T.C.
YENI YÜZYIL UNIVERSITY

HEALTH SCIENCE INSTITUTE

PROSTHODONTIC DEPARTMENT

COMPARATIVE EVALUATION OF MICROLEAKAGE AT THE TOOTH RESTORATION INTERFACE IN CERVICAL AREA BY DIFFERENT TOOTH COLORED RESTORATION WITH DIFFERENT BONDING MECHANISMS

MASTER THESIS

MARWA ELHTAB

Supervisor:

Assiss.prof **Melahat Çelik Güven**

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ACCEPTANCE AND APPROVAL

T.C. ISTANBUL YENI YUZYIL UNIVERSITY

This study which was conducted within the framework of the prosthodontic Dentistry Department of Esthetic Specialization Program was accepted by president of jury as a Master Thesis.

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Assiss.prof: **Melahat Çelik Güven**

Prosthodontic Department

Yeni Yüzeil University

Assiss.prof: **Işıl Doĝruer**

Conservative Department

Yeni Yüzeil University

Assiss.prof:**Işıl Turp**

Prosthodontic Department

Bezmialem vakıf University

CONTENTS

YÖK watermark

LIST OF FIGURES

LIST OF TABLES

ABBREVIATION AND SYMBOLS

µm: Micrometer

DEJ: Dentinoenamel junction

mm^2: Square millimeter

i.e.: that is

Bis-GMA: Bisphenol A diglycidymethacrylate

NCCLs: National Committee for Clinical Laboratory Standars

nm: nanometer

PPRF: Pre-polymerized resin filler

UDMA: Urethane dimethacrylate

TCB: Tetracarboxylic acid

C.G.I: Conventional Glass Ionomer

-COOH: Carboxylic acid

Ca^{+2}: Calcium ion

Al^{+3}: Aluminum ion

CTEs: Coefficient of thermal expansion

LED: Light Emitting Diode

G.V Black: Greene Vardiman Black

3D mode: 3 dimension mode

SEM: Stereomicroscope

SE: Self Etch

mm: millimeter

sec: Second

Mw/cm²: milliwatt/square centimetre

Fig: Figure

MDP: Methacryloyloxydecyl dihydrogen phosphate

HEMA: Hydroxyethyl methacrylate

et al.: and others

ABSTRACT

Purpose: The purpose of this in vitro comparative study is to evaluate microleakage at the tooth-restoration interface of cervical area by different tooth colored restorations with different bonding mechanisms.

Materials and Methods: Totally 28 caries free permanent teeth used for this in vitro study, teeth stored for 1-2 weeks at room temperature inside distilled water, class V cavity prepared on the facial surface by dimensions 3-4 mm mesiodistally and 3 mm gingivoocclusally (half in enamel and half in cementum) and 2-3 mm in depth, teeth divided equally into four groups each group seven teeth (n=7), first group G1: cavities treated by Clearfil SE Bond from Kuraray and filled by Nanocomposite from Kuraray Majesty ES-2 Composite, second group G2: cavities treated by Clearfil SE Bond from Kurary and filled by Compomer from DENTSPLY Dyract® Extra, third group G3: cavities treated by GC conditioning and filled by Conventional glass ionomer Fuji IX GP Extra from GC, fourth group G4: cavities filled by Carbomer from GCP Dental, restored teeth stored for one week at room temperature in distilled water, apices of the teeth sealed with sticky wax and all the surfaces covered with two coats of nail varnish in red color, then immersed in a 0.5% solution of basic fuchsine dye for 24 hours at room temperature, teeth sectioned in faciolingual direction at middle of restorations, dye penetration evaluated under stereomicroscope at 20X magnification and scored.

Results: results are subjected to Ficher exact test for compare two step self-etching bonding materials to self-bonding materials, there were no statistically significant differences in dye leakage between groups occlusally and gingivally (p=1.000), Chic square test used for compare all materials occlusally were no statistically significant differences, (p=0.582) also at gingival margin (p=0.321), Nemar test used for compare occlusal versus gingival microleakage for each group, there were no statistically differences. (p=1.000)

Conclusion: In concluding two step self-etch bonding materials don't differ as regard

microleakage when comparing to self-bonding materials, clinical studies need to be carried out to substantiate these results.

Keyword: Microleakage, Nanocomposite, Compomer, Conventional glass ionomer, Carbomer, Restorative materials, Self-etching bonding materials, Self- bonding materials.

1. INTRODUCTION AND AIM

Restorative dental materials are the foundation for replacing diseased tooth or lost tooth structure and to restore form and function which one of the major requirements of a tooth restoration is protection of the exposed dentin against bacteria and their toxins.[1]

By the time many restorative materials were proposed through dental history: amalgam, resins based composite, glass ionomer cements and compomer which demanding for tooth colored restorations rather than non-aesthetic metallic restorations is increasing day by day.

Each class or type of aesthetic material has definitive and special features and benefits that are selected based on the assessment of the dentist and the specific clinical condition and needs of the patient.

Restoring vital teeth with minimal sacrifice of sound tooth structure depends mainly on adhesives restorations that provide strong and durable bonding to the remaining sound enamel and dentin which laboratory reports have proven that modern adhesives do effectively bond to tooth tissue in the short term.[2]

Perfect adhesion to tooth structure is the primary objective but the major drawback of this approach is retention of adhesive restorations for a reasonable time also maintaining the margins of adhesive restorations sealed against leakage phenomena remains the major factor that shortens clinical longevity.

Clinical experiences that are associated to leakage are staining around the margins of restorations which may lead to aesthetic breakdown and consequently need to replace the restoration, post-operative sensitivity, also every plaque retention site is a possible location for secondary decay[3]and restoration failure, pulpal pathology or pulpal death, partial or total loss of restoration.[4]

Although technological advances in materials and techniques have been developed in adhesive dentistry shortcomings persist [5] because persisting of microleakage occur with most of dental materials which contributing by several factors such as material physical characteristics, polymerization source, cavity location and configuration, morphological and histological composition of dentin and occlusion components and lack of strict adherence of manufacturers’ instructions and inconsistent clinical techniques by the practitioner can be variables that decrease any restorative success.

Various strategies have been proposed to minimize the negative effects associated with microleakage of tooth colored restorations and new materials are constantly being introduced on to the market.

In the absence of definitive clinical data the relationship between marginal leakage in restorations and type of restorative materials used has been extensively studied in laboratory experiments, laboratory studies such as microleakage tests remains an essential method in the initial screening of dental materials and acts as an indicator of the theoretical amount of leakage that may or may not occur in vivo also the in vitro evaluation of microleakage can provide important information on possible clinical performance of new tooth colored restorative materials.

The aim of study is comparative evaluating the microleakage of four tooth colored restorative materials two of them (Nanocomposite, Compomer) bonding to tooth structure by two step self-etch technique and other two restorative materials (Conventional glass ionomer and Carbomer) self-adhere to tooth structure by itself without bonding agent at interface between restoration and tooth structure.

2. REVIEW OF LITERATURE

2.1 Background of Tooth structure

Understanding different tooth structures is important for a successful adhesive restorative dentistry as different tooth structures as substrate have differently to dental adhesive bonding systems. It would be important to understand the adhesion principal as well.

2.1.1 Enamel

Enamel is the hardest tissue in the human body and highly mineralized tissue which covers crown of the tooth, responsible for color, esthetics, texture and translucency of the tooth.

The mineralized structure which mainly contains inorganic contents in the form of crystalline structure (hydroxyapatite) about 96% of its weight, in addition to inorganic contents it also contains a small portion of organic matrix along other minerals and trace elements (proteins and lipids) about 1% to 2% by volume and with small amount of water which is present in inter crystalline spaces about 4% by weight, the mineral elements (hydroxyapatite crystals) approximately 0.03 μm to 0.2 μm surrounded by a thin film of firmly bound water.

