleterious effects on human health and environment.

KEYWORDS

Dental materials; Biocompatibility; Hazards; Human tissues; Biological functions

PURPOSE

In the past, many documents have been developed and drafted to pro-vide information regarding the effects of dental materials being used on humans. However, there is a need for further evaluation to eliminate any potential toxic products that can damage any oral and maxillofacial tis-sues. If the products have narrow limits for safety, special precautions should be adopted to reduce occupational risks and prevent adverse ef-fects. Materials used for treating, augmenting, and replacing any tissue or function of the body can be modified or their use can be controlled to reduce its cytotoxicity. It is important to note that no dental material is explicitly safe, and the selection or use of dental materials should meet Food and Drug Safety guidelines. The validity of this study is justified on biological and theoretical basis. The sensitivity analysis and predictive performance of these materials can predict physiological, biochemical parameters and help to develop generic models that have reasonable outcomes.

SCOPE

Since the coronavirus pandemic 2019, the use of chemical agents with high bactericidal and virucidal properties has increased.

Currently, the new area termed biosafety materials is trending as it helps to prevent and control body harm and eliminates toxic products.

The analysis can support existing local and governmental protocols to prevent rapid responses toward outbreaks or pandemics of diseases. In addition, biosafe materials could set new benchmark limits for reliability of drugs, prevent environmental disruption, and reduce costs.

METHODS

There are two scientific methods used for research purposes.

In vivo studies can be carried out on human beings and *In vitro* studies can be carried out in a laboratory on human tissues. Before carrying out these tests, a presensitization test must be conducted on selected individuals or tissues in a controlled environment.

Subsequently, a preclinical usage test must be conducted to eliminate any clinical failures. The testing procedures and observations made had caused minimal destruction to the testers. Each study was divided into primary and secondary tests.

Primary tests are dose and time sensitive whereas secondary tests are independent.

In vitro procedures are conducted in a laboratory to observe any genotoxic effects on human tissues. The time interval was 24 to 48 hours. Methods that could determine the concentrations of active ingredients are cell culture strains, biofilm degradation assay method, electrophoresis and biosensing techniques.

In vivo studies are conducted to observe any dermal, structural, oral, lung, blood, bone, urine, gestational, blood, bone changes. The time interval for the secondary tests was 24 to 72 hours following 90 days intervals. Methods that could determine the changes based on levels of exposure, dose, and concentration of materials.

Preclinical tests were conducted directly on a tooth to evaluate its efficiency and histopathological properties. The observations made after preclinical studies were noted after 90 days intervals.

Any material demonstrating unacceptable toxicity levels was labelled as unstable Any chemical of concern needs further evaluation for risk assessments before introducing a ban in the market. The National Toxicology program can nominate these products by reporting them to a toxicologist.

For a material to be tolerable, it should exhibit a minimal or no response. If a response was detected, it should be of short interval and least inflammatory. The time required for an inflammatory response to disappear was noted in the results sections. The dental material should not contain any toxic diffusible substances that can cause a systematic toxic response.

Any material to be distinguished as biocompatible should determine its acceptability of physiochemical properties and clinical behaviour. However, it is evident that the performance of each dental material depends on its atomic structure and hence there is also scope for advances in dental materials by addition and manipulation.

A survey was then carried out over clinical data obtained because of this research and it does comply with GDPR. Data validation was conducted, and any clinical data carried over 3 years was considered unreliable and eliminated.

PROCESS

Equipment

- Homogenisers
- Sieves
- Stirrers
- Rotators
- Ovens
- Thermometer
- Ultrasonic baths
- Incubators
- Refrigerator
- pH meters
- Colorimeters
- Microscope
- Cell cultures and mediums
- Chemicals and solutions
- Microplates reader
- Saline
- Furnaces
- Vials
- Illuminators
- Paper
- Pipettes
- Data loggers
- Specimens
- Spectrometry
- Assay reagents

Steps

- Sterilization
- Sample preparation
- Concentration
- Cooling
- Heating
- Hydrolysis
- Testing
- Storage

- Data log
- Review

RESULTS

This research aimed to test a few materials and formulate a hypothesis. The results were based on various findings and cross validated by referring to resources. Each of these materials has been categorized as acceptable, provided they performed and reproduce results as proven previously. In other words, each of these materials should be capable of reproducing clinical properties as accurately as possible. Any clinical complications resulting in toxic and disagreeable effects on human tissues had been labelled as unstable and needs a further critical evaluation by an expert.

For Health Risk Assessment related to exposure, following equation was used,

Estimated daily intake of parent compound (mg/day) = Concentration in urine/blood (nmol/l) × total urine/ blood volume × molecular weight of parent compound divided by fraction of intake/dose × body weight.

