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3. Basic restorations in the elderly

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Dentist have a special role in health care of the elderly because they can improve their quality of life by keeping them free of oral infections, restoring their dentition, to make them capable of enjoying eating, and restoring their facial aesthetics (Ettinger, 1992). This elderly population is fast growing especially in all industrialized countries. The increasing number of the elderly and the retention of their natural teeth unto later years mean that there is an increasing need for restorative dental services among older adults (Ainamo and Osterberg, 1992; Dolon and Atchison 1993; Fure and Zickert, 1997). Dental caries was identified as the main reason for tooth extraction among the elderly (Fure and Zicket 1997). Root surface caries is especially prevalent in the ageing population (Konig 1990, Young 1994) though new coronal caries may also be found. Findings by Griffin et al, 2005, suggest that the United State (US) older adults experience caries at all rates equal to or greater than those in children, who are the primary recipients of caries preventive services. Caries among the elderly is also more likely to remain untreated; their mean number of untreated decayed surfaces (1.6) (Winn et al, 1996) is about four times that among US schoolchildren (0.4) (Kaste et al; 1996). There appears to be no difference in the pathogenesis or etiology of root and coronal caries (Faire et al 1992, Fejerskov 1994, McComb 1994, Saunders and Handleman 1992).

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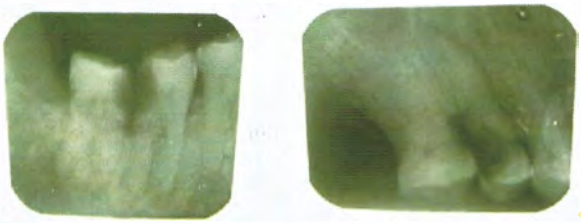
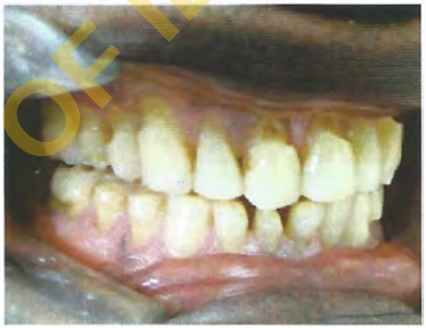


Root caries in a 78 year old

Tooth wear is part of the normal ageing process, therefore it is not surprisingly to find that older patients have more tooth wear lesions. Tooth wear, particularly in the elderly is often the result of a complex combination of causes. It may be difficult to attribute the aetiology to a single factor, and it is thus wrong to use a specific term which implies cause and effect. However the terms erosion, abrasion, attrition and abfraction can be used when there is a clear indication of the specific aetiology in the case under investigation (Bernard 1994). These tooth wear lesions and other class V lesions form a main indication for restorations in the elderly.



Tooth wear lesions in the elderly.

Occasionally, trauma to teeth leading to coronal tooth tissue fracture and cracked tooth syndrome may be the reason why the elderly population may seek restorative services. In all of these indications, an important principle in assessing the need for restorative treatment in the elderly is the outcome of such restoration. Each clinical decision depends on the patient's needs, but expecting an older patient to undergo prolonged and complex care, with the realization that the restoration may not necessarily prolong the life of the dentition is questionable. It may be wise to provide simple and basic

restoration in some cases; while in the others, advanced restoration may be acceptable and advisable. Simple restoration that can be employed in the treatment of dental defects include:

a. Amalgam restoration
b. Composite resin restoration
c. Glass ionomer cement restoration
d. Laminate veneers.

A major principle to follow when planning a restorative treatment for an elderly patient is treatment simplification. It is important that the options available for a particular problem be well communicated to the patient and the family and agreement reached by all the people involved. Occasionally however, the sequencing of a dental treatment plan can be difficult to explain to a patient because there are many factors that can make the care complex and the outcome difficult to predict. Therefore, a treatment plan often must be dynamic (Lindquist and Ettinger, 2003). As treatment proceeds, the patients health may change resulting in new modifying factors that will require constant re-evaluation and added communication with the patient based on his or her needs.