After tooth eruption, there is an enamel maturation process that makes it more resistant to demineralization, this maturation consists of mineral deposition from oral fluids in interprism spaces that were previously filled with water, in prismatic enamel which constitutes the main fraction, the crystals are densely grouped and arranged in three directions, with this arrangement lengthy prisms (diameter of about 5μm) from the dentin-enamel junction to near the outer most surface of enamel are formed which prisms maintain their integrity and support because of their transverse arrangement, irregular morphology and overlapping patterns, at the moment of enamel instrumentation the prisms are exposed in several planes according to their direction.

2.1.2 Dentin

Dentin is the most voluminous mineralized connective tissue of the tooth which covered by enamel in crown portion and by cementum in root portion, the hardness of dentin is less compared to enamel and even within the dentin the hardness decreases from superficial dentin to circum-pulpal dentin, It is less mineralized than enamel but more than cementum or bone, the mineral content is hydroxyapatite 70 % by weight arranged in a less systemic manner than enamel and the rest is organic substance 20% by weight consist of collagen type I and 10% water making it more resilient than enamel.

The morphologic characteristic of dentin is the dentinal tubules which extend from pulp to dentin enamel junction (DEJ) and filled with odontoblastic process that presents at peripheral layer of the pulp which is responsible of dentin formation and dentinal fluid that is a transudate of plasma, dentinal tubules have a highly mineralized lining along the tubular wall termed as peritubular dentin and separated by hydroxyapatite embedded collagen matrix called intertubular dentin.

The number and diameter of the dentinal tubules decreases towards the dentino-enamel junction which is superficial dentin contains about 20,000/mm^2 of dentinal tubules by each about 0.8μm in diameter and deep dentin contains about 76,000/mm^2 of dentinal tubules by each about 2.5- 3μm in diameter, this translates to more dentinal tubules close to the pulp where are greater in diameter than the superficial dentin close to the DEJ.

Dentin and pulp tissues in spite of its differences in structure and composition, they are related in many physiologic and pathologic reactions due to that tooth preparations should be done under constant air and water spray to avoid heat generation which further damages dental pulp and stimulus on exposed dentin results in outward movement and stimulates the mechanoreceptor of the odontoblast resulting in dentinal sensitivity because that dentin should always be protected by liners, bases or dentin bonding agents when tooth is cut considerable quantities of cutting debris made up of small particles of mineralized collagen matrix are formed, these debris form the smear layer on prepared tooth surface, this smear layer has to be removed or modified by etching or conditioning which the etching causes removal of smear layer and etching of intertubular and peritubular dentin for micromechanical bonding.

The efficacy of adhesive systems on the enamel surface has been proven. However, the same is not observed on dentin this is because of difference in morphologic, histological and compositional differences between the two as mentioned before.(It is 96% inorganic hydroxyapatite by volume in enamel while in dentin it is 70% dentin contains more water than does enamel and hydroxyapatite crystals have a regular pattern in enamel whereas in dentin hydroxyapatite crystals are randomly arranged in an organic matrix and presence of smear layer makes wetting of the dentin by the adhesive more difficult).

Dentin is a dynamic tissue which shows changes due to aging, caries or restorative procedures so fluid present in dentinal tubules constantly flows outwards which reduces the adhesion of the adhesive tooth colored restorations, restorations should be well adapted to the preparation walls so as to prevent microleakage and thus damage to underlying dentin-pulp complex.

2.1.3 Cementum

Cementum can be defined as specialized, hard, a vascular connective tissue that covering the outer most layer of calcified matrix on root surface, it is light yellow in color and can be differentiated from enamel by its lack of luster, darker hue, very permeable to dyes and chemical agents from the pulp canal and the external root surface and softer than dentin, it represents the less characterized mineralized tissue similarly to the other connective calcified tissues, cementum composed from inorganic content (hydroxyapatite) 45 to 50 % by weight, organic matter 50 to 55% by weight consists mainly of collagen type I which form 90% of organic matrix and collagen type III which form 5% of organic matrix and water.

Cementum is an area at risk of carious demineralization or invasion by plaque bacteria so regeneration of cervical dental structures is of clinical importance and it seems challenging to dentists.

The tissue bonding properties with cementum have not been adequately elucidated, it may interfere in the marginal quality of root restorations which are very limited information exists on cementum bonded restorations,[6][7] Ferrari et al reported that cementum treated with dentin bonding systems is infiltrated by the resin but the predictability of the bond is unclear.[8]

Furthermore, it is still unclear whether or not the problem of bonding to cementum is related to the structure and properties of the tissue or to a limited effectiveness of the adhesive materials at the region.

A complete understanding of tissue microstructure, chemical composition and the basic reaction patterns of root dentin and cementum to restorative techniques and materials must be pursued, in addition to the future directions in adhesive dentistry. [9]

2.2 Adhesion to tooth structure:

Adhesion or bonding can be described as attachment or intimate contact of two materials, any material or substance can be called adhesive when between two surfaces has the ability of keeping them joined through a mechanical locking interaction between them through chemical bonds with them or through the interaction of both, the success of tooth colored restorations depends on the adhesion of restorative materials to hard tooth tissue, the adhesives have different tooth colored restorations interface morphologies, different bond strengths and different abilities in microleakage prevention, which the known goal for a perfect adhesion between dental tissues and the teeth restorative materials is the most basic point of new researches on adhesive restorative materials.

The most significant development in the history of dentistry over the past 100 years is the ability to bond materials to tooth structure, adhesion of restorative materials to the hard components of the tooth structure has been a goal pursued by many researchers ever since Michael Buonocore pioneered adhesive dentistry in 1955 which he could increase the retention of acrylic based restoratives by first treating the teeth with phosphoric acid,[10] subsequent research by Buonocore, Gwinnett, and Matsui elucidated the mechanism of adhesion between enamel and resin restoratives via resin tag formation,[11] in that old time clinicians can generally bond predictably to enamel, but not nearly as predictably to dentin because of the morphological, histological, and compositional differences between the two substrates,[12] because enamel is quite consistent throughout and is also considerably more mineralized than dentin which the inorganic content of mature enamel is approximately 96% hydroxyapatite by weight and the remainder consists of water and organic material but dentin on the other hand is approximately 70% hydroxyapatite by weight, 18% organic material (i.e. predominantly collagen) and 12% water,[13] it presents as well a very complex physical structure which varies according to the depth where it is found, in the course of the last decade, dentin adhesives materials have experimented changes pertaining to composition and clinical handling after that time some researches presently try to adapt to the ever-increasing knowledge on dentin and dentinal fluid behavior.[14][15] the proposing to etch dentin with the aim of creating micro-retentions as is the case in enamel, they did not bear in mind the fact that dentin is a basically organic substrate and inside the tubules there is fluid pressure which hinders to the extreme the penetration of hydrophobic substances such was the case of resin materials used in that period of time.

At a later stage, bi-functional molecules were designed, they possessed the ability to chemically react with organic and inorganic components found in dentin, and simultaneously, copolymerize with restorative materials.[16] although the presence of a layer of dentinal debris during the preparation of the cavity would preclude the intimate contact between resin and dentin which is essential for chemical adhesion,[16] due to all the aforementioned reasons, a dentin conditioner has been used in treatment.

In later days, it is accepted that bonding to dentin has a micro-mechanical component through the formation of resin extensions (interlocked in the porosities) by using resin monomers within the dentinal tubules, this bonding would improve with the formation of a dentin-resin inter-diffusion area which Nakabayashi calls hybrid layer,[17] It was commonly thought that humidity in dentin reduced adhesion success, this was sustained with research conducted by Terika et al. in 1987 but Glasspoole et al. in 1991[18][19] but in later research, it was pointed out that strong bonding to dentin can be elicited in the presence of humidity and that this bond can be stronger than when dentin is dry as shown in research conducted by Kanca and Gwinnett in 1992. [20]

Based upon the adhesion strategy, three mechanisms of adhesion are currently in use, a review by De Munck et al. in 2005 described these different types of adhesives. [21] It summarized in table.1.