Hazards Quotient is obtained by estimated daily intake of parent compound divide by reference dose for exposure. If hazard Index was less than 1 then it represents low risk adverse effects on humans.

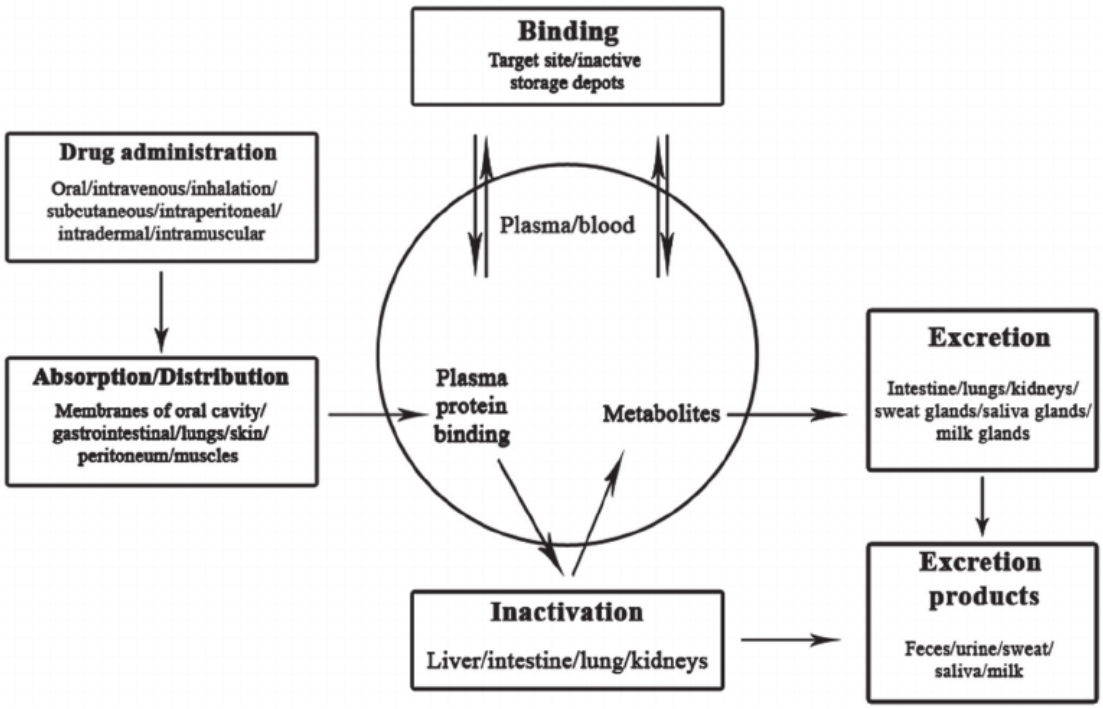


Figure 1: Schematic diagram of pharmacokinetic phenomenon.

In order to investigate the mechanisms of a drug ‘s absorption, biodistribution, metabolism and excretion, pharmacokinetics assays procedures ensure comprehensive results. In addition to the assays method, dose response assessment, bioanalysis of specimens and toxicokinetic study adds value to validation of results.

While testing a material, information about quantity of exposure, dose level, route and statistical evaluation has been considered.

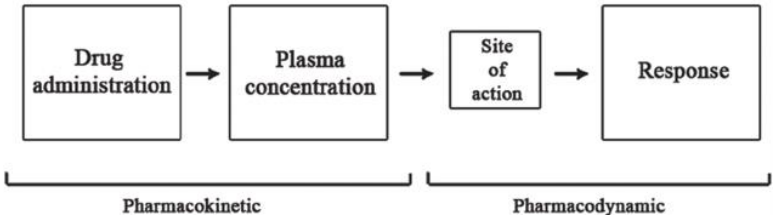


Figure 2: Flowchart of pharmacodynamic and pharmacokinetic relationship.

