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CLINICAL EVALUATION OF FACET MATERIALS IN FIXED PROSTHODONTICS

2004

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CZECH REPUBLIC

CONTENTS

1. Introduction

1.1 INTRODUCTION TO FIXED PROSTHODONTICS

Prosthodontic treatment aims not only 011 renewing the masticatory functions and rehabilitating the patient's esthetics, but also on using such treatment approach that allows the reconstruction to act and behave physiologically as long as possible. It should fulfill the preventive aspects aiming to protéct the proper function of the vvhole stomatological systém.

Mistakes in both the office and laboratory working procedures may lead to failures of biological biophysical and technical character.

Fixed prosthodontics is the art and science of restoring damaged teeth with cast metal, metal ceramic or all ceramic restorations, and of replacing missing teeth with fixed prosthesis.

Successfully treating a patient by means of fixed prosthodontics requires a truthful combination of many aspects of dental treatment: patient education. and the prevention of further dental disease, sound diagnosis, periodontal therapy, operative skills, occlusal consideration. and sometimes, placement of removable or complete paitial prosthesis and endodontic treatment.

Restoration in this field of dentistry can be the finest service rendered for dental patients, or the worst disservice perpetrated upon them. The path taken depends upon one's knovvledge of sound biological and mechanical principle. the growth of manipulating skills to implement the treatment pian, and development of critical eye and judgment for assessing detail. As in all fields of the healing arts in the recent years, there has been tremendous change in this area of dentistry.

Improved materials, instruments and techniques have made it possible for today's operátor of average skills to provide a service vvhose quality is on par with that produced only by the most gifted dentist of years gone by. This is possible, however only if the dentist has a thorough background in the principles of prosthodontic dentistry, and an intimate knowledge technique required.

The scope of fixed prosthodontic treatment can range from the restoration of single tooth to rehabilitation of the entire occlusion. Single teeth can be restored to full function. and improvement in cosmetic effect can be achieved. Missing teeth can be replaced with fixed prosthesis that wil! improve patient comfort and masticatory ability, maintain the Health and integrity of dental arch, and, in many instances, elevate the patient's self image. ít is also possible, by the use of fixed restorations. to render supportive long range corrective measures for the treatment of problems related to the tempromandibular joint, and its neuromuscular components. On the other hand, with improper treatment of occlusion, it is possible to create disharmony and damage to the stomatognathic systém.

A crown: is a cemented extra coronal restoration that covers, or veneers, the outer surface of clinical crown. It should reproduce the morphology and contours of damaged coronal portions of a tooth vvhile performing its function. It should also protéct the remaining tooth structure from further damage. If it covers all of the clinical crown. the restoration is a full or complete veneer crown. It may be fabricated entirely of gold alloy, or some other uncharitable metal, a ceramic veneer fused to a metal, an all ceramic material, resin and metal or resin only. If only portions of clinic crown are veneered, the restoration is called a partial veneer crown [64].

Crowns and bridges are an integrál part of fixed prosthodontics. The materials used in the manufacture of facet crowns and bridges can be roughly divided into ceramic, plastic and metal; the latter being rarely used nowadays.

In my thesis I have tried to evaluate these facet materials by the help of clinical observation. I have also followed the condition of the crowns in the mouth after a number of years. the condition of the soft tissues in these patients and eventually the choice between metal ceramic or plastic jacket crowns for the long term use of crowns and bridges.

I begin by discussing the materials and the methods that I have come across in my study course in the Czech Republic. Ceramics have been used for tooth restoration for a long time as 1 have mentioned in my "brief history of crowns and bridges".

Single jacket crowns were the first all-ceramic restorations developed by Land in the last century for the restoration of severely damaged teeth. Although conventional jacket crowns have been improved so that they can offer excellent clinical results. their strength still remains fairly low and it is difficult to obtain a reproducible marginal fit.

The material being used is glass which lacks any fracture toughness. Porcelain jacket crowns are extremely sensitive to the presence of surface micro-cracks and its use is restricted only to low-stress bearing areas. This type of crown was well accepted until the advent of the porcelain-bonded-to-metal crown in the 1960's.

1.2 A BRIEF HISTORY OF CROWNS AND BRIDGES

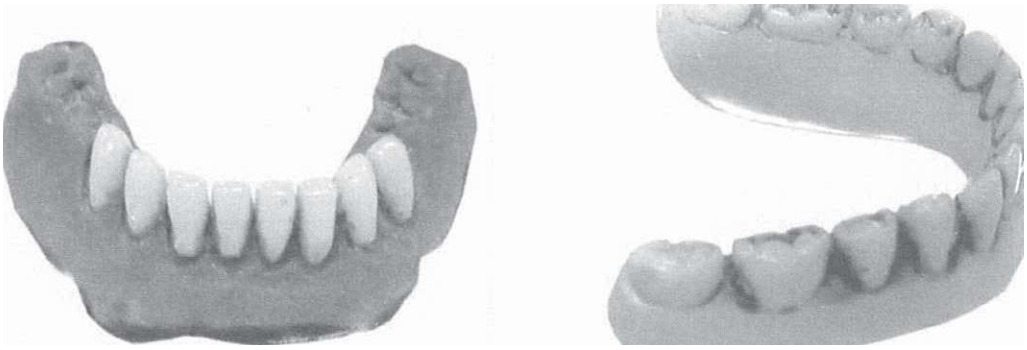
Replacements for decayed or lost teeth have been produced for millennia. Crowns (used to replace and cover missing portions of teeth) and bridges (mountains for artificial teeth attached at either end to natural teeth) were made of gold and used by the Etruscans 2,500 years ago. The Etruscans made skillfully designed falše teeth out of ivory and bone, secured by gold bridgework, as early as 700 B.C. unfortunately; this level of sophistication for falše teeth vvas not regained until the 1800s.

Fig. 1. Tooth extraction in Medieval Times [81]

During medieval times, the practice of dentistry was largely confined to tooth extraction (fig. 1); replacement was seldom considered. Gaps between teeth were expected, even among the rich and powerfui. Queen Elizabeth I (1533-1603) filled the holes in her mouth with cloth to improve her appearance in public.

When falše teeth were installed, they were hand-carved and tied in pláce with silk threads. If not enough natural teeth remained, anchoring falše ones was difficult. People who wore full sets of dentures had to remove them when they wanted to eat. Upper and lower plates fit poorly and were held together with steel springs; disconcertingly, the set of teeth could spring suddenly out of the wearet's mouth. Even George Washington (1732-1799) suffered terribly from tooth loss and ill-fitting dentures. The major obstacles to progress were finding suitable materials for falše teeth, making accurate measurements of patient’s mouth, and getting the teeth to stay in pláce. These problems began to be solved during the 1700s.

Since antiquity, the most common material for falše teeth was animal bone or ivory, especially from elephants or hippopotami. Human teeth were also used, pulled from the dead or sold by poor people from their own mouths (fig.2). These kinds of falše teeth soon rotted, turning brown and rancid. Rich people preferred teeth of silver, gold, mother of pearl, or agate.



A B

Fig. 2. A, Denture of wood and human teeth. **B,** Denture of bone, 15th century [81]

In 1774 the French pharmacist Duchateau enlisted the help of the prominent dentist Dubois de Chemant to design hard-baked, rot-proof porcelain dentures. De Chemant patented his improved version of these "Minerál Paste Teeth" in 1789 and took them vvith him when he immigrated to England shortly afterward. The single porcelain tooth held in pláce by an imbedded platinum pin was invented in 1808 by the Italian dentist Giuseppangelo Fonzi. Inspired by his dislike of handling dead people's teeth, Claudius Ash of London, England. invented an improved porcelain tooth around 1837.

Porcelain teeth came to the United States in 1817 via the French dentist. A. Planteau. The famous artist Charles Peale (1741-1847) began baking minerál teeth in Philadelphia, Pennsylvania, in 1822. Commercial manufacture of porcelain teeth in the United States was begun, also in Philadelphia, around 1825 by Samuel Stockton. In 1844 Stockton's nephew founded the S.S. White Company, which greatly improved the design of artificial teeth and marketed them on a large scale [171].

Bridge vvork developed as crovvns did; dentists would add extra facing to a crovvn to hold a replacement for an adjacent missing tooth. The major advance came with the detachable facings patented by Dr. Walter Mason of New Jersey in 1890 and the improved interchangeable facings introduced by Mason's associated Dr. Thomas Steele in 1904. The common problém of broken facings was now easy to fix, and permanent bridge installation became possible and successful [171] [172].

1.3 INTRQDUCTION INTO DENTAL FACET MATERIALS

Dental materials science is derived from material science. The field of material science can be organized in terms of four categories of materials with their structural considerations governing their properties, and their generál properties which have been discussed in the following few pages. For each of these there is a rich base of materials science definitions.

1.3.1 Materials categories: The four categories of materials are: metals, ceramics, polymers, and composites. Each one of these has characteristics structures and resulting properties. Formal engineering definitions of each category are not practically useful. The following definitions are most often substituted instead:

- **Metals:** A metal is based on an element which diffusely shares valence electrons amongst all of atoms in the solid, instead of forming local ionic or covalent bonds. A metal alloy is an intentional mixture of metallic elements which occurs in a chemically intimate manner. As a result of mixing, the elements may be completely soluble example: Au-Cu or may be only partially soluble, Example: Ag-Sn, producing more than one phase. Different phases represent locally different chemical compositions. The periodic table consists mostly of metallic elements. Thus, there are a wide range of metallurgical systems which are possible.

- **Ceramics:** Ceramics are chemically intimate mixtures of metallic and non metallic elements, that allow ionic (K20)and -or covalent bonding (Si02) to occur. In the periodic table, there are only a few non metallic elements, such as oxygen, nitrogen, hydrogen, and chlorine. The most common ceramics in dentistry are alloys of three main metallic oxides (Si02, A1203, K20). Ceramics also may result from corrosion of metals (Fe203, SnO, Ag2S). The corrosion behavior of metallic elements is classified as active, passive, or immune with respect to chemical or electrochemical reactions with other elements in their environment. Active metals corrode to form solid ceramic products or soluble products. For example, iron reacts with oxygen to form iron oxide. Passive metals corrode to form thin films of ceramic products that remain adherent to their surfaces and prevent further corrosion (passivation). Titanium reacts with oxygen to form a titanium dioxide coating (Ti02) that prevents further reaction and thus protects the surface. Immune metals, such as gold. are not reactive under normál environmental conditions. Most metals are active, and thus ceramics are much more common than metals in the world. Many of the key ceramics used for dentistry are oxides.
- **Polyniers:** Polymers are long molecules composed principally of non metallic elements (example: C. O, N, H) that are chemically bonded by covalent bonds. Their principál distinction from other common organic materials is their large size and thus molecular weight. The process of forming a polymer from identifíable sub units, monomers, is called polymerization. The word monomer means "one unit". The word polymer means "many units". A common commercial and dental example is the polymerization of methyl methacrylate monomer (100 grams/moles) into methyl methacrylate polymer (typically 300000gm/mole). Most polymers are named by adding "poly-" as a prefix to the word for the major monomer in the polymer chain (polymethyl methacrylate) or by adding "poly" to the description of the chemical links formed between monomer units (poly amide , polysaccharide, polyester, polyether, polyurethane). In other cases, the originál commercial brand name has become the common name (nylon, Teflon). Polymers may be classified in terms of kinetics of the polymerization reaction. The chain reaction polymerization involves rapid

monomer addition to growing chains. Stepwise reaction polymerization occurs slowly by random addition of monomers to any growing chain ends.

- **Composites:** Composites are physical mixtures or blends of metals, ceramics, and or polymers. The goal is to average the properties of the parts to obtain intermediate properties or to take advantage of good properties of each part. The classic mixture for dental restorations involves ceramic particles mixed with the polymer matrix. This is commonly called dental composites. The properties of dental composites can be explained readily in terms of the volume fraction of the phases being physically mixed. This principál is called the "rule of mixtures" and actually had wide application for all materials. By knowing the phases present in any material and the interfacial interactions, it is possible to predict the overall properties fairly well.

Composites can be describes as a dispersed (fíller) phase mixed into a continuous (matrix) phase. The matrix phase is generally the phase which is transiently fluid during manipulation or placement of materials. It is also the phase which tends to have the least desirable properties in the mixture. As a generál rule, minimizing the matrix of any systém produces materials with more desirable clinical properties. For a composite to distribute energy within the systém to all of the phases, it is important that the dispersed phase to be bonded effectively to the continuous phase.

1.3.2 Materials structure Traditionally a material is defined in terms of its composition. However, the composition of a material is only one of four the important categories describing its structure, and hence properties. The four structural categories are atomic arrangement, bonding, composition, and defects. Atomic arrangements may be crystalline (ordered) or non crystalline (disordered, glassy, amorphous). Primary bonding may include metallic, ionic, and /or covalent chemical bonds. Secondary bonding is much weaker and may include Van der Waals forces or hydrogen bonds. Composition includes the elemental components and the resulting phases which form. The defect encompasses a wide range of imperfections from those on the atomic scale to voids or pores. The thermal and mechanical histories strongly influence these structural categories producing a wide range of possible properties for the same overall chemical composition. Gold alloys will have different mechanical properties if their defect concentrations are changed. Si02 can be produced as a non crystalline solid or as any of three equilibrium crystalline solids (quartz) [2,3,8,29,31,33,34,61,63,92,101,117.123,126,128,133,135,179, 188].

1.4 THE SEARCH FOR THE 1DEAL CROWN AND BRIDGE MATERIALS

#	Gold Alloy	Used when maximum strength is desired and appearance is not a factor. There are many formulations of gold. varying from 1% to 99%.
	Titanium	Used when maximum strength is desired. appearance is not a factor, and a gold alloy is not biocompatible. There are different purities of titanium, with grade 1 being the purest. This is the metal used in joint replacement. dental implants, and bone pins. Cost is the same as for a gold alloy.
»	Non-Precious Alloy	Used when maximum strength is desired, appearance is not a factor, but cost is most important. Since it does not contain any gold, cost is less. There are 2 basic formulations, one that contains nickel and one that is nickel-free. The controversial issue is that nickel, beryllium, cobalt, chromium, and palladium may relate to immune problems and/or toxicity.
	Porcelain	Used when appearance and wear resistance is the most important factor. It is much more fragile than metal and may break easily. Porcelain, alone, is not normally recommended for bridges.
%	Indirect Composite	Used when appearance is an important factor, but when the risk of porcelain fractures and wearing down the other teeth is to be avoided. Not quite as wear resistant or esthetic as porcelain, but very acceptable for normál situations.
m	Combination of metal beneath either porcelain or composite	Used when both strength and cosmetics are important.

Despite modem dental facet materials and techniques, the oral cavity presents a demanding environment for facet materials. Facet materials break dovvn for a variety of reasons including: dietary factors, masticatory stresses, acid-base shifts, temperature changes, failure of the tooth structure itself. the adhesive nature of plaque, the complex and different structures of cementům, dentin, and enamel. and interaction with other materials. The consequences of breakdown include recurrent caries. surface wear, leakage at the tooth-restoration interface (often referred to as microleakage), marginal fracture. bulk fracture, discoloration, corrosion, lack of biocompatibility, and sensitivity of the pulp to bacteria. chemicals, temperature, and pressure. Indeed, no test systém is available that can duplicate readily the combined stresses of the oral cavity over a lifetime. Yet, even though the ideál restorative material does not exist, ideál characteristics can be outlined. as suggested below.

1.5 THE PROPERTIES OF A GQOD FACET MATERIAL

Physical/Mechanical Properties

- Stability in the acid/base oral fluids
- Insolubility in and low sorption of fluids present in the mouth
- Low thermal conductivity, as similar to the tooth substance enamel and dentine
- Ability to resist permanent deformation or fracture under the forces of mastication
- Ability to achieve and maintain a highly polished or homogeneous surface
- Tooth-colored
- Adequate strength characteristics, resistance to fracture and marginal breakdown
- Wear rate similar to enamel
- Resistance to corrosion
- Adhesive to or chemically bonded to the tooth structure, plastic and porcelain
- Capability to adapt well to the cavity walls. if not an adhesive material
- Nonconductive of electrical currents in the oral cavity
- No corrosion in the oral environment
- Not sensitive to moisture contamination during placement
- Minimal thermal and dimensional changes during setting and at the "set" phase.
- Coefficient of thermal expansion similar to enamel and dentine

Technical Features for the Provider

- Easy manipulation (preparation and application)
- Easy fabrication and reparation properties
- Easy trimming and polishing qualities
- Safe to handle
- Requires minimal preparation of the tooth for placement
- Able to be repaired in the mouth
- When warranted, easy to diagnose the need for replacement. and then easy to replace or repair
- Relatively insensitive to the technique of the provider.

Patient Acceptability

- Reasonable cost to the patient
- Natural appearance (colour and translucency)
- Esthetic Stability of colour and translucency
- Functional
- Long-lasting (ideally. a lifetime)
- Safe.
- Absence of taste odor and oral tissue irritation(pulp. gingiva)
- Resistance to staining from food, drinks, cigarettes.

Clinical Aspects

- Biocompatible with oral tissues and normál metabolic and physiological processes
- Anticariogenic
- Not disposed to the accumulation of dental plaque
- Long-lasting (e.g., 95 percent survive at least 10 years)
- Able to determine when replacement is necessary based on recognizable clinical measurements such as clinical examination and/or X-ray.

Although this list is extensive, undoubtedly there are additional desirable characteristics for a dental facet material. Given the number and range of characteristics, it is not surprising that no restorative material available today meets all, or even most, of the requirements for each category of ideál properties. Every dental procedure requires the use of materials. It is thus obvious that the choice of material given for any application is dependent on choice of material for a given application and the ability to carry out manipulative procedures to gain optimum properties of that material.

1.6 DENTAL MATERIAL PHILOSOPHY

*	**Conventional**	Except in rare situations, currently used dental materials are safe in the mouth. The important criteria are how durable, natural looking, inexpensive, and practical it is for the dentist and dental laboratory to use.
	Sensitivity	Because some people have a sensitivity to certain substances, the choice of dental materials may have to be limited. A speciál blood test may be utilized to determine sensitivity to corrosion by-products.
	Toxicity	Some dental materials contain toxic substances which, depending on exposure and other factors, may impact total toxic body load. Non-toxic alternatives should be used to decrease exposure to and accumulation of scientifically confirmed environmental toxins.
	Interference Fields	Some dental treatment and materials can be disruptive to the normál flow of energy through the acupuncture meridians. Eastern philosophy believes chronic disruption of energy flow causes dysfunction and resultant health problems on that meridian, therefore the choice of dental materials and treatments is limited.
	Electro galvanism	Dissimilar metals in the mouth. including different formulations of the "same" metal, create micro amps of current which could cause oral pain, corrosion of the metal (black mercury amalgam fillings), | dry mouth, metallic taste, erythema (red & swollen gums), and j possible dysfunction of other organ systems, endocrine glands, etc. on : that meridian.

1.7 BASIC MECHAN1CAL PROPERTIES OF DENTAL FACET MATERIALS

Knowledge of the magnitude of biting forces is essential in understanding the importance of the mechanical properties of dental materials. Maximum biting force decreases from the molars to the incisor region, and the average biting force on the first and second molars are about 130 pounds (1 pound = 4.44 Newton) force, whereas the average forces on the premolars, canine, and incisors are about 70, 50, and 40pounds force. Patients exert lower biting force on bridges and dentures than on their normál dentition. For example when the first molar is replaced by fixed bridge, the biting force on the restored side is approximately 50 pounds compared with 130 pounds when the patient has natural dentition [41].

STRESS - is the force with which a structure resists an external load placed on it. It is the internal reaction to an externally applied load and is equal in magnitude but opposite in direction to the external load; although technically the internal force, this is difficult to measure and so the accepted way of measuring stress is to measure the external load applied to the cross sectional area; measured in force per area units such as kg/cm2, MPa (MN/m2), is represented by the Greek letter, sigma.

Stress = Force/Area

Just as there are three types of pure force or load, there are three types of pure stress (fig. 3), [140,35,56]:

- *Compressive*: a force that results in a decrease in length along the direction of the force.
- *Tensile:* a force that results in an increase in length along the direction of the force
- *Shear*. a force that causes a sliding displacenient of one side of a structure relative to another side.

Units of force include Kilogram, Newton, and Pound.

Tensile Compressive Shear

Fig. 3 Schernatic representation of tensile. compressive, and shear stress(Modified from Craig RG : Restorative dental materials [31])

STRAIN - is the change in length per unit length that a material undergoes when a force is applied to it; it is dimensionless because it has length per length **lin**its of measurement; is often expressed as a percentage; is represented by the Greek letter, epsilon.

Sírain = Change in Length/Originál Length

Strain can either be *elastic* or *plastic.* (Fig 4)

Elastic strain is strain that totally disappears once the external load that caused it is removed. Elastic strain is based upon the fact that a net force of zero exists between two atoms when they are at equilibrium. If a compressive or tensile force is exerted on the atoms, an opposite force will attempt to move them back to their equilibrium position. When the applied force is released. the atoms retům to their originál position; therefore, the material is not permanently deformed.

Plastic strain is strain that permanently remains once the external load that caused it is removed. It occurs when the force applied to the atoms moves them so far from their equilibrium position that they do not return to it once the force is removed.

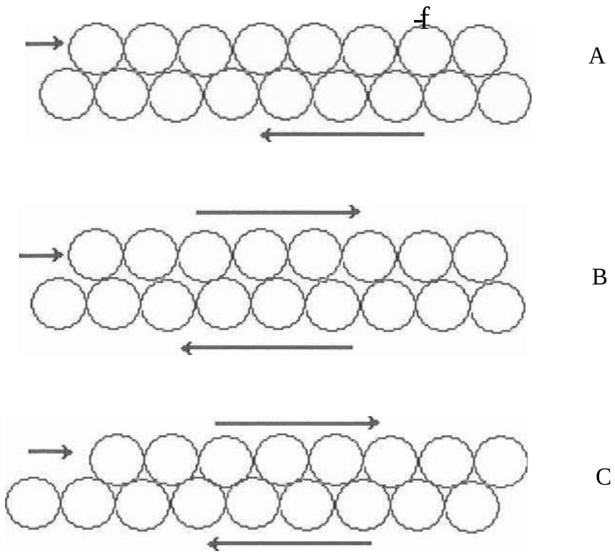


Fig 4. Sketch of an atomic model showing atoms in A: originál position, **B:** after elastic deformation, C: after plastic deformation.(Adapted from Cottrell AH: Sci Am 217{3} :90,1967)

STRESS-STRAIN DIAGRAM - is a graphic way of displaying stress and strain (fig. 5). Generally, the diagram is produced by gradually loading a material using an Instron or similar testing machine. The resultant strain values are measured and used to calculate stress values. These are then plotted against strain to produce the stress-strain diagram for the material. Traditionally, stress is plotted on the vertical axis and strain on the horizontál axis. Many of the basic physical properties of dental materials can be represented on a stress-strain diagram. For example:

—the straight part of the line represents the region of elastic deformation

—the curved part of the line represents the region of elastic and plastic deformation

—the slope of the straight part of the line represents modulus of elasticity

—the length of the curved part of the line represents ductility (which is the ability of the material to be plasticaliv deformed)

—the area under the straight part of the line represents resilience (is the resistance of the material to be permanently deformed)

—the area under the entire line represents toughness (resistance of the material to fracture) [141] [36] [37] [51] [52] [53] [56] [122] [168]

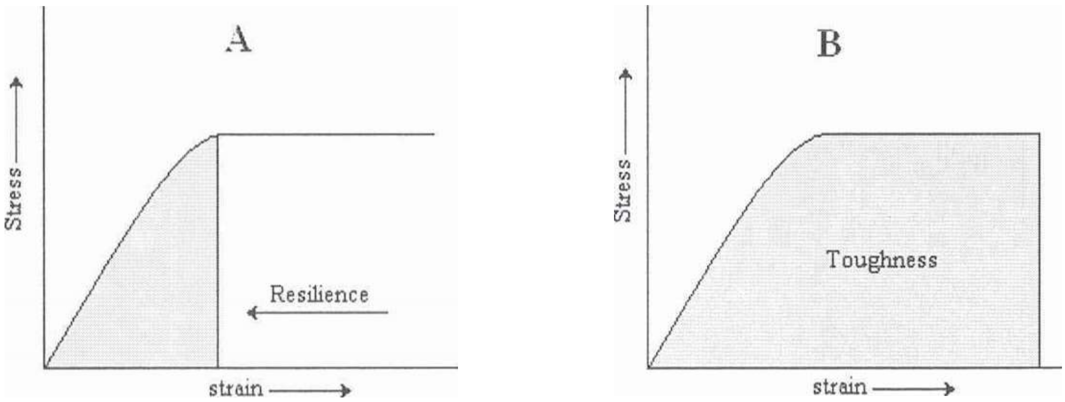


Fig. 5, Stress-strain curves illustrating the areas that give a measure of the resilience, A, and toughness, B. [1 18]

MODULUS OF ELASTICITY (ELASTIC MODULUS, YOUNG'S MODULUS)

Is a measure of the relative stiffness or rigidity of a material. The unit values are those of force per area because Modulus of Elasticity = Stress/Strain. The elastic modulus can be determined from the stress strain diagram by calculating the ratio of stress to strain or the slope of linear region of the curve [141].

Stiffness is important in selection of the restorative materials, since large deflections under stress are not desired [50].

PROPORTIONAL LIMIT - is the amount of stress required to produce permanent deformation of a material; can alternatively be defined as the limit of proportionality of stress to strain; is represented on the stress-strain diagram as the point vvhere the plotting converts from a straight line to a curve. Below the proportional limit, stress is proportional to strain. Stresses below the proportional limit cause elastic (non-permanent) deformation and those above it cause elastic and plastic (permanent) deformation. A high proportional limit is desirable for a restorative facet material. . A plastic with low proportional limit will begin to deform permanently at a low stress, and if the percentage elongation is relatively high, it will deform permanently to a considerable extent before rupture. If the proportional limit is high. then considerable stress is required before any permanent deformation will occur.

ELASTIC LIMIT - is the maximum amount of stress that a structure can vvithstand and still return to its pre-stressed dimensions; it is, for all practical purposes, the same as the proportional limit.

YIELD POINT - is the point of first marked deviation from proportionality of stress to strain on the stress-strain diagram; it indicates that the structure is undergoing a pronounced degree of deformation with little additionally applied stress.

YIELD STRENGTH - (table 1) is the amount of stress required to produce a predetermined amount of permanent strain (usually 0.1% or 0.2% which is called the percent offset). Although many feel it is equivalent to proportional limit, it is a useful property because it is easier to measure than the proportional limit. This is because you are already a certain way out on the stress-strain curve and are not attempting to measure the exact point where proportionality of stress to strain ends. It is measured using the stress-strain diagram by locating the point 0.1% or 0.2% out on the strain axis and drawing a line up to the curve which is parallel to the line found in the elastic region.[141] [143]

Material	Yield strength(MN/m^2)
; Human dentine	165
Human enamel	344
Gold alloys	207-620
Composite plastics	138-172
: Unfilled acrylic plastic	43-55
i Nickel-chromium allov	359
Cobalt-chromium allov	710

Table 1. Yield strength of selected dental materials. [143]

ULTIMATE STRENGTH: (table 2) is the maximum amount of stress that a material

withstand without undergoing fracture or rupture. It can be applied to compressive, tensile, or shear stresses (i.e., compressive strength is the maximum amount of stress that a material can withstand without undergoing fracture or rupture in compression).

Material	Tensile strength		Compressive strength	
	Kg/cm^2	MN/m^2	Kg/cm^2	MN/m^2
Human dentine	490	48	3010	297
Human enamel	105	10	4060	400
Composite plastics	420-700	41-69	1750-3010	170-300
Unfilled acrylic plastics	280	28	980	97
Porcelain(feldspathic)	350	40	1540	150

Table 2. Ultimate strength of some dental materials. [143]

FRACTURE STRENGTH - is the amount of stress required to produce fracture or rupture.

BRITTLENESS - is the material behavior where a material undergoes fracture or rupture with little or no prior permanent deformation. Materials that are brittle usually have a very ordered atomic structure which does not permit the easy movement of dislocations. A good example is the class of materials known as ceramics. Their ordered atomic structure does not permit easy dislocation movement. and hence, they are brittle. Brittle materials are sensitive to interna! flaws/cracks/voids and do not respond well to tensile or bending forces because these forces tend to propagate the flaws/cracks/voids. Brittle materials do well under compressive forces. however, because they tend to close cracks.

TOUGHNESS - (Fig.6) is the resistance of a material to fracture under sudden impact or the amount of energy absorbed by a material when it is stressed to a point just shy of its fracture point. It is the area under the entire stress-strain diagram. Strong materials are generálly tough. Toughness is primarily a concern where materials are brittle. A great deal of effort has been expended in dental materials research in an attempt to find ways of increasing toughness. [93] [106] [147]

Fig. 6. The area showing under elastic and plastic portions of the Stres s-Stann curve representing the toughness of a material.

Toughness

strain •

FRACTURE TOUGHNESS - is a measure of the resistance of a material to fail from crack propagation. It is most often measured by using a single-edge notch, three-point loading test. Since fracture toughness is an inherent property of a material, it telis more about the material than transverse strength which is more dependent upon specimen preparation. May arise naturally in the material or nucleate after time in service. In either case. any defect generally weakens a material. Because fracture toughness relates to crack propagation as opposed to crack initiation, surface condition is of little importance. Sudden catastrophic fractures typically occur in brittle materials that don't have the ability to plastically deform and redistribute stresses. [47] [40] [166] [176]

Material	KIC(MN m~^{3,2})
Human dentine	3.1
1 Human enamel	0.6-1.8
Porcelain	2.6
Composite plastics	0.8-2.2
! Ceramic	1.5-2.1
| Amalgam	1.3

Table.3 - Fracture toughness (K1C) of selected dental materials. [141]

TRANSVERSE STRENGTH (FLEXURE STRENGTH, MODULUS OF RUPTURE)

Is a measure of how a material behaves when under multiple stress. It is measured by subjecting a beam of the material to three-point loading (3PB) which results in the development of compressive stresses on the top of the beam. tensile stresses on the bottom. and shear stresses on the sides (fig.7). Compressive stresses convert to tensile ones through the neutral axis along the center of the beatn. This type of test is reserved for materials like long bridges spans and denture base resins that experience these types of multiple stresses during biting function. The test is very sensitive to specimen preparation, specifically to the condition of the surface on the tensile side (table. 4).