First type is the etch and rinse adhesives which involve separate etch and rinse phases where acid is applied and rinsed off followed by an application of primer and application of adhesive step or a simplified procedure where in prime and adhesive are combined in one application preceded by etch and rinse.

Second type is the self-etch adhesives which are based on the use of non-rinse acidic monomers that simultaneously condition and prime dentin regarding user friendliness and technique sensitivity, it do not remove the smear layer but incorporate it into adhesive, this approach seems clinically most promising by eliminates the rinsing phase which not only lessens the clinical application time but also significantly reduces the technique sensitivity or the risk of making errors during application, there are two types of 'self-etch' adhesives: strong and mild,[21] the strong self-etch adhesives have a very low pH of 1 exhibit a bonding mechanism and interfacial ultra-morphology in dentin resembling that produced by etch and rinse adhesives while mild self-etch adhesives have a pH of around 2 dissolve inorganic phase dentin surface only partially so that a substantial number of hydroxyapatite crystals remain within the hybrid layer which specific carboxyl or phosphate groups of functional less acidic monomers can then chemically interact with this residual hydroxyapatite,[22] so from expected the microleakage will reduce, this two-fold bonding mechanism of mild self-etch (micro-mechanical and chemical bonding) is believed to be advantageous in terms of restoration durability, the micro-mechanical bonding component may provide particular resistance to de-bonding stress and chemical interaction may result in bonds that better resist hydrolytic break down and thus keep the restoration margins sealed for a longer period, the demineralization and the impregnation of the adhesive into the enamel-dentin support appear simultaneously the demineralization process results from the acidic monomers which are components of the adhesive system. therefore, the SE adhesive must not be rinsed.

The third type is Glass ionomers and glass ionomer adhesives which are self-adhere to tooth tissue, a short polyalkenoic acid pretreatment cleans the tooth surface which is removes the smear layer and exposes collagen fibrils up to about 0.5-1 μm deep[23] followed to that glass-ionomer components inter-diffuse and establish a micromechanical bond following the principle of hybridization.[24][21]

In addition to this, chemical bonding is obtained by ionic interaction of the carboxyl groups of the polyalkenoic acid with calcium ions of hydroxyapatite that remained attached to the collagen fibrils.[24] this additional chemical adhesion may be beneficial in terms of resistance to hydrolytic degradation.

Consequently, a two-fold bonding mechanism is established, similar to that mentioned above for mild self-etch adhesives, the basic difference with the resin based self-etch approach is that glass ionomers are self-etching through the use of a relatively high-molecular-weight polycarboxyl-base polymer which this limits their infiltration capacity, so that only shallow hybrid layers are formed, because of this high molecular weight, they cannot infiltrate phosphoric acid decalcified dentin, consequently, such aggressive conditioners should not be used with glass ionomers.[25]

In the self-etch and self-adhesive systems, dentin is conditioned and primed by the adhesives at the same time with no need for rinsing, as the result, the clinical application time is shorter in these systems and technique sensitivity is greatly decreased, also an adhesion is mediated through the chemical interaction of residual hydroxyapatite crystals and functional monomers present in the composition of these adhesives,[23] on other side major drawback of this approach is retention of adhesive restorations for a reasonable time is no longer a clinical problem, maintaining the margins of adhesive restorations sealed against leakage phenomena remains the major factor that shortens clinical longevity.[21]

Table.1. Different types of Adhesives according to De Munk et al. in 2005

Types of adhesion	Subtypes:	Mechanism of action
Etch and rinse adhesives	a.3 steps[etch +prime +bond] b.2 steps[(etch+(prime +bond)]	micro-mechanical
Self-etch adhesives	a. strong ph. around 1	micro-mechanical
	b. mild ph. around 2	micro-mechanical + chemical bonding
Self-adhere	Glass ionomer and glass ionomer Adhesives	micro-mechanical + chemical bonding

2.3 Background of tooth Colored Restorative Materials

In general profile twelve restoration types are presented in the restorative dentistry, some of it listed in following pages to provide a frame of reference help to making a decision whether to use a plastic restoration or a cemented restoration, the plastic restoration is inserted as a soft mass into the cavity preparation where it will harden and be retained by mechanical undercuts or adhesion.

Understanding the new innovation of tooth colored materials need known and follow historical introduction of it from starting, It starting by Thomas Fletcher in 1873, introduced the first tooth-colored material silicate cement which it did not become popular until Steenbock introduced an improved version in 1904 but even the improved silicates discolored easily and lasted only a few years, after that in the early of 1940s German chemists developed the first acrylic resins while the first dental acrylic resin product was introduced in 1948, these acrylics demonstrated better color stability but significant shrinkage, limited stiffness but it has poor adhesion, in 1951, Swiss chemist Oscar Hagger developed the first dimethacrylate molecule which allowed for a cross-polymerized matrix but the first dental product to use the more durable and color stable dimethacrylate was produced in 1964 but it was not accepted by clinicians.

The important event related to adhesion happened in 1955, Michael Buonocore published a milestone article that described a simple method of increasing the adhesion of acrylic fillings to enamel, his ideas resulted in the development of dental adhesives with the ability to bond to tooth structure and the first tooth colored restorative using bonding was not introduced until two decades later, Ray Bowen and others in 1962 developed a large molecule hydrophobic dimethacrylate monomer (Bis-GMA) which is a key advance in resin chemistry in restorative dentistry, Bis-GMA forms the basis of present-day composite resins because of its limited shrinkage and fracture resistance, it was first used in a composite in 1969, in 1963, Dennis Smith developed the polyelectrolyte cement that led to the polycarboxylate adhesive cements, that key component for developing glass-ionomer cement, finally Wilson and Kent with the assistance of John McLean, In 1974 developed the first glass-ionomer cement.[26]

Dental restorative materials appear as protecting after completing preparation to protect the pulp against further trauma like thermal and chemical insulating bases under metallic restorations, pulp-capping agent and cavity liners, also some fluoride containing cements can be used as core build-up for restoration of broken-down teeth to build crowns and bridges, fissure sealants and root canal sealants, also there are multiple uses as cements, repairing cements, repair of fracture restorations and fillings.

The requirements of any restorative material used in patient's mouth can be categorized into biological, chemical, rheological, physical and mechanical, thermal and esthetic whatever directly after putting inside mouth or after long time of uses, all of these requirements help as guidelines in the selection of a suitable restorative dental materials in clinical practice and the major problem in restorative dentistry when loss one of any previous requirements is that dental materials do not adhere efficiently to the natural tooth structure, because that the ideal tooth colored restorative whatever direct or indirect restorative would have the capacity to adhere to enamel and dentin which maintain a smooth surface, place easily and repair easily, desired color, resist water (insolubility), resist fracture (resemble tooth structure in stiffness), react to temperature change like other tooth structures, not irritate pulpal tissues, inhibit caries and resist leakage which contributes to corrosion, dissolution or discoloring of certain restorative materials maintain marginal integrity.