Factors that may influence decision making when planning restorative care can be divided into the general factors and those that relate to the mouth as a whole and the individual tooth.

General factors

Patient's desires and expectations: when older patients seek dental care, it is imperative to resolve chief complaints as quickly as possible when developing the treatment plan. Other dental problems may be present but the patient may not perceive this as a need, therefore including these in the restorative plan, for a better quality of life must be well explained to the patient. Prioritization of such restorative needs is pertinent.

Medical condition

Many common systemic illnesses become increasingly frequent with advancing years. These may result in physical disabilities and use of complex medications which may be relevant to dental practice. Simple restorative procedures may be more beneficial to such patients, rather than a more technical idealized treatment. The projected amount of stress involved with an idealized treatment plan may pose health risks in older medically compromised patients and may limit the potential benefit of the treatment, thus making it inappropriate.

Psychosocial factors

Restorative treatment plan must take into consideration the patient's attitude and social schedule that may influence their restorative demand and availability for restorative treatment. The educational and professional background of some elderly still make them relevant in social circles, if such patients are medically and psychologically stable, they still co-operate with the dentist even if the procedure is extensive.

Economy

The patient's financial status will determine the type of restoration that is provided for him/ her, even if there are oral indications. An implant retained prosthesis for an elderly living in a home, depending on social welfare or the elderly who is retired and dependent on pensions which are more often than not very irregular, may be unaffordable though functionally preferable.

Previous dental history

Patient's past experiences with dental treatment may influence their attitude and predisposition towards dental care generally and restorative care in particular. Even for a regular attender, treatment simplification and modification may be necessary as the patient ages. Because an elderly patient may not be able to coordinate or tolerate extensive restorative procedures which may not have been a problem when the patient was much younger and medically sound.

Transportation problem

The fabrication of advanced restoration may necessitate that the patient comes for several appointments before the completion of the treatment. Non-ambulant elderly patients should have their treatment simplified and the number of visits minimized. At the outset of treatment, all carious teeth should be restored using simple conventional techniques prior to any further care.

Dental considerations

a) Residual tooth tissue

A proper assessment of the residual tooth tissue is required before deciding the form of restoration to be used. The aetiological factors of the toothwear must be identified and dealt with, for instance a bruxing habit is likely to lead to the destruction of porcelain occlusal surfaces of bonded

crowns. Metal occlusal surfaces would be a better option and also cause less damage to the opposing natural teeth. Furthermore, advanced restorative treatment should not be offered until erosive factors have been identified and controlled. If it is necessary to place full coronal restorations in a subject with an ongoing erosive problem, the crown margins should be placed subgingivally. As a general rule, as much tooth tissue as possible must be retained and utilized.

b) Occlusion

In planning advanced restoration for an elderly patient, one of the major considerations is the decision whether to use the conformative or reorganized occlusion. Simple restorative dentistry is usually done, using the patient's existing intercuspal position (ICP) i.e simply assessed obvious 'bite'. When the dentition is extensively worn, there is a risk, if this approach is adopted, that what is being conformed to will be inappropriate. In summary, a conformative approach is justified where;

1) A full examination of the occlusion has been done.
2) It can be predicted with confidence that few teeth are likely to require cast restorations with the forseeable future
3) Sufficient teeth remain to provide an acceptable occlusion
4) Wear is not severe and space considerations permit acceptable restorations to be made.

Reorganisation of occlusion will result in new jaw relationship when the restorative work has been completed. Properly planned, well approached reorganized occlusion is more than simply raising the vertical dimension. It is indicated in the following conditions;

1. When an increase in vertical height is wanted or indicated
2. When a tooth / teeth is / are significantly out of position (i.e overerupted, tilted or rotated
3. When a significant change in appearance is wanted
4. History of occlusally related failure or fracture of existing restorations
5. Recurrence of temporomandibular disorder that has relapsed after a period of successfully splint therapy.

The changed occlusion can be beneficial and even well tolerated by the older patients.