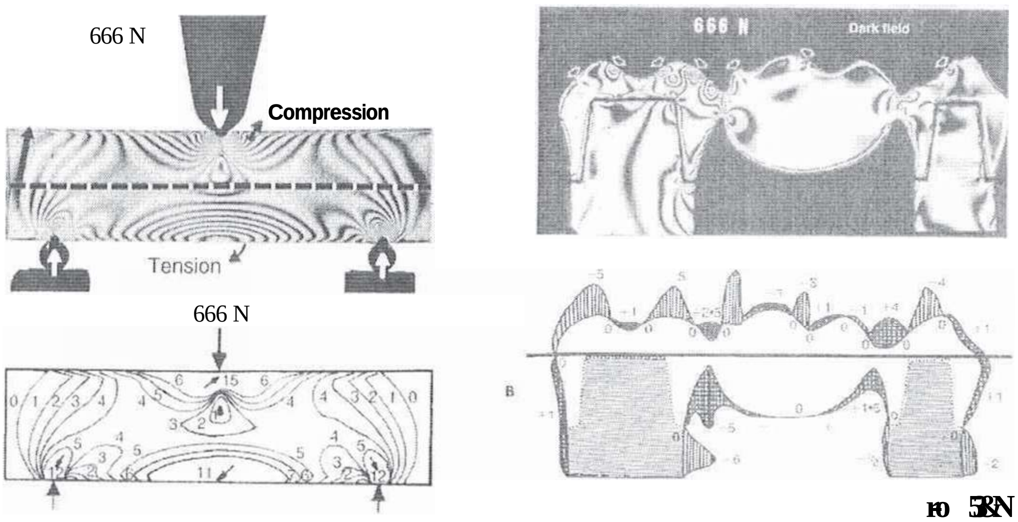


Fig 7. Stress distribution in a model of a dental bridges showing **A,** the isochromatic fringes or lineš of constant stress when loaded in compression, and **B,** the fringe order or a measure of the magnitude of the stress at the periphery [48] [77].

Material	Transverse Strength(MPa)
Gold foil	292
Composite plastics	139
Amalgam	124
Porce lain	65

Table.4 - Values of transverse strength for some restorative dental materials **[141].**

FATIGUE: Fatigue refers to the fact that under cyclic loading a material will undergo failure at a lower applied stress than it normally would if it were not under cyclic loading. The name "fatigue" is derived from the fact that the materials seem to tire under this type of repetitive loading. Two common ways are used to discuss fatigue; *endurance limit* and *service lifetime.* Endurance limit is the maximum applied stress that a material can withstand and still have an unlimited number of cycles to failure. Service lifetime describes a way of predicting the number of cycles to failure a material can be expected to undergo prior to failure when it is loaded with a specific force. Fatigue leads to failure of materials because it promotes crack propagation. Surface conditions (roughness and sharp angles) promote fatigue failure. Fatigue has a role to play in the failure of dental facet materials.

LINEAR COEFFICIENT OF THERMAL EXPANSION

Is certainly one of the most important thermal properties in the field of dentistry in which changes in dimensions because of environmental variations are of unusual concern.

The linear coefficient of thermal expansion is defined as the change in length per unit length that a material undergoes when it is subjected to a 1°C change in temperature. This number, which varies from material to material. is often expressed in exponential form.

The basis for coefficient of thermal expansion relates to the fact that at equilibrium, atoms are at their lowest energy level. When energy is applied to them, they begin to vibrate and move apart. This results in a gross expansion of the material. A relationship exists between coefficient of thermal expansion and melting point in that materials with low melting points exhibit large coefficients of thermal expansion. This is because their inter-atomic bond strengths are low and their atoms easily move apart when energy is applied. The opposite is true for materials with high melting points. Because their inter-atomic bond strengths are high, they exhibit small coefficients of thermal expansion. When coefficients of thermal expansion of a restorative material and tooth structure are different, they expand and contract to differing degrees as temperatures change; this promotes leakage at the interface between them [82].(table.5)

Material	Coefficient(x 10~7°c)
Human teeth	10-15
Composite plastics	25-50
Gold alloys	12-15
Unfilled acrvlic	70-100
Porcelain	8
Inlav wax	300-1000

Table.5. Linear thermal coefficient of extension of dental materials in the temperature range of20°to 50° C. [82]

THERMAL CONDUCTIVITY

Has been used as a measure of the heat transferred and is defined as the number of calories per second **flowing** through an area of lcm2 in which the temperature drop along the length of the specimen is Idegree C/cm. The higher the value, the greater is the material's ability to conduct thermal energy. These values may vary according to the specimen material and have been measured for tooth structure, cements, and dental amalgam [1].(table.6)

Material	Thermal conductivity(cal/sec/cm^2[°C/cm])
Human enamel	0.0022
Human dentine	0.0015
Composite plastics	0.0025
Gold alloys	0.7100
Unfilled acrvlic	0.0005
: Porcelain	0.0025

Table.6 - Thermal conductivity of dental materials[82].

THERMAL DIFFUSIVITY

Measures the rate of transfer of thermal energy when the heat source is fluctuating (table 7). This may be a more important property in dentistry than thermal conductivity because temperatures change rapidly in the oral cavity. It can, for exarnple. be related to the ability of a base material to protéct a tooth from thermal damage. The effectiveness of a base material in this regard is inversely proportional to the square root of the thermal diffusivity.

Material	Thermal Diffusivity(mm^2/sec)
Pure gold	119.0
Amalgam	9.6
Composite plastics	0.675
Porcelain	0.64
Enamel	0.469
Zinc phosphate cement	0.290
Glass ionomer cement	0.198
Dentine	0.183
Acrylic resin	0.123

Table.7. Thermal diffusivity of various dental materials [141].

HARDNESS

Hardness can be defined as resistance to permanent indentation. [42]

Reasons to know about hardness:

We study hardness not so much for the property itself but as an indicator of other properties; it is, however, sometimes valuable to know just how hard a material is. For example, knowing that the base metal alloys are 30% harder than the Type IV gold alloys indicates that speciál finishing equipment will be needed to finish them.

Hardness can also be used as an indicator of:

*resistance to wear - although hardness is not an absolute indicator of wear resistance, in the case of resin composites it has been shown that hardness of the matrix plays a major role in resistance to wear

* strength - some materials like gypsům show a relationship between hardness and strength

*degree of polymerization - hardness indicates degree of monomer conversion in denture base resins and resin composites; higher hardness values indicate a greater degree of polymerization.

*depth of cure of resins - depth of cure of light-activated resins can also be evaluated using hardness tests. This is done by light activating a composite specimen of known depth. measuring the surface hardness, then turning it over and measuring the hardness on the bottom surface: to be considered completely polymerized. the bottom surface must be at least 80% as hard as the top surface. [97]

Thickness of the tested specimen is important in performing hardness tests because if the specimen is too thin, you will actually be measuring the surface beneath the specimen and not the specimen itself. Changes in the indenter tip (dulling, in particular) can alter the accuracy of the hardness test.

One of the most commonly used tests for measuring the hardness of dental materials, the Knoop hardness test is a microindentation test using a pyramid-shaped diamond indenter with a rhomboidal base. It can be used for measuring hardness of both ductile and brittle niaterials(table.8) Higher values for KHN represent harder materials. [42] [97] [169] [195]

Material	(KHN) Knoop Hardness Number (kg/mm^2)
Porcelain	460
Human enamel	343
Human dentine	68
Hybrid resin composite	36
Microfill resin composite	25
Unfilled acrylic	21

Table.8. Knoop Hardness Numbers (KHN) of dental materials [122].

1.7.19 WEAR

Wear is the loss of material from one or both of two contacting surfaees because of the mechanical activity between them. It is a complicated process and is affected by properties such as ductility, hardness. and ultimate strength.

Four ty pes of Wear.

1. A braši ve
2. Adhesive
3. Fatigue
4. Corrosive

Abrasive or Frictional:

It happens when a smooth, soft surface is worn away by a rough, hard surface.

It is important to note that abrasive wear can either be two-body or three-body; two-body may convert to three-body if portions of the sliding surfaees break away and act as an abrasive. Hardness is not an absolute indicator of wear and wear resistance. Hard surfaees do not necessarily exhibit greater wear resistance than do soft surfaees.(table.9)

Two requirements for abrasive wear are: 1- there must be a definite difference in hardness between the two surfaees 2- the harder one has to be the rougher.[86.87]

Material	mm
Enamel- Composite	95
Enamel- Enamel	125
Enamel- Ceramic	160

Table.9. Abrasion of dental surface occurring naturally by masticatory mechanism.

Adhesive:

It oceurs when asperities (microscopic projections) from the two contacting surfaces adhere or cohere to each other and fragment as the surfaces move. This is the most common type of wear and the most difficult one to prevent because even the most high ly polished surfaces exhibit asperities.

Fatigue:

It occurs when fatigue from cyclic loading causes cracks to develop under the contacting surfaces; the sliding action then causes the surfaces to be lost.

Corrosive:

Occurs when two contacting surfaces corrode and the sliding action causes the corrosion by-products to be worn away.

WEAR TESTING:

In vitro testing: the basic problém with laboratory wear testing of dental materials is that laboratory tests frequently have little predictive value as to what will happen intraorally.
The reason is that usually the test process has to be accelerated in an attempt to produce data in a reasonable period of time. This skews or distorts the results and reduces their predictive ability.

Some in vitro tests for wear do exist:

1. Weight loss and volume loss
2. Two-body and three-body wear
3. Indentation hardness
4. Surface profilometry

In vivo testing: in vivo wear evaluation may be either direct techniques in which existing clinical wear is compared using established categories to assess degree of wear. or indirect techniques which utilize replicas that are microscopically examined or are compared to standardized dies. [68.87,132.144.167,194]

Characteristics of an ideál abrasive:

1. Irregular shape
2. Harder than the surface it is intended to abrade
3. High impact (or body) strength
4. High attrition resistance

Porcelain is a good example of the fact that intraoral wear must always be considered to be a coupled phenomenon; not jList the involved material should be examined for wear, but also the opposing dentition or restorative material.

DIMENSIONAL CHANGE: Affects a wide range of dental materials. For some materials, like investments, dimensional change is both necessary and beneficial. For other materials, such as resin composites, dimensional change is an unwanted propeity.[16.17,30,160,163].

Three Sources of Dimensional Change: 1.Thermal. 2.Chemical, 3.Mechanical

Thermal dimensional change:

Occurs when thermal energy is added to a systém: atoms move away from their equilibrium positions and dimensional change results.

Chemical dimensional change:

Takés pláce when reactants come together and produce a product having a volume that is different than that of the reactants. A good example is the denture base resins which undergo a volumetric shrinkage of 7% when polymer is added to monomer in a ratio of 3:1 by volume.

Mechanical dimensional change:

Is simply strain. the change in dimension that occurs when a load is applied to a material.

1.8 CERAMICS AND THEIR GENERAL PROPERTIES

Types of dental porcelain:

Dental porcelain is generally classified into three different types according to its fusion temperature:

1. High - fusing: 1200 to 1400C
2. Medium-fusing: 1050 to 1200 C
3. Low-fusing: 800 to 1050 C

High fusing porcelains are used to manufacture artificial denture teeth but rarely for tooth restoration. Medium and low fusion porcelains are used in the construction of all-ceramic restorations such as the porcelain jacket crown. A metal-ceramic crown utilizes low fusion porcelain. The most common ceramics in dentistry are alloys of three main metallic oxides (Sio2. AL203, K20) [l 03] [12].

Here I shall not be going into detail of the chemical structure of my chosen materials as that their biochemistry is not my topič of discussion.

METAL CERAMIC RESTORATIONS

Metal ceramic restorations combine the strength and accuracy of cast metal with the esthetics of porcelain. Their use has grown markedly in the last 30 years as a result of technical improvements. However, restraint should be exercised in the selection of these types of restorations, as there is a tendency to overuse it. Metal ceramic restorations should not be substituted for less destructive types of restorations when the latter will serve as well. A 1986 survey of 80 dentists revealed that 70% of them placed metal ceramic crowns on their patient's posterior teeth 70% to 100% of the time. but the same dentist indicated a preference for partial veneer gold crowns in their own mouths. [23]The metal ceramic crown has gone by a variety of names since its introduction to dentistry nearly four decades ago. It was called, at different times and in different parts of the world. a "ceramco crown" (for one of the first brands of porcelain used for fabrication this type of restoration), a"porcelain veneer crowns" (PVC),"porcelain fused to gold" (PFG), as well as "porcelain fused to metal" (PFM), a term commonly used in dental literature during the 1970s and '80s.

Metal ceramic is more precise term scientifically, and it is compatible with the terminology used to describe all ceramic crowns, inlays, veneers, etc. Because there seems to be a proclivity in the English language for three letter abbreviation, MCR appears to be a reasonable abbreviation for Metal-Ceramic Restoration. The metal-ceramic restoration is composed of a metal casting. or coping, which fits over the tooth preparation and ceramic that is fused to the coping. The coping may be little than thin thimble, or it may be clearly recognizable as a cast crown with some portion cut away. The contours in the area that has been cut away will be replaced with porcelain that will mask or hide the metal coping. produced the desired contours, and make the restoration esthetically pleasing. The metal coping in a metal-ceramic restoration is covered with three layers of porcelain (fig.8):

1. Opaque porcelain conceals the metal underneath. initiates the development of the shade. and plays an important role in the development of the bond between the ceramic and the metal.
2. Dentine, or Body, porcelain makes up the bulk of the restoration, providing most of the color, or shade.
3. Enamel. or Incisal. porcelain imparts translucency to the restoration.

Other porcelains, such as opaque or dentine modifiers, or clear porcelain, are utilized with in the three basic layers for speciál effects and characterization.

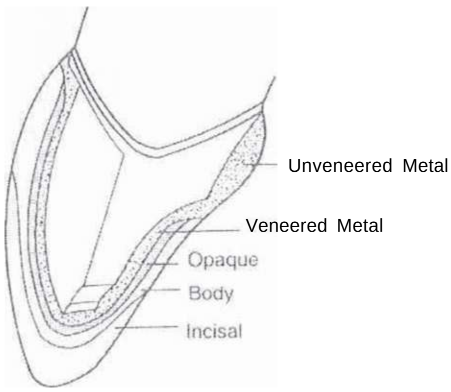


Fig.8. Layers of a metal-ceramic restoration [64].

There are two principál reasons for acceptance of metal-ceramic restorations. First, they are more resistant to fracture than the traditional all ceramic crowns, the porcelain jacket crown (PJC), because the combination of the ceramic metal bonded together is stronger than the ceramic alone, the strength of ceramic metal restorations depends on the bond between ceramic and metal substructure, the design and rigidity of metal coping, and compatibility of the metal and porcelain, second, the MCR is the only dependable means of fabrication an esthetic fixed partial denture when full coverage is required on one or both retainers.

Bonding mechanism

Four mechanisms have been described to explain the bond between the ceramic veneer and the metal substructure:

1. Mechanical entrapment.

2. Compressive forces

3. Van der waaPs forces

4. Chemical bonding

Mechanical entrapment - creates attachment by interlocking the ceramic with micro abrasions in the surface of the metal coping. which are produced by finishing the metal with non contaminating stones or discs and air abrasions. When compared with unprepared metal, surface finishing enhances the metal ceramic bond. [78]

Air abrasion appears to enhance wettability, provide mechanical interlocking, and increase the surface area for chemical bonding. [21] The use of bonding agent, such as platinum spheres.3 to 6 micrometer in diameter, also can increase bond strength significantly [58].Compressive forces within a metal ceramic restoration are developed by a properly designed coping and a slightly higher coefficient of thermal expansion for the metal coping than for the porcelain veneered over it. This slight differences of coefficient of thermal expansion will cause the porcelain to "draw" toward the metal coping when the restoration cools after firing

Van der WaaVs forces'. Comprise an infinity basecl on a mutual attraction of charged molecules. They contribute to bonding. but are a minor force that is not as significant as was once thought [102]. Although the molecular attraction makes only a minor contribution to overall bond strength, it is significant in initiation of the most important mechanism the chemical bond.

Chemical bonding: is indicated by formation of an oxide layer on the metal [85,4] and by bond strength that is increased by firing in an oxidizing atmosphere. [180,43] When fired in air, trace elements in the gold alloy, such as tin, indium, gallium, or iron, migrate to the surface, form oxides, and subsequently bond to similar oxides in the opaque layer of porcelain. A gold alloy containing minuté amounts of tin and iron creates a significantly stronger bond with porcelain than a pure gold alloy does [178]. The bond strength oftrue adhesion is such that failure or fracture will occur in the porcelain rather than at the porcelain metal interface [150].The clean separation of porcelain from metal coping is evidence of bond failure from contamination of the coping surface, or an excessive oxide layer. Base metal alloys readily form chromium oxides that bond to porcelain without adhesion to any trace elements.

Alloys used: The properties of porcelain cannot be considered alone. The porcelain and metal used for restoration must have compatible meiting temperature and coefficient of thermal expansion. Conventional gold alloys have a high coefficient of thermal expansion. While conventional porcelain process a much lower value. A very small difference can produce sufficient shear stress to produce failure of the bond [150].The meiting range of the alloy used in coping must be 170-280C higher than fusing temperature of the porcelain applied to it. A similar meiting range of two materials would result in distortion or meiting of the coping during the firing and glazing of porcelain. The greater the difference, the fewer are the problems that are encountered during firing. A noble metal coping is subject to flow or creep, when it is heated to 980C [128].The porcelain used must not require that the metal be heated much beyond this point. Porcelains most commonly used for this purpose have a fusing temperature of 980C, and noble alloys melt at near 1260C. Many alloys have been used for metal ceramic restorations. A classification systém proposed by American Dental Association is based on the noble metal content [26]. High noble alloys have a noble metal (gold, platinum, palladium) content greater than 60%, with at least 40% gold. Noble alloys have a noble metal content of at least 25%, and predominantly base alloys have less than 25% noble metal content. Major constituents also are used to further describe an alloy, e.g - a gold palladium alloy. The choice of an alloy will depend on a variety of factors, including cost, rigidity, stability, ease of finishing and polishing, corrosion resistance, compatibility with specific porcelains and personál preference. No alloy systém is superior in all aspects. Alloys that have proven most satisfactory for metal ceramic crowns and fixed partial dentures are composed of gold (44-55%) and palladium (35-45%), with small amounts of gallium, indium and/tin. Disadvantage most often attributed to the gold palladium alloys are cost. and incompatibility with certain types of porcelains. Other systems developed over the past 20 years also have been successful. The choice of an alloy must be made after weighing all factors. Due to high costs of gold alloy an alternative of copper or cobalt can be used in the alloy. Unfortunately the addition of these elements cause dark-oxide formation and poor high temperature strength [112]. Subsequently formulation replaced the copper or cobalt with a small amount of gold and silver. One of the most common disadvantages of the silver containing alloys is the potential of porcelain discoloration, most commonly described as "greening" effect No systém is without disadvantage whether they be financial or technical. Other side effect of noble alloys which may be used instead of gold are briefly given below

Beryllium, which is added to alloys to control oxide formation, is a carcinogen. It can pose a hazard to laboratory personnel who may inhale it as dust in improperly ventilated work areas [104].

Nickel: approximately 5% of generál population is sensitive to nickel, and that sensitivity is 10 times as prevalent in women as in men [125].Contact dermatitis from nickel containing prosthesis appear to be a risk to some patients [84]. Nickel sensitivity should be considered in the diagnosis of any soft tissue changes that occur after crown placement [125].

Coping design

The metal coping is an important part of the metal ceramic restoration, and one that unfortunately is often overlooked. Its design can have an important effect on the success or failure of the restoration. To provide a structural integrity in function. the coping must reflect the unique relationship of the two dissimilar materials used to fabricate metal ceramic restorations. The coping must allow porcelain to remain in compression by supporting the incisal regions, the occlusal table, and the marginal ridges. Otherwise occlusal forces, will create a situation similar to applying a load to a pan of glass suspended between two saw horses. Without any underlying support, the glass would break and so will unsupport porcelain on restoration. There are four features of importance to be considered when designing the metal coping for a metal ceramic restoration [64]:

- Thickness of metal underlying and adjoining the porcelain
- Placement of occlusal and proximal contacts
- Extensions of the area to be veneered for porcelain
- Design of the facial margin

Thickness of metal

Porcelain should be kept at a minimum that is still compatible with good esthetics. Relatively thin porcelain of uniform thickness and supported by rigid metal, is strongest. The absolute minimum thickness of porcelain is 0.7mm and the desirable thickness is 1 .Omm.defeciency in incisal edge. interproximal areas, or occlusal surface of tooth preparation that have been caused by caries or previous restorations should be blocked out in the preparation or compensated for with extra thickness of the coping in those areas. An evenly flowing convex contour of the veneering area distributes stress best. Sharp angles and undercuts should be avoided. The outer junction of porcelain to metal should be at a right angle to avoid burnishing of the metal and subsequent fracture of the porcelain. An acute angle of the metal and the metal porcelain interface is more likely to produce porcelain crazing than an angle of 90 or 135 degrees [117]. On the other hand if the edge of metal at the porcelain metal junction metal line is beveled or rounded. the porcelain will end in a feathered edge, through which the oxidized metal or opaque will show. Maximum restoration strength and longevity is achieved by coping rigidity. The metal must not flex during sitting or under occlusal forces, because flexure places the porcelain in tension and leads to its shearing. The metal must be as hard as practical, and the coping design must ensure an optimum bulk for rigidity. For adequate strength and rigidity, a noble metal coping should be at least .3 to .5 mm thick [109]. A base metal alloy with a higher yield strength and elevated melting temperature may be as thin as 2mm. [186], the thickness of coping may vary. depending on the configuration of the preparation. These values are only minimum thickness for different alloy systems. The ultimate goal of achieving a uniform thickness of approximately 1 .Omm of porcelain will dictate the thickness of the metal coping.

Occlusal and proximal contacts

If the coping is designed to pláce occlusal contacts on unveneered metal surfaces, their location and area covered by ceramic can be more precisely controlled. With the less resultant wear on opposing teeth. Studies and clinical experience have documented the highly abrasive nature of dental porcelain and its deleterious effects on enamel or gold [105-190]. Jacobi et al [73] found that glazed porcelain removes 40 times as much opposing tooth structure as gold. Therefore, occlusal contacts should occur on metal whenever possible well away from the porcelain metal junction line. Contact near the junction can lead to metal flow and subsequent porcelain fracture. The porcelain-metal junction should be placed 1 .Oním from occlusal contacts at the position of maximum intercuspation. (fig.9-A)

A

Fig.9. A, Metal occlusal contact on the lingual surface of a maxillary incisor. **B.** Porcelain may fracture if the metal extends too far incisally. **C.** Porcelain occlusal contact on the lingual surface of a maxillary incisor [64].

To minimize stress resulting from occlusal contacts on the lingual surface of maxillary anterior restorations, the porcelain metal junction should not be placed in the vicinity of those contacts with the mandibular teeth [38].The porcelain metal junction must not be placed too close to the incisal edge. Incisal translucency will be destroyed and the chances of porcelain fracture will be increased greatly because the porcelain is no longer supported by metal. When occlusal forces are exerted, the porcelain will be placed in tension, a condition that it does not resist well (fíg 9-B). When there is inadequate vertical overlap to pláce the contact on metal, the porcelain metal junction is placed far enough gingivally for the contact to occur on porcelain close to the junction line (fig 9-C). A constant application of increasing compressive force on the porcelain metal junction line, irrespective of its angulations, produces failure less readily than a load applied to porcelain 1.0 or 2.0 mm from the junction.[193].Anterior metal ceramic restoration with guidance in lateral excursions and protrusion on porcelain will abrade opposing natural teeth. The patient should be cautioned that the opposing teeth eventually will require restorations. The collar of exposed metal should be at least 3.0 mm wide inscisogingivally. Whenever there will be porcelain on the Iingual surface, there must be greater tooth reduction. Proximal contacts for anterior teeth should be on porcelain which the dentists must facilitate during the tooth preparation by adequate reduction of the interproximal areas. The cosmetic effect is improved by placing the metal lingually, so that proximal porcelain has greater depth and translucency. Interproximal metal tends to darken the unrestored proximal surfaces of adjacent teeth. An optimum stress distribution also occurs when porcelain-metal junction is Iingual to the proximal contact areas [39]

Extent of veneered area

To pláce occlusal contacts in metal, the porcelain on the facial surface extends over the cusp tip and about half of the way down the Iingual incline of the facial cusp on the maxillary premolars and molars [66].there must be around it a ledge of metal under the facial cusp to support the porcelain.(fig 10-A).Without a supporting ledge the ceramic will fracture (fig 10-B) .this configuration will satisfy the cosmetic requirements of most patients and provide longevity if the porcelain metal junction is kept away from the occlusal contacts .This design is more resistant to fracture than those in which the porcelain extends to the centrál groove or covers the entire occlusal surface [100].

A B

Fig.10. Proximal views of a maxillary posterior metal-ceramic coping with (A) and without (B) proper metal support under the facial cusp [64].

Mandibular first premolars will require complete porcelain coverage of the occlusal surfaces of metal ceramic crowns placed on them. The degree of porcelain occlusal coverage on metal ceramic crowns for mandibular molars and second premolars will be dictated by the patient's wishes, occlusal restoration of the opposing arch, and the presence or absence of bruxism. The distal half of premolars and molars can be unveneered to allow more occlusal contact to be on metal, if the patient can be satisfied with the tooth colored veneer on the mesial marginal ridge proximal contact, fossa and cusp incline. If the patient is extremely concerned about esthetics the occlusal surfaces of mandibular molars can be covered by porcelain. A 1.0-2.0 mm wide metal collar can be used on the facial surface to minimize the destruction of tooth structure for facial solder. The patient should be informed of the potential damage to opposing teeth and the necessity for a more destructive crown preparation to provide adequate space for porcelain. In the finál analysis, it is the patient's mouth, and hence the finál decision belongs to the patient.

A posterior crown with porcelain occlusal coverage should have 3.0mm metal collar on the lingual, with the metal support under the marginal ridge. Also the greater portion of the crown will be veneered with porcelain.

Facial margins

For many years, the conventional facial margin for a metal ceramic crown was a narrow metal collar. To avoid an unesthetic display of metal on highly visible teeth, the facial finish line often was placed subgingivally, which may eontribute to chronic gingival inflammation or more serious periodontal problems. Gingival recession may occur from the trauma of tooth preparation, impression making, or an improper contour provisional restoration. Following cementation, 60% of subgingival margins beconie visible within a 2 year period [185]. The association of subgingival crown margins and detrimental effects on the periodontium is well documented [181,152.153,94].To avoid showing an unsightly band of metal, porcelain was extended onto the collar itself. This can create an over contoured gingival margin, thin. fracture prone porcelain, or an undetected open margin. The frustration with esthetics of conventional metal collar lead to the usage of all porcelain facial margin, which can be done with the gingival or even a slightly supra gingival position. An improvement in periodontal health was an unexpected bonus.

Improved esthetic and periodontal health made the all porcelain margin popular, and the demand spawned many ways of fabricating one. A number of studies have shown the accuracy of all porcelain margins to be quite acceptable, the quality of margins is directly related to skills of ceramist [5,10,69.184,187].

1.9 CAST METAL AND METAL-CERAMIC RESTORATIONS

Cast metal restorations such as crowns are indirect restorations generally requiring two or more appointments. The successful fabrication and placement of these restorations depend on close attention by the dentist and laboratory technician to minuté details in a multi procedural, step-by-step process. Each restoration is designed carefully to restore anatomy, function, appearance, and comfort. The decision to restore with crowns, and/or bridges depends on many factors, including the degree of tooth destruction, esthetic needs, missing teeth. oral hygiene, and the financial capability and desires of the patient. Cast metal posterior inlavs only cover a portion of the occlusal surface. It is believed that these inlays weaken the tooth and may lead to cuspal fracture (Norman. 1991). Therefore, crowns that cover and protéct the cusps are the reconimended restoration for high stress-bearing situations where there is inadequate natural tooth remaining to support a direct restorative material and where one or more cusps need replacement. Since tooth preparations for full crowns are easier for the dentist to prepare and are less likely to involve the pulp than tooth preparations for an onlay, they are becoming the cast restoration of choice when cuspal coverage is indicated.

The selection of casting alloys depends on the location of the tooth in the mouth, the presence and type of adjacent restorations and opposing teeth. the need for esthetics, and the patient's financial capability. Casting alloys for metal-ceramic restorations are divided into three categories: high noble, with at least 60 % noble metal content and at least 40 % gold; noble metals, with at least 25 % noble metal; and predominantly base metal, which has less than 25 % noble metal. The noble metals in casting alloys are priinarily gold, platinum, and palladium (ADA, 1984). Base metal alloys, which can include nickel, beryllium. cobalt and chromium have gained widespread use, because of their low cost and superior physical properties. These properties include: high mechanical strength. resistance to sag when fired with porcelain at high temperatures, porcelain bond strength, thermal compatibility between porcelain and metal, and resistance to corrosion. A survey of dentists in Minnesota by Olin et al. (1989) revealed that 62 % of dentist prescriptions written in that year were for base metal alloys. Fabricating fixed prosthetics like crowns is extremely technique-sensitive, and the skill and attention to detail by both the dentist and technician play a major role in the longevity of these devices.

Metal-ceramic restorations PFM (Porcelain Fused to Metal,) combine the strength of cast metal with the esthetics of porcelain. In these restorations, porcelain is baked onto a thin coping (cast metal substructure) prepared from an impression of the tooth. Metal-ceramic restorations have been successfully employed for single crowns and multiunit bridges for the past 30 years. These restorations are used for more than 60 % of the crown and bridge restorations performed (Anusavice, 1991).