Adhesive systems in dental restorations have been on the market for more than 50 years, which are widely accepted and used by practitioners worldwide, it used to replace the missing tooth structure characteristic of NCCLs, clinicians who understand the chemical nature and physical properties of a material are more likely than those who do not to make good decisions concerning its use and application. [26]

2.3.1 Resin composite restorations

Resin composites were first developed in 1962, due to their good aesthetic value, absence of mercury being thermally nonconductive and ability to make acceptable bond to the enamel and dentin, they are widely popular as the material of choice for most restorations.[27] and have evolved significantly since then dental composites is multiphase substance were produced by combining between four major components: resin (organic polymeric matrix) typically dimethacrylates, reinforcing (inorganic) fillers typically made from quartz powder, a sialane coupling agent for binding the filler to the matrix and chemicals that promote or modulate the polymerization reaction,[28] composite classified according to filler size with each type of composite which the size of filler particles incorporated in the resin matrix of commercial dental composites has continuously decreased over the years from the conventional to the nanocomposite materials, the conventional classification system introduced by Lutz and Phillips (1983) divided the composites into conventional macrofill, microfill, and hybrids composites of macrofill and microfill particles, conventional macrofill composites had average particle sizes that far exceeded 1 μm and typically had fillers close to approximately 50 μm, it were very strong but difficult to polish but to meet the need for long term esthetic restorations and better polishability manufacturers began to formulate microfill composites materials, the microfill composites were polishable but generally weak due to their relatively low filler content which increased by incorporating additional microfill particles were added.[28] the highly filled pre-polymerized resin fillers (PPRF) within the matrix and a compromise was needed to produce adequate strength with enhanced polishability and esthetics therefore further refinements in the particle size through enhanced milling and grinding techniques resulted in composites with particles that were sub-micron typically averaging about 0.4–1.0 μm which were initially called “minifills”[29] and ultimately came to be referred to as “microhybrids.” these materials are generally considered to be universal composites as they can be used for most anterior and posterior applications based on their combination of strength and polishability.[28] that were truly nanocomposites as the average size of the amorphous spherical silica reinforcing particles was approximately 40 nm, these were further distinguished as midifills with average particle sizes slightly greater than 1μm but also containing a portion of the 40 nm-sized fumed silica microfillers.

The most recent innovation has been development nanofiller composites is containing only nano-scale particles that are extremely small (0.005-0.01 μm) because these small primary particles can be easily agglomerated full range of filler sizes is possible and optimal particle packing is facilitated and have better polishing characteristics because nanoparticles may result in wear to surfaces with lower defects over time,[30] offer the advantage of optical property improvement and are capable of increasing the overall filler level due to their small particle sizes, an increase in the filler level results in a lower amount of resin in nanocomposites and will also significantly reduce polymerization shrinkage and dramatically improve the physical properties of composites. However, the increase in nanofillers also increases the surface area of the filler particles which limits the total amount of filler particles because of the wettability of the fillers, most manufacturers have modified the formulations of their microhybrids to include more nanoparticles and possibly pre-polymerized resin fillers similar to microhybrid found in the microfill composites and have named this group “nanohybrids.”

2.3.2 Compomers (Polyacid-Modified Composites)

Compomer probably are best described as composites to which some glass ionomer components have been added to provide combined advantages of composites (term ‘Comp’ in their name) and glass ionomer (‘Omers’ in their name), which it is anhydrous resins that contain ion leachable glass as a part of the filler and dehydrated polyalkenoic acid, it tries to mix the desirable qualities of both materials, the fluoride release over a long period, easy handling of the glass ionomers and chemically bonds to tooth structures, the esthetic aspects of the composites also bond strength and physical properties fracture toughness and also its adaptation at cervical margin are very much similar to composites.

The first compomer was introduced in 1993 under the name ‘Dyract’, later to that on Compoglass followed by Hytac was introduced, compomer composed from resin matrix (dimethacrylate monomers) with two carboxylic group present in their structure for example: urethane dimethacrylate (UDMA) and butane tetracarboxylic acid (TCB), filler (strontium fluorosilcate) glass, a reactive silicate glass containing filler (fluoroaluminiumsilicate), photoinitiators and stabilizers, there is no water in the composition and ion leachable glass is partially silanized to ensure bonding to matrix which the particle size of fillers in compomers ranges from 0.2 μm up to 10 μm.

These materials set by free radical polymerization reaction, there are two stages in the polymerization reaction which first stage a typical light activated composite resin polymerization reaction occurs and helps in forming resin networks enclosing the filler particles, this reaction causes hardening of products and the stage two which occurs after the initial setting of material, the restoration absorbs water and carboxyl groups present in the polyacid and metal ions in the glass ionomers show slow acid base reaction this results in formation of hydrogel so the setting reaction compomers relies on the polymerization of acidic monomers.[31]

Compomer restoration adhere to tooth structure by micromechanical means and requires acid etching and use of primer and adhesive because have been shown insufficient retention without pretreatment of the dental hard tissue with an adhesive system, [32] the properties of adhesives used basically for compomers are not different from adhesives used for composite restorations.

2.3.3 Conventional Glass Ionomer

Wilson and Kent developed Glass Ionomer Cements in 1969, glass ionomer is the generic name of a group of materials that use silicate glass powder and an aqueous solution of polyacrylic acid which were developed in an attempt to capitalize on the favorable properties of both silicate and polycarboxylate cements, this material acquires its name from its formulation of ion leachable glass powder which is mainly composed of fluoroalumino-silicate glass and an ionomeric acid that contains carboxylic (-COOH) groups which help in chemical bonding with the natural tooth and to certain alloys as well and also a polyelectrolyte (polyacrylic acid) as liquid, [(33)] however, the early version of glass ionomer cement had several undesirable characteristics that made this cement not a very popular one in its early years, after that considerable researches have been carried out over the last 20 years which dental profession has been benefited with an improved physical properties and better handling characteristics of the material.

These cements can chemically bond to enamel and dentin and have the ability to release fluoride with superior physical and mechanical properties.[(34)] by undergo to complex acid base setting reaction calcium (Ca^2) ions and aluminum(Al^3) ions released from the powder react with the carboxylic acid (-COOH) groups to form divalent salts (initiate gelation and hardening of the cement) which cross link and cure the polymeric acid, the same carboxylate groups also interact strongly with surface Ca^2 ions in enamel and dentin to effect chemical adhesion to tooth structure.[(35)] this chemical adhesion may also be beneficial in terms of resistance to hydrolytic degradation.

The conventional glass ionomer also has the same coefficient of thermal expansion (CTEs) as tooth tissue.[(36)] and a low setting shrinkage therefore provide good marginal sealing, minimal microleakage at the restoration/tooth interface and high retention rate, however, its most important characteristic is its ability to repair damaged (demineralized) enamel and dentin also the bond is increased during time due the forming of a fluorapatite layer (approximately 500 microns width) at the margin of the filling and tooth structure this layer is insoluble and is no longer sensitive for decay.

In other hand these materials have some clinical limitations including a prolonged setting time, moisture sensitivity during initial setting, dehydration and rough surface character which can block mechanical resistance. [37]

A newer generation of high viscosity glass ionomers has improved mechanical properties and provides higher levels of fluoride release compared with traditional glass ionomers and wear resistance is improved also a variety of resin based cements have now become available because of the development of the direct filling resins such as the acid etch technique for attaching resins to enamel and molecules with a potential bond to conditioned dentin with organic or inorganic acid.

First of all a short polyalkenoic acid pretreatment can be used to clean the tooth surface contamination and to eliminate the smear layer, exposing collagen fibrils to a depth of about 0.5-1 micron, micromechanical bonding of the glass ionomer components occur by inter diffusion so can increase the bond strength of the glass ionomer and lead to better adhesion to the dental hard tissue, both enamel and dentine adjacent to glass ionomer cement restoration, the hydrophilic free carboxyl groups within the cement bond to the dentin and increase the surface wetness in order to make hydrogenic bonds between the two surfaces strontium, Ionic exchange of silica and alumina by diffusing and migrating from the restorative into the tooth substance may be presumed to possess a bactericidal, anti-cariogenic influence and may also enhance remineralization, calcium ion exchange into the restorative may, in turn, aid in transforming the material into a more robust, enamel-like material,[38] importantly, also fluorine showed a dramatic presence within the surrounding tooth in vivo, therefore with such a broad span of valuable properties one may consider that this material may form the basis for a universal-type dental application.