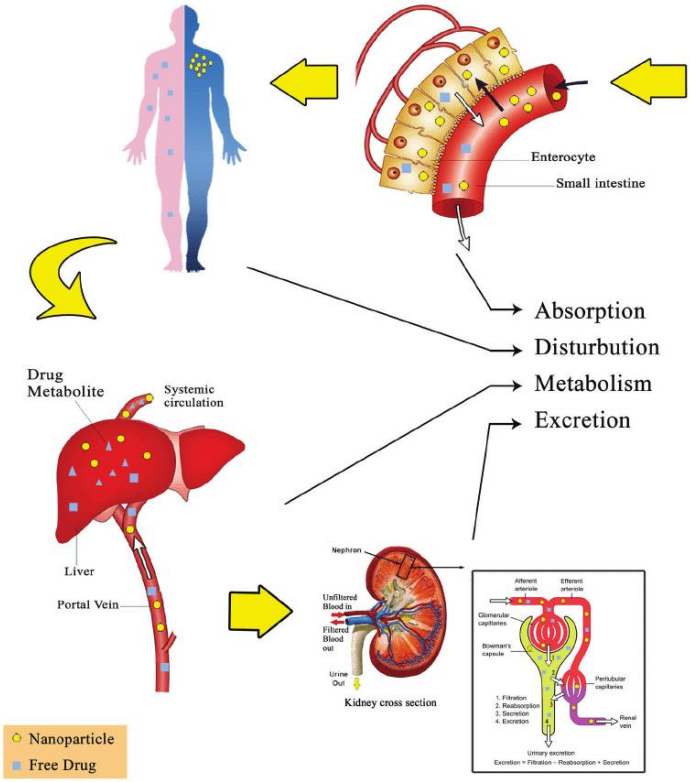


Figure 3: Diagram of drug metabolism for absorption, distribution, metabolism, and excretion.

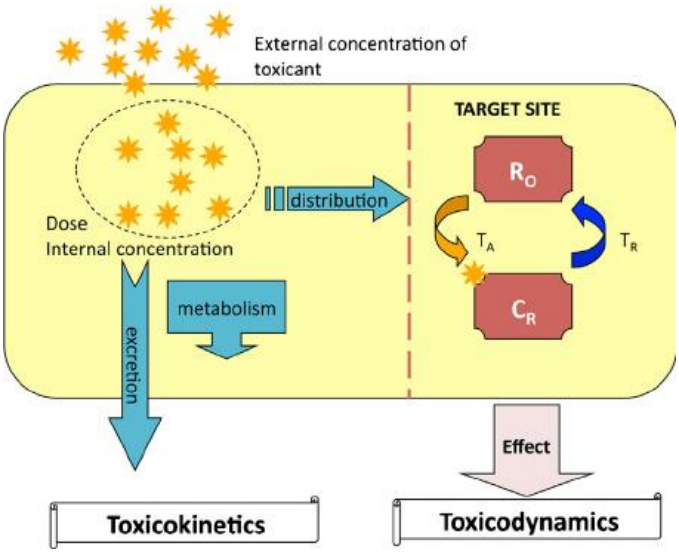


Figure 4: Toxicokinetic and toxicodynamic study.

Lethal dose is the dose that is given at once and kills 50% of the test population. This determines the mortality parameter. Local toxicity causes skin, mucosa, eye or blood vessel irritation.