Amalgam restoration

Dental amalgam continues to be the most used restorative material (Leinfelder 1991) though its use has sometimes been controversial (Millner et al 1991). The controversy has largely been due to the belief that amalgam releases mercury which is toxic to health. However, there is no confirmed evidence to indicate that the mercury in dental amalgam is related to any diseases (Ahquist et al 1988, Bjorkman et al 1996, Kingman et al 1998, Osborne and Albino 1999).

Also, the Federation of Dental International (FDI 2007) issued an expert policy statement which declared amalgam to be a safe and effective restorative material.

Indications

1. Moderate to large class1 and 11 restoration especially restoration that involve heavy occlusion, that cannot be isolated well, or that extend onto the root surface.
2. Class V restoration (including restoration that are not esthetically critical, cannot be well isolated or are located entirely on the root surface.
3. Temporary caries control restoration (including teeth that are badly broken down and require a subsequent assessment of pulpal health before a definitive restoration).
4. Foundations (including for badly broken down teeth that require increased retention and resistance form in anticipation of the subsequent placement of a crown or metallic onlay)

Contraindications

1. In prominent esthetic areas of the mouth. These areas include anterior teeth, premolars and in some patients, molars
2. In small to moderate defects in posterior teeth, composite restorations are better suited.

As a restorative material, dental amalgam has many advantages. It is strong, durable, and relatively easy to use. It is the least time consuming to place and has the lowest cost. However it is not tooth colored, and it does not on its own bond to tooth structure, although amalgam bonding systems are available to provide a mechanical attachment of amalgam to enamel and dentine (Nakabayashi et al 1992).

The durability of amalgam restoration has been demonstrated by several studies (Mjor et al 1990, Smales 1991, Osborne et al 1991) especially when

the material is placed in well designed tooth preparations, with all the principle carefully observed.

The following goals should therefore guide the preparation and restoration of teeth:

1. Removal of pathosis (carious tooth structure)
2. Preservation of the integrity of tooth and periondontium
3. Maximization of the life of the restored tooth (Summit and Osborne 1992).

Furthermore, in preparing the carious teeth for amalgam restoration in the elderly the usual principle should be carefully followed as discussed below:

Outline form

In establishing the outline form in an initial carious lesion, the carious tooth structure should be eliminated and the margins placed on sound tooth structure. All the undermined enamel should be removed; however the preparation should not be unnecessarily widened. The outline should be smooth, with no sharp angles. This is important so as to facilitate the uncovering of the margins during carving of amalgam. If an occlusal carious lesion encroaches on the enamel of the proximal surface so that, when the carious dentine is removed the proximal enamel has no dentinal support, consideration should be given to converting the class1 to a class 11 preparation. This consideration should be determined based on the forces to which the marginal ridges will be exposed. If there is a direct occlusal contact between the opposing tooth and the weakened marginal ridge, the marginal ridge should be removed and restored with amalgam.

Many elderly patients may have had some restoration for years some of which may fail secondary to recurrent caries, fracture of the tooth or the restoration itself. In such a situation, the outline form will be determined by several factors such as the outline form of the old restoration, the extent of the additional pathosis and the need to improve the resistance form for the tooth structure or restoration. A tunnel restoration should be considered in a minimally deep dentinal carious lesion, initiated through demineralization of enamel in a proximal surface.

A tunnel restoration does not usually involve the use of dental amalgam. However, a class 11 restoration indicated only because of a proximal carious lesion having an occlusal outline limited to the marginal ridges is treated using what is referred to as a slot restoration. Care should

be taken to avoid nicking or scarring of an adjacent tooth by leaving a shell of enamel between the preparation and the adjacent tooth when the tooth is being prepared.

Resistance and retention form

The opposing walls should be parallel or converge occlusally. The enamel margins should be prepared at a 90° or more obtuse angle in order to enhance their ability to resist fracture. Marginal fracture will usually cause marginal gaps or ditches, between the amalgam and the enamel. If the facolingual width of the preparation exceeds one third the distance between the tips of the facial and lingual cusps (intercuspal distance). The remaining cusps should be carefully evaluated. If a cusp is too weak to withstand function, it should be reduced for coverage.

Occlusal amalgam restorations should have an occlusogingival thickness of at least 1.5mm, and preferably 2.0mm, to resist fracture during function (resistance form for the restoration).