2.3.4 Carbomer

Glass Carbomer is new generation of restorative materials firstly developed in 2004 which a glass ionomer cements based restorative materials has been introduced with claims of improved physical characteristics,[39] it is designed for use as either restorative materials or as fissure sealants and as part of its function when placed is promote mineralization.

It has the same glasslike base as glass ionomer cement except that it has a much finer structure (contains nanosized powder particles) as a result of which less matrix remains between the glass particles so that the material is stronger and most suitable initiator for the regeneration of the natural tooth structure via biomimetic processes by meaning promote mineralization within the tooth.

The liquid of glass carbomer is polyacrylic acid similar to high viscosity GICs incorporation of nanosized filler particles into the glass carbomer cement may improve its compressive strength and wear resistance, the rationale for the addition of fluorapatite (as secondary filler) into the powder is based on previous work by Van Duinen et al.(38) who demonstrated the in vivo chemical transformation of glass ionomer into a fluorapatite like material in teeth, the interaction of fluoride with the tooth mineral (hydroxyapatite) which findings are presented to demonstrate that low levels of fluoride are able to promote remineralization via precipitation of fluorapatite or a calcium fluoride like substance both of which lead to increased crystallization and incorporation of fluoride into the mineral phase, an organic carbon chain based additive which is completely biocompatible and is also added to Glass Carbomer to provide the material with greater strength and increased transparency which optimizes the material for the heat based setting process so the radiant heat is able to penetrate more deeply also improves the aesthetic aspect of the material and gives it a beautiful gloss as a result of this additive the material also becomes practically insoluble and therefore less sensitive to the influence of acids also has a liquid silica supplement for provide an extremely low solubility, superior flexural strength, compression strength and high durability.

The setting of glass carbomers has been shown to resemble that of glass-ionomers closely especially in the behavior of aluminium, this element is present in the glass powder in 4-co-ordination but changes to 6-co-ordination in the matrix of the set material. (40) presumably the initial setting of the glass carbomer with such units may increase the compressive strength of the material,

Glass Carbomer fill is 100% biocompatible and safe for the dentist, the patient and the environment, it easier and faster to apply than conventional materials and has natural biofusion bonding with dentin, when comparing to conventional glass ionomer cement, the nanoparticles will accelerate the transformation into fluorapatite, this fluorapatite layer will not stop after 500 microns but will expand over the whole filling which the new layer down is the most solid and hard biological structure that can be formed inside the mouth and is practically impermeable to the process of decay

Glass Carbomer must be mixed using a powerful mixer for a longer period of time in order to ensure that all the particles are fully wetted and it will be extremely smooth surface and can be highly polished, as a final step the manufacturer stipulates photo-polymerization of this new material by using a number of light curing sources (high energy LED Halogen lamp) with a high output range.

2.4 Cervicle area lesions of teeth

2.4.1. Class V cavity its types and margins

Cervical lesions are lesions which occur because of loss of hard tooth tissue in the coronal (cervical) part of the tooth near or at the cemento-enamel junction (between the enamel of the crown and the root of the tooth), any lesion found in the gingival third of facial (buccal) and lingual smooth tooth surfaces of anterior and posterior teeth according to G.V Black these lesions named class V, these lesions can be carious and non-carious defects, the majority of these cavities are encountered are the result of caries.

However, the etiology is multifactorial, while caries does present on the buccal and lingual aspects of teeth, many such defects are not related to bacterial action (non caries defect) and have been attributed to erosion, abrasion or abfraction, [41] many literatures suggest that cervical lesions occur in 85% of the population[42]

The incidence may be significantly higher in individuals with permanent teeth because the aging population is increasing dramatically, at a time when people are maintaining their natural teeth longer, there is an increased likelihood that caries will develop in class V areas [43] and middle age patient

The cavity configuration in class V varies according to the caries removal extension which it is exhibit mixed cavity margins positioned on both the enamel and the dentin or the cementum, (which have varying adhesive properties of the tooth structure also the biomechanical aspects of the cervical area and difficulties in accessing and isolating the area to be restored) the amount of remaining healthy tooth structure, the tooth region, location and type, in such situations the potential for the material to bond to the tooth may be more important as it may avoid the need to prepare sound tissue to achieve retention.

2.5 Microleakage

Microleakage is defined as the passing (clinically is not detected) of bacteria, fluids, molecules or ions between the cavity wall and the restorative material,[(44)] according to Nakabayasi and Pashley, microleakage is defined as the as the passage of fluids and substances through minimal gaps on the interface restoration-teeth.[(45)]and is considered to be a major factor influencing the longevity of dental restorations,[(46)] it is a phenomenon that involves diffusion, thus the knowledge of the dynamic relation between the dental structure and the restorative material is of prime importance.[(47)]

In theory, microleakage is deemed as an indication of failure because it reduces the sealing's effectiveness, [(46)] while clinically, microleakage can lead to staining around the margins of restorations, postoperative sensitivity, secondary caries, restoration failure, pulpal pathology or pulpal death and partial or total loss of restoration. [(48)]

The integrity of interface between tooth structure and adhesive dental materials is considered as the key to the longevity of the restoration as it is known one of the major objectives of tooth restoration is the protection of exposed dentine against bacteria and their toxins.[(1)]

The marginal adaptation becomes more difficult in Class V cavities where there is little or no enamel at the gingival margin and the restoration comes in contact with cementum,[(49)] for this reason adequate sealing is essential for optimal clinical performance, most of literatures on adhesive restorative materials and techniques focuses on the elimination of leakage which is regarded as one of the major factors in determining the long term success of restorations which an ideal restorative material would create a permanent and perfect seal between the restoration margin and the tooth structure.[50] because any imperfect bonding leaves a microscopic gap that allows the infiltration of bacteria, fluids, molecules and ions between the restoration and the tooth structure and considred as main causes to microleakage, given that it have to work with the available materials, many attempts to reduce microleakage are performed by clinicians during restorative procedures involving application of combinations of different materials, direct or indirect techniques, different curing strategies.

2.5.1 Development of Microleakage

There are many factors that can cause microleakage which is occur due to many factors like poor adhesion and wetting, where the level of compatibility of restoration materials to tooth substances is also considered as an important factor in microleakage generation and some of tooth colored restorations placed in conjunction with certain dental adhesives are believed to lose their sealing ability over time thus permitting microleakage,[46] and polymerization shrinkage of adhesive restorations has been commonly decumented where the hardening phase causes a considerable contraction in volume, creating stress and forming gaps between tooth structure and restorations, thermal stresses, some restoration materials such as GICs have the property of thermal expantion and water absorption which is susceptible to leakage formation,[51] also mechanical loading where long term effect of mechanical loading and thermal changes can cause elastic deformation and physical alteration of both tooth substances and restoration resulting in microleakage[52] and it can also be created by improper manipulation of materials by operatorator.

2.5.2 Adverse effect of Microleakage

Gaps performed at restorative marginal permits the ingress of oral fluid are considered a major reason for pulpal reaction and in time pulpal injuries.

Morever, it is reported that the most substantial biological effect of microleakage on a restored tooth may be the development of recurrent caries which accounts for approximately 50% of causes of clinical failure for restorations, [(47)(55)] recurrent caries also named secondry caries, it can be clinically and radiographically identified at the restoration margins which is most frequently on the gingival margins of class V restorations where dental plaques accumolation is accelerated by the presence of microleakage[(52)] or may develop from a primary lesion.

The fluid leakage not just related to esthetic defects also may cause an acute reaction of the pulp following the placement of a reaction leading to post operative hypersensitivity or even acute pain, this problems may become more severe during function as the restoration can act as a plunger during mastication which is causing increased fluid motion in the dentin tubule, other adverse effects of microleakage may include marginal defects which favor dental plaque accumolation leading to periodontal problems.