One of the main disadvantages of metal-ceramic crowns is the high abrasive potential of ceramics relative to opposing natural teeth or other dental materials. Mahalick et al. (1971) reported a high wear rate of enamel-porcelain surface interactions. as compared to gold alloy against enamel. DeLong et al. (1986) reported a high coefficient of friction between enamel and dental porcelain and concluded that the wear of porcelain appears to be one order of magnitude (10X) greater then that of dental amalgam. When the surface of the porcelain is roughened through occlusal adjustment, care must be taken to restore a highly polished surface or severe wear of the opposing tooth structure may result. Schwartz d al. (1970) reported a mean lifetime of 10.3 years for full metal crowns. Recurrent caries was the primary cause of failure for 58 % of the crowns. Kerchbaum and Voss (1977) estimated that only 3 % of PFM restorations failed over a 10-year period. When properly fabricated, however, it is likely that a cast metal or metal-ceramic restoration will be in service for many years longer than large, direct restorations.

The failure rates reported for PFM restorations appear to be relatively low (Kerchbaum and Voss, 1977; Coomaert et al., 1984; Glantz et al., 1984; Leempoeletal., 1985; Christiansen, 1986). The reasons for failures of PFM crowns and bridges fall into five major categories: (1) clinical deficiencies, (2) laboratory deficiencies, (3) inadequate dentist-technician communication, (4) technique sensitivity of materials, and (5) patient factors. The principál cause of failure varies considerably among dentists and among laboratory technicians.

The success of any cemented restoration will depend on the strength and lack of solubility of the luting agent (cement), as well as the ability to achieve an extremely close Fit between the tooth and restoration. A tight junction must be established between the restoration and the finish line of the preparation on the tooth. A space of only 50 microns between the restoration and tooth will result in a visible cement line. This cement line eventually will result in a defective seal that will permit progressive dissolution of the cement from beneath the restoration. When the cement dissolves, food particles, oral fluids, and bacteria can enter the defect and may cause caries in the supporting tooth (Zander. 1957).

There are limits to the use ofPFM and cast metal restorations. For the most part. they are used only on permanent teeth in adults because the necessary removal of tooth structure for proper fabrication would threaten pulp vitality in children and even many young adults. Also, the restorations are costly, amounting to more than eight times the cost of amalgam.

1.10 COMPARISON OF CERAMICS WITH OTHER MATERIALS

Comparison of ceramics with metallic materials

It is not always possible to make a sharp distinction between these two classes of materials. For example, compounds between metals and metalloids. such as carbides, maybe considered to be either ceramics, or inter-metallic compounds. Nevertheless, it is useful to compare a contrast typical metals and ceramics:

A: *Chemical properties*: many metals and alloys can corrode whereas ceramics are very resistant to chemical attack.

B: *Mechanicalproperties*: metals have value for tensile and compressive strength which are of comparable order of magnitude. On the other hand, ceramics are considerably stronger in compression than in tension. They are also usually much more brittle than metals, and have low impact strength.

C: *Thermal and electrical properties*: Metals are good conductors ceramics are good insulators.

Comparison of ceramic with polymeric materials

A: *stability:* polymers at high temperature are usually less stable than that of ceramic materials.

B: *Mechanical properties*: Generally polymers are less rigid and more easily capable of plastic deformation than ceramics.

C: *Crystallization:* Polymers and ceramics in generál crystallize less readily, and have more complex structures than metals and alloys.

Ceramic substances are composed of compounds of metallic and non-metallic elements. Examples include oxides, nitrides and silicates.

Dental porcelain is essentially a glass prepared from high purity feldspar. it sometimes contains crystalline phase for example to give increased strength.

Simple ceramics found in use in dental materials include alumina (aluminum oxide), silica (silicon dioxide) and tungsten carbide. Complex ceramics include potassium aluminum silicate (potash feldspar) and hydrated aluminiím silicate (kaolin).

Dental porcelains are finely ground ceramic particles that are pigmented to provide colors that approximate natural tooth structure.

1. Chemical properties

Ceramics in generál are extremely resistant to attack by chemicals, a property that is of great advantage to dental applications. To dissolve a ceramic a strong chemical such as hydrofluoric acid is required [177].

2. Mechanical properties

Ceramics are said to have excellent biocompatibility, chemically inert, can have excelient esthetics because of their: translucency, capability of being pigmented, good colour stability, stain resistance.

One of the problems associated with ceramics is their liability to fracture in tension. They exhibit little plastic deformation. because dislocation movement requires high energy, and the impact resistance of many ceramics is low. Stress within the material can cause internal cracks, which can propagate rapidly through a material until fracture occurs. Several factors can cause stress:

- Dislocation in crystals
- Cooling of sarnple from its firing temperature, due to differences in the coefficient of thermal expansion between different phases in materials.
- Abrasion of surface can cause stress concentration to occur. The stress is concentrated where there is any irregularitv of contour
- Porosity within a material

3. Thermal properties

The thermal conductivity and coefficient of thermal expansion of these materials is very low. This is because there are no free electrons, as in metals.

4. Optical properties

From the dental point of view, these are excellent dental porcelains which are translucent because there are no free electrons (in contrast to metals) and can be colored to match the shadeof teeth. [177]

Aclvantages:

- Superior to direct materials in high stress-bearing areas
- Excellent wear resistance; low abusiveness against tooth enamel (gold and glazed or polished porcelain)
- Excellent longevity

- Excellent biocompatibility
- Esthetic (metal-ceramics).

Disadvantages:

- High cost
- Require at least two appointments for fabrication
- Possible wear of opposing teeth
- Allergic reactions in some people
- Corrosion
- Potential for galvanic reaction
- Technique-sensitive, requires moderately high level of clinical skill

Indications:

- In situations where high stress is expected
- For moderate-to-severe breakdown of the natural tooth, requiring cusp replacement
- When the patient demands esthetics rather than conservative treatment (metal-ceramic).

Contraindications:

- In patients under 18 years of age
- In patients with extremely high biting forces; in moderate to high occlusal force situations, metal occlusal surfaees are indicated to reduce wear of opposing teeth/restorations and to reduce the risk of ceramic fracture
- Where there is evidence of extensive bruxing and/or clenching
- When there is documented allergy to the metals used in casting alloys (speciál concern in females forwhom up to 9 percent may demonstrate nickel allergy).

1.11 PLASTIC FACET MATERIALS IN FIXED PROSTHODONTICS

The use of synthetic resins in Czech Republic has become an essential part of prosthodontic treatment. Resin materials may be indicated for an individual restoration or as a veneer over a časting. As an esthetic alternative to porcelain, the resin restoration offers the advantages of low cost, convenient repair, ease of fabrication, and no abrasion of opposing dentitions. Whereas acrylic resins have dominated resin applications for years. more refined polymers have emerged and assumed a more extensive role. Current resin materials are not a replacement for dental porcelain, but clinical situations arise when resin is indicated; e.g., function and economics.

TYPES OF SYNTHETIC RESINS

Currently used resins may be classified as:

- Type I (acrylic)
- Type II (dimethacrylate)
- Type **III** (composite)

The acrylic resins are powder-liquid systems based on methyl methacrylate polymer beads and monomer liquid. They are similar to the self-cured acrylic resins available for custom trays and denture bases. The dimethacrylate resins replaced the methyl methacrylate with higher-molecular-weight dimethacrylate monomers. Because these monomers are high boiling and difunctional, they are cured at higher temperatures and yield cross-linked resins that are wear resistant. The composite resins are similar to composite restorative filling materials. They contain dimethacrylate monomers, usually B1S-GMA or related monomers, or urethane dimethyacrylates and inorganic filler.

Properties

The properties often investigated that are critical to the clinical behavior of resins include wear resistance. color stability, water sorption, coefficient of thermal expansion, hardness, compressive strength, and tensile strength. While direct correlations have not been fírmly established between laboratory properties and clinical behavior. they are helpful in understanding the limitations of resins and offer guidance when selecting a material for a patient.

Early resin formulations were low-strength resins with high water sorption and low hardness [127]. As a result, wear resistance, color stability, and deformation were noted [129,32]. A common clinical finding is an accelerated loss of material, exposing the metal framework. This requires repair with a direct filling resin or fabrication of a new restoration.

The disparity in thermal expansion between the resin and metal framework, including a lack of adhesion of resin to the metal, precipitates the percolation of oral fluids at the resin-metal interface, which contributes to a discoloration of the resin and corrosion of non-noble casting alloys .[72,90.156]

The low modulus of elasticity and proportional limit associated with the resin veneering materials necessitates a suitably designed metal framework for support during function to prevent plastic deformation.fi 29] Processing porosity also leads to weakness of the resin, opaque appearance, potential for incubating microorganisms, and tissue irritation due to roughness.[165,175]

The deficiencies of the early resins were obvious. so these materials have been restricted in favor of porcelain for esthetic restorations. Unfortunately, porcelain can be potentially destructive when opposing natural teeth and certain restorative materials. Recommendations focus on avoiding occlusal contacts in porcelain. despite highly glazed surfaces [105,99]. However. patient demands for anterior esthetics commonly result in compromise.

A new generation of resin-based veneers for prosthodontics has been introduced as a result of technological advancements with composite filling materials. In contrast to the unfilled acrylic resins, the composite resins contain reinforcing filler particles in the form of silica. Patterned after the "microfilled" restorative composite resins, the silica is routinely introduced in the form of prepolymerized polymer complexes.

Various systems have been developed for the polymerization of these resins, but visible light is the most popular activation and can be used alone or combined with vacuum or heat. One systém utilizes high temperature and pressure to accomplish polymerization.

Laboratory testing of these materials has been limited, but initial results are encouraging. With acknowledged improvement in mechanical and physical properties compared to originál resin formulations.[80.111,161]

1.11.1 MANIPULATION AND PROCESSING TECHNIQUES OF THE SYNTHETIC RESINS

Acrylic resins

The use of acrylic resins has recently diminished in crown and FPD procedures. A technique involving one acrylic resin for the esthetic veneering of castings is still used to a limited extent. The polymer is moistened with a speciál monomer and applied in small increments to the metal casting (Pyroplast). It is cured directly. exposed to 135 C for 8 minutes. Then the gingival and the incisal colors are applied and blended; curing then follows each lamination. A speciál curing oven is used that controls the temperature and distance at which the restoration is maintained. After being fully processed the veneer is finished and polished [154].

Composite resins

The first composite resin formulation to be used for crown and FPD work was a chemically activated resin. Isosit. The resin material is supplied in preactivated capsules in various shades. The restoration is formed from the resin dough and placed into a pressure unit that operates a 6 bar pressure with a temperature of 120' C for .3 minutes.

The majority of composite resin materials use visible light to initiate polvmerization. The composite resins are supplied as a single paste containing a photoinitiation systém. When the material is exposed to visible light at a wavelength of approximately 470 mm, the diketone is transformed to an excited statě and combines with the reducing agent to form a complex that is diminished by the free radicals of polvmerization.

Composite resins in direct contact with air during, polvmerization develop unpolymerized surface layers as a result of oxygen being diffused into the resin. One commercial systém provides for light curing under vacuum to overcome air inhibition. Other commercial systems bulk pack the restoration on the die or casting and process for various times with visible light at room temperature or at elevated temperatures.

RESIN RETENTION

The retention of crown and FPD resins to underlying metal frameworks is accomplished with mechanical retention or an intermediary coupling agent. The use of retentive beads, loops. or ladders has been suggested since the introduction of acrylic resins as a veneer material in the early 1940s. There must be sufficient mechanical retention without sacrificing the strength of the metal framework or influencing esthetics .Opaque layers of material are applied so that the retentive patterns are not totally obstructed. thus leaving ,the opaque laver as the only material locked into the retentive patterns. Failures upon debonding occur at the resin-opaque interface: if the finál resin engages the retentive patterns. greater retention results."[l 14]

The use of adhesive coupling agents to retain crown FPD resins is relatively new. One systém based on the principle of flaming silica onto the casting alloy has reported retentive bond strengths comparable to those obtained with conventional retentive methods.[174,134] Another form of retaining resin materials to base metal alloys involves electrolytically etching a microretentive surface. Adapted from the technology of resin-bonded retainers (RBRs) extremely high bond strengths are accomplished with this technique.

The obvious advantages of the new techniques of resin retention over conventional beads are a more conservative preparation, reduced cost. and improved esthetics. A disadvantage to the alternative retention systems is the diffículty in clinical repairs of fracture veneers. If a fracture occurs at the opaque-metal interface, bonding a resin chairside requires additional mechanical retention.

1.11.2 CLINICAL APPLICATIONS OF SYNTHETIC RESINS

Crown and FPD resins have numerous clinical applications. If the dentist is familiar with the limitations of these materials and is knowledgeable about clinical techniques, these resins can be a vital adjunct to prosthodontics.

Tooth preparation for resin veneer crowns

The restoration of a tooth with an artificial veneer crown duplicates the morphology of the natural tooth to ensure the health of the dentition. With this goal in mind, adequate tooth preparation is performed to accommodate the demands of function and esthetics. In areas where the resin material provides esthetics, a minimum depth of tooth preparation of 1.5 to 2 mm is required to adequately mask the underlying metal framework, with sufficient space for mechanical retention of the resin (Fig. 11). A beveled shoulder is prepared on the labial surfaees and into the interproximal surfaees to accommodate the veneer. The shoulder blends into a chamfer fínish line on surfaees without a veneer. Most tooth surfaces to be veneered possess a vertical convexity. They should exhibit a similar convexity after preparation if the veneer is to have adequate thickness to duplicate originál tooth size without overcontouring the restoration (Fig. 12).

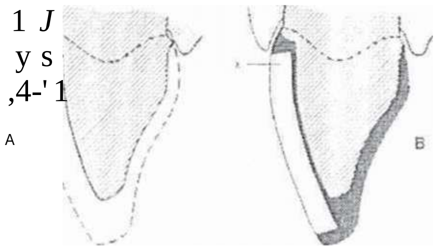


Fig. 11. Perceptively prepared tooth. A. Dotted line is contour of originál tooth, Cervical flnishing line on surfaces to be veneered must be a shoulder, at least 1.5 mm wide. B. Composite resin veneer crown on tooth; 1.5 mm shoulder permits composite veneer to extend apically to free margin of gingival tissues and to be thick enough at X to effectively mask underlying metal without being over contoured.

It is advisable to restrict occlusal function to the casting alloy and protéct the veneer resin materials due to weak wear resistance. The occlusal or incisal boundaries of the veneer are extended for esthetics without subjecting the resin to excessive occlusal loading. Identifying the maximum extension of the veneer onto the occlusal of incisal table requires an awareness of the patient's occlusal patterns. For example, if a patient possesses an anterior protected disclusion. a veneer for a premolar can be extended onto the occlusal surface short of the centric holding areas. Conversely if a patient possesses a group function occlusal relationship, excessive forces can cause premature fracture of the veneer. Therefore. acrylic veneered gold FPDs are commonly indicated for patients with a reduced interocclusal relationship. Repair of fractured or discolored facings can then be satisfactorily accomplished with light activated resins.

Fig. 12. Hastily prepared tooth. A. Cervical shoulder on this preparation is less than 1.5mm vvide. B, lnadequate shoulder width permits composite veneer to extend apically to free margin of gingival tissues, but veneer is too th in at X to effectively mask underlying metal. C. Veneer on this crown is overcontoured at X to mask metal. Resultant restoration does not duplicate size and shape of originál tooth, as shown by dotted line in A.

Complete crown restorations

Resin-based materials for complete crowns can only be described realistically as interim restorations, but there are specific clinical situations when they are indicated. Developing esthetic and suitably contoured restorations with mandibular centrál and lateral incisors is arduous. In most cases, extensive tooth reduction is required to fabricate esthetically pleasing veneered casting. A more conservative preparation is possible when the resin materials are used to minimize the underlying framework. Sufficient preparation is made to allow room for the composite material (I to 1.5 mm), and a complete crown is fabricated with composite resin. This technique is also helpful in managing a case having a guarded prognosis. When occlusal conditions are favorable. i.e., with minimal function, reasonable success can be anticipated for an otherwise difficult clinical situation.

Pontics for resin-bonded retainers

The pontic of an acid-etched. resin-bonded retainer has been traditionally fabricated with dental porcelain. The use of porcelain requires that the metal be compatible with porcelain. This restriction combined with the requirement that the alloy be electrolytically etched, limits the alloys used with this technique. The porcelain pontic also substantially increases the cost of the appliance.

A laboratory heat-cured composite material for an esthetically desirable pontic is a reasonable solution to these concerns. The cost of the prosthesis is less, due to decreased laboratory time and ease of fabrication. Alloy selection is more expensive if the alloy can be electrolytically etched. These prostheses are usually designed to have limited function on the pontics. The tissue surface of the pontic can be in alloy, which produces a favorable tissue response with less plaque.

1.11.3 PHYSICAL PROPERTIES OF PLASTIC FACET MATERIALS

In generál way, physical properties may be generálly divided into strength, and thermal characteristics.

STRENGTH CHARACTERISTICS

The strength characteristics include such properties as tensile and compressive strength, percentage elongation, elastic modulus, proportional limit, fatigue strength and hardness. These have been explained in detail before but we have recapitulated a few terms with regards to plastic materials in particular.

Elongation

The elongation, in combination with the ultimate strength is an indication of the toughness of the plastic. Materials having a combination of reasonable tensile strength and elongation will be tough materials. and those with low elongation will be brittle materials. Examples of tough materials are poly vinyl chloride or poly ethylene, where poly methyl methacrylate is somewhat more brittle plastic. The poly vinyl acrylics are considerably tougher and permit larger deformation to take pláce before fracture.

Impact strength

Impact strength is a measure of energy absorbed by a material when it is broken by a sudden blow. The impact strength for the poly vinyl acrylics is about twice that of the poly methyl methacrylate, which indicates that the poly vinyl acrylics will absorb more energy on impaet and more resistant to fracture when they sustain a sudden blow.Although the addition of plasticizing ingredients may increase the impaet strength of plastics, the inereases are combined by deereases in hardness, proportional limit, elastic modulus. and compressive strength.

Fatigue strength of plastics

In addition to a large momentary or a sudden force, plastics are subjected to a large number of smaller cyclic stresses during masticatioit's. For these reasons, the fatigue properties of plastics are of considerable importance. The fatigue strength represents the number of cycles before failure at a certain stress [13] [127].

Thermal characteristics

The thermal properties of plastics are important in dentistry, since the plastic materials are usually fabrieated with heal used as an accelerator, and they are placed in the mouth, where they are in contact with hold and cold foods and beverages. If a chemical accelerator rather than heat is used. the material is still subjected to the heat resulting from the polymerization reaction. [142]

Thermal conductivity:

As a group of materials the dental plastics are poor thermal and electrical conductors. Transfer of heat in a plastic material is slow, for which reason care should be taken to avoid excessively high polymerization during the processing of a heat -curing type of dental plastic(table 10). The thermal conductivity of plastics used as restorative materials is likewise important and has a bearing on the amount of dimensional change that will result from sudden temperature changes in the mouth [140].

Material	Thermal conductivity(cal/sec/cm^2[°C/cm])
Human enamel	0.0022
Human dentine	0.0015
Composite plastics	0.0025
Gold alloys	0.7100
Unfilled acrylic	0.0005
Porcelain	0.0025

Table. 10. Thermal conductivity of dental materials [122].

Indications for plastic facet crowns

Where low costs are required. Easy manipulation as porcelain requires much expertise and artistic ski 1 Is in the laboratory stages, Ability to match tooth structure. Acrylic resin is translucent in varying degrees, therefore is able to give a natural appearance in the mouth. Is easier to fabricate than porcelain restorations, requires less time but not verv elastic so therefore must alwavs be reinforced with metallic framework in order to resist the stresses in the mouth.

Contraindications for plastic facet crowns

Poor resistance of resins to abrasion so in an instance where the opposing teeth are restored with a stronger material eg - Porcelain. use of plastic jacket crowns is not recommended.

Acrylic resin has a tendency to abrade with aggressive tooth brushing. Those patients having such habits should either be instructed to use a softer tooth brush or should not be provided with these sorts of crowns.

Colour changes may be expected within a matter of time due to habits so therefore not recommended in patient who require a good permanent esthetic result

Tendency for plaque accumulation on the plastic surfaces is higher with time than a well polished ceramic facet crown; so therefore not recommended in patients who do not maintain a satisfactory oral hygiene [44].

1.12 <u>CONSIDERATION REGARDING CHQ1CE OF FACET MATERIAL</u>

Patient age and pulpal and periodontal considerations:

Ceramic and plastic crown restorations generally should not be used in young patients. The large pulp size encountered during childhood and adolescence does not permit removal of sufficient tooth structure to achieve an esthetic thickness without pulpal damage or gross over contouring. Resin restorations should be used as temporary restorations. and as alwavs respecting the policv "'*primům nou nocere*" "not to harm the patient". Prosthodontics aimed at children should ensure undisturbed development of teeth. to make easy the healing after injury to the teeth, and to perform preventive orthodontic goals if need be. Further reasons restrieting the use of eeramic and plastic crowns in adolescence, may be presence of less than optimal oral hygiene.

If full coverage crowns are required margins should be located supra gingivally in order to reduce soft tissue problems.

Condition of the tooth

Often teeth requiring crowns have been extensively damaged or have large existing restorations. And a full coverage restoration is indicated. A ceramic restoration is the first choice when this situation exists in a visible area of the mouth. Therefore when considering esthetics the choice of crowns should be ceramic or plastic of course also further depending on patient's demands, costs and so on.

Tooth form and alignment

The coronal morphology of some teeth with short axial walls may not allow for satisfactory retention when they are prepared for full coverage restorations. Abnormal axial alignment of the abutment teeth can lead to pulpal damage when full coverage restorations are used. Therefore correct tooth form and tooth alignment may be part of the requirements for using a ceramic or plastic crown. This eventually also reiies on the individual dentist and his or her discretion.

Wear and habits

Extensively worn teeth generally indicate the presence of excessive occlusal forces from functional activity or oral habits such as bruxism. Ceramic restorations often fail prematurely under these conditions. The use of partial coverage restoration, when possible, provides greater fracture resistance. Also if porcelain is in contact with the opposing teeth there is a greater wear of these teeth than would occur if partial coverage metal restorations were used. Plastic crowns being softer in nature are may also be used in pláce of ceramic restoration, but yet again in the case of for instance abnormal jaw activity námely bruxism there may be premature loss of the plastic crowns too.[79]

Esthetic considerations

Is that portion of the disciplině that deals with retaining or achieving the ultimate in appearance. Several factors are considered essential to creating facet restorations that

simulates natural tooth beauty and thereby improve the patient’s appearance rather than detract from it. And that is why I have chosen to discuss esthetics briefly and separately.
A poor soft tissue response around the cemented restoration can negate gratifying esthetic accomplishments achieved in the restoration. It can become visually obvious. In the presence of normál gingiva it would not be readily detected. Many factors can reduce abnormal gingival colour or form. Also the patient’s gingival health and oral hygiene may be barely adequate and this coupled with the normál trauma inherent in placing a restoration with sub gingival margins may alter unfavorably the biologie balance. Plaque accumulation and the resultant and gingival inflammation can occur when a ceramic restoration fails to vertically reach the finish line of the prepared tooth. This results in poor esthetics [44].

1.13 ESTHETICS

Shade selection

Clinical shade selection involves direct visual comparisons of the different colour samples that are present in a shade guide with the natural teeth and determination of which one best matches the teeth. Dental shade guides are examples of various colour combinations available from manufacturers of denture teeth restorative plastic and porcelain. These samples are compared with natural teeth and the closest colour match is determined. There are several guide lineš that are helpful in the development of clinical colour matching skills. Shade selection and esthetics also relies on eventual experience and training from the side ofthe dentist. [25.62.108,119.170]

Correct lighting:

Light comes from a variety of sources. It occurs naturally as sunlight and artificially.
Out of my experience natural light is the best light under which the correct shade of the tooth can be selected and the adequate amount of light is very important in shade selection also helping in reducing eye fatigue. When there is a significant difference between the brightness level in the mouth and that of the immediate surroundings excessive eye fatigue occurs. Enough light should fall on the tooth or teeth in question and enough time should be dedicated to choosing the correct shade and esthetics has become a high requirement in today's dav and age [158].

Surrounding colors:

When iight strikes an objeet sorne wave lengths are absorbed by the objeet and some are reflected. What is commonly called"' the eolor of an objeet" is actually the colour of the Iight that has been reflected. The dentists or patient's brightly colored clothes can reflect undesirable colour into the selection environment.

Patient position:

It is extremely important that the patient be in an upright position when the shade is selected so that the teeth may be viewed in the clinic under the same conditions under which they will be seen in his business and sociál life.

From the previous information it becomes apparent that comparing colour samples from a shade guide with natural teeth and arriving at the best selection is a blending of art and science. This process requires knowledge of dimensions of colour as well as clinical experience in an environment that optimizes the selection process. [44.157.196]

Dental consideration

In many aspects of restorative dentistry, esthetic considerations are important - for example, dentures, porcelain restorations. anterior restorative materials. The following factors are of relevance:

a. Materials are pigmented by the manufacturer. and care should be taken in choosing a shade of material to give color rnatching. Shade guides are often provided for this purpose. It is important to match colors under appropriate conditions of lighting.
b. Esthetic materials should be permanent in color. neither showing staining (caused by external factors e.g. constituent of diet) nor discoloration (caused by internal factors such as chemical change in the component of the material).
c. For best esthetic effeets. materials should be translucent, unless it is necessary agent to enhance esthetic appeal. [170.108]

COLOR: PHYSIOLOGICAL AND PSYCHOLOGICAL ASPECTS

a. The retina of the eye contains specialized cells. which are called rods and cones. Stimuli received by the cones result in detection of color.
b. Some people have defective color vision; this is caused by cell abnormalities.

c. The eye is not equally sensitive to all colors; the greatest sensitivity is to green(wavelength c. 550 nm)

d. Color fatigue can occur. After seeing one color constantly for a long period, the response of the eye to that color is diminished.

e. Physiological aspects are important, since optical illusions can occur. For example the appearance of an object depends on its background; darker backgrounds make the material appear lighter.

COLOR MEASURMENT

To define color unambiguously, three parameters are important: (fig 13)

a. The *hue* is the color e.g. blue, red, green.

b. *Value* is the darkness or lightness of the colour.

c. *Chromá* or saturation measures the intensity of the color e.g. low value of chromá indicated a weak color.

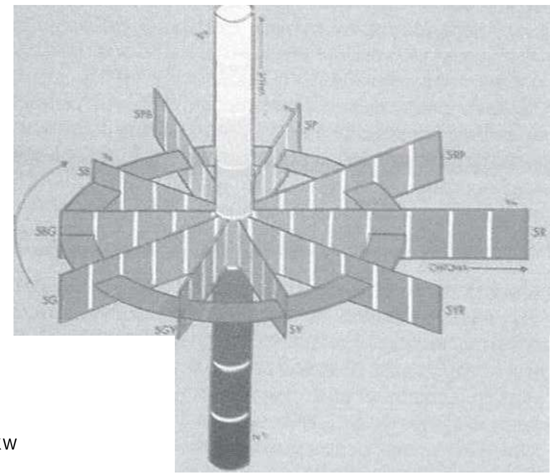


Fig.13. Munsell Flue, Value, and Chromá scales in colour space. (Courtesy of the Munsell Corporation, Baltimore, MD).

One frequent used method of specifying colors is the munsell color coordination systém, on virtual axis is plotted the value. The hue is represented by circle. The chromá is the distance from the centre.

An alternative systém is to express color in the L*a*b systém designated by the Commission Internationale de PEclairage (CIE), where L is the lightness factor and a* and b* are chromaticity coordinates; chromaticity includes both the hue and chromá [130,159.192.14].

1.14 CORROSION AND ELECTRO DEPOSITION

Definition and types of corrosion

Corrosion can be defined as chemical reaction between a metal and its environment to form metal compounds. Many metals can react spontaneously with either a gaseous or aqueous environment. The compounds thus obtained are chemically more stable than the metal from which they have been formed. In the mouth corrosion can result because of the same conditions when adjacent restorations are of dissimilar metals. Corrosion is obviously undesirable. as it can spoil the esthetic of an alloy, and in extreme cases can severely weaken the material, as in the rusting of iron. To avoid this in both dental and implant alloys only a few types of alloys can be used and conditions that favor corrosion must be avoided as far as possible.

Corrosion reactions can be classified into two types:

A: Non aqueous corrosion. when metals can react to form compounds such as oxides and sulphides, e.g:

- Tarnishing of brass due to formation of sulphides
- Discoloration of the surface of casting caused by oxidations
- Oxidations of metal surface during soldering and lieat treatment procedures

B: Aqueous corrosion can occur in the oral environment and this occurs by electro chemical reactions

The oral environment

In many respects the mouth is an ideál environment for aqueous corrosion of metals and alloys to occur. The presence of moisture, temperature fluctuations, and the changing Ph caused by diet and the composition of food stuffs, can all contribute to this phenomenon.

Examples of galvanic corrosion:

- **Differences in composition of materials**

Example 1: If a gold inlay comes into contact with an amalgam restoration. the amalgam can form the anodě of an electrical cell and so corrode.

Example 2: A soldered appliance or denture may corrode, since the composition of the solder differs from that of the alloys it joins

- **Differences in composition of electrolyte**

A homogenous metal or alloy can undergo electrolyte corrosion where there is a difference in electrolyte concentration where there is a difference in electrolyte concentration across the specimen.

Example 1: Consider the case of a metallic restoration which is partly covered by food debris. The composition of the electrolyte under this debris will differ from that of saliva, and this can contribute to the corrosion of the restoration.

Example 2: Where there are differences in concentration of oxygen in an electrolyte, an oxidation type concentration cell is formed. Corrosion is greater at portions of metal an alloy with lower concentration of oxygen .This can happen in an unpolished metallic restoration. The surface concavities become fIlled readily with food debris, this lowers the concentration of oxygen at those parts which corrode and lead to pitting of filling.