Material	Duration	Purpose	Primary Test	Secondary Test	Preclinical Test
Nickel and Nickel chromium containing materials	40 hours to 3 years - 5 years	Orthodontic, Implants, Root canal files, ultrasonics, reduce tarnish and corrosion resistance	Contact Dermatitis, adjacent bone fracture can occur, periodontitis	Apoptosis resulting into Intraoral lesion	Respiratory cancer, Intraoral lesion, Reproductive system
Calcium hydroxide	15- 20 seconds to 24 hours	Pulp capping agent, thermal insulator	It reacts biologically with phosphoric acid containing cements, normal tooth vitality, healthy mucosa, or minor irritations	Effect on bleeding wounds can cause coagulation, necrosis, & inflammation resulting in non-vital pulp or apoptosis	Better expected outcomes
Nickel titanium	40 hours to 3 years-5 years	Implants, dental pins, wires	Wires should only be annealed with low force as severe embrittlement of adjacent structures may Occur because of its spring back property, adjacent bone fracture can occur, periodontitis	It is better accepted for artificial heart pumps, pacemaker, bone splints, load bearing hip joints	Better expected outcomes
Isopropyl alcohol (2%-12.7%) (60%-90%)	1-2 seconds 60-120 seconds	Canal irrigation, soaps, lotions, pharmaceuticals, dye solutions, antiseptic agent, petroleum, painters, carpenters	Skin irritant, eye irritant, dizziness, demineralization, erosion or abrasion, gingival bleeding, enamel split < 250 micrometre has no adverse effects	Highly flammable, drunkenness, vomiting, respiratory irritation	Narcotic effect, serious eye irritation
Sodium hypochlorite	1-2 seconds	Canal irrigation, disinfectant	Corrosive, gingival bleeding, delayed hypersensitivity	Highly flammable, drunkenness, vomiting, respiratory irritation	Respiratory irritation, allergic reaction
Zinc oxide eugenol	60 seconds	Intermediate restoration, periodontal surgical dressing, antiseptic	Irritant to skin or mucosa, chemical burns, dentinal hypersensitivity, acute pulpitis	Chemical insult especially for children resulting into apoptosis	Dimensionally unstable or clinically poor results
Chlorhexidine gluconate	30 seconds	Mouthwash, Canal irrigation, canal lubrication	Irritant to skin or mucosa, chemical burns, allergic reaction	Allergic reactions, not recommended in children under 8 years	Better expected outcomes
3D Technology or Red Cyan glasses (Polarized or unpolarized)	10 - 15 minutes	Movies, Dental clinics for UV radiation protection	It can cause headaches or dizziness in children younger than 6 years	Flickering in eyes, lower resolution images	Eye strain or migraines
Silver	24 hours to 3 months	Inlay, Crown, Amalgam	Electro galvanism with dissimilar metals, discoloration of gingiva or tarnish	Silver nano particles can exert cytotoxic effects at high concentrations	Better expected outcomes depending on purity scale
Dental varnish	15-20 seconds	Sealer or coating	Irritant to skin or mucosa, low hypersensitivity	Sealer preventing leakage	Unreliable outcomes
Resin	17 hours - 12 months	Impressions, Dentures, Denture liners, Prosthesis	Irritant to skin or mucosa	Periodontitis, Candidiasis	Dimensionally unstable
Ultaire	24 hours - 6 months	Flexible Dentures	Biocompatible	Periodontitis	Biocompatible
Cetaryl alcohol (5% - 40%)	30 seconds - 24 hours	Cosmetics, emulsifiers, cleaning solutions, preserver, tooth whitening	Irritant to skin or mucosa, dentinal hypersensitivity	Highly flammable, drunkenness, vomiting, respiratory irritation	Better expected outcomes
Dental etchant	25-30 seconds	Etchant	Irritant to skin or mucosa	Respiratory irritation	Unreliable outcomes or clinically satisfactory
Polyvinylpyrrolidone (250-500 mg/kg)	5-10 minutes	Blood plasma expander for trauma patients, Surgical disinfectant, periodontal pockets, pharmaceuticals	Allergic reaction	Apoptosis resulting in to pulmonary vascular injury, Cytotoxic, Chemical pneumonitis	Unreliable outcomes or clinically satisfactory
Hydrogen peroxide	30 seconds - 1 minutes	Canal irrigation, periodontal conditions, toothpastes, mouthwashes	Dentinal hypersensitivity	Blisters, chemical insult when used with other chemicals	Unreliable outcomes or clinically satisfactory
Beryllium	30 minutes	Cast metal and metal ceramics, laser, radiographic unit, optical systems, nuclear weapons	Contact dermatitis	Apoptosis resulting in chemical pneumonitis, Lung carcinoma	Unreliable outcomes or clinically unsatisfactory
Povidone iodine	30 seconds	Oral rinse, surgical scrub, haemostatic agent	Irritant, dentinal hypersensitivity	Allergic reaction	Biocompatible and possess healing properties or clinically satisfactory

Table 1: *In vivo* method.

Materials	Stable	Unstable
Nickel and Nickel Chromium containing materials		Stable -> Unstable
Calcium Hydroxide	Stable	
Nickel Titanium	Stable	
Isopropyl Alcohol (30%-90%)	Stable -> 2%-30%	Stable (60%-90%) -> Unstable
Sodium Hypochlorite		Stable -> Unstable
Zinc Oxide Eugenol	Unstable -> Stable	
Chlorhexidine Gluconate	Stable	
3D Technology or Red Cyan glasses (polarized or unpolarized)		Unstable -> Stable
Silver	Stable (Pure form)	Unstable (high concentrations)
Dental Varnish	Stable	
Resin		Stable -> Unstable
Ultaire	Stable	
Cetaryl Alcohol (5%-40%)	Stable	
Dental Etchant	Stable	
Polyvinylpyrrolidone (250-500 mg/kg)		Stable -> Unstable or Null Hypothesis
Hydrogen Peroxide		Unstable -> Stable
Beryllium		Stable -> Unstable

Table 2: Composition of materials currently available in the market.

Technical Analysis for Determining Probability of the Hypothesis

The word probability can be defined as the certainty or uncertainty of the occurrence of an event. The value for probability of any event lies between 0 and 1. 0 indicates the impossibility of an event whereas 1 indicates the certainty of an event. The probability of any event E is defined as the ratio of the number of outcomes to the total number of possible outcomes.