2.5.3 Evaluation of Microleakage

Microleakage is definitely an important issue in modern dentistry particularly when new versions of adhesives materials are constantly introduced various methodologies have been introduced.

Analysis of the microleakage can be done by quantitative or qualitative methods, In the quantitative method the use of a microscope with gauged oculars is needed[(53)] or a software[(54)] and some method to copy images so the infiltration can be measured in metric units or in percentage,[(53)] It was also reported a quantitative method by absorbance, using the volumetric measure of the colorant infiltration and another measuring the infiltration in a 3-D mode, it is more expensive and detailed but allows parametric statistical analysis making the study of values and results easier.

The qualitative method can be done by many methods including direct observation with microscopy or SEM by dyes, bacteria and radioactive isotopes which has been widely used as markers, techniques employing ions as marker which can be detected by neutron activation has also been used, some other methodologies include electrical conductivity measurement, compressed air and compressed fluid, the qualitative method is the most used one [(55)] because it is easy and simple needs only slide projector, magnifying glasses or a low- magnification microscope, through a score system, calibrated evaluators analyze individually the infiltration in the restorative dental material interface in relation to the cavity walls and the results are compared.

The direct observation is doing by placing a restoration in an extracted tooth and immersing it in a dye solution, after coating the unfilled parts of the tooth with a waterproof varnish and after an interval of time the specimen is removed, washed and sectioned before visual examination to establish the extent of penetration of dye around the restoration. [(55)]

However, the use of standardized procedures for quantitative methods, as well as qualitative measures under scan electronic microscopy for the evaluation of the adaptation of the restorations in the cavity [(56)] would allow the attainment of more reliable results and would be liable to discussion in the studies of microleakage measure the penetration of the colorant into the specimens in which the evaluator is the one that controls the extension that the infiltration has attained.

The most effective, commonly employed method is evaluating the sealing of restoration materials to cavity walls by scientists that use colored dye agents which are able to penetrate into and stain the tooth restoration interface. [(57)]

Different types of dyes are available including methylene blue, eosin, india ink, methyl violet, hematoxylin, prontosil soluble red, basic fuchsin, fluorescein, rhodamine blue and procaine brilliant green,[(55)(58)] there varying in particle size and affinity to substrates have been used and are known to significantly influence microleakage results.[(55)]

One of these dyes is basic fuchsin (Rosaniline hydrochloride) which is a mixture of rosaniline , pararosaniline and new fuchsine, with chemical formula $C_{20}H_{19}N_3.HCl$ in which have been most frequently used, it becomes magenta when dissolved in water as a solid, it forms dark green crystals as well as dying textiles.

This methodology has many advantages over the other techniques, first of all the microleakage is demonstrated by single colored agent without the need for any further introduction of chemical reaction or hazardous radiation, in addition to that the researches can have a range of choices of available dye agents which allows the method to be easily conformed to the instruments and methods available at the center in which the research is to be carried out and also its simplicity and the ability to detect marginal discrepancies beneath the surface, therefore, it's highly feasible in any circumstances and can be easily repeated, finally, it is highly technique sensitive and is not able to exclude the diffusion of the dye substance into tooth structures and the restoration from the measurement.

An understanding of leakage patterns of restoration material can lead to an increase of a warness of the mechanism and etiology of microleakage, resulting in the establishment of the microleakage pattern subsequently this will have relevance for restorative material selection in dental practice. (54)

3. MATERIALS AND METHODS

3.1 Overview

All in vitro procedure were conducted at Yeni Yüzyil University, Istanbul, Turkey with the aim of this study was to perform a comparative analysis of microleakage in class V cavities in four types of tooth colored restorations by using different bonding mechanisms. A pilot study was carried out to investigate the reliability of the test that was used. The restorative materials used in this study along with category, manufacturer, batch number, shade and cure time are listed in (table.1).

Four direct tooth-colored restorative materials were used in this study along with their respective adhesive systems as recommended by each manufacturer, firstly the Nanocomposite from Kuraray majesty ES-2 composite direct restorative material along with Kuraray SE bond (Self Etch) adhesive was used for restoring first group of the prepared cavities, second group of cavities was restored using Compomer from Dyract Dentsply with Kuraray SE bond (Self Etch) adhesive which third group of cavities was restored by using Conventional Glass Ionomer from GC Fuji IX GP-EXTRA, then Carbomer from GCP used for teeth in the fourth group which both of them self-adhere to tooth structure.

3.2 Main Study

3.2.1 Specimens Collection and Storage

Totally twenty eight caries free permanent teeth extracted due to periodontal diseases or orthodontic treatments used in this Vitro study, immediately after extraction the teeth were washed under running water to remove blood and mucous and scaled to remove calculus and remnants of soft tissues, teeth were then carefully checked by visual examination for any damage that might have been caused during extraction, which the inclusion criteria followed are no caries or any dental hypoplasia in these teeth selected, Absence of history of spontaneous pain, Absence of apical pathology and calculus was removed with dental scaler followed by cleaning with pumice slurry (in water) and rubber prophylaxis cup, teeth stored for 1-2 weeks in room temperature inside distilled water until ready for use.

3.2.2 Specimens preparation

A standard Class V cavity prepared on the facial surface by diameters (mesio-distal dimension of 3-4 mm, gingivo-occlusal dimension of 3 mm (half in Enamel and half in cementum) by the meaning the gingival margin in dentin of each cavity was prepared 1.5 mm beyond the cemento-enamel junction, while the occlusal margin was prepared 1.5 mm above it (Fig.1.a) (Fig.1.b) (Fig.1.c) and depth of 2-3 mm considering of the tooth morphology.

Fig.1.a Diagrammatic labial view of class V **Fig.1.b Labial view of class V**

Fig.1.c Diagrammatic proximal view of class V

All preparations did by using diamond fissure bur no836 by length 3mm and width 10 under a water-cooled high speed hand piece (W&H TE-95 RM) (Fig.2), each bur was used for completion of one group and then discarded, Enamel and dentin margins were prepared without bevel. Prepared teeth divided equally into four groups treated and filled according to filling tooth colored material used.

Fig.2. W&H handpiece and Bur No. 836

3.2.3 Materials of Study:

The Nanocomposite by Kuraray Majesty ES-2 was used for restoring cavities in the first experimental division (Fig.3), while cavities in the second division were restored using Compomer (Dyract Extra) from Dentsply (Fig.4.a) (Fig.4.b) which both of them bonded by Clearfill SE Bond (Fig.5).

Cavities in third group conditioning by conditioner from GC then filled by Conventional glass Ionomer (GC Fuji IX GP-EXTRA) and varnished by Varnish coat from EQUIA (Fig.6.a) (Fig.6.b) (Fig.6.c) which the last fourth group filled by Carbomer from GCP Dental (Fig.7.a) (Fig.7.b) which both of third and fourth group is self-bonded to tooth structure. (No any bonded material was used)

Fig.3: Majesty ES-2 Composite (Nanocomposite) from Kuraray

Fig.4.a: Dyract from Dentsply

Fig.4.b: Compomer capsule gun inside Gun

Fig.5: Clearfil SE Bond from Kuraray

Fig.6.a. Cavity Conditioner from GC

Fig.6.b. C.G.I Fuji IX from GC

Fig.6.c: Varnish coat from EQUIA

Fig.7.a: Carbomer from GCP Dental

Fig.7.b: Carbomer and its Gloss

3.2.4 Specimens grouping and restoration procedures

The prepared teeth were randomly divided into two equal groups according to the bonding mechanism each group will divided to two groups according to material used.