Stress corrosion:

A combination of corrosion and stress conditions can cause failures of metals by stress corrosion. At an anodic portion of surface. electrolyte action can form a minuté crack. This can increase in size as a result of stress concentration. More corrosion can occur in the enlarged crack. and so on. until eventual failure occurs [6.60].

Corrosion and galvanic pain

In addition to corrosive attack to dental alloys, electrolyte corrosion can cause galvanic pain. Many people have experienced when a peace of metal foil wrapping has inadvertently been taken into the mouth. If the foil contacts an amalgam restoration, an electric circuit is setup usually completed by the tongue. The current causes painful stimulation of the tooth pulp. Galvanic pain is occasionally encountered in the mouth, when dissimilar metal restorations come into intermittent contact

Long term contact is unlikely to give severe galvanic pain, because polarization can occur. Polarization being due to the formation of a film on the surface of the electrode can reduce the rate of electrochemical reaction. This film can be composed of adsorbed gases or metallic oxides. Polarization is an advantage in limiting corrosion. [110,186]

Prevention of corrosion

Choice of alloy:

Alloys for long term use in the mouth must be either noble or passive.

A: noble metals are those such as gold. platinum and palladium. Dental gold alloys contain some copper which has poorer corrosion resistance. However, such alloys should ideálly contain at least 70-75% noble metals.

B: Passive alloys, such as those containing chromium are widely used dentally examples: Stainless steel, cobalt chromium and nickel chromium

Use of alloys: In addition to choosing suitable materials, alloys must be used correctly and situations which are likely to lead to corrosion, as we mentioned before must be avoided as much as possible [118.45,27].

1.15 <u>PRINCIPLES OF TOOTH PREPARATION FOR FACET CROWNS</u>

The abutment teeth must be prepared to accept a fixed prosthesis. Successful completion of this reduction process requires certain mechanical principles.

Types of occlusal forces

lt is important to understand the types of forces commonly present in the mouth and to study those aspects of preparation form and prosthesis design that allow restorations to possess adequate retention and resistance form and thereby to resist these forces. Only then can the most appropriate mechanical design principles be developed and applied.

Three types of forces can be directed against prosthesis during function: tipping forces, twisting or rotational forces and path-of-insertion forces (Fig. 14).

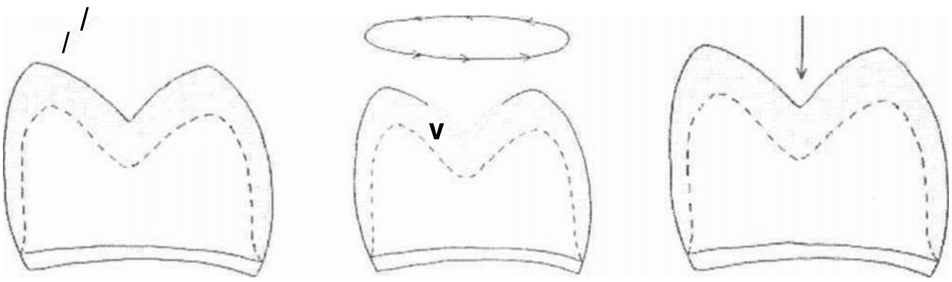


Fig.14. The types of the forces that tend to, tip (A), twist or rotate (B), dislodge (C) a restoration off the prepared tooth.

Tipping can occur in buccolingual or mesiodistal directions, depending on the point and direction of force application. Twisting or rotational forces may cause a restoration to start to move circumferentially around the prepared tooth. As an example, if a facially directed force is applied to only one retainer, the periodontal ligament permits some facial movement of that abutment tooth. producing rotational forces on the retainers. Path-of-insertion forces can be apically or occlusally directed. depending on whether the mandible is closing into a bolus of food or opening with sticky food interposed between the prosthesis and opposing teeth.

Preservation of tooth structure

ln addition to replacing lost tooth structure, a restoration must preserve remaining tooth structure. Whole surfaces of tooth structure should not be needlessly sacrificed to the bur in the name of convenience or speed. Preservation of tooth structure in some cases may require that limited amounts of sound tooth structure be removed to prevent subsequent uncontrolled loss of larger quantities of tooth structure. Hasty preparation of a tooth can result in belated degeneration or death of the pulp [182]. Crowns are commonly placed on compromised teeth, so carefully designed preparations are needed for the tooth to retům to function. [120.121.22]

Retention and resistance

For a restoration to accomplish its purpose, it must stay in pláce on the tooth. No cements possess adequate adhesive properties to hold a restoration in pláce solely through adhesion. Retention prevents removal of the restoration along the path of insertion or long axis of the tooth preparation. Resistance prevents dislodgment of the restoration by forces directed in an apical or oblique direction and prevents any movement of the restoration under occlusal forces. The essential element of retention is two opposing vertical surfaces in the same preparation.

a. Axial wall height

Occlusogingival length is an important factor in both retention and resistance. Longer preparation will have more surface area and there for be more retentive. Because the axial wall occlusal to finish line interferes with displacement, the length and inclination of the wall become factors in resistance to tipping forces (fig .15). [155]

The walls of shorter preparation should have as little taper as possible to increase the resistance. Even this will not help if the walls are too short.

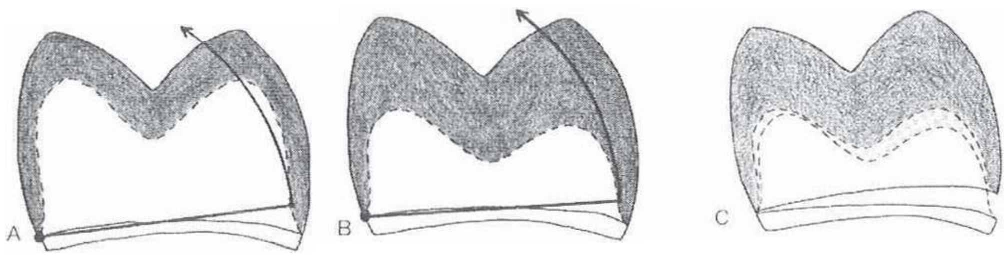


Fig.15. A, preparation of adequate height in which tooth structures interferes with are of rotation. B, short preparation providing no interference with are of rotation. C. Casting being dislodged from short preparation.

It may be possible to successfully restore a tooth with short walls if the tooth has a small diameter. The preparation on the smaller tooth will have a short rotational rádius for the are of displacement, and the incisal portion of the axial wall will resist displacement (fig. 16).

Parker et al found that approximately 95% of anterior preparations analyzed had resistance form. while only 46% of those on molars did. [124]

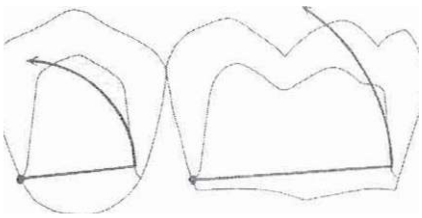


Fig.16. Ful! veneer preparation of approximately the same height and taper eompleted on mandibular premolar and molar i11 ustrate the better resistance to mesiodistal tipping inherent in the smaller diameter tooth.

b. Taper of the Preparation

As a tooth is prepared, opposing walls must converge occlusally. since divergent walls create undercuts and prevent a restoration from seating (Fig. 17).

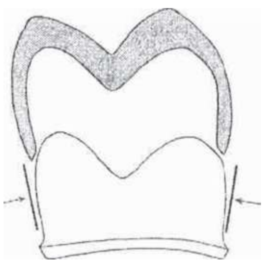


Fig. 17. Rigid casting cannot be seated. owing to divergent axiai walls.

Increased taper reduces the abiiity ofa restoration to resist occlusally directed dislodging forces and also lessens its abiiity to interfere with the are of rotation as tipping forces act to unseat the restoration (Fig. 18).

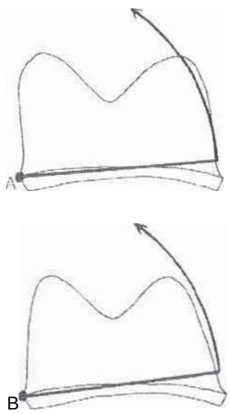


Fig.18. A. Preparation taper allowing tooth to interfere with are of rotation. B. Over tapered preparation providing no interference with are of rotation.

c. Substitution of internal futures

It may not alvvays be possible to use opposing walls for retention: one may have been destroyed previouslv, or it may be desirable to leave a surface uncovered for a partial veneer restoration. Generally internal futures such as the groove, the box form, and the pin hole are interchangeable and can be substituted for an axial wail or for each other **(fig.19).**

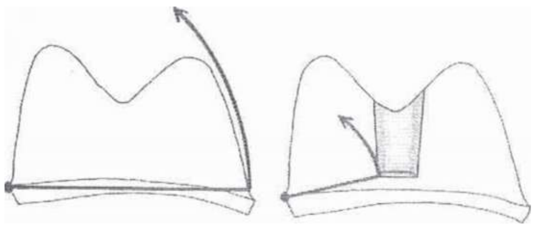


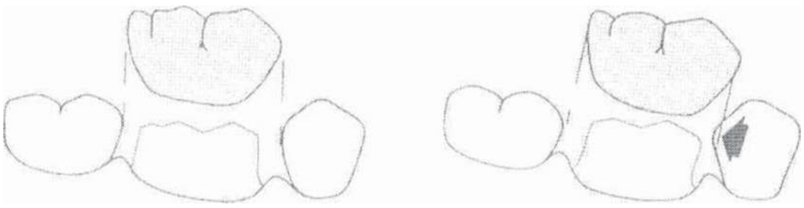
Fig.19. The overtapered preparation on the left offers no interference to are of rotation. On the right, a proximal box has been placed to provide tooth structure. which interference with the are of rotation.

d. Path of insertion

The path of insertion is an imaginary line along which the restoration will be placed onto or removed from the preparation. It is determined mentally by the dentist before the preparation is begun, and all futures of the preparation are eut to coincide with that line. It is important that the preparation be viewed with one eye closed. The path of insertion must be considered in two dimensions: faciolingually and mesiodistally. The faciolingual orientation of the path can affect the esthetics of facet crowns. For the metal ceramic crowns, the path is roughly para! lei with the long axis of the teeth (fig 20).

Fig.20. The patli of insertion of a preparation for a metal-ceramic crown should parallel the long axis of the tooth (A). If the path is directed facially, the prominent facioincisal angle may create esthetic problems of overcontouring or "opaque show-through" (B). However. if the path is directed lingually, the facial surface will intersect the lingual surface, creating a shon preparation. It also may encroach on the pulp(C).

The mesiodistal inclination of the path must parallel the contact area of adjacent teeth. If the path is inclined mesially or distally, the restoration will be held up at the proximal contact areas and be "locked out" (fig.21).



A Gorrecí B "1 uek!.'d nut'

Fig.21. The path of insertion of a preparation must parallel the adjacent proximal contacts (A), or it will be prevented from seating (B).

Structural durability

A restoration must contain a bulk of material that is adequate to withstand the forces of occlusion. This bulk must be confined to the space crated by the tooth preparation:

a. Occlusal reduction

One of the most important features for providing adequate bulk of metal and strength to the restoration is occlusal clearance (fig.22).

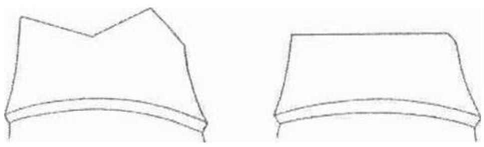
Inadequate Adequate

Fig.22. Inadequate occlusal reduction does not provide the needed space for a restoration of adequate thickness.

For gold alloys, there should be 1.5 mm clearance on the functional cusps (Iingual of maxillary molars and premolars and buccal of mandibular molars and premolars). Not quite as much is required on the (nonfunctional cusp, where 1.0 mm is sufficient.

Metal- ceramic crowns will require 1.5 to 2.0 mm on functional cusps that will be veneered with porcelain and 1.0 to 1.5 mm on nonfunctional cusps to receive ceramic coverage. There should be 2.0 mm of clearance on, preparations for all-ceramic crowns. Malposed teeth may have occlusal surface that are not parallel with the occlusal table. Therefore, it may not be necessary to reduce the occlusal surface by 1.0 mm to achieve 1.0 mm of clearance [145].

The basic inclined plane pattern of the occlusal surface should be duplicated to produce adequate clearance without overshortening the preparation (Fig.23).



Correct incorrect

Fig.23. Occlusal reduction should reproduce basic inclined planeš rather than being cut as one fiat plane.

A fiat occlusal surface may overshorten a preparation whose length is already minimal to provide adequate retention. Inadequate clearance makes a restoration weaker.

b. Functional cusp bevel

An integrál part of the occlusal reduction is the functional cusp bevel (fig.24). A wide bevel on the lingual inclines of the maxillary lingual cusps and the buccal inclines of mandibular buccal cusps provides space for an adequate bulk of material in area of heavy occlusal contacts.

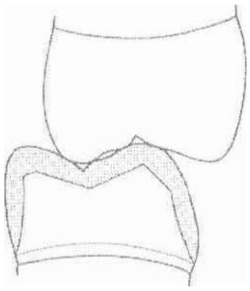


Fig.24. The functional cusp bevel is an integrál part of occlusal reduction.

If a wide bevel is not placed on the functional cusp. the casting will be extremely thin in the area overlving the junction between the occlusal and axial reduction (fig.25).

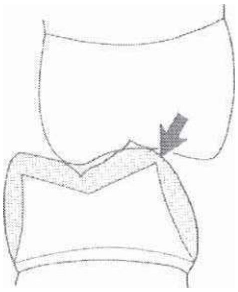


Fig.25. Lack of a functional cusp bevel can cause a thin area or perforation in the casting.

To prevent a thin casting when there is no functional cusp bevel. an attempt may be made to wax the crown to optimal thickness in this area. An overcontoured restoration will result and a deflective occlusal contact is likely to occur unless the opposing tooth is reduced (fig.26).

Fig.26. Lack of a functional cusp bevel may result in overcontouring and poor occlusion.

If an attempt is made to obtain space for an adequate bulk in a normally contoured casting without a bevel. the result will be an overcut axial surface (Fig.27). In addition to the unnecessary destruction of tooth structure, the severe inclination of the surface renders it useless for retention.

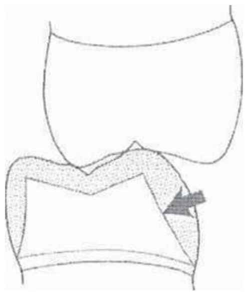


Fig.27. Overinclination of the buccal surface will destroy excessive tooth structure while lessening retention.

c. Axial reduction

Plays an important role in securing space for adequate thickness of restorative material (fig.28). Restorations with inadequate axial reduction they will have thin walls that will be subjected to distortion. Frequent laboratory technicians attempt to compensate for this by overcontouring the axial surfaces. While this "solution" to the problém strengthens the restoration, it can have a disastrous effect on periodontium.

A B

Fig.28. Inadequate axial reduction can cause thin walls and a weak restoration (A) or a bulbous overcontoured restoration (B).

d. Finish line requirements

The point at which a preparation terminates on the tooth is called the *finish line.* A successful cast restoration usually implies a smooth gingival margin with a supportive relationship to the gingival margin; we have to determine a suitable finish line before tooth preparation., the gingival finish lineš are not overextended gingivally to violet the biologie vvidth, it can be located I mm coronal to the CEJ (Cement-Enamel Junction), but variations are commonly instituted by the dentist. A finish line serves many functions (fig.29)[149,173]:

(1) During visual evaluation of the tooth preparation, it is a measure of the amount of tooth structure already removed. It also deiineates the extent of the eut in an apical direction. The more distinct it is, the better it serves these purposes.

(2) The finish line is one of the features that can be used to evaluate the accuracy of the impression made for indirect procedures.

(3) On the die, a distinct finish line helps in the evaluation of the quality of the die and aids in trimming it accurately.

(4) The correct marginal adaptation of the wax pattern depends on an obvious finish line.

(5) The evaluation of the restoration is also aided by a proper finish line.

(6) At cementation, a sharp finish line aids in determining whether the restoration is fully seated.

\ \ ji /

Fig.29. The gingival finish line requires eareful review before preparation, and the tissue response can reflect the validity of the determination.

Several fornis of finish lineš can be developed: chamfer, knife edge or chisel edge, feather edge. shoulder, and beveled shoulder (Fig.30).

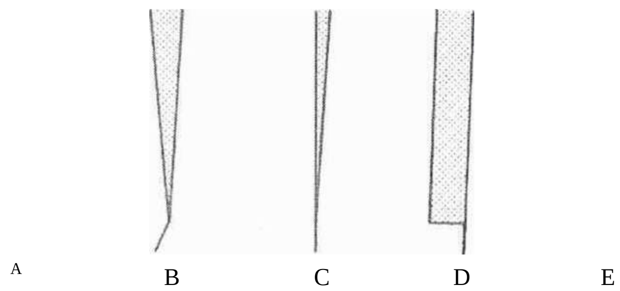


Fig.30. The five types of finish lineš: (A) chamfer, (B) knife edge or chisel edge, (C) feather edge, (D) shoulder, and (E) beveled shoulder.

A chamfer is the preferred cervical finish line for veneer metal restorations and should be utilized whenever possible because it is easily developed and visually distinct. This finish line has been shown experimentally to exhibit the least stress, so that the cement underlying it will have less likelihood of failure it can be cut with the tip of round-end diamond [49,55,151].

The knife edge or chisel edge finish line is acceptably distinct, although it is not as well defined as the chamfer. It is most often used on tipped teeth when formation of a chamfer would result in excessive tooth reduction (Fig.31).

Fig.31. Use of knife edge finish line on mesial side of tipped mandibular molar to avoid pulpal proximity.

A feather edge finish line is unacceptable because it is not sufficiently distinct and results in so little cervical tooth reduction that the restoration must be overcontoured to possess adequate rigidity. Also. since a feather edge is difficult to see visually, occlusocervical undulations and irregularities in the finish line are more likely to be present, making it much more difficult to fabricate a restoration that fits accurately.

The shoulder and beveled shoulder are not advocated for routine use cast metal restorations because they are difficult to form and produce the greatest depth of tooth reduction. However, they are required with all-ceramic restorations. The wide ledge provides:

- Resistance to occlusal forces
- Minimizes stress that might lead to fracture of the porcelain
- Produces the space for healthy restoration contours
- Maximum esthetics. in which proper color is achievable only through material thickness.

1.16 FAILURE OF CROWN RESTORATIONS

. Factors influencing the Success of a restoration (fig. 32).

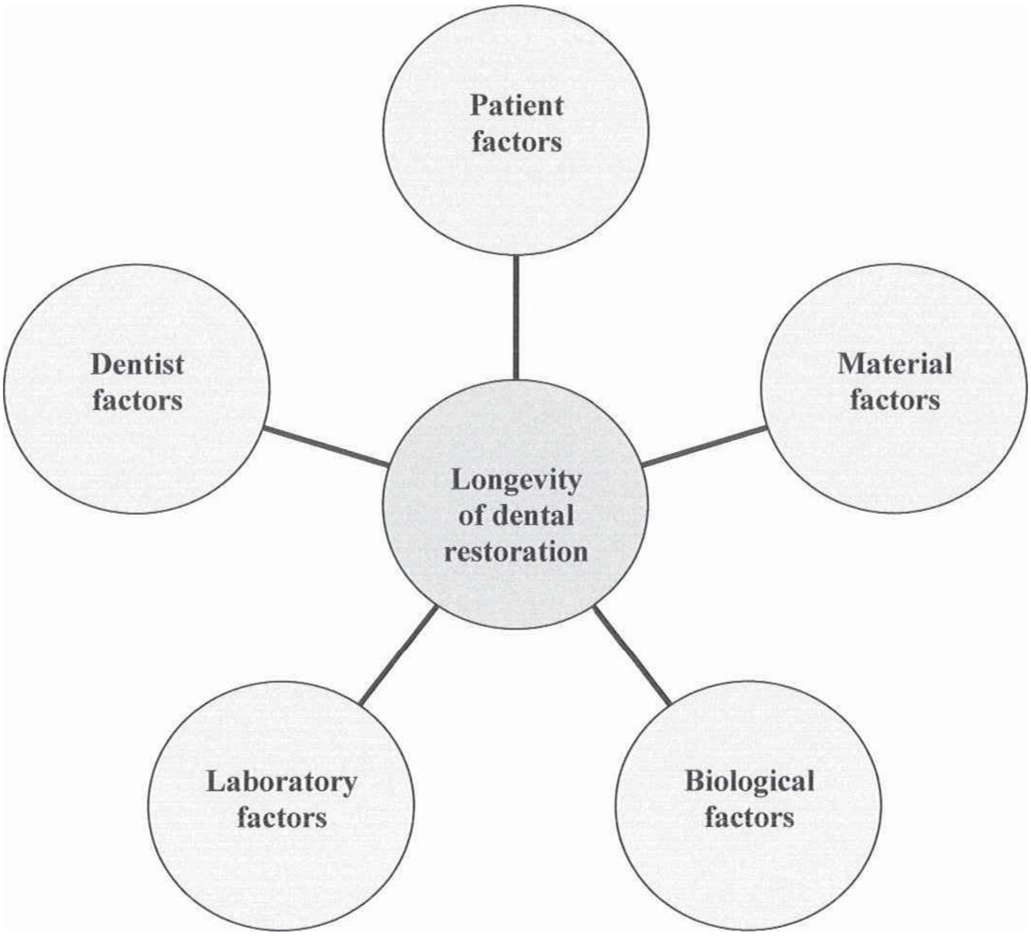


Fig.32. Factors influencing the success of restoration.

In order to summarize we could say that failures can be classified in one or more of five categories: I.material related, 2. laboratory related, 3. dentist related, 4.patient related, 5. biological related.

1. **Material related** failures result because of inadequate properties for the intended use and environment, wear, strength, durability, technique sensitivity.
2. **Laboratory related** failures are caused by improper processing procedures and incorrect manipulations or the misuse of dental material products.

3. **Dentist related** failures are caused by poor judgment, lack of experience, or improper procedures:

- Incorrect diagnoses and treatment planning
- Incorrect preparation of the tooth
- Incorrect choice of restorative material

4. Patient related failures are associated with allergic reactions, poor oral hygiene, excessive bite force capability, other masticatory habits (such as bruxing and crushing of ice cubes or hard candy with their teeth), poor esthetic results, and environmental factors (such as low saliva flow and excessive alcohol consumption).

5. **Biological related** failures: Caries is one of the most common biological failures. Fluoridation and Conventional operative dentistrv procedures can generally be used to restore a small carious lesion without the need to fabricate a new prosthesis.

Also a restoration may simply wear out. After all, prosthesis cannot routinely be expected to last a lifetime [74,138,139].

Periodontal breakdown

Periodontal diseases can produce extensive bone loss that in time results in the loss of abutment teeth and attached prosthesis. Poor implementation of proper hygiene procedures or a restoration that hinders good oral hygiene may also be a cause of the eventual loss of the prosthesis.

Occlusal problems

The presence of heavy occlusal forces or habits such as clenching, bruxism which are patients related can cause failure. Centric or eccentric occlusal interferences also pláce forces on porcelain that are capable of causing fracture.

Esthetic failures

Ceramic restorations fail more often esthetically than biologically. Esthetic failures also occur because of incorrect form or framework design that displays metal. In addition, natural teeth undergo colour changes that do not occur in porcelains, so that an unacceptable colour match is caused over the years. Partial veneer restorations can be esthetically unacceptable because of over extension of the finish line facially. This displays excessive amounts of metals. Even with proper facial extension, an artificial appearance can be created if the facial outline form of prepared tooth does not resemble an unprepared tooth. The marginal fit or cervical form of prosthesis can promote plaque accumulation, causing gingival inflammation. which produces and unnatural soft tissue colour or form that is esthetically unacceptable. [131.65]

1.17. POST INSERTION PRQBLEMS AND CARE

The clinical procedures involved in fixed partial dentures can elicit a variety of responses from the dental pulp, periodontal tissue, and associated anatomie structures. Some of the pulpal and periodontal responses are considered to be normál because they are encountered frequently and exist only for a limited time without producing serious problems. Other responses indicate major problems or the need to provide additional treatment in order to avoid severe complications. The potential for irreversible pulpal damage exists each time the tooth is prepared, but a healthy pulp usually withstands the trauma, and only minimal temporary side effects are manifested. However, failure to follow biologically correct procedures for tooth reduction, temporary restoration, fabrication, adjustment and cementation of the finál restoration. or post insertion care may result in discomfort to the patient or the need for endodontic treatment. Even with the use of proper technical procedures, the need for endodontic treatment may arise if the pulp is unhealthy but asymptomatic from previous trauma. The same principles that govern the health of the pulpal tissues apply to the periodontal tissue.

Thermal sensitivity

This results from the removal of enamel and dentine, which have insulating properties, and their replacement with metal, which is an excellent thermal conductor. The duration of this effect ranges from few days to several months before all sensitivity ceases. The magnitude and duration of this sensitivity are inereased when the preparation is in close proximity to the pulp.

Thermal diffusion through substance is related to the thermal conductivity of the metal as well as its thiekness. Failure to use copious amount of water spray during the bulk reduction of the tooth and prolonged dry cutting also increases the potential for post insertion sensitivity.

Discomfort during function

The pain experieticed when occlusal forces are applied to the prosthesis during chewing are often caused by premature centric occlusal contact or excessive contact during eccentric mandibular movements. Occlusal adjustment of the offending area provides relief from the pain. Tenderness to percussion can also result from heavy centric or eccentric occlusal contact. Occlusal discrepancies that are not corrected may lead to irreversible damage. A tooth that has been out of occlusal function for a long time may initially exhibit discomfort during function when placement of the prosthesis brings it back into normál function. With time, the tooth adjusts to the increased functional activity.

Gingival inflammation

Usually, some gingival irritation is caused by the clinical procedures performed in conjunction with a fixed partial denture, but if those procedures are carefully executed. and the patient maintains good oral hygiene throughout the treatment, the effect is minimal and the soft tissue rapidly returns to normál. Inflammation that manifests itself after cementation of the finál prosthesis probably is related to faulty cervical contour. marginal fit of embrasure form of the prosthesis; it also could be related to the inadequate oral hygiene instruction by the dentist.

Retention of food

The collection or adherence of certain foods to the prosthesis cannot be avoided. however proper instruction in the use of oral hygiene aids the patient in removing the foreign material and preventing breakdown of the periodontal tissue. The frequent impaction of the food can be caused by either poor occlusal relationship or lack of adequate proximal contacts.

Trauma to the cheeks and tongue

The eheek or tongue can be irritated by contact with the sharp areas or poorly poiished portions of prosthesis.

Sensitivity to sweets

Post insertion discomfort from sugar containing foods can be caused by failure of the finál prosthesis to completely cover all prepared tooth surfaces.

Tooth mobility

Mobility in prosthesis can be caused by a poor occlusal relationship that produces heavy centric occlusal contact or particularly by eccentric occlusal interferences. The overloading of the prosthesis causes change in periodontal ligament and supporting bone. thus allowing excessive movement. Occlusal adjustment eliminates the excessive force and usually reduces the mobility to a normál level.

Non specific complaints

Some patients may not have a specific complaint of pain but are aware that the prosthesis is present and that something feels different and is slightly uncomfortable, which may be related to some aspects of prosthesis that the patient does not like such as esthetics or financial aspects, which have been known to produce unspecific complaints. [131]

Post insertion follow up

Patient receiving restorations should be observed aíter normál functional activity has occurred and ideally during the first few days following cementation. The patient may occlude slightly differently under normál chewing conditions and without the presence of local anesthesia. A post insertion appointment allows the detection and adjustment of any interfering centric or eccentric occlusal contact before problems arise. This time also allows for evaluation of the effectiveness of homecare and other symptonis that the patient may manifest. Generally post insertion observation should continue on extended time intervals until at least one visit has occurred without the need for additional adjustment or home care instructions. Patients should be advised to call if any untoward symptoms occur prior to the next periodic examination.

Home care instructions

Every patient should receive instructions regarding proper brushing and flossing of restorations. In addition, the use of aids for passing floss under pontics and connectors and the use of an interproximal brush should be demonstrated on the cemented prosthesis Oral hygiene aids should be provided to the patient or information given as to where these items can be obtained. The relationship of oral hygiene to the health of the surrounding tissues and thus the longevity of the prosthesis must be emphasized. Below is some information concerning dental polishing and cleaning materials. Every dentist should have an awareness of these substances and their properties in order to infonn the patient in the best possible way.

Cleaning techniques

These are means to remove the food and other debris from the surface without damaging. Polishing and cleaning are routine procedures for maintaining the health of the natural dentition. These procedures however can lead to roughened surfaces by the use of excessively abrasive dentifrices. The materials used for polishing and finishing are primarily abrasive. Abrasion results when hard rough surfaces such as sandpaper disk or hard irregularly shaped particles such as those present in an abrasive slurry. plow grooves in a softer material and cause material from such grooves to be removed from the surface. The process of abrasion is affected by the physical and mechanical properties of the material being abraded. The rate of abrasion of a given material is determined primarily by three factors: 1 .the size of the abrasive particle, 2. the pressure of the abrasive against the material being abraded and 3. The speed at which the abrasive particle moves across the surface being abraded. [20]

Prophylactic paste

Routine dental prophylaxis for the removal of exogenous stains. pellicle. material alba, and oral debris is widely used proceduře in the dental office. Prophylaxis should precede the application of a fluoride gel or solution to make the enamel accessible and more reactive to fluoride. Ideally the dental prophylactic paste should be sufficiently abrasive to remove effectively all types of accumulation from tooth surface without imparting undue abrasion to the enamel. dentine, or cementům. In addition to acting as a cleansing agent, the past should have the quality of endowing the dental hard tissue with a highly polished, esthetic appearance. Certain prophylactic pastes contain sodium fluoride or stannous fluoride either mixed with the abrasive or in a more complex, buffered systém [28].