Developments in cavity design

In recent times, a conservative cavity design is advocated for amalgam restoration. Smaller burs can be used to create preparations that involve the removal of only diseased and weakened enamel and dentine, and width the use of fissure sealants, sound tooth tissue can be preserved.

Resin coated amalgam

In overcoming the limitation of microleakage with amalgam restorations, a coating of unfilled resin is placed over the restoration margins and the adjacent enamel (after etching the enamel). Though the resin may wear away over time, but it delays the microleakage until corrosion products begin to fill the tooth restoration interface.

Fluoridated amalgam

Recently formulated amalgam has fluoride as one of its constituents. Fluoridated amalgam has been known to release fluoride for several weeks after insertion of the material in the mouth. The anticariogenic action of the fluoride amalgam is based on its ability to deposit fluoride in the hard tissues around the fillings and to increase the fluoride content of plaque and saliva and subsequently affecting remineralization. This may be very beneficial in restoring root caries in the elderly.

Composite resin restoration

Resin composite has become the most frequently used esthetic restorative material in Dentistry (Leinfeld 1993). Composite is widely preferred over amalgam because it is esthetic, conservative in terms of tooth structure removal, repairable and it has low thermal conductivity. Despite being aesthetic, durable predictable, resin composites have several undesirable properties, the main one the main one being the volumetric shrinkage during polymerization. This can be as high as 7% (Feitz et al, 1988) and can generate contraction force of 4.0-7.0mPa (Davidson and De GEE 1984, Eick and Welch 1986) leading to crazing and cracking at the margins. Marginal gaps may result in microleakage, sensitivity, staining at the margins of the restoration and recurrent caries (Lutz et al 1991).

The polymerization that occurs in pre –gel phase can be compensated for by the flexure and flow of the material. However stresses occurring in the post-gel phase are not relieved by the material flow and may cause gap formation between the resin composite and the wall of the preparation, with its resultant consequences.

Composite restoration may be indicated under the following condition:

1. Class I,II,III,IV,V and VI restoration
2. Core build up
3. Preventive resin restorations
4. Esthetic enhancement procedures
   a. Partial veneers
   b. Full veneers
   c. Tooth contour modification
   d. Diastema closure
5. Cement for indirect restorations
6. Temporary restorations
7. Periodontal splinting
8. Fractured teeth
9. Tooth wear lesions

Contraindications are as follows

1. Inability to isolate the operating site from contamination by oral fluids
2. For patients with heavy occlusion, bruxism or restorations that provide all of a tooth's occlusal contacts, amalgam, rather than composite is usually the material of choice.
3. Lesions that extend to the root surface area may result in less than ideal marginal integrity if restored with composite resin.

Advantages of composite restoration (Robertson et al 2006)

1. Aesthetic
2. Conservative of tooth structure removal (less extention, uniform depth not necessary, mechanical retention usually not necessary).
3. Less complex when preparing the tooth
4. Insulative, having low thermal conductivity
5. Used almost universally
6. Bonded to tooth structure, resulting in good retention, low microleakage, minimal interfacial staining and increased strength of remaining tooth structure.
7. Repairable.

Disadvantages

1. Composite restorations may have a gap formation, usually occurring on root surfaces as a result of the forces of polymerization shrinkage of the composite material being greater than the initial early bond strength of the material to dentine.
2. They are more difficult, time consuming and costly (compared with amalgam restorations) because tooth treatment for bonding usually requires multiple steps.
3. Insertion is more difficult.
4. Establishing proximal contacts, axial contours, embrasures and occlusal contacts are more difficult.
5. Finishing and polishing procedures are more difficult
6. They are more technique sensitive than amalgam because the operating site must be appropriately isolated, and the placement of etchant, primer, and adhesive of the tooth structure (enamel and dentine) is demanding of proper technique
7. May exhibit greater occlusal wear in areas of high occlusal stress or when all of the tooth's occlusal contacts are on the composite material
8. Have a higher linear coefficient of thermal expansion (LCTE), resulting in potential marginal percolation if an inadequate bonding technique is used.