First group:

Seven teeth were prepared, a two-step self-etch adhesive system (Clearfil SE Bond, Kuraray, Tokyo, Japan) was applied to all cavities according to the manufacturers' instructions, [Table .2.] (after conditioning the tooth surface by self-etch primer for 20 s, the bond was applied to the entire surface of the cavity obtaining the bond film as uniform as possible using a gentle oil‑free air 5cm away from tooth then the cavity were polymerized with a conventional halogen light-curing unit (Demetron LC, Kerr, Orange, CA, USA) for 20s and the composite resin from (Clearfil Majesty ES‑2, Kuraray, Tokyo, Japan) was inserted in a single increment and light cured for 20s.

Second group:

Seven teeth were prepared and were etched by used self-etch (Clearfil SE Kuraray,Tokyo, Japan) which applied to all cavities according to the manufacturers' instructions, [Table .2.] (after conditioning the tooth surface 20 sec by the primer to the entire cavity walls then bond was applied to the entire surfaces of the cavity obtaining the bond film as uniform as possible using a gentle oil‑free air stream 5cm away from tooth, the cavities were polymerized with a conventional halogen light-curing unit (Demetron LC, Kerr, Orange, CA, USA) for 20s and the compomer from (Dyract DENTSPLY Extra) by each 2mm cured for 10sec.

Third group:

Seven teeth were prepared for cavities and these steps was followed (apply GC cavity conditioning for 10 seconds to the surface using cotton pallet and rinse with water, dry with gently blowing of air and mix the required amount of fill (GC GLASS IX) by dispensed powder and liquid onto the pad by plastic spatula, divided powder into two parts, mix the first portion with all the liquid for 10 seconds, incorporated the remaining portion and mix the whole thoroughly for 15-20 sec and transferred the restoration to the prepared cavity), finally applied final coat (Eqiua coat) after putted in dispense dish by disposable micro tip applicator and immediately light cured by conventional halogen light-curing unit (Demetron LC, Kerr, Orange, CA, USA) for 20 seconds, the light source was as close as possible to coated surface, If surface of coat tacky or yellowish repeated light curing.

Fourth group:

After complete cavity preparation for seven teeth, these steps followed with each capsule of carbomer to fill all cavities. (capsule shake from its side on a hard surface and press the plunger on a plane surface to the end of the capsule (Fig.8), after that insert the capsule into a universal Carbo CAP (carbomer capsule) (Fig.9) and click once to standardize (Fig.10) and insert the capsule into mixer (Carbo-MIX from GCP DENTAL) for 15 sec. (Fig.11)

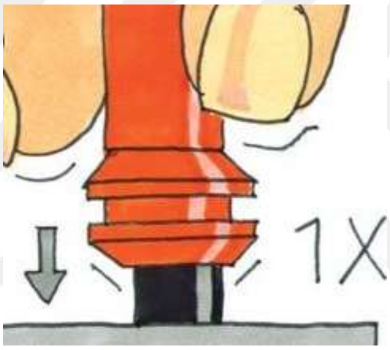


Fig.8: Shaking carbomer capsule on hard surface

Fig.9: Carbo CAP applicator

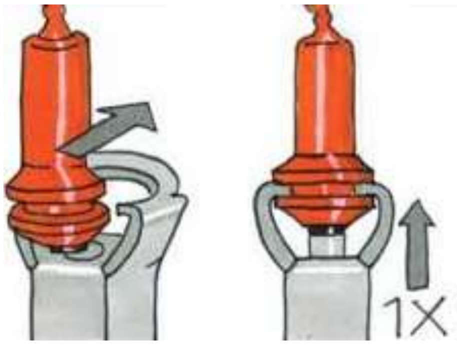


Fig.10: insertion the capsule in Carbo CAP

Fig.11: Carbo MIX from GCP Dental

Thereafter insert the capsule into GCP carbo-CAP (carbomer capsule) applicator, after that removed the pin from the nozzle, (Fig.12) and pull the lever two times (double click).

Fig.12: Removing the pin from the nozzle

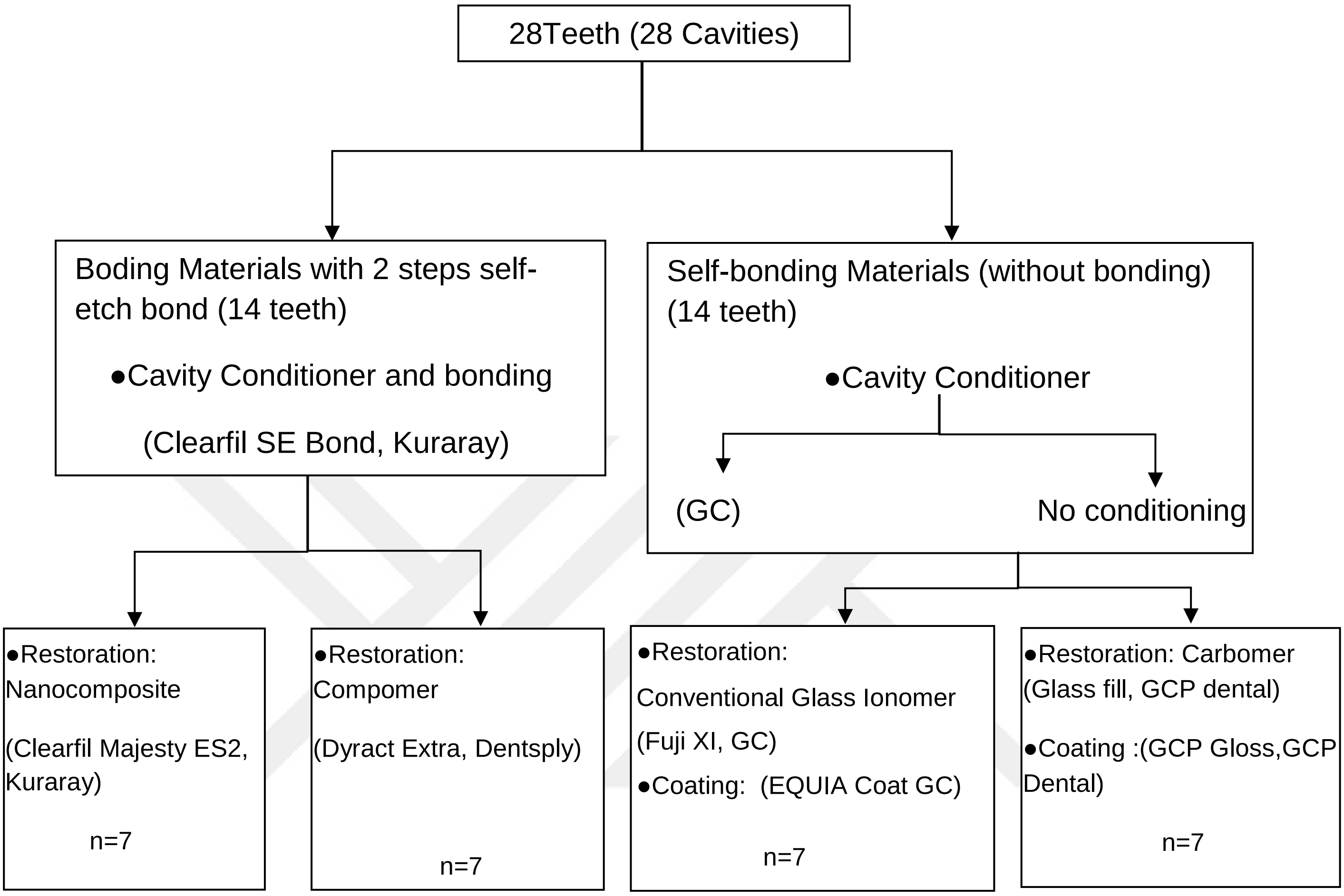
Directly extruded the fill to cavity and insured no air bubbles are included and applied GC gloss (monomer free protecting coat) with bold instrument and disposable brush into the surface of restoration then cured by light heating procedure (GCP Carboled Lamp) for 80 seconds has out-put of 1400 mw/cm² (Fig.13) where light cure device was used to enhance setting reaction of glass carbomer not as photo initiator, thereafter finished the restoration in the time about four minute after the start of mixing by using with diamond polishing burs.