Properties

Laboratory and clinical studies of cleaning and polishing have compared the efficiency of various prophylactic pastes. Products containing predominantly pumice and quartz show higher cleansing values but generally result in a greater abrasion to both enamel and dentine. In fact. abrasion data have indicated that some prophylactic pastes may be unnecessarily destructive to enamel. The products containing coarse pumice are generally the most abrasive. Prophylaxis pastes that contain fluoride have been subjected to several clinical trials. Results have varied from no benefit to benefit as high as 35% reduction in caries after three years. The design of some of these studies makes it difficult to assess the effect of prophylaxis agent alone. During prophylactic procedure, care must be exercised to avoid excessive abrasion of any restorative material present. Polymeric materials such as denture based and artificial tooth resins, acrylic veneering materials, and composite restorative resins are particularly susceptible to wear because of their low hardness. The result of such wear can be possible reduction in contours and increase surface roughness, both of which are undesirable. [54]

Dentifrices

The primary function of a dentifrice is to clean and polish the surfaces of the teeth accessible to a tooth brush. In addition to enhancing personál appearance by maintaining cleaner teeth. brushing with a dentifrice may reduce the incidence of dental caries, help maintain a healthy gingiva and reduce the intensity of mouth odors. During the process of cleaning, extraneous debris or deposits to be removed, given in order or increasing difficulty of removal from the tooth surface, are food debris, plaque (soft, mainly bacterial film), acquired pellicle (proteinaceous film of salivary origin, and calculus). [59]

Composition and role of ingredients

The dentifrices are prepared in various forms, including paste, powder, and liquids. Of these, the paste and powder forms are the most common. The liquids have not gained prominence because they are not sufficient abrasive to maintain clean teeth. Tooth powders contain an abrasive, a surface-active detergent, flavoring oils, and svveetening agents. In addition to the powdered ingredients, tooth paste contains water, humectants (to prevent dehydration), a binder. and a preservative. Some dentifrices contain fluoride in the form of sodium fluoride, sodium mono flouro phosphate, or stannous fluoride to help prevent dental caries.

The abrasives that are used in various dentifrices preparations should ideally exhibit a maximum cleansing efficiency with minimum tooth abrasion. In addition an abrasive should be present to polish the teeth. Abrasion of enamel by modern dentifrices is generally not a problém unless unusual oral conditions exist however exposed dentine and cementům are susceptible to abrasion. Polymeric restorative materials are also susceptible to abrasion from tooth brusli and dentifrice use.

Effect of tooth brusli

A number of studies have examined the influence of the toothbrush and its effects on abrasion. When compared with abrasion of common dentifrices, the bristles have little abrasive power. Properties of bristles, such as geometry, hardness. stiffness, and number, generally do not influence abrasion by themselves. although they do effect the abrasion caused by the dentifrice. Mechanical tooth brushing devices generally cause less abrasion of enamel and dentine than manual brushing because the force applied by the mechanical device is lesser. [164]

Selection of tooth brusli and dentifrice

The best available guidelines to followv in selection a dentifrice for a patient are based on evaluation of the following factors:

1. Degree of staining of the dentition
2. Force exerted on the brush.
3. Method of brushing.
4. Amount of exposed dentine and cementům.

Choice of a dentifrice for appropriate prevention of abrasion can then be based on the ranking of the abrasivity of dentifrices reported by the American Dental Association. Even so. comparison of products with similar abrasivity scores is not possible because of the experimental error associated with measuring the abrasion data. Selection of a tooth

brush must be based on requirements of the patient's soft tissue. In particular, abrasion of soft tissue by hard, stiff bristles should be avoided [7].
Prosthesis in facet materials collect deposits in the same manner as do natural teeth. Soft food debris that clings to prosthesis can be removed easily by light brushing followed by rinsing. Hard deposits of calculus and stains. such as those that occur from tobacco tars are much more difficult to remove. These can be removed professionally in the dental office by use of hand instruments or ultra sound calculus removing engines.

During my time in the clinic I used a certain method and technique during follow ups in which 1 instructed my patients on maintaining good oral hygiene and provided them with motivation and answers to any queries that they may have had. I have stated that briefly below.
On the arrival of my patient into the clinic I usually first proceeded with an intraoral examination. During the examination, the crown or bridge work was assessed. This assessment helped me to realize the points I should emphasize when dealing with individual patients. [115,116,131]

Oral examination

When the patient arrives at the clinic after the preliminaries, it is best to ask the patient as to how he/she feels about the new prosthesis in the mouth. This gives a good indication as to whether the patient is satisfied with the outcome or not. An intraoral examination will further help to highlight any problems about which the patient may be unaware.

2. The aims and objectives of study

The following thesis deals with clinical evaluation of facet materials used in fixed prosthodontics. The aim and purpose of this study was to evaluate the long-term stability of facet crowns. the changes of facet surface, marginal adaptation. cracks or breakage of material, changes of shape and colour as well as gingival status and finally the search for the ideál facet restorative material.

This work consists of two main parts:

First is the theoretical part which includes introductions. indications, contraindications, checking and review of functional stability and esthetic durability of facet materials.

Second part is the independent practical evaluation of each work in the patient's mouth for a period of time.

We have prepared an assembly report of collection of 625 fixed faceted prosthesis from 119 patients, 58 males and 51 females.

In my thesis I have tried to evaluate these facet materials with the help of clinical observations. 1 have also followed the condition of the crowns in the mouth after a number of years, the condition of the soft tissues in these patients and eventually the choice between metal ceramic or plastic jacket crowns for the long term use of crowns and bridges.

From the above I have chosen for my discussion the combination of ceramic or plastic materials with metal, due to their high availability and demand in the time of my study. These fixed restorations were checked according to modified US Public Health Service System Criteria.

3. Materials and method

We begin by discussing the materials and the methods that I have come across during my study in the Czech Republic. My evaluation involves those selected patients that attended one of the prosthodontic clinics of the teaehing hospital in Pilsen, Department of Stomatology. The patients vvere randomly chosen and the common factor of all these patients were the type of the fixed facet prosthesis. Patients were undergoing regular treatment and they were cooperating with us in clinical examination.

The research was permitted by the Postgraduate Science Research Committee of Charles University. Faculty of Medicine in Pilsen.

We prepared a filé on each patient that contained: Name, Surname, National number. Age. Sex. Health condition and dental examinations.

We independently prepared assembly report of collection of 625 fixed facet prosthesis from two main facet materials, plastic and ceramic. The teeth were prepared at subgingival, paramarginal or supragingival level with a round step and we took impressions with silicon materials (Stomaflex, Dental, Ypeen). Most of the pontics were protected by temporary crowns.

The crowns were prepared according to the standard work protocol in our Faculty Hospital Dental laboratory. The crowns were cemented with Adhesor Zinc-phosphate cement/ Spofadent, Carbofine Zinc Polycarboxylate cement/ Spofadent or Glass-ionomer cement/ Espe, Spofadent, at time interval of 1, 2, 3 and more than 4 years. Clinical photographs were taken after cementation and after every subsequent examination with the help of the digital camera- OLYMPUS /v 300. These photographs were placed appropriately in the files of the patients.

In my thesis we have tried to evaluate these facet materials with the help of clinical observations. We independently subdivided our patients according to the time of crown cementation into four individual groups.

Group G1: Evaluation of 81 crowns in 26 patients, one year after permanent cementation (53 plastic facet crowns and 28 ceramic facet crowns).

Group G2: Evaluation of 85 crowns in 22 patients, two years after permanent cementation (61 plastic facet crowns and 24 ceramic facet crowns).

Group G3: Evaluation of 270 crowns in 40 patients, three years after permanent cementation (130 plastic facet crowns and 140 ceramic facet crowns).

Group G4: Evaluation of 189 crowns in 31 patients, four or more than four years after permanent cementation (167 plastic facet crowns and 22 ceramic facet crowns).

I have also followed the condition of the crowns in the mouth after a number of years, and also the condition of the soft tissues in these patients and eventually the choice between metal ceramic or plastic jacket crowns for the long term use of crowns and bridges.

My research involved '119' patients. '58' were males and '5T were females. The age range of these patients were between 18 and 70. They included smokers & non-smokers, coffee drinkers & non-coffee drinkers.

The materials used for these fixed appliances were gold, chrome-cobalt, chrome-nickel (Remanium/ Safina). These were covered with Resin (Superpont K+B/ Dental, C+B plast), Composite (Chromasit/ Ivoclar, Nicrallium N7 / Safina, Sinfony/ Espe) and Ceramic (Vita Omega, Vita Omega 900 / Vita).

The reason for choosing metal ceramic or metal plastic materials, during the time of my study, was due to the high availability and demand. These fixed restorations were checked according to the modified US Public Health Service System Criteria [86.148].

The crown and the bridge in the mouth should be examined for the following:

- Whether the patient is following a satisfactory level of oral hygiene (this is done with the WHO probe gently being passed around the crown or bridge to detect for plaque or calculus)
- Whether vestibular edges of the crown are:
  1. subgingival
  2. paramarginal
  3. supragingival

- Whether oral edges of the crown are:
  1. subgingival
  2. paramarginal
  3. supragingival
- Whether the condition of vestibular and oral gingival margins are:
  1. healthy
  2. bleeding on probing
  3. has a stained tattoo effect
- Whether the condition of the prosthesis is:
  1. intact
  2. minutely cracked or abraded
  3. fractured
  4. with crowns missing or removed
- Whether secondary caries are :
  1. absent
  2. present
- Whether the adaptation of the margins of prosthesis to tooth (Marginal integrity) is accurate; this is detected by passing the Hook probe under the alloy and drawn in the occlusal direction. Results may be:
  1. probe goes straight unhindered
  2. probe is hindered
  3. probe detects a normál pocket around the prosthesis
  4. probe detects a distinct pocket around the prosthesis
- Whether vestibular and oral margins of the crown are:
  1. unchanged from the time the crown was first set in the mouth
  2. slightly stained (stain free after polishing)
  3. distinctly stained (cannot be removed with polishing)
  4. heavily stained (Extensive discoloration)
- Whether the colour of the prosthesis compared to surrounding teeth is:
  1. normál
  2. with little change
  3. distinct change
  4. gross change

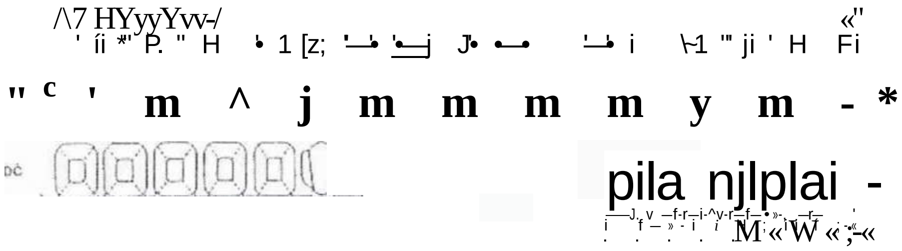
Příjmení: Jméno: Datum narození

Povoláni; Pojišťovna : Rodné číslo :

Zdravotní stav: ne-kuřák alergie léky:

Stav chrupu:

18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38



Pcríodontální stav : CPITN

Periodontálni stav : PBi

PBI 7 6 5 4 3 2 1 1 2 3 4 5 6 7 PBI

Hygiena horní čelisti : Velmi dobrá [Dobráj^ Špatná j

Hygiena dolní čelisti: Velmi dobrá Dobrá) | Spalná |___|

Instruktáž hygieny : Ano|___| Ne| I

PBI 7 6 5 4 3 1 2 3 4 5 6 7 PBI

Hygiena horni čelisti : Velmi dobrá [Dobrá}___| Spalná [

Hygiena dolní čelisti: Velmi dobrá [Dobráj___1 Špatná |___1

Instruktáž hygieny : Anoj NcO

	můstku	solo	18	17	16 15	14 j13 12	11	21	22	23	24	25	26	27	28	48)47	46	45	44	43	42	41	31	32	33	34 35	36	37	38
palsrgen																I													
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zíato																													
pryskyřice																													
keramika																													
kompozitní plast						j																							
neznámý																													

FAZETA 18 16 15 22 23 24 25 27 28 48 47 46 45 43 42 41 31 32 33 34 35[36 37 38

keramika

kompozitní past

MEZ!ČLENY(pontics)	18	17	16	15	14)13	12	11	21	22	23	24	25j26|27	28	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37138
proplachovací																												
dotykové íazetovací																												
dotvkové ceíckovové																												

PREPARACE	18	17	16	16	14	13 12 j11	21	22	23	24	25 26 27	28	48 47	46 45	44	43	42	41	31	32	33	34	35	36	37	33
subQirtaivélni																										
supragínivélni																										
schůdkové																										
bszschudkové																										

POUŽITY CEMENT	16	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	48	47	46 45	44 43	42	41	31	32	33	34	35 36	3?	38
zinkoxidfcsfátcvý (adheser)																													
polykarboxylatový (carbofme)																													
sklopoiyalkenoatový																													
pryskyřióný																													
hybridní																													
neznámý																													

CISLO BARVY																																
	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
CEPOVÁ NASTAVBA																																
IMPLANTAT																																
ZUB PO HEMIRESEKCI																																

KONTROLA A DATUM

KOMPLIKACE u zubu číslo

okrajový uzávěr dokonalý
nedokonalý

povrch beze změn
drsný
Hladký

mirna
upíná ztráta

barevné změny ne
ano

zlomenina
poškozeni
uvoléni

materiál použitý na opravy

spokojenost pacienta
s funkci ano

s estetikou ano

Poznámky:

POSITION OF VESTIBULAR EDGES OF (G4) FACET CROWNS							
G4		**Subgingival**		**Paramarginal**		**Supragingival**	
C	P	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	**167**	**0**	**26**	**8**	**58**	**14**	**83**
%		**0**	**15**	**36**	**35**	**64**	**50**

POSITION OF ORAL EDGES OF (G4) FACET CROWNS							
G4		**Subgingival**		**Paramarginal**		**Supragingival**	
C	P	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	167	9	85	7	52	6	30
%		41	51	32	31	27	18

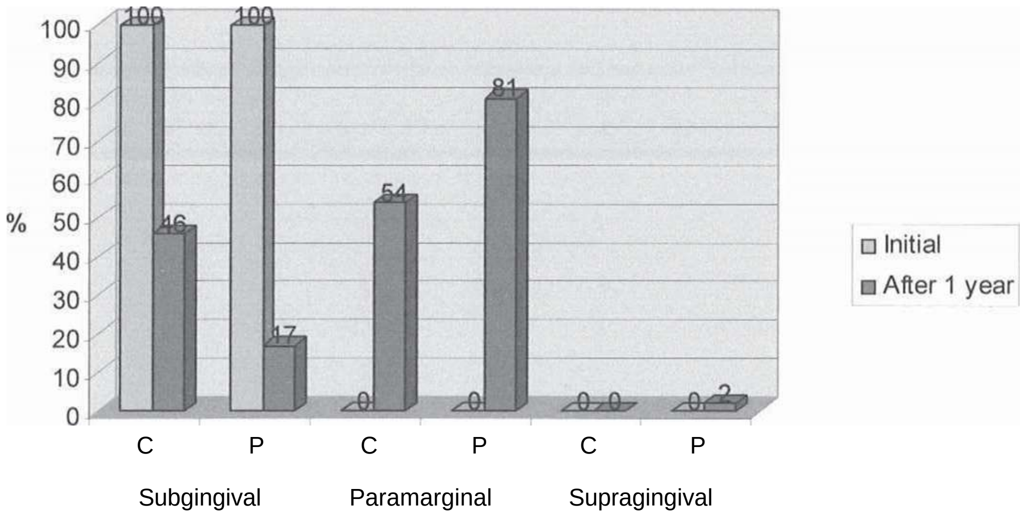
CONDITIONS OF VESTIBULAR AND ORAL GINGIVAL MARGINS OF (G4) FACET CROWNS							
G4		**Healthy**		**Bleeding on Probing**		**Metallic Stain (Tattoo)**	
C	p	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	167	13	62	9	105	2	6
%		59	37	41	63	9	4

4. RESULTS, OBSERVATIONS & STATISTICS

POSITION OF VESTIBULAR EDGES OF FACET CROWNS

G1 P = 0.0056 (++)	Subgingival		Paramarginal		Supragingival	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	28	53	0	0	0	0
%	I00	100	0	0	0	0
After I year	13	9	15	43	0	1
%	46	17	54	81	0	2

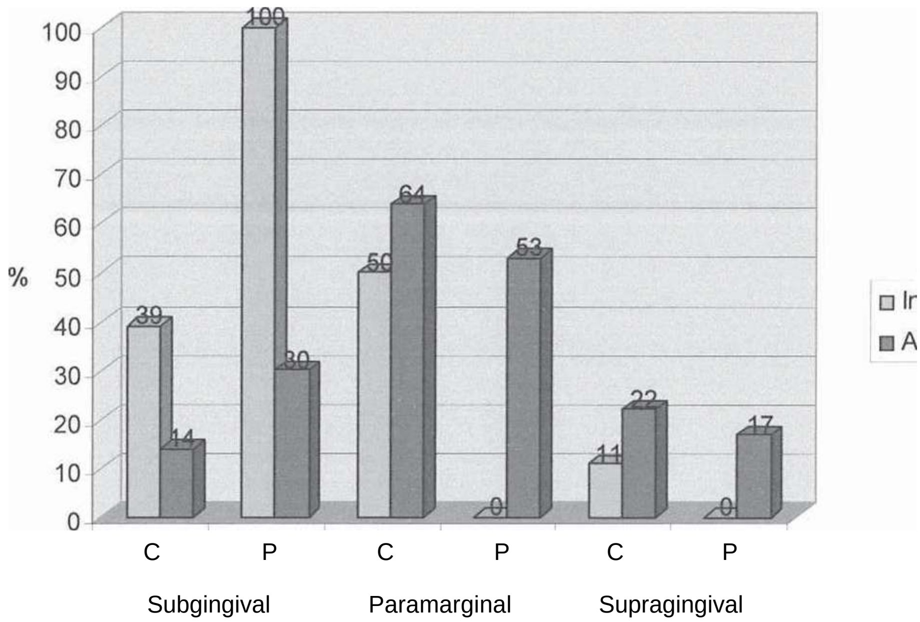
POSITION OF VESTIBULAR EDGES OF (G1) FACET CROWNS



POSITION OF ORAL EDGES OF FACET CROWNS

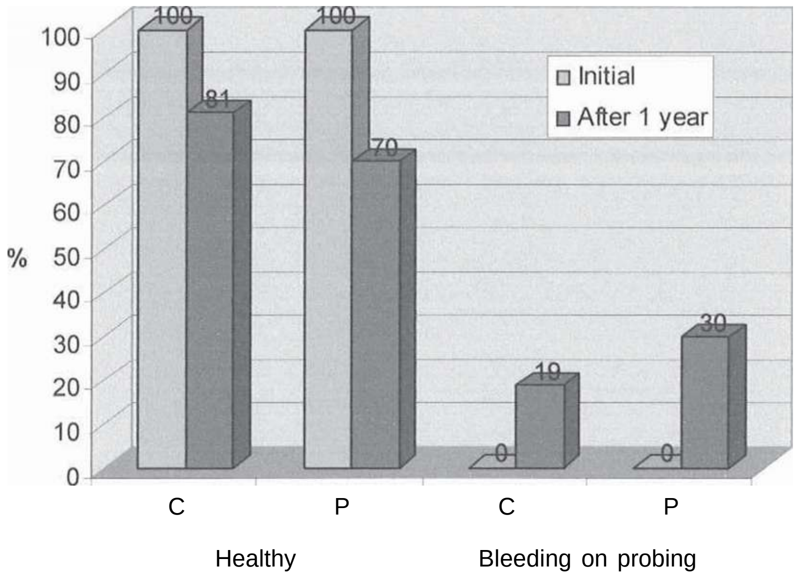
G1 P = 0.001 (+++)	Subgingival		Paramarginal		Supragingival	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	11	53	14	0	3	0
%	39	100	50	0	11	0
After I year	4	16	18	28	6	9
1 »/	14	30	64	53	22	17

POSITION OF ORAL EDGES OF (G1) FACET CROWNS



CONDITIONS OF VESTIBULAR AND ORAL GINGIVAL MARGINS OF FACET CROWNS				
G1	**Healthy**		**Bleeding on Probing**	
NS	Ceramic	Plastic	Ceramic	Plastic
Initial	28	53	0	0
%	100	100	0	0
After I year	23	37	5	16
%	81	70	19	30

CONDITIONS OF VESTIBULAR AND ORAL GINGIVAL MARGINS OF (G1) FACET CROWNS

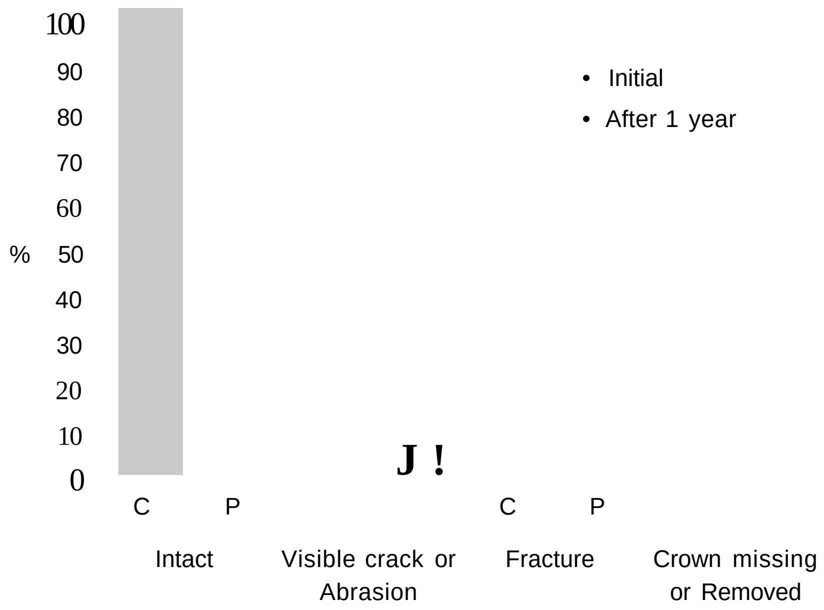


CONDITIONS OF FACET CROWNS

G1 NS	Intact		Visible[1] Crack or Abrasions		Fracture		Crown Missing or Removed	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	28	53	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After I year	28	49	0	4	0	0	0	0
%	100	92	0	8	0	0	0	0

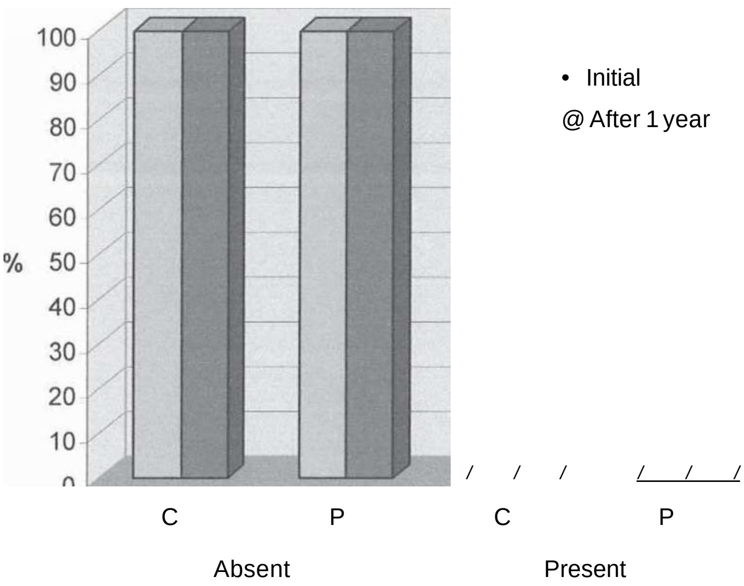
- With the help of naked eyes.

CONDITIONS OF (G1) FACET CROWNS



SECONDARY CARIES				
G1	**Absent**		**Present**	
	Ceramic	Plastic	Ceramic	Plastic
Initial	28	53	0	0
/o	100	100	0	0
After I year	28	53	0	0
0/ /o	100	100	0	0

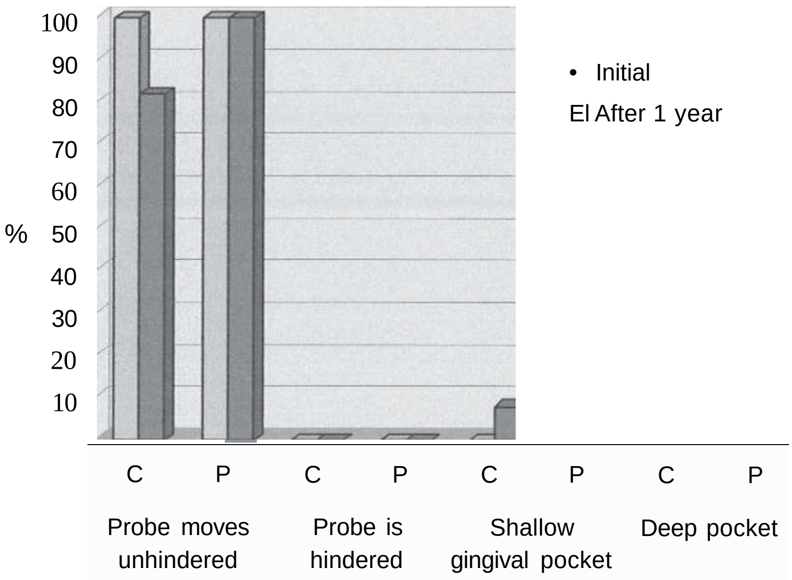
SECONDARY CARIES (G1)



MARGINAL INTEGRATION & MARGINAL ADAPTATION OF PROSTHESIS

G1 NS	Probe moves unhindered		Probe is hindered		Shallow gingival pocket		Deep gingival pocket	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	28	53	0	0	0	0	0	0
o/ /o	100	100	0	0	0	0	0	o
After I year	23	53	0	0	5	0	0	0
%	82	100	0	0	8	0	0	0

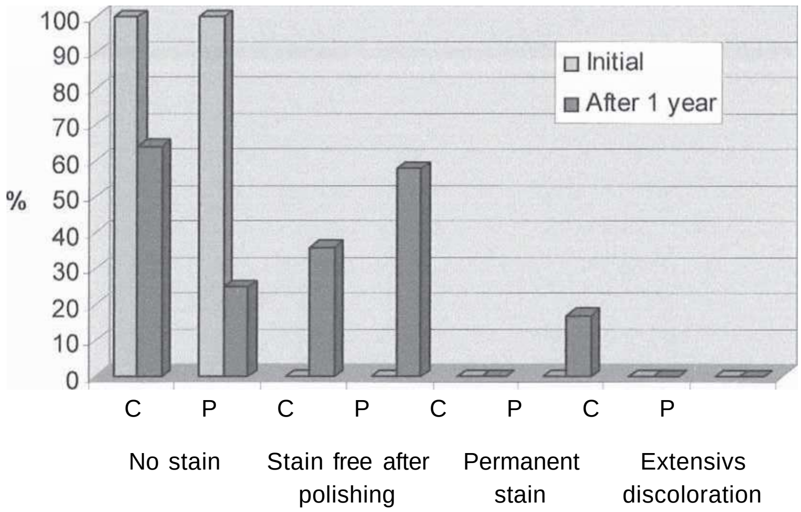
MARGINAL INTEGRATION & ADAPTATION OF (G1) PROSTHESIS



EVALUATION OF VESTIBULAR AND ORAL MARGINS OF FACET CROWNS

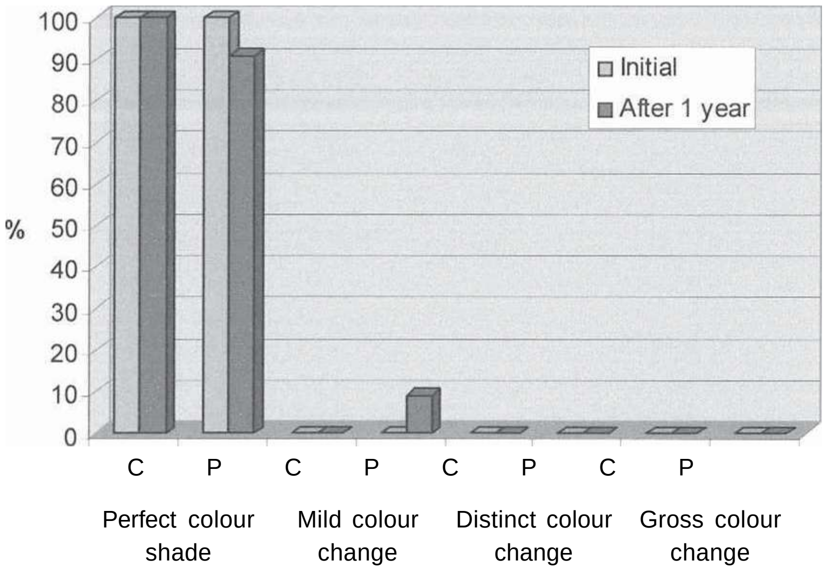
G1 P = 0.0005 (+++)	**No stain**		**Stain free after polishing**		**Permanent stain**		**Extensive discoloration**	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	28	53	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After I year	18	13	10	31	0	9	0	0
%	64	25	36	58	0	17	0	0

EVALUATION OF VESTIBULAR & ORAL MARGINS OF (G1) FACET CROWNS



COMPARISON OF PROSTHESIS COLOUR CHANGE TO SURROUNDING TEETH								
G1 NS	**Perfect colour shade**		**Mild colour change**		**Distinct colour change**		**Gross colour change**	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	28	53	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After I year	28	48	0	5	0	0	0	0
%	100	91	0	9	0	0	0	0