Tooth preparation

In restoring carious lesions, the outline is determined only by access and by the extent of the carious lesions. There is no need for extension for prevention and removal of sound tooth structure to gain mechanical undercut retention is contraindicated.

When a class I restoration is being placed due to initial carious lesions, the preventive resin restoration is usually the technique of choice, margins of occlusal preparation for resin composite should not be beveled.

For a class II composite restoration, if there are one or more areas of fissure carious lesions in the teeth in addition to the proximal surface lesion(s) they should be treated separately, if possible using preventive resin restoration technique. Enamel margins may /may not be beveled. Bevels in enamel provide more area for acid etching and bonding, bevel is designed to expose enamel rods transversely to achieve a more effective etching pattern.

Recommendation regarding bevel placement in class II

a. **Facial and lingual proximal margins:** conservative bevels should be placed at approximately 45° to the surface on the facial and lingual cavosurface margins of the proximal box preparation. Bevels on these margins significantly reduce marginal leakage (Hilton et al 1999, Opdam et al 1998).
b. **Gingival margins:** the gingival margin should be beveled only if the margin is well above the CEJ and an adequate band of enamel remains. The enamel layer at the CEJ is very thin, therefore beveling may remove the little enamel that exist. When a cavity preparation approaches within approximately 1mm of the CEJ, adhesion is essentially no better than bonding to dentine (Ferrari et al 1999, Hilton et al 1999, Hilton et al 1997). Use of an inverse bevel or so called internal bevel has been shown to significantly reduce microleakage compared to a butt margin (Holan et al 1997). Also, placement of a cervical groove should be considered when there is no enamel at the gingival cavosurface margin (Coli et al 1993).
c. **Occlusal margins:** the use of occlusal cavosurface margin bevels is not recommended. Avoidance of bevels on the occclusal surface prevents the loss of sound tooth structure, decreases the surface area of the final restoration, lessens the chances of occlusal contact on the restoration, eliminates a thin area of composite that would be more susceptible to fracture and presents a well demarcated marginal periphery to which composite can be more precisely finished (Barnes et al 1990, Jordan et al 1991, Lehinfelder 1991, William and Johnson 1993).

In a class III restoration, cavitated enamel caries requires minimal or no preparation, the finished preparation resembles a saucer, and has no retentive undercuts. Adhesion to acid –etched enamel provides the necessary retention.

Dentinal caries with enamel margins:-the preparation may be done with or without bevels. Bevels were advocated by some authors (Eick and Welch 1986, Porte et al 1984) but enamel bonds have been demonstrated clinically to be adequate without bevels (Qvist and Strom 1993).

Margins should only be bevelled if this will improve aesthetics and retention of the material. If the peripheral margin is entirely composed of enamel, no undercuts retentive points or grooves are necessary, as the restoration will be retained by adhesion (Summit et al 1993).

Dentinal caries with margin extending onto the root surface: in situation where there is little or no enamel for bonding, the marginal adaptation of the restoration may be optimized in two ways:

a. Sandwich technique using a resin–modified glass ionomer restorative material to seal the cervical portion of the restoration and filling the remaining cavity with resin composite to improve aesthetics
b. Dentine Bonding Agent: if this is the only form of adhesion at the cervical margins, placement of a retentive groove to the depth of 0.4or 0.5mm may help to minimize gap formation.

Restorative technique

Etching, priming and adhesives placement steps are accomplished with strict adherence to the manufacturer's directions for the particular bonding system.

The proximal surfaces of the adjacent unprepared tooth should be protected from inadvertent etching by placing a polyether strip. Then a gel etchant is applied to all of the prepared tooth structure, and left for 15 to 30 second. Washed away copiously with water, and then air-dried with airjet. If dentin is exposed, rather than air dry the rinsed area, it may be better to use a damp cotton pellet, a disposable brush or a paper tissue to remove excess water. If the area is dried it can be rewetted with gluma desentizer (Hansen et al 1997, Reinhard et al 1995).

