Direct Restorations

Amalgam

CONSTITUENTS: alloy made up of silver, tin, palladium, indium, zinc and copper
PROPERTIES: silver-tin complexes produce relatively non-reactive cores, the addition of copper produces a copper-tin core, which decreases the amount of the highly reactive tin-mercury content (gamma 2 phase), this improves strength and reduces creep, corrosion and overall micro-leakage at the restorative interface
Gamma = Silver-Tin
Gamma 1 = Silver-Mercury
Gamma 2 = Tin-Mercury
The addition of palladium increases strength and its resistance to corrosion, indium is used to increase wetting, meaning less mercury can be incorporated and reducing the potential vapours
VARIATIONS:
Conventional (low copper) - now superseded
High Copper (average content around 30% weight)- Dispersed (copper particles are dispersed throughout) or Ternary (silver, tin and copper are one complex)
Alloy shapes- Lathe (flat, irregular particles, usually show faster setting reaction and require extensive packing) or Spherical (easier to pack and working time is longer) or Admix (a mixture of both lathe and spherical particles)
ADVANTAGES: high compressive strength, proven long term success, corrosion is seen as having anti-cariogenic properties, placement is not as technique or moisture sensitive, faster placement compared to composite
DISADVANTAGES: no chemical bonding to tooth so requires mechanical retention via undercuts/occlusal locks which can result in a more destructive preparation, brittle (weak against tensile forces), greater coefficient of thermal expansion and a high diffusivity resulting in micro leakage, material changes shape more than the surrounding structure which can result in tooth fracture, margins corrode, poor aesthetics, takes longer to set (polishing/ preparation of core needs to be done at the following appointment), mercury content causing environmental pollution, biocompatability (lichenoid reactions, galvanic current, tooth discolouration and amalgam tattoo)
INDICATIONS: areas where moisture control is poor, large posterior restorations with high occlusal load, consider in high caries risk patients, nayyar core
CONTRAINDICATIONS: children under age of 15 years and pregnant patients
CLINICAL POINTS: minimum 2mm thickness, polishing reduces pits, plaque retention and corrosion

Composite

CONSTITUENTS: mainly matrix, filler and coupling agent
PROPERTIES: monomer (when activated polymerise to forms the resin matrix e.g. BisGMA, UDMA), diluent (decrease the viscosity for ease of handling e.g. TEGDMA), filler (provides strength and optics e.g. glass or ceramic), coupling agent (e.g. silane, bonds the hydrophilic filler to the hyrdrophobic matrix via acid based reaction which requires meticulous moisture control), radiopacifiers (allows to be viewed on a radiograph e.g. barium or strontium), pigmentation (alters shade e.g. metal oxides iron or titanium), curing (chemical or light) stabilisers, inhibitors and initiators (prevent oxidation occurring which would impact on the stability of the shade and accelerate the reaction needed to form adequate functional properties)
Curing-light cure wavelengths between 460-470nm result in free radical polymerisation in three phases: propagation phase, pre-gelatin phase and post-gelatin phase, dual cure composites exist for circumstances when the clinician isn't sure if sufficient light will get to the resin
The setting reaction is anaerobic which is useful as the oxygen inhibition layer allows for the material to be layered and bond to itself
VARIATIONS: Monomers- e.g. poly BisGMA (Bowen's Resin), UDMA and TEGDMA, lower molecular weight improves the handling ability of the composite
Filler- greatest impact on clinical capabilities and can increase strength, optimise optics, decrease the shrinkage and exothermic reaction of polymerisation, decrease coefficient of thermal expansion, it is usually glass which provides strength and optic properties (either quartz which is harder or silica which allows easier surface finishing), or ceramics can be used (in composite this is Zirconia based and is very strong)
Filler size and shape- generally speaking the bigger the stronger, but this needs to be balanced with handling and aesthetic considerations: Macro (5-100 micrometers, withstands load but hard to polish and gain a good finish so plaque retentive), Micro (0.04 micrometers is supposedly meant to shrink less but is found to degrade via hydrolytic degradation), Fine (allows for better packing of the filler), Hybrid (universal resin composite, has strength of the larger molecules, packing ability of the smaller particles and allows an adequate finish but difficult to maintain a uniform consistency throughout, advantage of less matrix required so less shrinkage), Nano (1/1000 of a micron packed together to form nano cluster, developments may show promise in this area)
ADVANTAGES: aesthetic, adhesive to tooth structure so less reliance on mechanical adhesion so preparation can be more conservative, resin has a similar coefficient of thermal expansion and will therefore mimic the tooth more than amalgam
DISADVANTAGES: technique sensitive and requires meticulous moisture control, time consuming, contact dermatitis through gloves
INDICATIONS: aesthetic restorations , conservative restorations, PRR/fissure sealants, children under 15 years, bonding indirect restorations, cores
CONTRAINDICATIONS: high occlusal loads (although newer composite can withstand higher loads), poor OH/ high caries risk, poor moisture control
CLINICAL POINTS: minimum 2mm thickness, configuration factor (c-factor) is the stress of the material which is released when setting and comes down to the ratio between the surface area of the bonding surfaces in relation to the exposed surface restorative interface, c-factor is reduced by using incremental layers which also reduces polymerisation shrinkage and allows full curing light penetration
Polymerisation shrinkage results in micro-leakage, micro-fractures, marginal staining and post-op sensitivity
Consider smaller increments with darker shades and avoid eugenol containing temporary material as can interfere with setting

GIC

CONSTITUENTS: glass filler (calcium fluoroaluminosilicate) and acid (poly-acrylic acid and tartaric acid to lengthen working time and decrease setting time)
PROPERTIES: setting reaction in 4 phases- dissolution (poly acid attacks the surface of the glass raising the pH and ionisation propagates, releasing glass constituents), gelation (calcium, alumina and fluoride ions are liberated into the surrounding solution creating a silica gel), hardening (polymer chains open (from the polyacrylic acid) and condensation of the matrix occurs, as the material hardens the aluminium is slower to cross-link with the polymers, compared to the calcium ions, this can take hours to fully set, this is now the insoluble salt matrix that incorporates the unreacted glass particles) and maturation (this can take weeks and this system is very dynamic in the oral environment)
GIC adheres chemically to the tooth by chelating calcium (ion exchange displaces calcium and phosphate in the hydroxyapatite in enamel and forms hydrogen bonds to the collagen fibres in dentine), this bond is dynamic and if disrupted it shows the capabilities to reform, therefore failure of GIC usually occurs cohesively within the material itself rather than at the tooth-restorative interface
Fluoride property is seen to be advantageous due to its perceived anti-cariogenic, remineralisation effects, and anti-biofilm properties
VARIATIONS: RMGICs still go through an acid-base reaction but with the additional polymerisation of the resin
ADVANTAGES: simple and fast technique
DISADVANTAGES: poor aesthetics, moisture sensitive and lower strength
INDICATIONS: interim restorations, abfraction and abrasion restorations, decidous teeth and luting cements
CONTRAINDICATIONS: aesthetic and high load restorations and cores
CLINICAL POINTS: dentine conditioners aim to remove the smear layer and enhance the collagen scaffold (the main constituent is polyacrylic acids)
Resin reaction is directly inhibited by the contamination of water, whereas with GIC, it is vulnerable to water incorporation particularly during its setting reaction and the week or so to follow which can weaken the cement, therefore protection varnishes are recommend to limit the amount of water absorption occurring, for at least an hour but ideally 24hrs
Desicating GIC can cause cracks to form

REVISE DENTAL

REFERENCES:

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