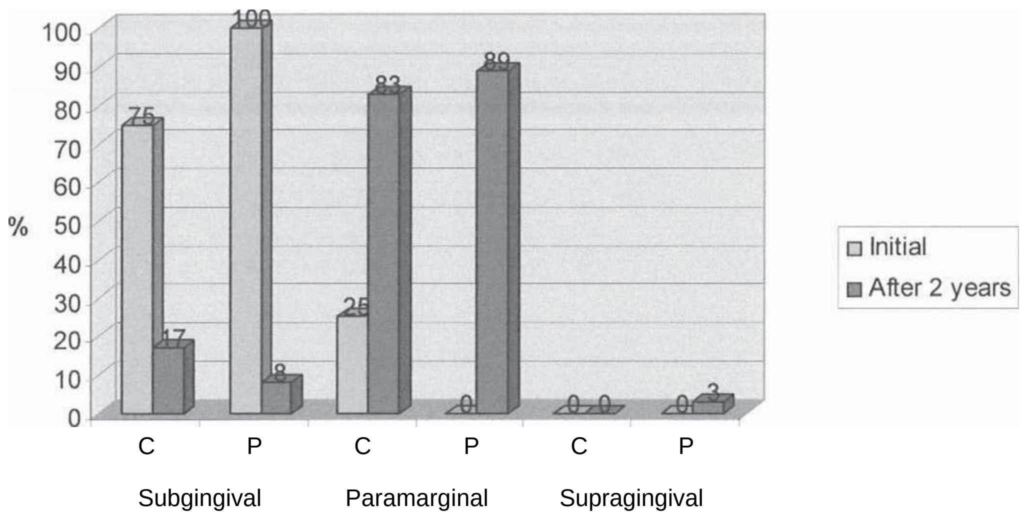
COMPARISON OF (G1) PROSTHESIS COLOUR CHANGE TO SURROUNDING TEETH



POSITION OF VESTIBULAR EDGES OF FACET CROWNS

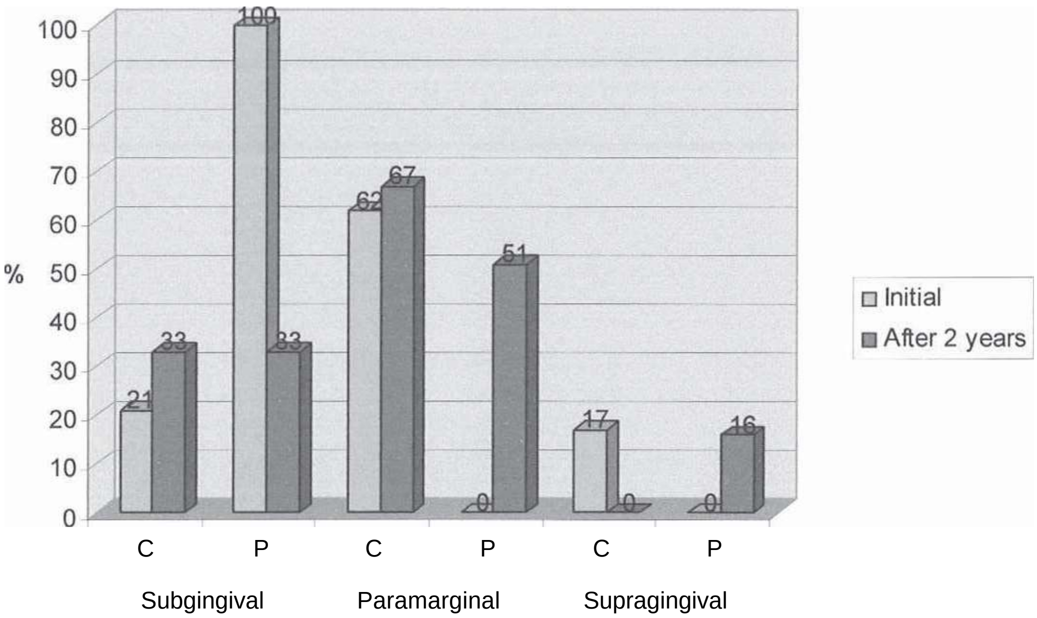
G2	**Subgingival**		**Paramarginal**		**Supragingival**	
P = 0.0007 (+++)	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	18	61	6	0	0	0
%	75	100	25	0	0	0
After II years	4	5	20	54	0	2
%	17	8	83	89	0	3

POSITION OF VESTIBULAR EDGES OF (G2) FACET CROWNS



POSITION OF ORAL EDGES OF FACET CROWNS						
G2	**Subgingival**		**Paramarginal**		**Supragingival**	
P = 0.0000 (+++)	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	5	61	15	0	4	0
%	21	100	62	0	17	0
After II years	**8**	20	16	31	0	10
%	33	33	67	51	0	16

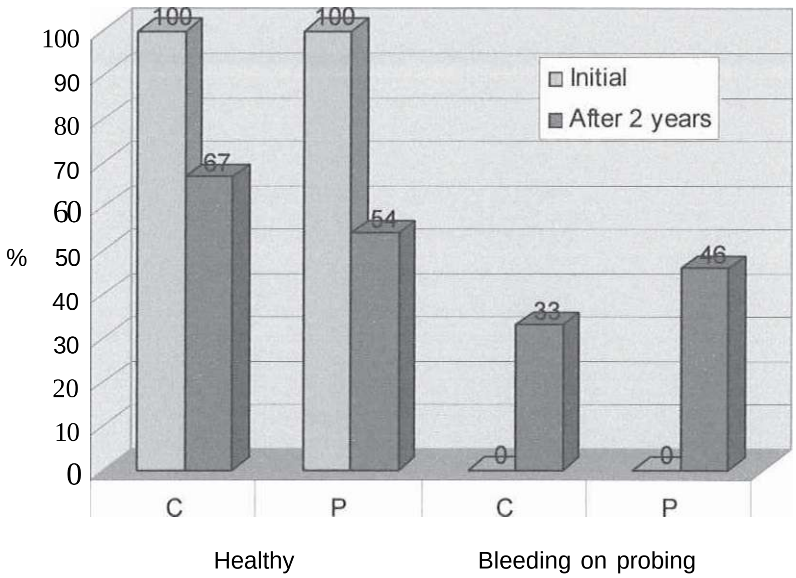
POSITION OF ORAL EDGES OF (G2) FACET CROWNS



CONDITIONS OF VESTIBULAR AND ORAL GINGIVAL MARGINS OF FACET CROWNS

G2	Healthy		Bleeding on Probing	
	Ceramic	Plastic	Ceramic	Plastic
Initial	24	61	0	0
%	100	100	0	0
After II years	16	33	8	28
%	67	54	33	46

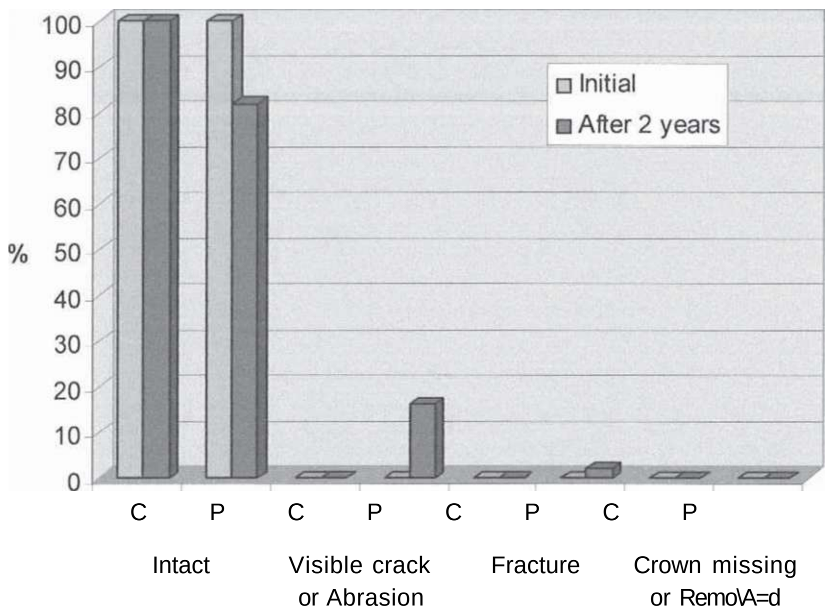
CONDITIONS OF VESTIBULAR AND ORAL GINGIVAL MARGINS OF (G2) FACET CROWNS



CONDITIONS OF FACET CROWNS								
G2 P = 0.019 (+)	**Intact**		**Visible[1] Crack or Abrasions**		**Fracture**		**Crown Missing or Removed**	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	24	61	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After II years	24	50	0	10	0	1	0	0
%	100	82	0	16	0	2	0	0

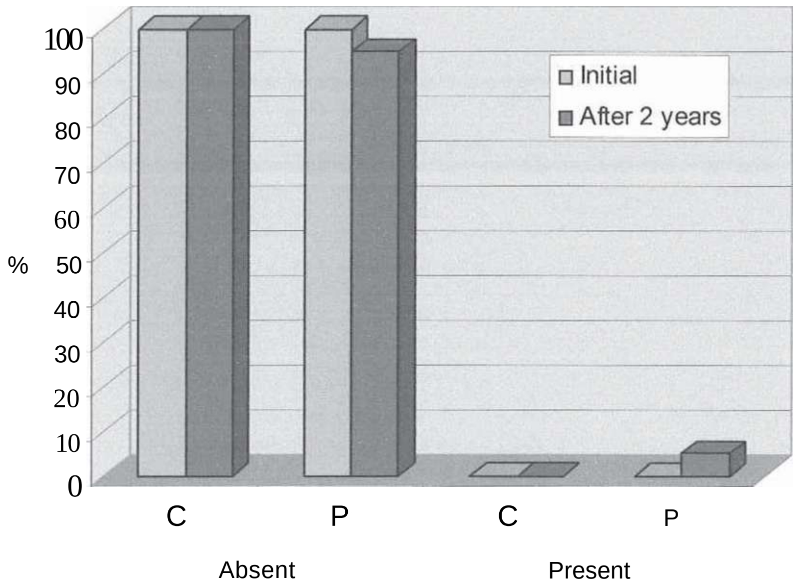
1 - With the help of naked eyes.

CONDITIONS OF (G2) FACET CROWNS



SECONDARY CARIES				
G2 NS	**Absent**		**Present**	
	Ceramic	Plastic	Ceramic	Plastic
Initial	24	61	0	0
%	100	100	0	0
After II years	24	58	0	3
%	100	95	0	5

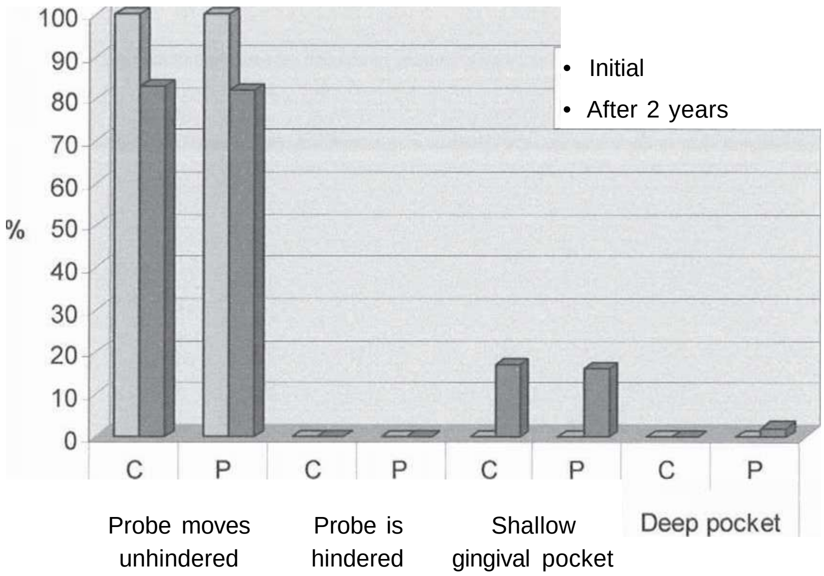
SECONDARY CARIES (G2)



MARGINAL INTEGRATION & MARGINAL ADAPTATION OF PROSTHESIS

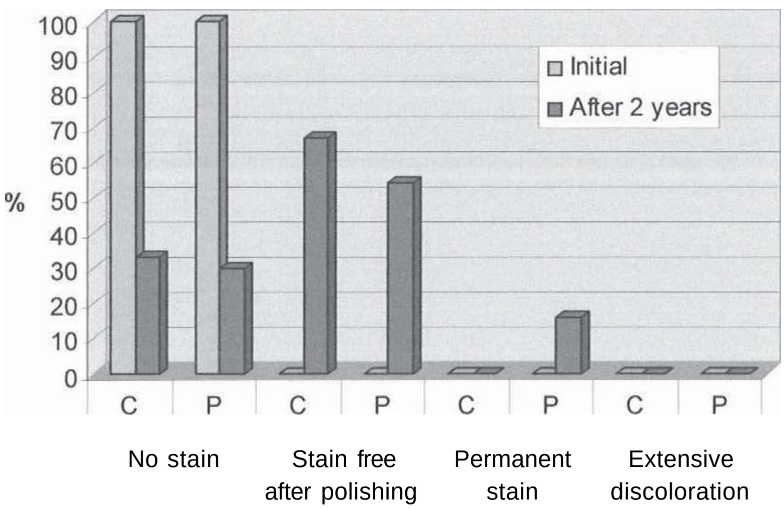
G2 NS	Probe moves unhindered		Probe is hindered		Shallow gingival pocket		Deep gingival pocket	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	24	61	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After II years	20	50	0	0	4	10	0	1
%	83	82	0	0	17	16	0	2

MARGINAL INTEGRATION & ADAPTATION OF (G2) PROSTHESIS



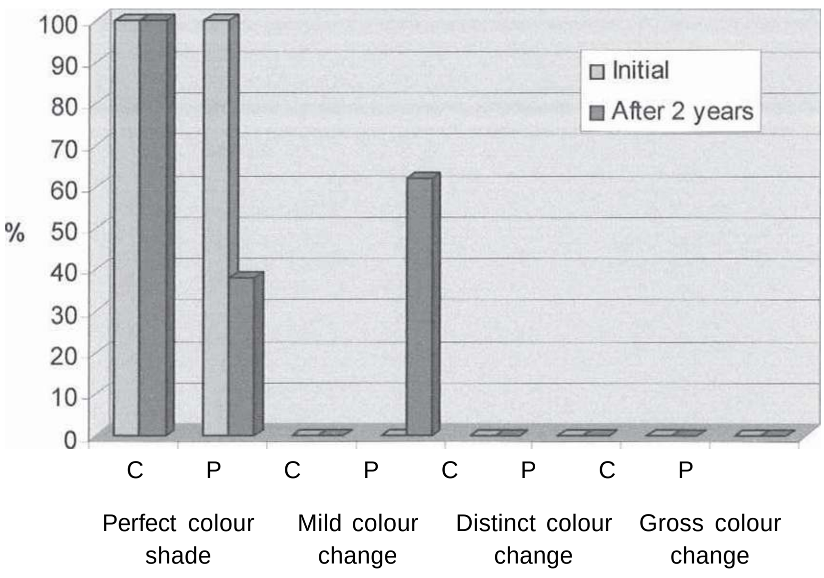
EVALUATION OF VESTIBULAR AND ORAL MARGINS OF FACET CROWNS								
G2 NS	**No stain**		**Stain free after polishing**		**Permanent stain**		**Extensive discoloration**	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	24	61	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After II years	8	18	16	33	0	10	0	0
%	33	30	67	54	0	16	0	0

EVALUATION OF VESTIBULAR & ORAL MARGINS OF (G2) FACET CROWNS



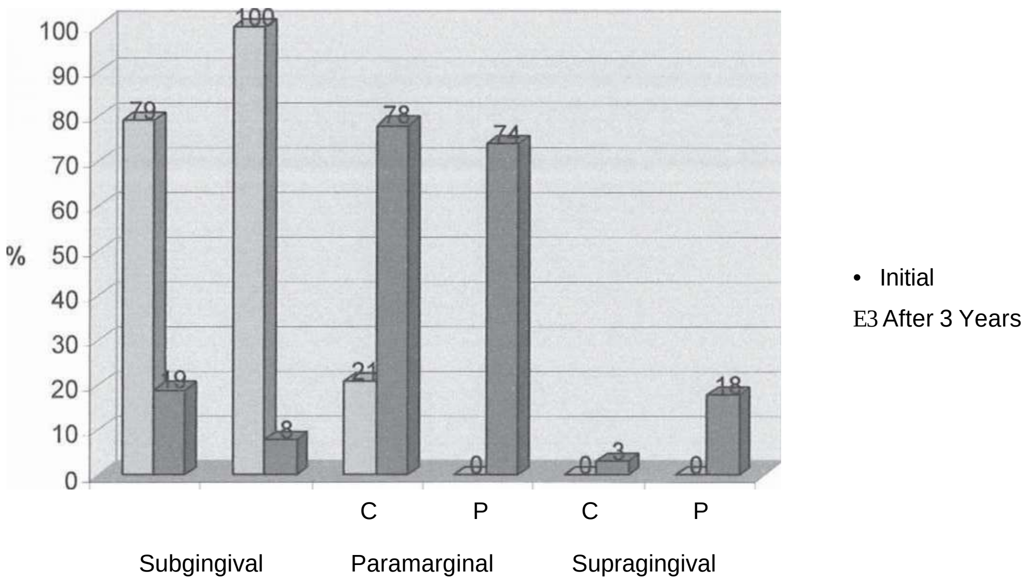
COMPARISON OF PROSTHESIS COLOUR CHANGE TO SURROUNDING TEETH								
G2 P = 0.0000 (+++)	**Perfect colour shade**		**Mild colour change**		**Distinct colour change**		**Gross colour change**	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	24	61	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After II years	24	23	0	38	0	0	0	0
%	100	38	0	62	0	0	0	0

COMPARISON OF (G2) PROSTHESIS COLOUR CHANGE TO SURROUNDING TEETH



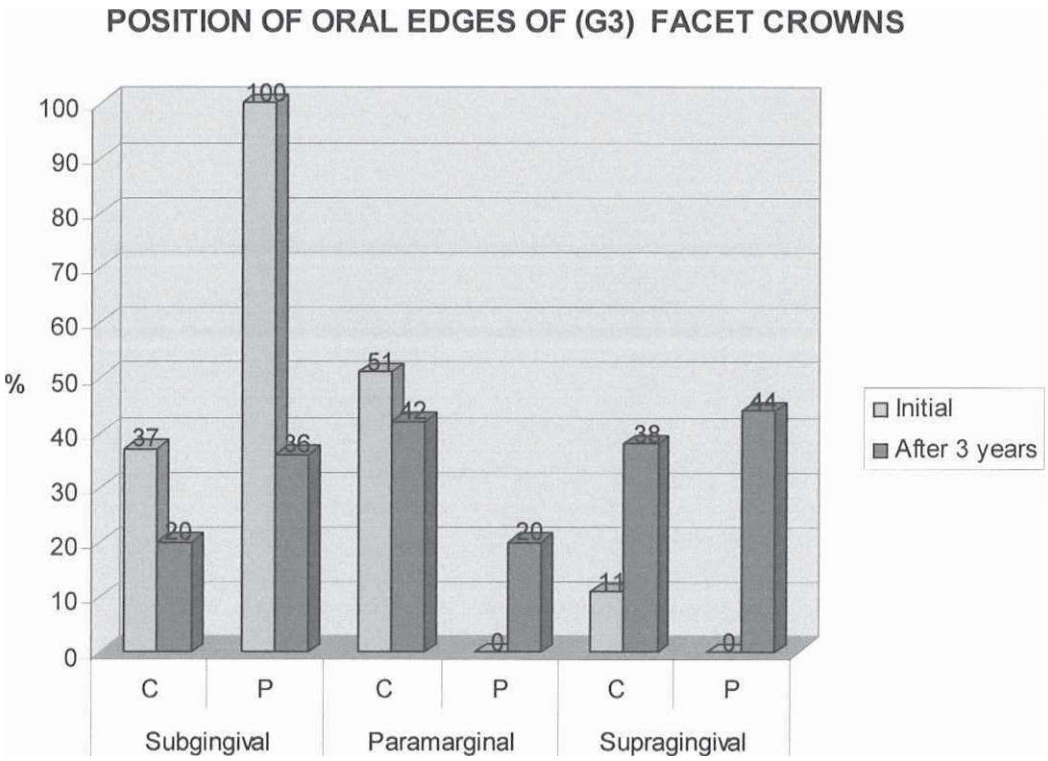
POSITION OF VESTIBULAR EDGES OF FACET CROWNS						
G 3	**Subgingival**		**Paramarginal**		**Supragingival**	
P = 0.0000 (+++)	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	110	130	30	0	0	0
%	79	100	21	0	0	0
After III years	27	10	109	97	4	23
%	19	8	78	74	3	18

POSITION OF VESTIBULAR EDGES OF (G3) FACET CROWNS



POSITION OF ORAL EDGES OF FACET CROWNS

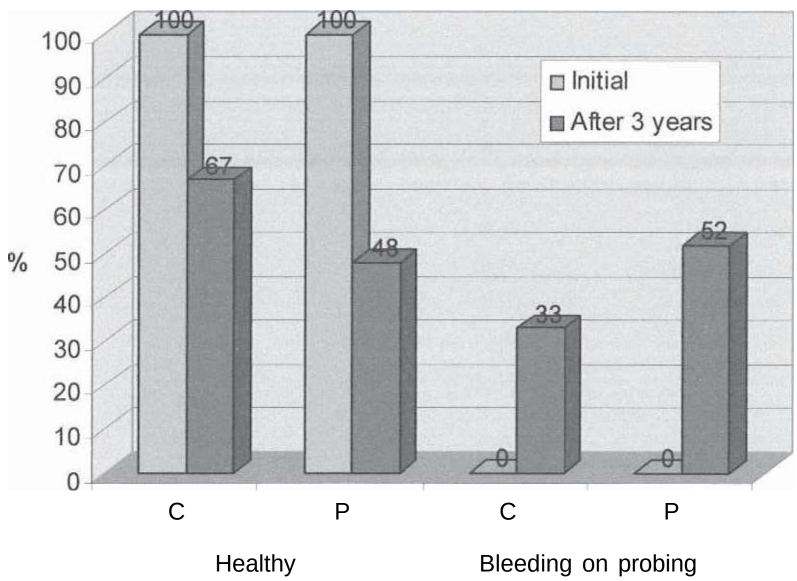
G3 P = **0.0000** (+++)	**Subgingival**		**Paramarginal**		**Supragingival**	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	**52**	**130**	**72**	**0**	**16**	**0**
%	**37**	**100**	**52**	**0**	**11**	**0**
After III years	**28**	**47**	**59**	**26**	**53**	**57**
%	**20**	**36**	**42**	**20**	**38**	**44**



CONDITIONS OF VESTIBULAR AND ORAL GINGIVAL MARGINS OF FACET CROWNS

G3 P = 0.0009 (+++)	**Healthy**		**Bleeding on Probing**	
	Ceramic	Plastic	Ceramic	Plastic
Initial	140	130	0	0
%	100	100	0	0
After III years	94	62	46	68
%	67	48	33	52

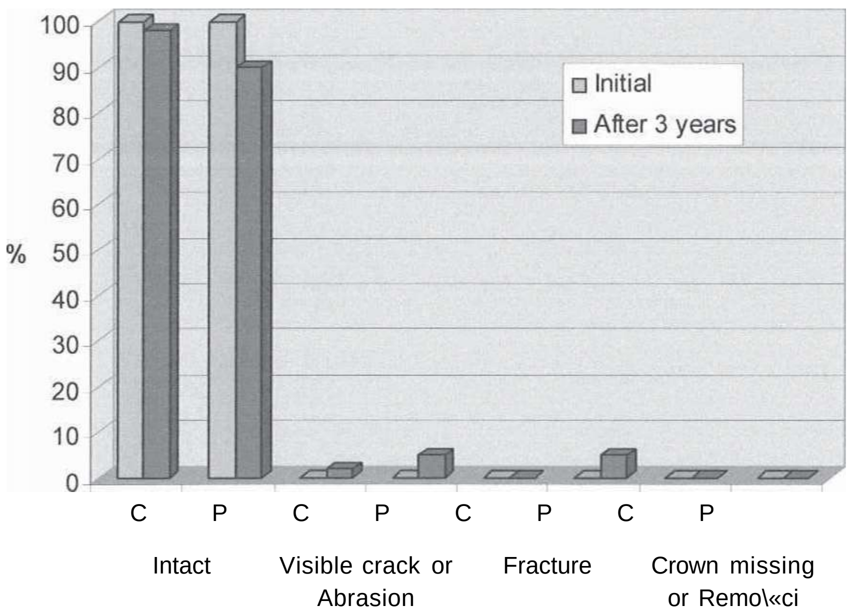
CONDITIONS OF VESTIBULAR AND ORAL GINGIVAL MARGINS OF (G3) FACET CROWNS



CONDITIONS OF FACET CROWNS								
G3 P = 0.0000 (+++)	**Intact**		**Visible[1] Crack or Abrasion**		**Fracture**		**Crown Missing or Removed**	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	140	130	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After III years	139	117	**l**	6	0	7	0	0
%	98	90	2	5	0	5	0	0

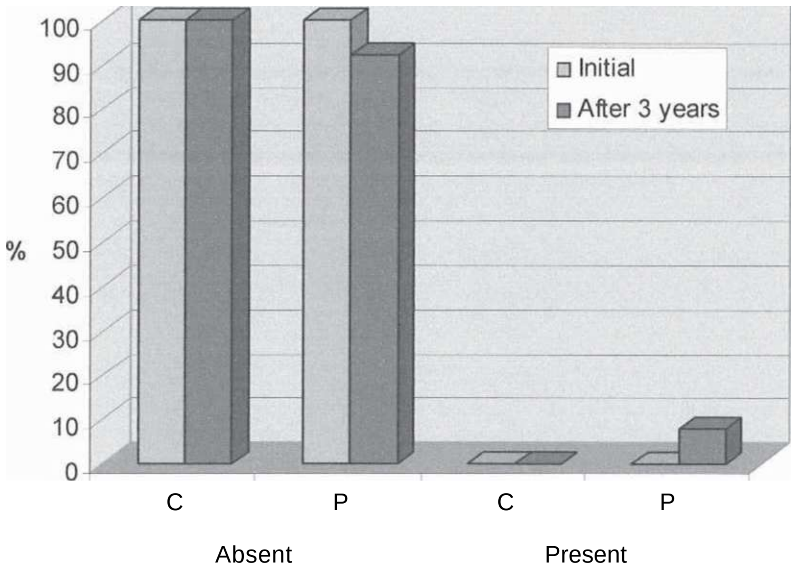
1- With the help of naked eyes.