Probability formula denoted as,

P (E). P (E) = n / N

Important terms associated with probability formulae are as follows,

Experiment

An experiment is a method that can be infinitely repeated and consists of a set of possible outcomes.

Sample space

The set of all possible outcomes of an experiment is called the sample space.

Outcome

The result of an experiment is termed an outcome.

Event

Event is the combination of all possible outcomes of an experiment.

Probability Function

The function that enables determining the probability of each outcome of an experiment is called the probability function.

A variable whose values are dependent on the outcomes of a random experiment is called a random variable. It is also called a stochastic variable, random quantity.

A mathematical function that helps in deriving the probability of occurrences of various possible outcomes of a random experiment is called a probability distribution.

For example, in tossing a coin, the probable outcomes are either ahead or a tail. Say, X – is the outcome of tossing a coin. The probability distribution of the term X can take the value 1 / 2 for a head and 1 / 2 for a tail. The two types of probability distributions are discrete and continuous probability distributions.

Discrete Probability Distribution Formula

Consider a discrete random variable X. The probability distribution of this variable X consists of each possible value of that variable along with the probability that it can take in a trial of the random experiment. The different discrete probability formulae are,

Binomial Probability Distribution Formula

Let X be a binomial random variable that includes n and p as its parameters.

Then the probability formula is given by P (x) = next pxqn-x where q = 1 – p.

Poisson Probability Distribution Formula

P (x; μ) = [(e-μ) (μx)] / x!

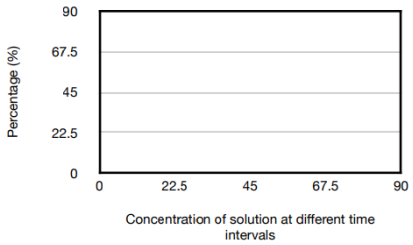
Here μ is the mean number of successes, x is the exact number of successes and e is approximately equal to 2.71828.

Dynamic Risk Taking

If you take risks repeatedly then the way to count is exposure. Ruin probabilities are in the time domain and do not correspond to statespace tail probabilities.

Results are summarized in table 2 and graphs.

Figure 1(a)



Temperature of mouth

Data References

Figure 1(b)

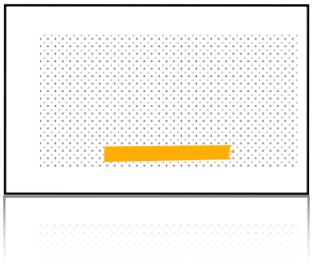
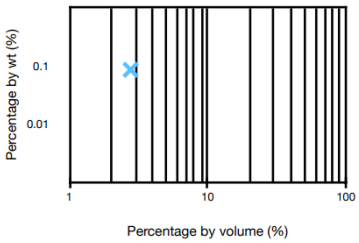


Figure 2(a)



Polymethyl methacrylate Resin

Data References

Figure 2(b)

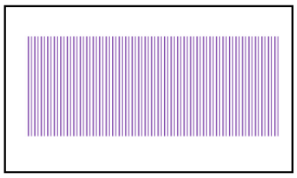
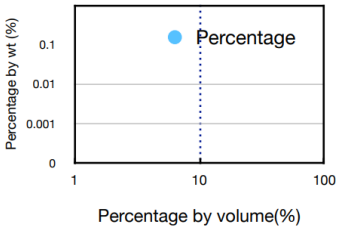


Figure 3(a)



Povidone Iodine 0.75%-10%

Data References

Figure 3(b)

Table 1 **In-vivo Test**

Name: Zinc oxide Eugenol	Percentage
Zinc oxide	87
Fixed oil/Mineral oil	13
Eugenol	12
Polymerized resin	50
Filler	20
Lanolin	3
Resinous balsam	10
Accelerator solution(CaCl2)	5
Shrinkage	0.10%
Temperature of mouth	25'C
Time	3-6 minutes
Reacts	Dermatitis
	Allergic reaction
Result	Stable

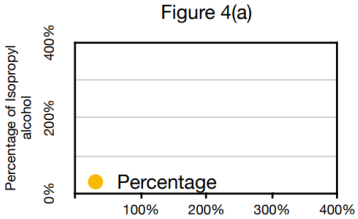
Table 1 **In-vivo Test Results**

Name: Polymethylmethacrylate	Percentage
Monomers	25%-75% by wt
Filler particles (organic/inorganic)	30%-70% by wtg
Coupling agents	0.5-2% by wt
Activator-Inhibitor system	0.2%-0.15%,
Optical Modifiers	0.001-0.007% by wt%
Residual monomer (allergic	0.90%
Shrinkage by volume	21%-10%
Temperature	25'C to 50'C
Activators: Light, heat and UV	250nm-470nm,50'C-100'C
Reacts with	
	Halogen
Result	Unstable