The primer is applied to all of the prepared tooth structure and then cured. Bonding adhesive (if not combined with primer) is then applied next. The adhesive is lightly dried to evaporate any solvent (acetone, alcohol, or water) and eliminate any water in the self etch bonding system. The adhesive is polymerized by light curing. The composite material bonds directly to the cured adhesive when applied. The composite material can be self cure or light cure. Self cure will require mixing (base and catalyst) while light cure usually comes in syringes and after selecting the appropriate shade, it is cured.

Contouring and polishing the composite

Good technique and experience in inserting composites significantly reduce the amount of finishing required. Flame shaped carbide finishing bur or polishing diamond is recommended for removing excess composite on facial surface. Lingual excess of composite is removed and a smooth surface is produced using round or oval twelve bladed carbide finishing bur. Proximal surface contour and margins should be assessed visually and tactilely with an explorer and dental floss.

Rebonding/Glazing

This is performed after the restoration is finished and polished. The enamel margins are re-etched, coated with unfilled or lightly filled low viscosity resin and polymerized.

Rebonding has been reported to improve marginal integrity and color stability, improve early resistance, and help reduce staining of the restoration (Dickinson and leinfelder 1993).

Grossly broken down tooth

After composite restoration

Glass ionomer restoration

Glass Ionomer cements possess the favourable quality of releasing fluoride when exposed to the oral environment (Mount 1991). Because of this potential anticariogenic quality, GIC may be the material of choice for restoring root surface caries which is more prevalent in the elderly than in the younger generation. Furthermore, the material also offers adhesive bonding and a unique ability to recharge or take up fluoride when exposed to an external source such as topical application of fluoride mouth rinse.

The perceived advantages of adhesion and fluoride release have generated a lot of intense research to improve Glass ionomer products to the point of being competitive with other restorative material options.

Modifications of the initial powder and liquid formulations have been done to improve physical, chemical and mechanical properties. Powder particles were reduced in size and modified by incorporating additional types of powder particles for reinforcement. Ag-Sn particles (amalgam alloy particles) were admixed in some formulations to produce an amalgam substitute. This combination became known as 'Miracle mix' (Simmons 1983). The properties were however far inferior to amalgam and the matrix would not adhere strongly to the Ag-Sn alloy particles. To circumvent this difficulty, silver palladium (Ag-Pd) was substituted. Ag-Pd generates a passivating oxide film of palladium oxide that is chemically active by chelation with polyacrylic acid. These mixtures, were much stronger than unmodified GICs, but had poor esthetics and could not be highly modified or else they would not set as well. These materials are used mostly as cores.

In the early 1990s, reformulated ionomer based materials replaced part of the original GI formulation with alternative filler particles or matrix setting reactions to make them more composite like (Mitra et al 1992). These materials are categorized as hybrid or resin modified glass ionomers. They are light cured, less technique sensitive, and may be finished at the time of placement. Because they are stronger, they are recommended for class V restorations and can be used for class 1 and 11 restorations in primary teeth.

Another formulation produced polyacrylic modified resin composites or compomers which are essentially polymer-based composites that have been slightly modified to permit fluoride release from the glass or special matrix phase. The mechanical properties are superior to the properties of traditional and resin modified glass ionomers, and in some cases, rival those of contemporary polymer –based composites.

A special temporary filling material has been fabricated from GI for use in atraumatic restorative treatment (ART) technique. This technique was developed for the promotion of oral health in communities with lower socio-economic or in those who live in remote areas of developing or underdeveloped countries where dental treatment is not readily available. The ART approach may not be a very useful tool when treating some patients such as those with caries risk, children and disadvantaged patients such as special care patients, the elderly and those who have experienced discomfort, anxiety/pain. Yet another type of GIC is called a Giomer. This was developed in an attempt to retain some traditional GI properties. Precured and pulverised particles of GI were added as an additioned dispersed phase within a compomer.

Indications for GI restorations in the elderly

Glass ionomer (GI) restorations seem well suited for situations involving high caries risks. These include patients known to be more caries susceptible,

patients with reduced or no saliva flow, and patients with oral diseases that accelerate the pathogenic activities associated with caries. The caries preventive effect of GI (due to fluoride release) is highly important especially in the elderly patients who may have compromised oral self care skills owing to either physical handicap, lack of motivation or disinterest. (Pilot T 1999).