CONDITIONS OF (G3) FACET CROWNS



SECONDARY CARIES				
G3 P = 0.0002 (+++)	**Absent**		**Present**	
	Ceramic	Plastic	Ceramic	Plastic
Initial	140	130	0	0
0/ /o	100	100	0	0
After III years	140	119	0	11
%	100	92	0	**8**

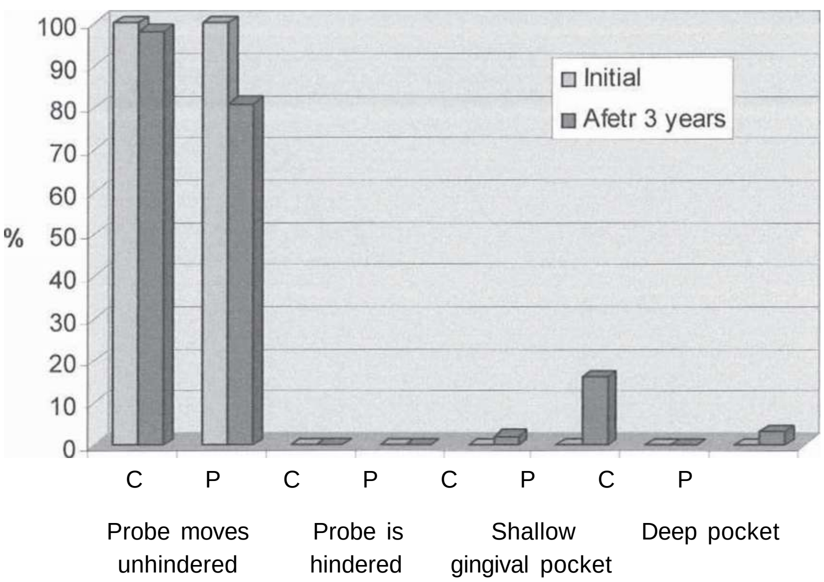
SECONDARY CARIES (G3)



MARGINAL INTEGRATION & MARGINAL ADAPTATION OF PROSTHESIS

G3 P = 0.0000 (+++)	Probe moves unhindered		Probe is hindered		Shallow gingival pocket		Deep gingival pocket	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	140	130	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After III years	137	105	0	0	3	21	0	4
%	98	81	0	0	2	16	0	3

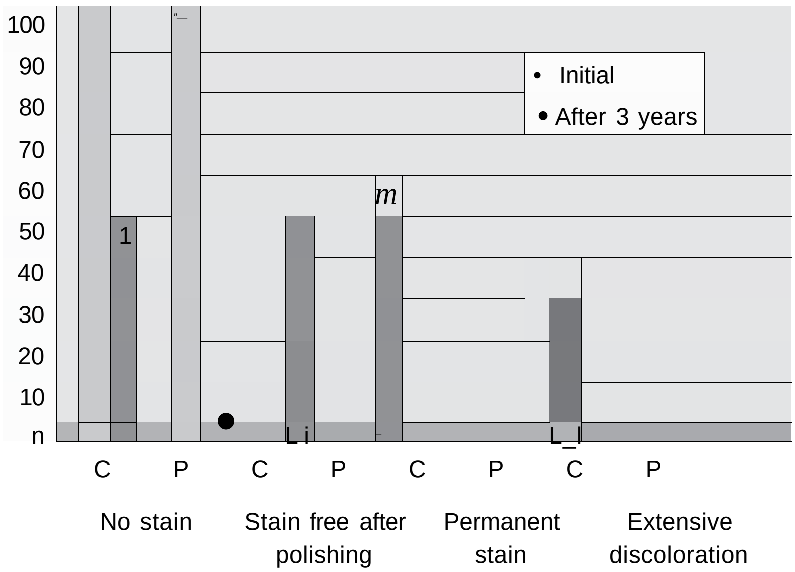
MARGINAL INTEGRATION & ADAPTATION OF (G3) PROSTHESIS



EVALUATION OF VESTIBULAR AND ORAL MARGINS OF FACET CROWNS

G 3 P = 0.0000 (+++)	No stain		Stain free after polishing		Permanent stain		Extensive discoloration	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	140	130	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After III years	69	10	71	74	0	46	0	0
%	49	8	51	57	0	35	0	0

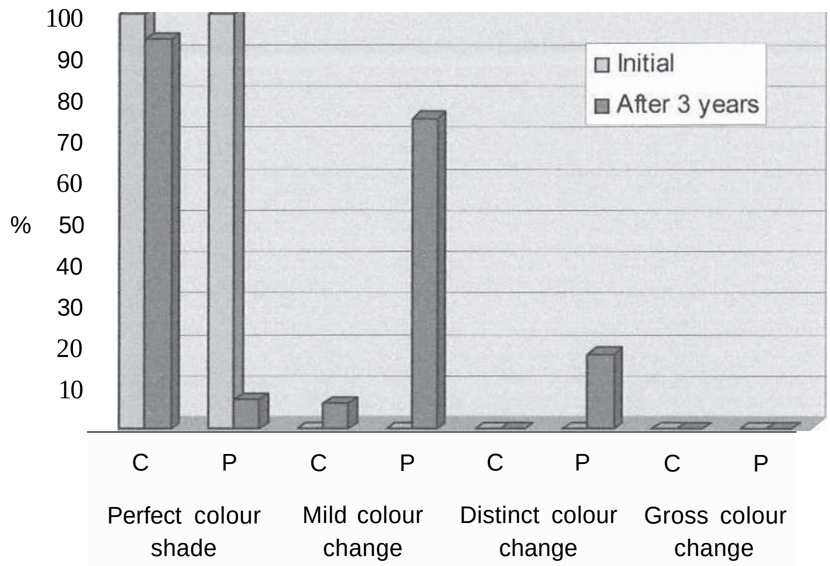
EVALUATION OF VESTIBULAR & ORAL MARGINS OF (G3) FACET CROWNS



COMPARISON OF PROSTHESIS COLOUR CHANGE TO SURROUNDING TEETH

G 3 P = 0.0000 (+++)	Perfect colour shade		Mild colour change		Distinct colour change		Gross colour change	
	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
Initial	140	130	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
After III years	132	9	8	98	0	23	0	0
%	94	7	6	75	0	18	0	0

COMPARISON OF (G3) PROSTHESIS COLOUR CHANGE TO SURROUNDING TEETH



POSITION OF VESTIBULAR EDGES OF (G4) FACET CROWNS							
G4		**Subgingival**		**Paramarginal**		**Supragingival**	
C	**p**	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	167	0	26	8	58	14	83
/o		0	15	36	35	64	50

POSITION OF ORAL EDGES OF (G4) FACET CROWNS							
G4		**Subgingival**		**Paramarginal**		**Supragingival**	
C	p	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	167	9	85	7	52	6	30
0/ /o		41	51	32	31	27	18

CONDITIONS OF VESTIBULAR AND ORAL GINGIVAL MARGINS OF (G4) FACET CROWNS							
G4		**Healthy**		**Bleeding on Probing**		**Metallic Stain (Tattoo)**	
C	p	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	167	13	62	9	105	2	6
0/ /o		59	37	41	63	9	4

CONDITIONS OF (G4) FACET CROWNS									
G4		Intact		Visible[1] Crack or Abrasion		Fracture		Crown Missing or Removed	
C	P	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	**169**	**21**	**113**	**1**	**45**	**0**	**7**	**0**	**2**
%		**95**	**68**	**5**	**27**	**0**	**4**	**0**	**1**

1- With the help of naked eyes.

SECONDARY CARIES OF (G4) FACET CROWNS					
G4		Absent		Present	
C	**P**	Ceramic	Plastic	Ceramic	Plastic
22	**167**	**21**	**130**	**1**	**37**
%		**95**	**78**	**5**	**12**

MARGINAL INTEGRATION & MARGINAL ADAPTATION OF (G4) PROSTHESIS									
G4		Probe moves unhindered		Probe is hindered		Shallow gingival pocket		Deep gingival pocket	
C	P	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	**167**	**18**	**81**	**4**	**47**	0	**35**	0	**4**
%		**82**	**49**	**18**	**28**	0	**21**	0	**2**

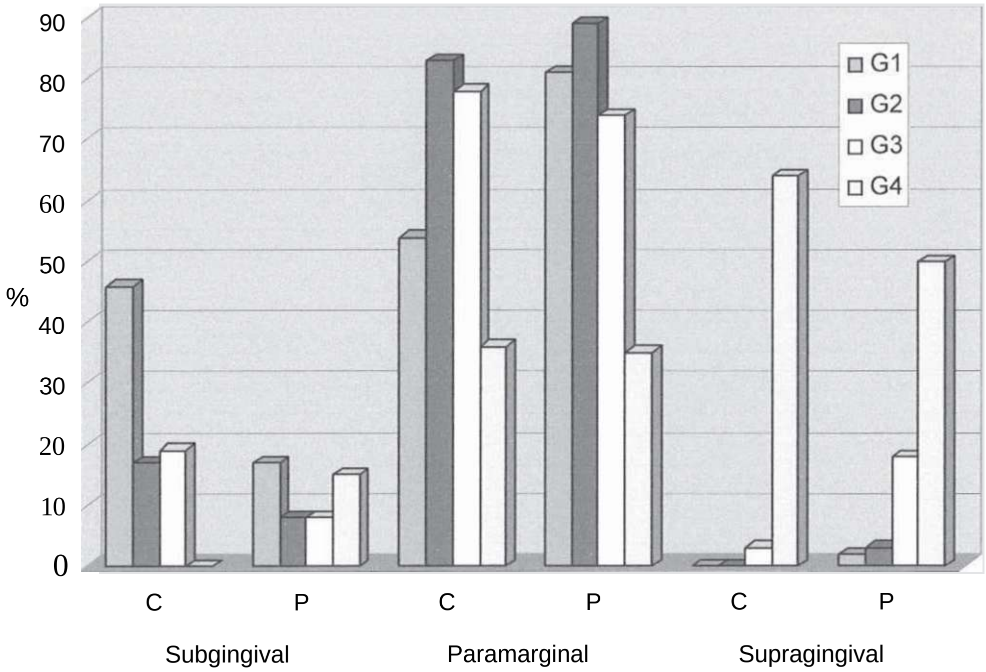
EVALUATION OF VESTIBULAR AND ORAL MARGINS OF (G4) FACET CROWNS

G4		**No stain**		**Stain free after polishing**		**Permanent stain**		**Extensive discoloration**	
C	P	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	167	0	9	22	63	0	101	0	0
%		0	2	100	38	0	60	0	0

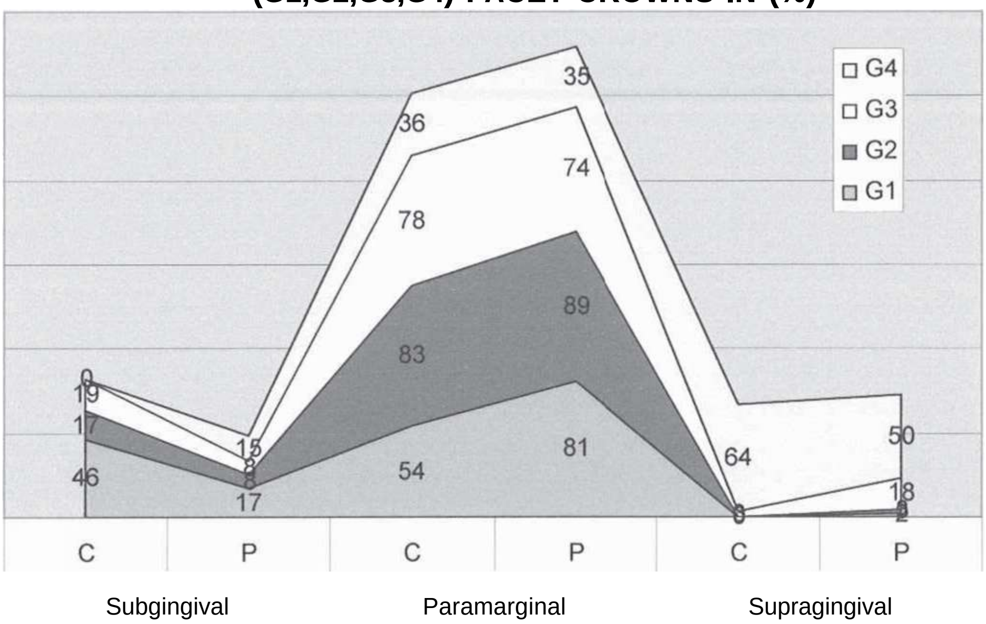
COMPARISON OF (G4) PROSTHESIS COLOUR CHANGE TO SURROUNDING TEETH

G4		**Perfect colour shade**		**Mild colour change**		**Distinct colour change**		**Gross colour change**	
C	P	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic	Ceramic	Plastic
22	167	15	0	7	89	0	71	0	7
%		68	0	32	53	0	43	0	4

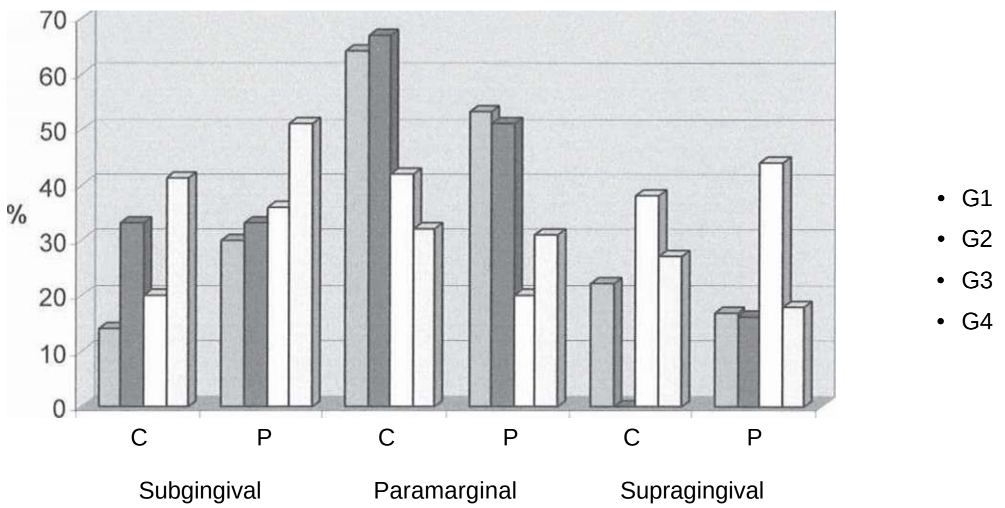
POSITION COMPARISONS OF VESTIBULAR EDGES OF(G1,G2,G3,G4) FACET CROWNS



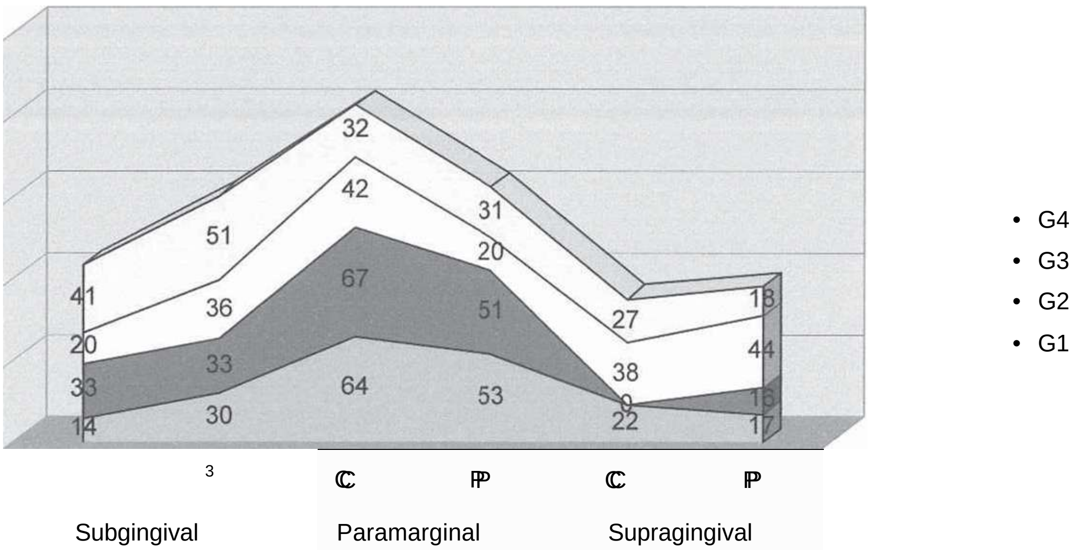
POSITION COMPARISONS OF VESTIBULAR EDGES OF (G1,G2,G3,G4) FACET CROWNS IN (%)



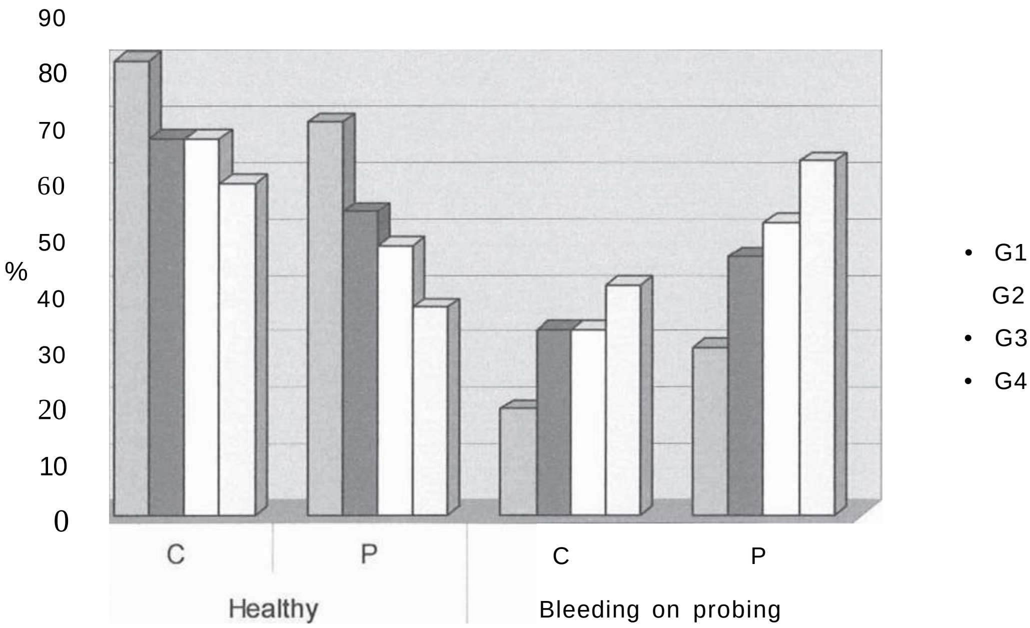
POSITION COMPARISONS OF ORAL EDGES OF (G1,G2,G3,G4) FACET CROWNS



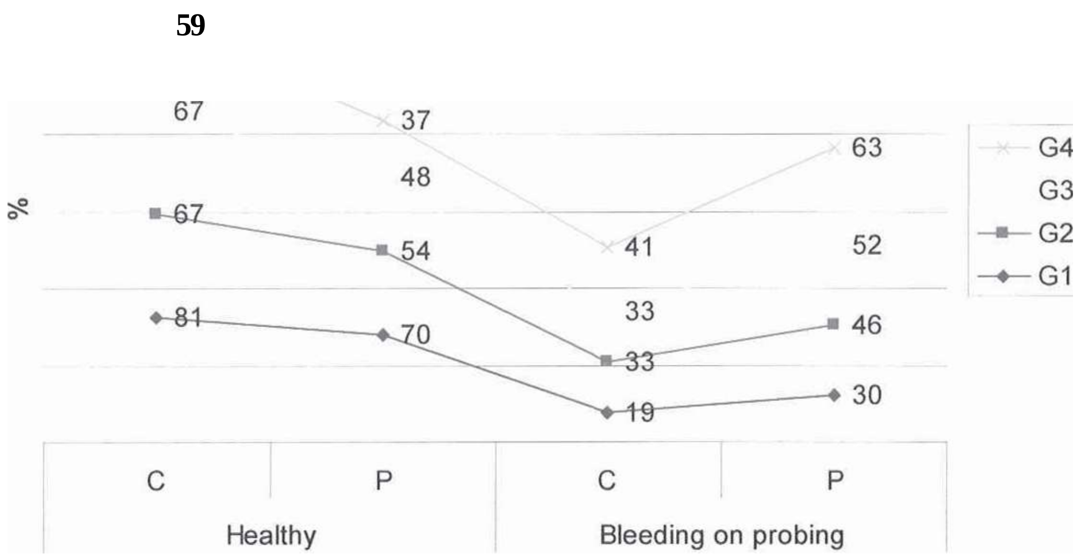
POSITION COMPARISONS OF ORAL EDGES OF (G1 ,G2,G3,G4) FACET CROWNS IN (%)



COMPARATIVE CONDITIONS OF VESTIBULAR & ORAL GINGIVAL MARGINS OF (G1,G2,G3,G4) FACET CROWNS



COMPARATIVE CONDITIONS OF VESTIBULAR & ORAL GINGIVAL MARGINS OF (G1,G2,G3,G4) FACET CROWNS



COMPARATIVE CONDITIONS OF (G1,G2,G3,G4) FACET CROWNS

m n

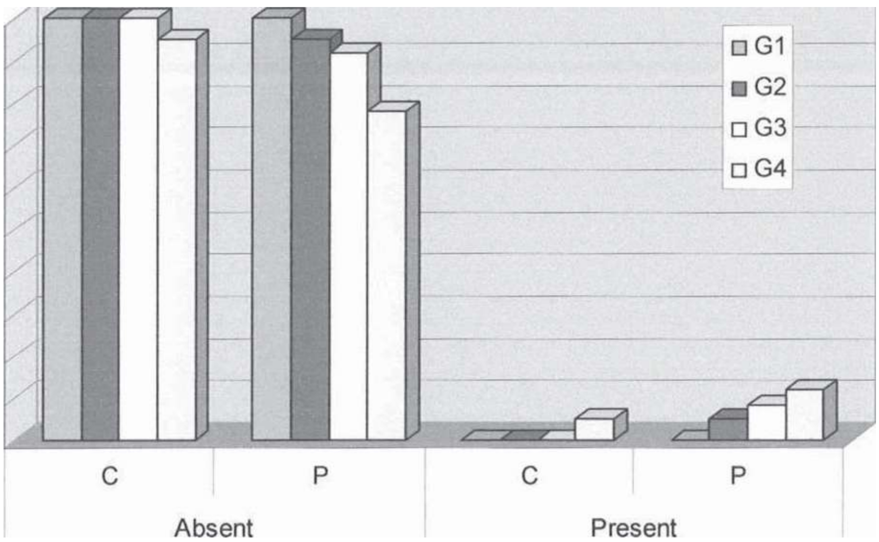
- G1
- G2
- G3
- G4

J

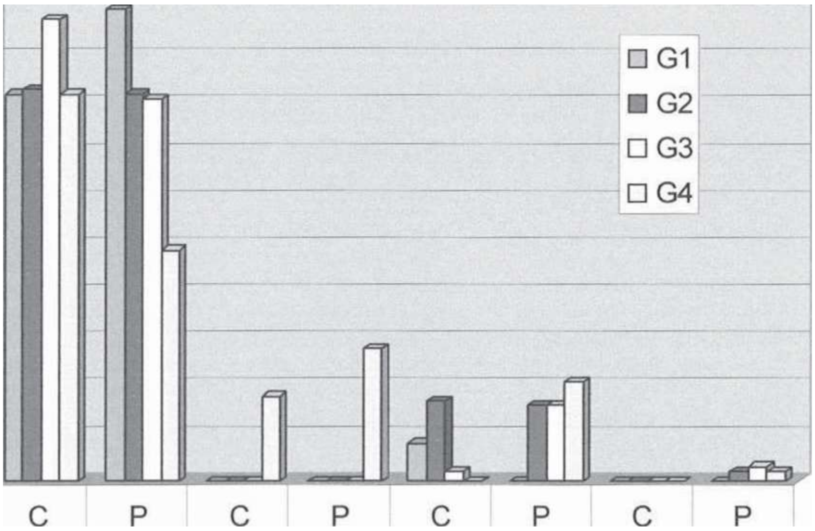
C P C P

Intact | Visible crack or abrasion | Fracture | Crown missing or removed

SECONDARY CARIES (G1,G2,G3,G4)

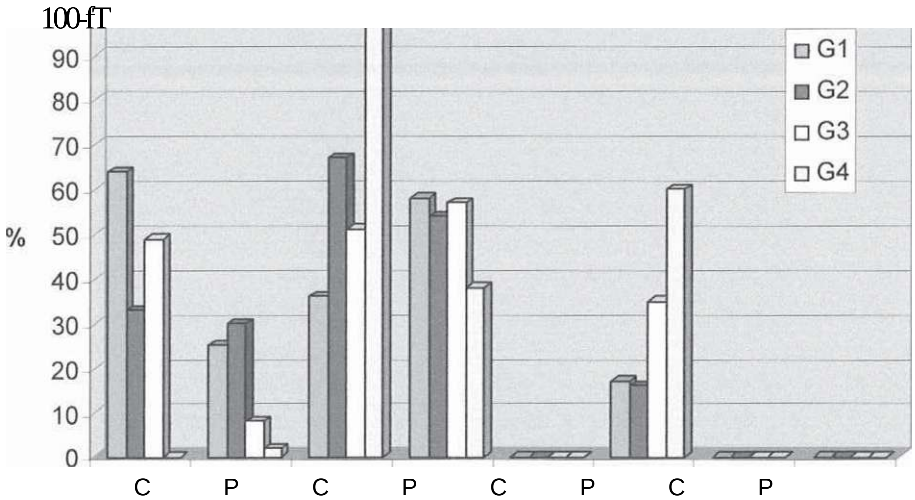


COMPARISON OF MARGINAL INTEGRATION & ADAPTATION OF (G1,G2,G3,G4) PROSTHESIS



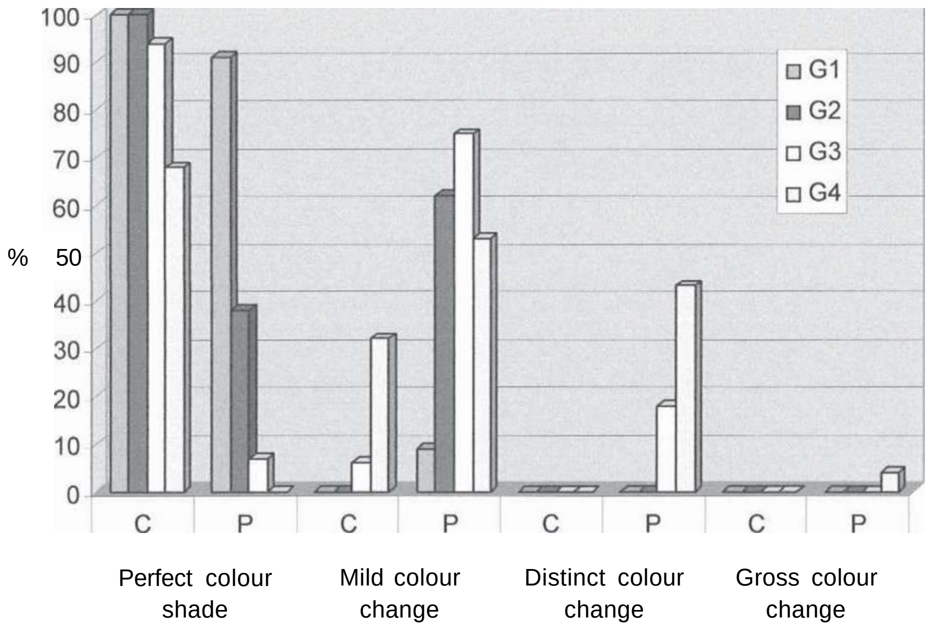
Probe moves unhindered | Probe is hindered | Shallow gingival pocket | Deep gingival pocket

COMPARATIVE EVALUATIONS OF VESTIBULAR & ORAL MARGINS OF (G1 ,G2,G3,G4) FACET CROWNS



No satin | Stain free after polishing | Permanent stain | Extensive discoloration

COMPARISON OF (G1,G2,G3,G4) PROSTHESIS COLOUR CHANGE TO SURROUNDING TEETH



4.1 STATISTICAL EVALUATION OF FACET MATERIALS

Clinical Evaluation of Ceramic and Plastic facet materials was done statistically according to ***Fisher's exact probability test***. one-tailed (FEPT)

According to this test, the attributes and qualities of both plastic and ceramic facet materials were compared.

We assessed the statistical significance (P) of the materials at different levels:

1) Symbol: +++,P = 0.001 (0.1%)
2) Symbol:++, P - 0.01 (1%)
3) Symbol: +, P = 0.05 (5%)
4) Symbol: NS = Non-significant

Example: In group Gl, we evaluated position of vestibular edges of facet crowns. 53 Plastic facet crowns were prepared initially subgingivally. After a period of one year, 9 plastic preparations showed no change, 44 showed a change in position out of which 43 became paramarginal and 1 became supragingival.

Gl FEPT P = 0.0056 (++)	Ceramic facet material	Plastic facet material
Change in position	15	44
No change in position	13	9

4.2 COMPARISON BETWEEN PLASTIC AND CERAMIC FACET MATERIALS

Critical Parameters in Evaluating Facet Materials	PLASTIC facet fused to metal	PORCELAIN facet fused to metal
General Description	Plastic is fused to an underlying metal structure to provide strength to crown or bridge	Porcelain is fused to an underlying metal structure to provide strength to crown or bridge
Strength	Moderate	High
Medián Longevity Estimate[1]	Fair-good	Good
Dentisťs Choice of Patient	Those with good oral hygiene, motivated patients	Those with good oral hygiene, motivated patients
Contraindications		Bruxers, clenchers, abusive occlusal habits
Tooth preparation	Tooth reduced moderately during preparation	Tooth reduced moderately during preparation
Cervical Marginal Leakage	Depends on sealing ability, materials underlying tooth structure and proceduře used for placement	Depends on sealing ability, materials underlying tooth structure and proceduře used for placement
Number of Appointments Required	Ideally two to three	Minimum of two office visits. Esthetic matching of teeth may require more visits

Resistance to Wear	Gentle to opposing teeth; excessive wear of facet in stress bearing situations	Highly resistive to wear, but porcelain can rapidly wear opposing teeth if its surface becomes rough
Resistance to Fracture	Plastic prone to fracture when placed under tension	Porcelain is prone to impact fracture
Biocompatibility	Probably low, but some patients may show allergic sensitivity	Well tolerated but some patients may show allergic sensitivity to base metals
Technique Sensitivity	sensitive	More sensitive
Polishing & Cleaning	Polishing and cleaning is possible	Cleaning is possible
Esthetics	Good-excellent with high level laboratory support & correct patient selection	Excellent with high level laboratory support & correct patient selection
Post-Placement Sensitivity	Sensitivity if present is usually not facet material specific	Sensitivity if present is usually not facet material specific
Repair expectation	Low-moderate	Low
Repair difficulty	Simple remove defective portion, etch, bond, & repair with resin	Difficult. Must replace veneer or patch with resin with esthetic difference between resin & porcelain
Relative Costs for Patients[2]	x	3x. more expensive than plastic

[11] Longevity estimates differ according to clinical situations and may shorter or longer.

-[1] Relative costs (x) for patients - in relation to those seleeted patients that attended one of the prosthodontic clinics of the teaching hospital in Pilsen, dental department. There may also be considerable geographic variations.

NOTE: The information in this chart is provided to help comparison between plastic and ceramic facet materials. The chart is a simple overview of the subject based on the current dental work. It is not intended to be comprehensive. The attributes of a particular restorative material will vary from case to case depending on a number of factors.

5. DISCUSSION AND COMMENTS

"*/7 is beíter to have longer teeth than to have teeth no longer*" (American professor at European Prosthodontic Association Conference, Prague 2001).

The objectives of any oral rehabi 1 itative procedures are to increase masticatory efficiency, to retain the remaining teeth, to preserve their supportive tissues and to achieve the best possible esthetic effect. This remins trne if the treatment involves the restoration of normál function to a single tooth or the reconstruction of the entire dentition.

Gradual abrasion of facet crowns during chewing, hyper-function or incorrect tooth brushing can lead to procedural decreases in shape and size of fixed prosthesis [67] [99].

Any dental structure that is permanently deformed through the forces of mastication is usually a functional failure to some degree. For example, a bridge that is permanently deformed through the application of excessive biting forces would be shifted out of the proper occlusal relation for which it was originally designed. The prosthesis becomes permanently deformed because a stress equal to or greater than the yield strength was developed. A deformed prosthesis may therefore be subjected to greater stress than originally intended. Usually a fracture does not occur under such conditions, but rather permanent deformation results, which represents a destructive example of deformation [88].

Crown deformation and changes in its position can cause problems in proper cleaning of the tooth [67]. Dentistry is a health science that encompasses the study and application of measures designed to prevent deterioration of the oral structures and the use of pertinent clinical procedures to improve the oral health of those treated. [79].