Table 1 **In-vivo Test**

Name: Povidone Iodine	Percentage
Povidone Iodine(surgical scrub)	0.75%-10%
Cofomulants	
Water	q.s to 100g
Povidone-iodine(oral rinse)	0.50%
Citric acid	
Glycerin	
Purified water	
Sodium hydroxide	
Time	30 seconds
Temperature	25'C
Allergic reaction	Poison
Swallowed	Paracetamol
Reacts with	Hydrogen peroxide
	Thyroid condition
Result	Stable

Figure 4(a)



Percentage of purified water

Isopropanol alcohol 40-60%

Data References

Figure 4(b)

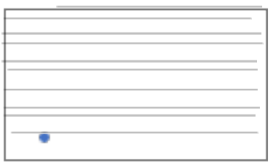
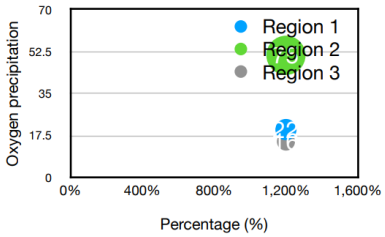


Figure 5 (a)



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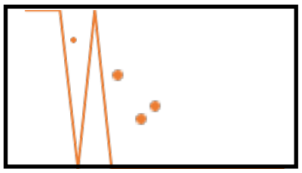
Data References

Figure 5(b)



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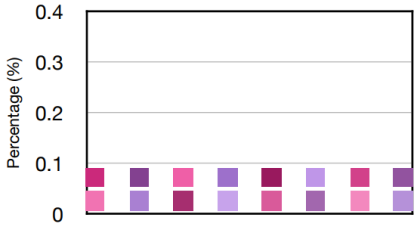


Purified water (%)

Sodium Hypochrolite 2-6%

Data References

Figure 6 (b)

Table 1 **In-vivo Test**

Name: Isopropyl Alcohol	Percentage
1.Isopropanol	40-60%
Purified water	30-40% by vol
2. Isopropanol	80-99.7%
Purified water	10-20% by vol
Time	30- 120 seconds
Temperature	20°C-25°C
Allergic reaction	Dermatitis
Inhaled	Narcotic effects
Ingested	GI bleeding in patients with GIT Ulcers
Result	1. Stable
	2. Unstable

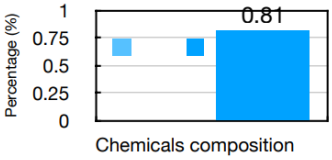
Table 1 **In-vivo Test**

Name: Berryllium	Percentage
1.Berryllium oxide	<0.1-2%
Iron	1.80%
Aluminium	35%
Nickel	1%
Molybdenum	2-6%
Chromium	11.80%
2. Beryllium oxide	3%-30%
Time	15-60minutes
Temperature	
Allergic reaction	Death
Inhaled	Lung cancer
Ingested	Stomach Ulcers
Result	Unstable

Table 1 **In-vivo Test**

Name: Sodium Hypochrolite	Percentage
Sodium hypochlorite	2-6%
Purified water	30%
Temperature	15°C-18°C
Time	30-60 seconds
Reacts with	Corrosive with chemicals
Inhaled	Lung oedema
Ingested	Mucositis, burns,blisters,allergy
Result	Unstable

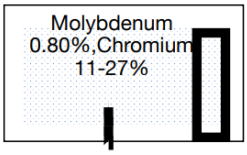
Figure 7 (a)



Chromium 11-27%

Data References

Figure 7|(b)



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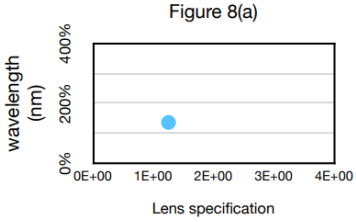


Linear polarised glasses specification 45/135 or 0/90

Data References

Figure 8 (b)

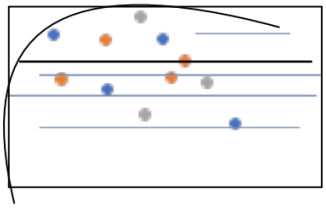
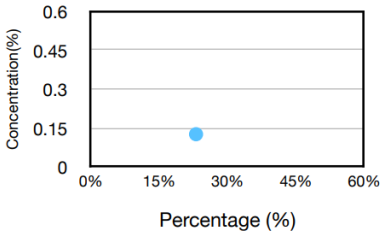


Figure 9 (a)