Root caries in the elderly

Root surface caries is a soft irregular, progressive lesion at or apical to the CEJ. It is caused by the presence of bacterial plaque and the repeated consumption of sugars which results in dissolution of minerals from the calcified tissue. (Shay 1997, D. Preza 2008). Root caries can occur in areas of abrasion, erosion, abfraction or as a primary root caries or a recurrent decay. (Jones 1995). Many root caries do not need restorative treatment. Incipient lesions, where there is no obvious surface defect, can be treated by preventive measures alone, with the aim of transforming active lesions to arrested lesions. Proper preventive measures of plaque removal, diet modification and topical fluoride application (Nyvad et al. 1986, Nyvad and Larsen 1994) have demonstrated significant results in arresting active carious lesions. Preventive measures include educating patients and people assisting them to avoid high sugar containing meals, maintaining a proper toothbrushing technique and oral hygiene measures, and regular dental check-ups. Elderly patients (especially those with limited manual dexterity) need to be educated about plaque control with the use of interproximal brush or electrical oral hygiene devices. Also, chemical control of plaque (chlorhexidine rinse, 0.12%) may be especially useful in old, confused or infirmed patients).

Accessible, shallow cavitated lesions may benefit from recontouring and smoothing together with topical fluoride application. The purpose of recontouring and smoothing is to eliminate the soft tissue, leaving a smooth, easily cleansable root surface (Billings, 1986).

Cavities, which cannot be made cleansable by recontouring or of such depth that the pulp is endangered, require restorative intervention. The challenges to effective restoration of root caries include impaired access, moisture control, pulpal proximity and nature of dentine substrate itself. Proper access and isolation are very important when treating root caries, and these involve use of a rubber dam, if the lesion is supragingival. If the lesion is subgingival or near the gingival margin, other forms of isolation like cotton rolls and retraction cords are used. Surgical exposure may sometimes be required to be able to place a satisfactory restoration.

Class V lesions

These are carious and non carious defects found in the gingival third of facial and lingual tooth surfaces. The non-carious class V lesions may be attributed to either abrasion, erosion, abfraction, or a combination of abrasion and erosions. Abrasion is defined as loss of tooth structure by mechanical or frictional forces. They are commonly caused by excessive forces from other materials such as toothpicks, dental floss or removable appliances.

Erosion is loss of dental hard tissues by non-bacteriogenic acid etching. Abfraction on the other hand is the non-carious cervical lesion caused by tensile strength generated from occlusal loading, and microfracture of cervical enamel rods (Grippo 1991). Good access and effective isolation are very critical to successful restoration of class V lesions. Inability to gain sufficient access to the gingival margin may result in a poor restoration- tooth interface, increased microleakage and premature loss of the restoration. Access and isolation can be achieved either surgically or by non-surgical approaches. The use of rubber dam, cotton rolls, retraction cords and other materials to isolate the lesion and absorb moisture can be employed. Surgically, gingivoplasty and surgical flaps (miniflaps and conventional flaps) can be made use of.

Indirect tooth colored posterior restorations

Tooth colored indirect systems include laboratory processed composites and ceramics such as porcelain fired on refractory dies or hot pressed glasses.

Indications

- Large defects or previous restorations: Indirect tooth colored restorations should be considered for restoration of large class 1 and 11 defects or replacements of large compromised existing restorations, especially those that are wide faciolingually and require cusp coverage. Indirect tooth colored restorative materials are more durable than direct composites when placed in large occlusal posterior restorations, especially in regard to maintaining occlusal surfaces and occlusal contacts (Burgoyne et al 1991, Soderholm, 1998).

Contraindications

Heavy occlusal forces: ceramic restorations can fracture when they lack sufficient bulk or are subject to excessive occlusal stress in patients who have bruxing or clenching habits (Donly et al 1999).

Inability to maintain a dry field: Adhesive techniques require near perfect moisture control to ensure successful long term clinical results.