In selecting suitable restorative materials for occlusal reconstruction. the problém of different wear must be born in mind. Tooth wear is a natural process ongoing throughout a patient's life. The rate of wear may vary depending on factors such as dietary and parafunctional habits. The process of wear may alter occlusal relationship in the long term. However, the process may be profoundly influenced by the introduction of restorative materials whose wear characteristics are very different from those of natural tooth tissue, a process termed differential wear. Plasmans [197] investigated the nature of occlusal contacts in natural and restored teeth and concluded that differential wear may disrupt occlusal contacts and leading to occlusal disharmony. Clinicians commonly employ porcelain 011 occlusal surfaces principally for its aesthetic advantages [198], but porcelain has long been recognized as an abrasive material that can cause considerable wear of opposing teeth and restorations. particularly where the surface glaze has been Iost during adjustment [199]. where porcelain must be employed, because of aesthetic demands. the correct treatment of the porcelain surface is essential, particularly following adjustment of occlusal contacts when fitting restorations. Traditionally this would have involved re-glazing. but Jagger and Harrison [200] have reported a verv similar wear pattern for both glazed and unglazed porcelain, and go on to suggest that surface glaze may be rapidly Iost once the porcelain is in the function. They proposed that, after occlusal adjustments, polishing with sandpaper discs and rubber points rather than reglazing of the surface to minimize abrasiveness. Any residual abrasiveness can be particularly destructive in patients who grind their teeth (parafunction). Early evaluation of some of the more recently introduced castable ceramics indicates that they may be less abrasive than conventional porcelains [201], reports of long term trials are awaited.

The facet crowns pose great strength and versatility. A cast metal framework covers the prepared tooth and provides the required strength, while porcelain or plastic is fused over visible portions of the metal to meet esthetic requirements. The failure rates reported for PFM restorations appear to be relatively low (Kerchbaum and Voss, 1977; Coomaert et al., 1984; Glantz et al., 1984; Leempoeletal., 1985: Christiansen, 1986). The most common failure of fixed crowns is due to fracture in pontics [183] which can be the main cause of fixed prosthodontics failure [98,24].

Prosthodontic reconstruction by means of fixed appliances is nowadays considered to be a standard treatment approach; from a long term point of view it is important that the reconstructions fulfill both functional and esthetic aspects. The problém of quality change during time is still widely discussed. Crown and bridge materials with polymer bases are most widely used in most of the Czech dental clinics. Reasonable price and minimal abrasion to opposed compared to that of natural teeth speak in their favor. Rough surface and the possible penetration of particles and smoke products leading to surface discoloration and transparency loss are only some of their clinical disadvantages.

Possible surface discrepancies in combination with inadequate oral hygiene may lead to gingivitis and consequently to secondary caries. Metal ceramic crowns' have a smooth surface protected with a glazing layer which may cause plaque retention in patients with inadequate oral hygiene. However, the smooth surface causes only limited gingival irritation in the cervical area and enables saliva penetration. Significant quality differences had been proven in association to the natural discoloration and caries detection. Regarding these parameters the results speak in favor of metal ceramic reconstructions.

According to the health insurance companies' regulations, metal ceramic reconstructions as well as other reconstructions should have the life time of at least five years (Czech health insurance Company). Fixed reconstructioit's long term durability is subject to dentists. dental technicians and patients discussion. Single-unit metal ceramic crowns have a high probability of 10 years clinical service with esthetic acceptability, when proper clinical and laboratory protocol is applied and placed correctly [70], Lovgren mentioned that fixed gold prosthesis has better tnarginal integration than other metals [96].

Full functional and esthetic value of the fixed reconstruction stands in contrast with its true maintenance in the oral cavity. Facet crowns are by far the most commonly used restorations in fixed prosthodontics, in which it represents approximately 90% of all restorations used. In the teaching hospital of Pilsen, plastic facet crowns were most commonly used due to affordability and ease in manipulation; but due to gradually increased patient awareness about better products in the market and better economical status (of the country as a whole), metal ceramic and full ceramic crowns are slowly but surely making their way into the patients mouths!

The comparison between the metal ceramic and plastic crown is very tričky. DeLong et al. (1986) reported a high coefficient of friction between enamel and dental porcelain and concluded that the wear of porcelain appears to be one order of magnitude (lOx) greater than that of dental amalgam.

As case studies and analysis have shown, both types of crowns have wear resistance, fracture durability and longevity. Hubalkova, in the period of two years, showed that there was some abrasion in both facet materials but this can be micro-abrasions in ceramic materials and more visible macro abrasions in plastic facet materials [30.67] of course if it is to be looked at closely then in some aspeets of conservation of tooth structure, cost and age related factors, plastic crowns stand a better chance; and yet metal ceramic would prove to be a better choice for an ideál adult patient who would like to enjoy good esthetics combined with strength of material. In one study (Christensen.1986)

70 % of the dentists indicated that PFM crowns with porcelain occlusion on maxillary first molars were highly successful, only 26 % indicated that they would have used PFM crowns with porcelain occlusal surfaces for their own personál treatment. Most of these dentists, for their own maxillary first molars, preferred a three-quarter gold crown (53 %), compared with a PFM crown with metal occlusion (7 %), a seven-eighths gold crown (11 %), or a full-gold crown (1 %). This preference is likely due to the potential for increased wear if the porcelain surface loses its glaze or polish.

In the past. the traditional concept has been to pláce margins as far subgingivally as possible. based on the mistaken concept that the subgingival sulcus is caries-free. [18]. The practice of routinely placing margins subgingivally is no longer acceptable. Subgingival restorations have been described as a major etiologic factor in periodontitis [181.107,76,146,191,152,91,136.189] the deeper the restoration margin resides in the gingival sulcus, the greater the inflammatory response [153.83.1 13,75]. Although Richter and Ueno reported no difference between subgingival and supragingival margins in a 3 year clinical study, they recommended that placement be supragingival whenever possible [137]. Eissmann et al made a similar recommendation [46]. Koth also failed to find a link between margin location and gingival health in a selected patient population on a strict hygiene regime [89].

These studies do not refute the evidence that subgingival margins are likely to cause gingival inflammation. They merely demonstrate that margin location is not as crucial when placed by a highly skilled dentist in the mouth of a motivated. cooperative patient. Because preparation length is such an important factor in resistance and retention, preparations are frequently extended subgingivally to increase retention. The placement of finish lineš can also be altered from ideál locations by caries, the extensions of previous restorations, trauma or esthetics. [91,1 1,15.162,9,57],

It is important that the patient's esthetic expectation is discussed and understood before a restoration is fabricated, absolute esthetic require that there be no metal visible, even if one were to look carefully. A dentist must remember that the patient is the ultimate judge of an esthetic crown or fixed partial denture [19].

We have analyzed and assessed data that has been collected from the Pilsen teaching hospital and also from abroad. Preference is alvvays for the best product that the dentist can offer to the patient in terms of esthetics, life span in the mouth, strength, cost and so on; but a choice between these two crown materials has to be made with the cooperation of both the patient and the dentist taking time to discuss the advantages and disadvantages. The patient at the clinic should be made aware that although he/she may want a eertain material as the choice of crown, it may not always be possible in terms of patient's oral hygiene (plastic materials require a better hygiene status than metal ceramic), expenses (metal ceramic crowns being more costly) and time factor. The aim is to arrive at a mutual agreement between the patient and the dentist. having highlighted all the possible long term benefits of the material of choice and the patient's finál approval and acceptance of it. Patient satisfaction rates highly, not only in Czech Republic, but all over in the world.

Henceforth in my discussion 1 have come to understand that with the ever improving field of prosthodontics no one material can be finalized and stated to be the best. Not so long ago gold crowns were held in high regard considering their strength and resistance to wear and tear. But with the advent of better education. information, research and economics the metal ceramic crowns and plastic crowns have become verv popular. A choice between these two materials lies eventually in the hands of the skilled dentist who is able to inform his patients and come down to the choice of material which will make both patient and dentist happy and satisfied in the long run. Patients undergoing extensive prosthodontic rehabilitation should be given the opportunity to ask and talk about their dental health, and dentists should minimize their question-asking and orientate their behavior during the encounters to help improve patient satisfaction and treatment outcome [71].

6. CONCLUSION

1. In selecting suitable restorative materials for occlusal reconstruction, the problém of different wear must be born in mind. differential wear may disrupt occlusal contacts and leading to occlusal disharmony.
2. Both metal ceramic and metal plastic facet crowns are ***fimctionally*** stable in the mouth during their life span but in three years time after cementation only 98 % of ceramic facet crowns and 90 % of plastic facet crowns are in perfect condition with esthetic acceptability; provided correct laboratory construction and placement.

3. Colour stability of metal ceramic is 100% and only 50% for plastic facet crowns in the course of three years time after cementation.
4. Mechanical stability of ceramics is higher than plastic crowns.
5. Mechanical abrasion is higher in plastic facet crowns.
6. Porcelain can be potentially destructive when opposing natural teeth and certain restorative materials. Recommendations focus on avoiding occlusal contacts in porcelain. despite highly glazed surfaces. However, patient demands for esthetics commonly result in compromise but this should be contraindicated in the cases of bruxers. clenchers and people with abusive occlusal habits.
7. A successful cast restoration usually implies a smooth gingival margin with a supportive relationship to the gingival margin; we have to determine a suitable finish line before tooth preparation. The DMF rate, height of gingival tissue. and oral hygiene directly influence the decision. but variations are commonly instituted by the dentist.
8. Subgingival margins are likely to cause gingival inflammation but this is not very crucial when the crown is placed by a highly ski 1 led dentist in the mouth of a motivated. cooperative patient. Whenever possible. the finish line should be placed in an accessible area where the margins of the restorations can be finished by the dentist and kept clean by the patient.
9. Life span of metal ceramic crowns is higher than metal plastic crowns. should last + 10 years with esthetic acceptability if laboratory construction is correct & placement correct.
10. Plastic facet crowns require polishing and cleaning at least twice a year; this is not very necessary for ceramics.
11. Plastic facet crowns are more affordable than ceramic facet crowns.
12. Ceramic facets are best recommended when opposing dentition have been restored, fi 1 led or have a crown or bridge with porcelain materials.
13. Repairing of plastic facet materials are much more convenient than metal ceramics, with the advantage oflow cost.
14. Repair expectations of plastic facet materials are higher than ceramics.
15. Plastic facet crowns are preferable in the elderly when many teeth are involved since they are lighter in weight than metal ceramic.

16. More tooth structures need to be sacrificed in a metal ceramic construction; therefore it is better in case of vital teeth to do a proper evaluation.

17. The preparation of a tooth for both types of facet materials duplicates the morphology of the natural tooth and the originál occlusal anatomy, to ensure the health of dentition so that reduction occurs to a minimum.

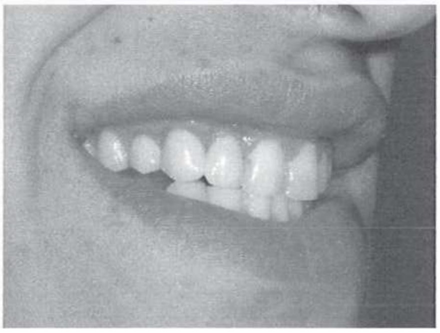
18. Eventual choice rests upon the decision taken after appropriate patient-dentist communication.

7. CLINICAL PHOTOS (few samples)

• Full ceramic veneer bridge 14,13 and 12, (A) first day after cementation, (B) 6 month after cementation, (C) 18 month after cementation of bridge.

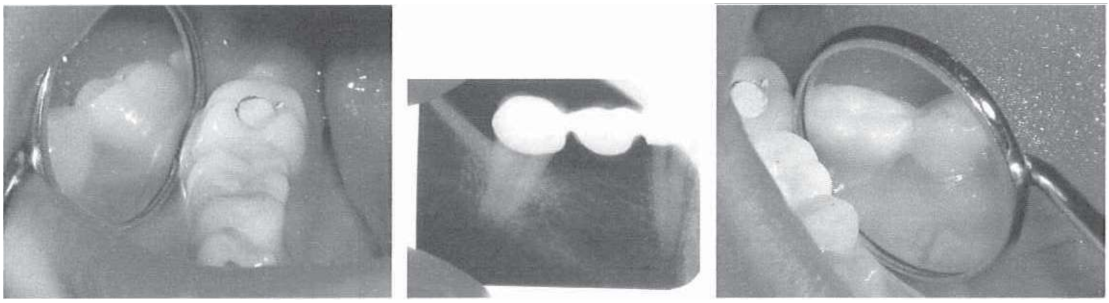
A

B

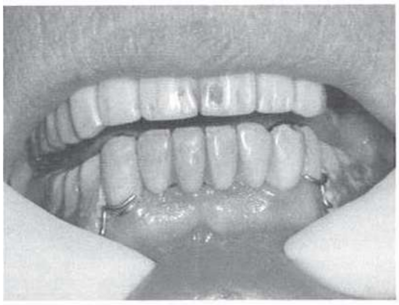


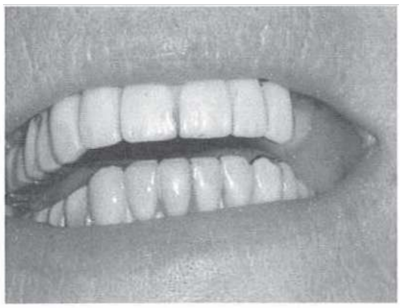
C

• 3 years after cementation of full ceramic veneer bridge 17,16 and 15, vve can see the vestibular and oral gingival margins are in perfect condition. On tooth 17 patient complained of pain (chronic pulpitis) 2 years after cementation and it was treated endodonticaily.

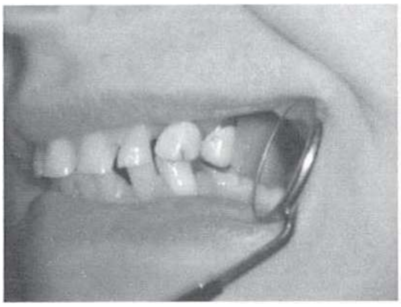


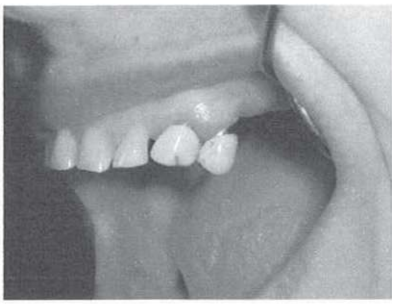
• Patient is a smoker and eoffee drinker, the plastic facet bridge was cemented more than 4 years ago we can see the heavy pigmentation on the surface of all of the teeth. We tried to remove the pigments by polishing it, we were able to clean it superficially, but the staining persisted.



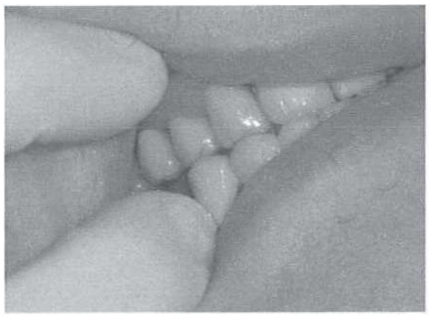


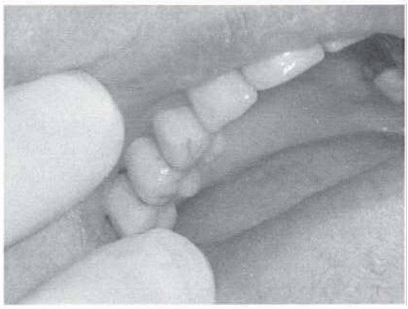
• We observed a visible crack and mild gingival retraction on tooth 23 covered with the plastic facet crown, 6 years after cementation.



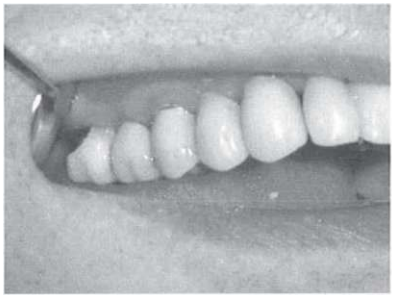


• Due to incorrect heavy contact with opposing ceramic tooth we were able to perceive visibly a crack due to extensive pigmentation at its margins, 4 years after cementation on tooth 14 covered with ceramic facet crown.



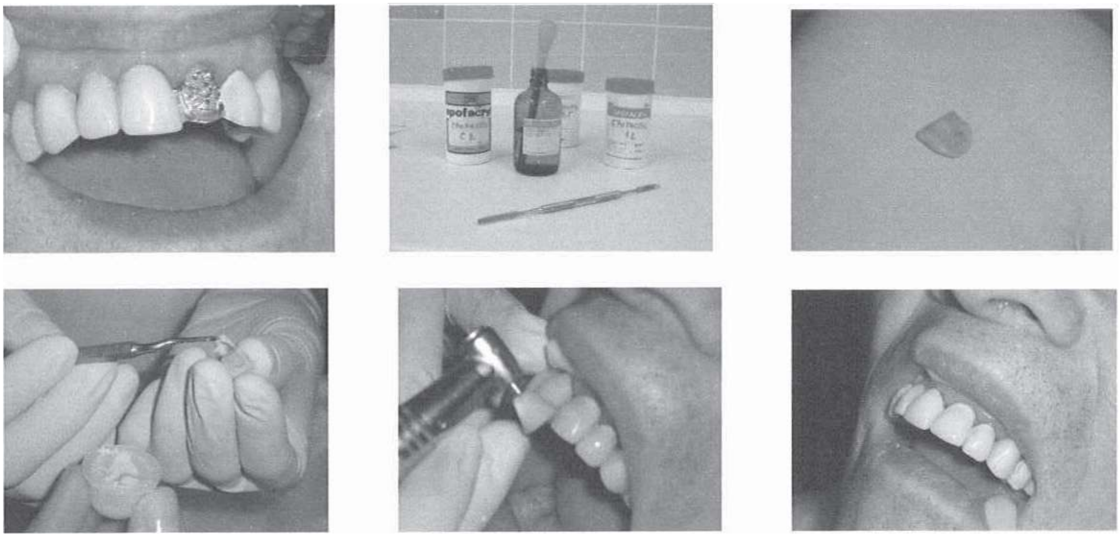


• 3.5 years after cementation, (A) we can see accumulation of plaque on vestibular surfaces and also the fracture of distal part of the partial plastic facet bridge on tooth 17 (B) after polishing.

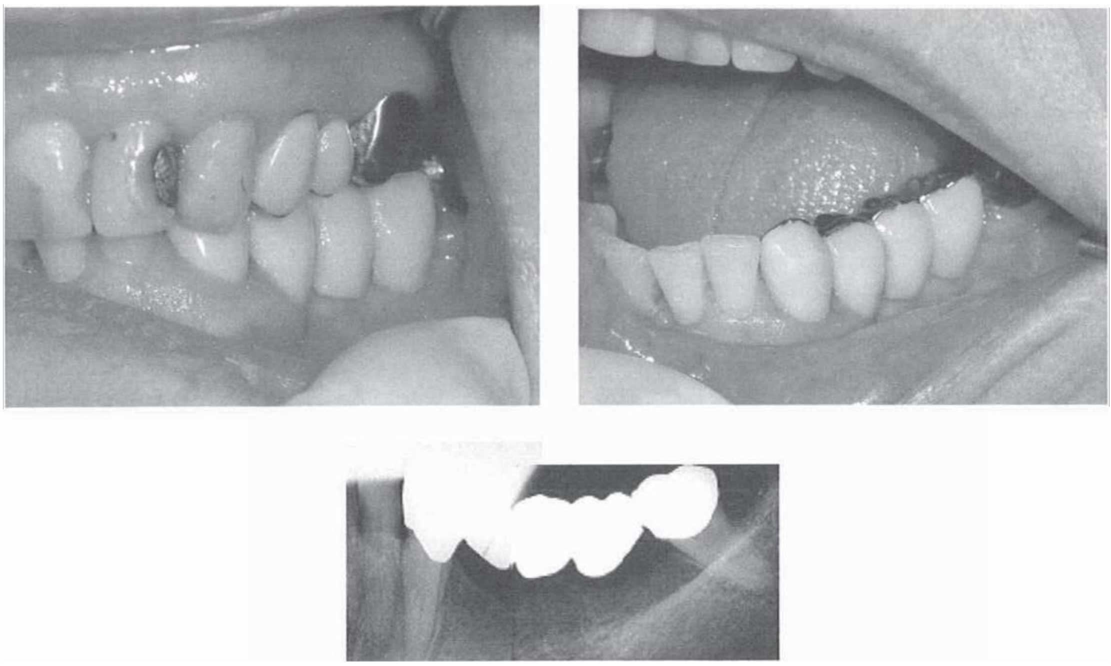


• This is an example of a clean tooth surface with perfect oral hygiene 3 years after cementation, there are healthy gingival margins with mild discoloration of the facet material.

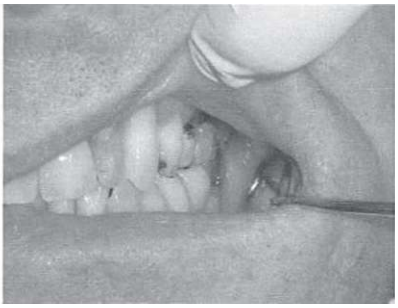
• We can now observe the fracture of the plastic facet bridge, 3 years after cementation, the facet is replaced back to the originál position by making small retentive grooves on the metal base and using Spofacryl (combination of polymer & monomer) for cementation.



• The body fracture of 33, 34, 35, 36 and 37 can be seen on the partial veneer plastic bridge at the junction between 36 and 37, on tooth 33 we can also see occlusal abrasion (9 years after cementation).

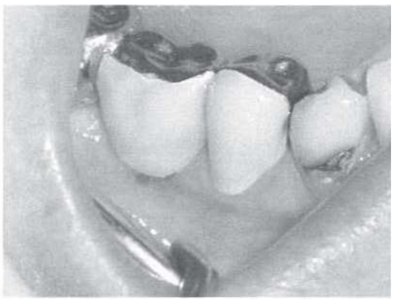


• Here, we can see the occlusal abrasion of tooth 35, due to heavy contact of opposing tooth on the facet surface after 3 years, and vestibular abrasion of tooth 25 can be due to incorrect brushing.

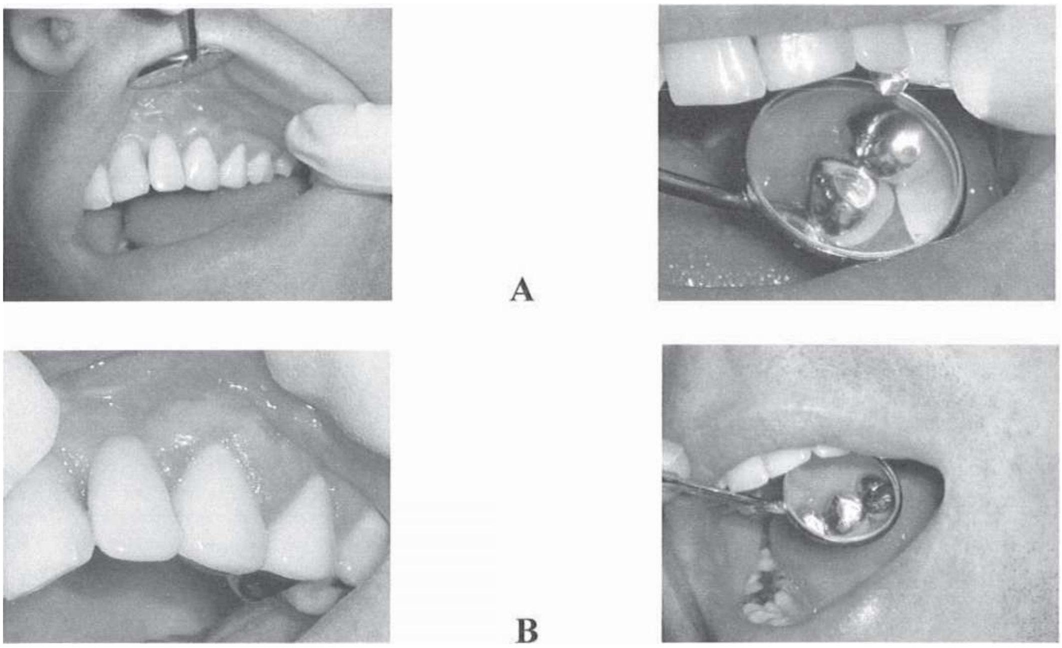


• 17 years old partial veneer plastic facet bridge with gradual abrasion of the vestibular facet surface.

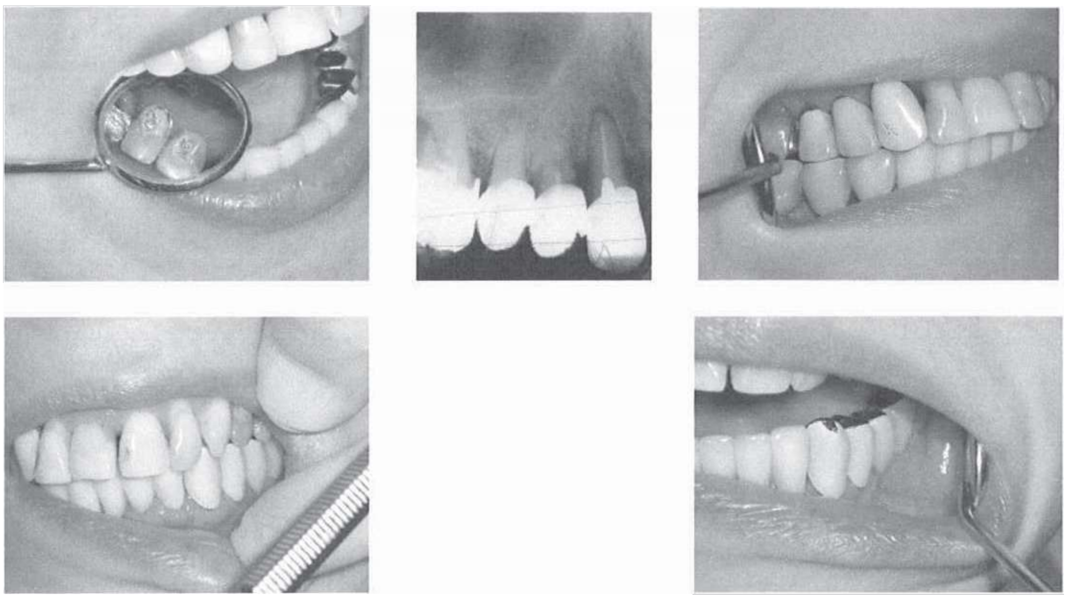
• Plastic facet bridge 47,46,45 provides an uneven surface for perfect retention of foreign particles in 2 years after cementation of the bridge. (A) After instruction of proper oral hygiene the teeth were cleaned by the patient with a classic tooth brush and tooth paste but we were able to observe the retention of dental plaque. (B) After mechanical polishing by the dentist, the resultant surface was clean and smooth.



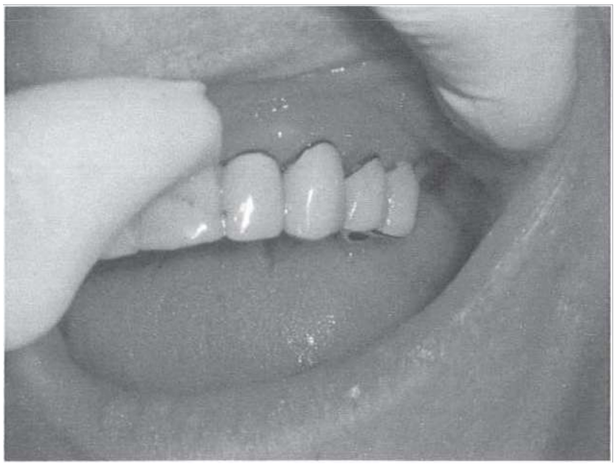
• The perfect condition of 22,23,24 Plastic facet Bridge (A) 2 years and (B) 3 years after cementation, we can see healthy gingival margins due to patients attention to proper oral hygiene, successful treatment proceduře and also good patient-dentist communication.



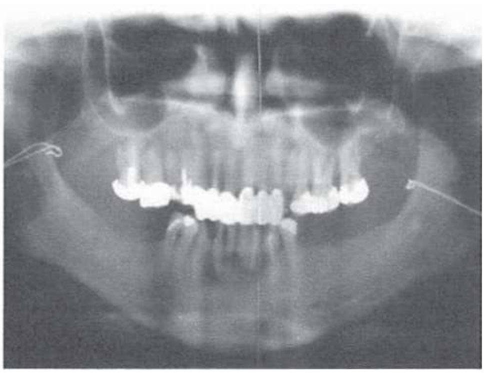
• Palatinal abrasion of teeth 13,14 and occlusal abrasion of tooth 33 due to direct contact with opposing tooth on the vestibular facet area. Subluxation of tooth 13 due to incorrect articulation, a few months alter having a new ceramic bridge placed on the lower jaw at area 43-32.



• We can see a 5 year old plastic facet bridge, all the gingival borders of the bridge are migrating supragingivally due to mild gingival inflammation, also we are able to see visible discoloration of the facets and the repair of tooth 21 with composite material.



• Plastic facet bridge 3 years after permanent cementation, all are shifted supragingivally due to retraction of the gingival margins, consequently causing the visibility of the metallic rings at the cervical border even with optimal oral hygiene (PBI 0-1).



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www.academvdentalinaterials.org

3. American Dental Association Council on Scientific Affairs:
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12. Society for Biomaterials:
www.biomaterials.org

13. Surfaces in Biomaterials Foundation:
www.surfaces.org

9. APPRECIATIONS

My deepest appreciation to my supervisor, MUDr. Eduard Cimbura, PhD. for his patience and guidance. His dovvn to earth attitude and good humor has helped me to face the difficult moments that I have come across in the span of these four years.

I would also like to thank Prof. MUDr. Jan Kilián, DrSc. vvho is the Honorable President of the Oborová rada of the Faculty of Medicine. Department of Stomatology in Pilsen. for his keen eye for my work. support and encouragement at this time.

My deepest gratitude to Doc. MUDr. Antonín Zicha. CSc, the head of the Department of Stomatology, for his kindness and having provided me with so much material which has helped me in giving body and substance to this thesis.

My father Prof. F. Boldaji. PhD and mother vvho have stood by me through thick and thin and been there always like solid rocks of support, without their constant encouragement this study would not have been possible.

My friends for all the times that they helped to raise my morale when I was stressed or feeling down.

And last but not the least my deepest thanks to MUDr. Aniza Lone for her superb literary skills. and insights that have helped my thesis immeasurably.