Hydrogen Peroxide

Figure 9(b)

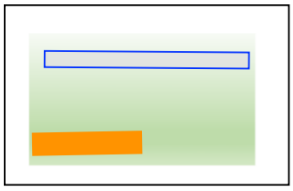


Table 1 **In-vivo Test**

Name: Nickel and Chromium	Percentage
Nickel	81%
Chromium	11%-27%
Molybdenum	2%-5%
Temperature	25'C-40'C
Time	15mins-130mins
Reacts with	Chemicals and metals
Inhaled	Pharyngitis
Ingested	Toxic
Result	Unstable

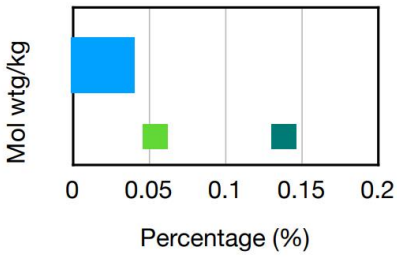
Table 1 **In-vivo Test**

Name: 3D Technology Glasses	Percentage
Linear polarized glasses specification	45/135 or 0/90
Sizes	Child or Adult
Polarized or Red Cyan	
Time	30-45 minutes
Temperature	25'C- 30'C
Light	Night vision
Result	Stable

Table 1 **In-vivo Test Results-6**

Name: Hydrogen Peroxide	Percentage
Hydrogen peroxide	3-6%
Purified water	60%
Temperature	25'C
Time	30-60 seconds
Reacts with	chemicals
Inhaled	Pnuemonitis
Sprayed	Eye irritation
Result	Stable

Figure 10



Polyvinyl Pyrrolidone,"binder 0.5-5%

Data References

Table 1 In-vivo Test

Name: Poly Vinyl Pyrrolidone	Percentage
As a binder	0.5%- 5% w/w
As a blood plasma expander	55,000 mol wtg
	250-500mg/kg
As a drug releaser in paracetamol tablet	4%
As a food additive	0-25mg/Kg wtg
Carcinogenetic limit	5000mg/Kg/day
Toxic in Prenatal or children	3000mg/Kg/day
Days	
Allergic Reaction	Pulmonary vascular
	injury
Result	Unstable

Graphs

Plot of the specimens tested in *in-vivo* binding assays. The ordinate (y-axis) is total specific binding in DPM and efficiency and (x-axis) is concentration of the materials.

Statistically, the difference between the value of the variable in the control group and that in the test group is known as ES. This difference can be expressed as the absolute or relative difference. For example, certain materials cause root/ tooth resorption. If the resorption in the control group is 2mm and in the test group is 4 mm, the absolute ES is 2 mm and relative reduction with test intervention is 2/4 or 50%

Thus, statistical analysis determines the effects of dental materials on tooth and helps to determine the toxic effects and their clinical significance.

CLINICAL SIGNIFICANCE

Pharmacokinetic and pharmacodynamic properties assess materials with maximum concentration, time to maximum concentration, bioavailability, distribution to clearance time. This determines the drug/material effects with achieved plasma concentrations. Dental Materials can have three main consequences: (1) Severe wear and irritation of pulp with clinical hypersensitivity or pulpitis (2) Functional effects that can alter tooth relationship, temporomandibular joint dysfunction (3) Wear of noble gold metal alloys and ceramic metals is low as compared to Nickel, Chromium and beryllium that can cause an allergic reaction and mutagenic changes.

These materials can get accumulated into tissues and can cause disease of lung, intestine, liver, and kidney. In this way, they reach the systemic circulation where it can further cause biological consequences on stomatognathic system. Clinical wear or ingestion of dental materials result in oral pathologies.

Controlled clinical trials remain single best measure of clinical response to dental materials. Patients can exhibit symptoms of pain, oral mucosal reactions, and radiographic changes.

Zinc oxide Eugenol

After conducting research and hypothesis, the results suggested that the score is reasonable. Hence, the material can be used cautiously using precautions. The benefits of this material, when used in limited quantity, outweigh the harmful effects. The dose and response curve also suggests there is room for improvement for this material. Currently, I would recommend its use for intermittent dressing and as an antiseptic agent.

Polymethylmethacrylate Resin

After conducting research and hypothesis, the results suggested that the score shifts to one side. Hence, the material needs a replacement. The adverse outcome of this material outweighs the benefits of this material. This material has evolved with time, so it can be used with great precaution. However, I would not recommend it for longterm use in patients with ongoing conditions. The better alternative is Ultaire as it is biocompatible. Polystyrol particles of different sizes (50 nm – 3 micrometres) can get accumulated into lymph nodes. This can result in some changes in tissues. Higher concentrations can cause tissue necrosis or weaken elastic bone surfaces.