Deep subgingival preparations : Deep subgingival margins are difficult to record with an impression and are difficult to finish. Also bonding to enamel margins is greatly preferred, especially along gingival margins of proximal boxes (Ferrari et al 1999).

Advantages

In addition to earlier mentioned advantages of composite restorations, indirect tooth colored restorations have the following additional advantages;

1. Improved physical properties- **Indirect** restorations have superior physical properties over the direct restorations because they are fabricated under relatively ideal laboratory conditions. Even, CAD/CAM restorations fabricated chairside make use of materials manufactured under nearly ideal industrial conditions (Thompson et al, 1996)
2. Variety of materials and techniques- Several types of composites or ceramics are available for fabricating indirect restorations
3. Wear resistance: Direct composite restorations wear more than the laboratory-processed composite restorations and even much faster than the ceramic restorations
4. Reduced polymerization shrinkage: Several problems associated with direct resin composite restorations are the result of polymerization shrinkage. Direct composite resin shrinks on the order of 2-4% (Feilzer et al 1988) resulting in marginal gap. Microleakage and bacteria ingress into the marginal gap may cause pulpal irritation and tooth sensitivity (Brannstrom 1987). However, indirect composite restorations have been reported to have fewer marginal voids, less microleakage and less postoperative sensitivity than direct composites (Dietschi et al 1995, Douglass et al 1989)
5. Ability to strengthen remaining tooth structure: Tooth structure weakened by caries, trauma, or preparation can be strengthened by adhesively bonding indirect tooth-colored restorations (Wendt, 1991)
6. More precise control of contours and contact: Inadequate proximal contours and open contours are common problems of direct resin composite restorations. These problems are however rare with the indirect restorations because of improved access and visibility outside the mouth.

7. Biocompatibility and good tissue response: Ceramics are considered chemically inert materials with excellent biocompatibility and soft tissue response (Arnelund et al 2004, Pistorious et al 2002)
8. Increased auxillary support- Most indirect techniques allow the fabrication of the restoration to be delegated totally or partially to dental laboratory technicians. Such delegation allows for more efficient use of the dentists time.

Disadvantages

1. Increased cost and time: Indirect tooth colored inlays and onlays are more expensive than the direct restorations. Such increased cost may result from laboratory fees, fabrication of a temporary restoration and the two patient appointments required.
2. Technique sensitivity: All the stages involved in the fabrication of indirect restorations require a high level of operator skill, devotion to excellence and diligence.
3. Brittleness of ceramics: Adequate thickness of material is required before ceramic restorations can resist occlusal forces and fracture. Fractures can occur either during try-in or after cementation, during try-in or after cementation, especially in patients who generate unusually high occlusal forces.
4. Wear of opposing dentition and restorations: Ceramic materials can cause excessive wear of opposing enamel or restoration.
5. Resin –to –resin bonding difficulties: Laboratory processed resins are highly cross-linked, so few double bonds remain available for chemical adhesion of the composite cement (Ruyter, 1992). The composite restoration must be mechanically abraded or chemically treated to facilitate adhesion of the cement (Tate et al 1993, Shortfall et al 1996). However, bonding of composite cements to properly treated ceramic restorations is not a problem (Roulet et al, 1995).
6. Short clinical track record: Long term clinical performance has not been documented.
7. Low potential for repair: When a feature involves an indirect composite inlay or onlay, an adhesive system and a high cured composite resin can be used to repair the restoration. The bond strengths of indirect composite and direct composite repair seem to be similar (Gregory et al, 1992) Repair of a fractured ceramic inlay/onlay involves mechanical roughening, etching with hydrofluoric acid, and application of a silane coupling agent before restoring with an adhesive and composite. However, direct

composite repairs are not usually suitable for some ceramic inlays/onlays because the composite might be exposed to a challenging environment.

8. Difficult try-in and delivery-indirect composite restorations can be polished intraorally with the same instruments and materials used to polish direct composites, although access to some marginal areas can be difficult. Ceramics are more difficult to polish because of potential resin-filled marginal gaps and the hardness of the ceramic surfaces.

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