Povidoneiodine

After conducting research and hypothesis, the results suggest that the score shifts to one side. IT is a volatile material and has been used in various forms and different combinations. It can cause allergic reactions, thyroid dysfunction on ingestion. 10% Povidone iodine may impair wound healing as inhibits fibroblasts. Vaginal and skin application of this material has cause anaphylactoid reaction. As, I do not have adequate information, I would recommend it to be used with precautions. However, I recommend buying this product only from authorized dealers for topical use.

Isopropyl Alcohol

After conducting research and hypothesis, the results suggest that the score shifts to one side. This material has been used in different concentrations. There is a biohazards safety concern over the use, storage, and maintenance of this product. This is a highly sensitive product, and its benefits outweigh the harmful effects. It reacts violently with strong acids and chemicals. It has occupational exposure limits of 2000 ppm that can result in an emergency. High concentrations can cause skin irritation. The dose and response curve suggests that there is some room for improvement.

Beryllium

After conducting research and hypothesis, the results suggest that the graph shows a peak activity and shifts to one side. The material is highly sensitive and has biohazard safety concerns. It reacts with various products and if used in excessive proportions, it can result in death. It also causes skin cancer, and it is carcinogenic in high proportions. It has an occupational exposure limit and so I would not recommend using this product.

Hydrogen peroxide

After conducting research and hypothesis, the results suggest that the concentrated solution is highly acidic and toxic. Prolonged use of this material can irritate or burn injuries to soft tissues and internal organs upon inhalation or ingestion. However, this product is stable and is highly effective against viruses and bacteria. The storage and maintenance of this product help to determine its efficiency and effectiveness. This product should not be used in patients with respiratory disorders, heart conditions, and epilepsy.

Sodium hypochlorite

After conducting research and hypothesis, the results suggest that the concentrated solution is highly acidic and toxic. This material should be used with purified water as can cause irritation or severe burn injuries to internal organs upon inhalation or ingestion. This product is slightly unstable but effective against viruses and bacteria. The storage and maintenance of this product help to determine its efficiency and effectiveness. This product should not be used in patients with respiratory disorders, heart conditions, and epilepsy. I would recommend the usage of this product only in rare circumstances.

Nickel and Chromium

After conducting research and hypothesis, the results suggest that the score shifts to one side. Also, the toxicity evaluations of this material are greater while cutting, processing, finishing, or polishing in the form of dust fumes. While using an exhaust system, the exposure is reduced. Exposure is more common in laboratory technicians. This material is mainly used for cast metal restorations and partial dentures. It can cause an anaphylactic reaction within 24 hours of exposure. A medical diagnosis is a must before consideration of this material. Randomised controlled trail of placing a dental Implant with conventional method showed marginal bone loss. In certain patients, it was statistically significantly more in the immediate loading arm, −0.296 mm versus −0.037 mm (intention to treat $p = .002$; per protocol: $p = .021$). Bone healing and remodelling were dependent on anatomical structure and medical history of patients.

3D Technology Glasses

After conducting research and hypothesis, the results suggest that the score shifts to one side. These glasses transmit polarized radiation, and the eye reads images as superimposed and passive. The newest technology includes shutters and adding a polarized screen. The glasses reduce one's peripheral vision and can cause vertigo in children less than 6 years old. These glasses are not recommended to be used by patients suffering from eye conditions or epilepsy. I would not recommend the use of these glasses.

Polyvinyl pyrrolidone

After conducting research and hypothesis, the results suggest a null hypothesis. The benefits of this material when used in limited quantity out-weighs the harmful effects. The material has been used in various forms and different combinations. For example, when used in trauma patients or combined with paracetamol, it reacts and can cause vascular injury or anaphylactic reaction. The incidence of this type of reaction is very low. As I do not have adequate information, I would recommend it to be used with precautions. However, I recommend buying this product only from authorized dealers. This material is not biocompatible, but it is widely used in cosmetics, drugs, and food additives and has been approved by FDA under limitations. Patients with complex medical history needs monitoring and extra precaution.

ETHICAL APPROVAL

All experiments were carried out to improve the standard of ethical guidelines and no animals were harmed during this study.

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This study was self-funded and does require additional funding to implement government protocols to enhance the outcome of this research. As some of the materials described need appropriate facilities to test the outcome for further evaluation.

DECLARATION OF COMPETING INTEREST

The author declares no competing interest related to this publication. The idea, paper design, literature, statistical analysis, graphical presentation, writing, and corrections have no competing interest.

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