Fig.13: GCP Carboled Lamp

Table.2. Restorative Materials used, its composition, manufactures and shade cure application

Material	Category	Composition	Manufacture	Batch No	Shade/Cure application
Clearfill SE Bond	Primer	10-MDP. 2-HEMA. Hydrophilic aliphatic dimethacrylate dl-Camphorquinone. N,N-Diethanol-p-toluidine. Water.	Kuraray, Okayama, Japan	000077	Applied for 20 sec
	Bond	10 MDP. 2-HEMA. Bis-GMA. Hydrophobic aliphatic dimethaacrylate dl- camphorquinone. N,N-Diethanol-p-toluidine. Collicoidal silica.			Air flowed then curing for 20 sec
Nano-composite	Kuraray Majesty ES-2 composite	Silanated barium glass filler. Pre-polymerized organic filler. Bis-GMA. Hydrophobic aromatic dimethacrylate dl-Camphorquinone.	Kuraray, Okayama, Japan	170032	A2/ 20 sec
Compomer Polyacid-modified composite	Dyract -Extra	UDMA. Tetracarboxylic acid hydroxyethyl methacrylate-ester Resin. Alkanoyl-poly-methacrylate. Strontium-fluoro-silicate glass. Strontium fluoride. Photo initiators.(Butyl hydroxyl toluedine) Iron oxide pigments	Dentsply USA	1010002769	A2/Each 2 2 mm cured for 10sec
Conventional Glass Ionomer C.G.I	GC Fuji IX GP-EXTRA	Powder. Liquid. 95% Aluminosilicate glass. 5% Polyacrylicacid powder.	GC Tokyo, Japan	1502031	A2
Conditioning	GC Conditioning	Mild polyacrylic acid.	GC Tokyo, Japan	1409171	conditioning for 10 sec
Coat Nanofilled surface sealant	EQUIA Coat from GC	Highly resin filled coating material. Urethane methacrylate. Methylmethacrylate. Camphorquinone. Silicon dioxide. Phosphoric ester monomer.	GC Japan	1308211	cured for 20 sec
Carbomer	Glass Fill	Nanofilled carbomised glass ionomer restorative cement. Treated Fluoroalumino Silicate glass powder with a poly (dialkylsiloxane) having terminal hydroxyl groups where in the alkyl groups contain 1-4 carbon atoms-an aqueous acid solution.	GCP Dental	7507054	A3/ cure for 60-90 sec
	GCP gloss	Silicone based coat.	GCP Dental	1407106	

3.2.5 Study Design



3.2.6 Miroleakage Testing

After filling procedure completed for each group, (Fig.14) all teeth stored inside distilled water at room temperature for 1 week after one week after that root apices of the teeth sealed with sticky wax (Fig.15) and all surfaces of teeth covered with two coats of nail varnish (in red color) to within approximately 1 mm of tooth-restoration margins to prevent leakage (Fig.16) and all specimens immersed in 0.5% solution of basic fuchsine (Fig.17) dye for 24 hours at a room temperature. (Fig.18)

Fig.14: Specimen of filled tooth **Fig.15: Sticky wax on apex of root**

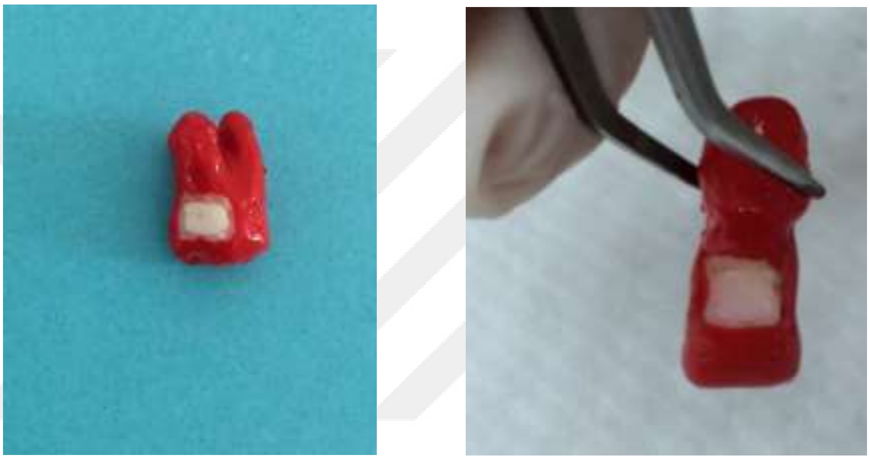


Fig.16: Specimen of teeth after applied nail polish

Fig.17.a. Basic Fuchsine

Fig.17.b. Specimen tooth after applied B.F

After removal from the dye solution the teeth were rinsed under running tap water, then sectioned facio-lingual at center of restoration with diamond disk 0.15 mm in width (Fig.18.a) (Fig.18.b) into two sections. (Fig.19)

Fig.18.a: Diamond Disc

Fig.18.b: Motor with low speed for cutting

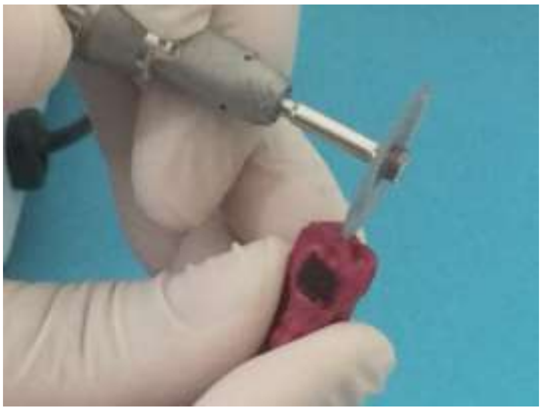


Fig.19. Cutting the tooth at middle

All sections were scanned under Stereomicroscope by 20X value (Fig.20)(Fig.21) and the larger score was recorded at occlusal and gingival margins by using 0- 4 calibration (Fig.22) (Fig.23) which is a parametric scale giving a qualitative measurement the depth of dye penetration at cavity walls was assessed according to the scores listed in table.3. and table.4.

Fig.20: Ordinary Stereomicroscope

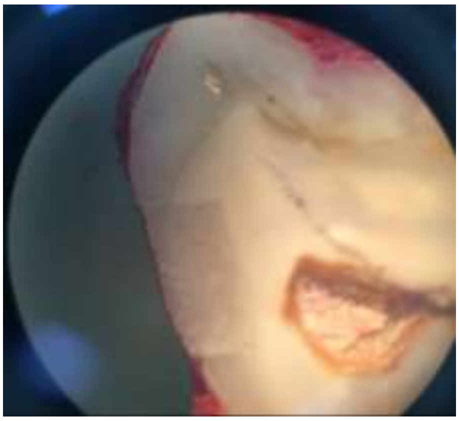


Fig.21: Sectioned tooth under Stereomicroscope

Dye penetrations were assessed independently to determine the extent of microleakage according to a five-point scale as follows and two examiners evaluated the extent of dye penetration for each tooth section.

Influence of the dye penetration and its measurement methodology and evaluation criteria on determining microleakage in enamel and dentin restorative interfaces has been obtained by Amarante de Camargo et al. (59)

Table.3. Scores followed to determine microleakage extent for Occlusal Margin

Score	Definition
0	No dye penetration
1	Dye penetration extending less than or up to ½ the distance to the dentin-enamel junction.
2	Dye penetration greater than ½ and up to but not past the dentin-enamel junction.
3	Dye penetration past the dentin-enamel junction along the axial wall or up to the cavity depth.
4	Dye penetration beyond the cavity depth in pulpal direction.

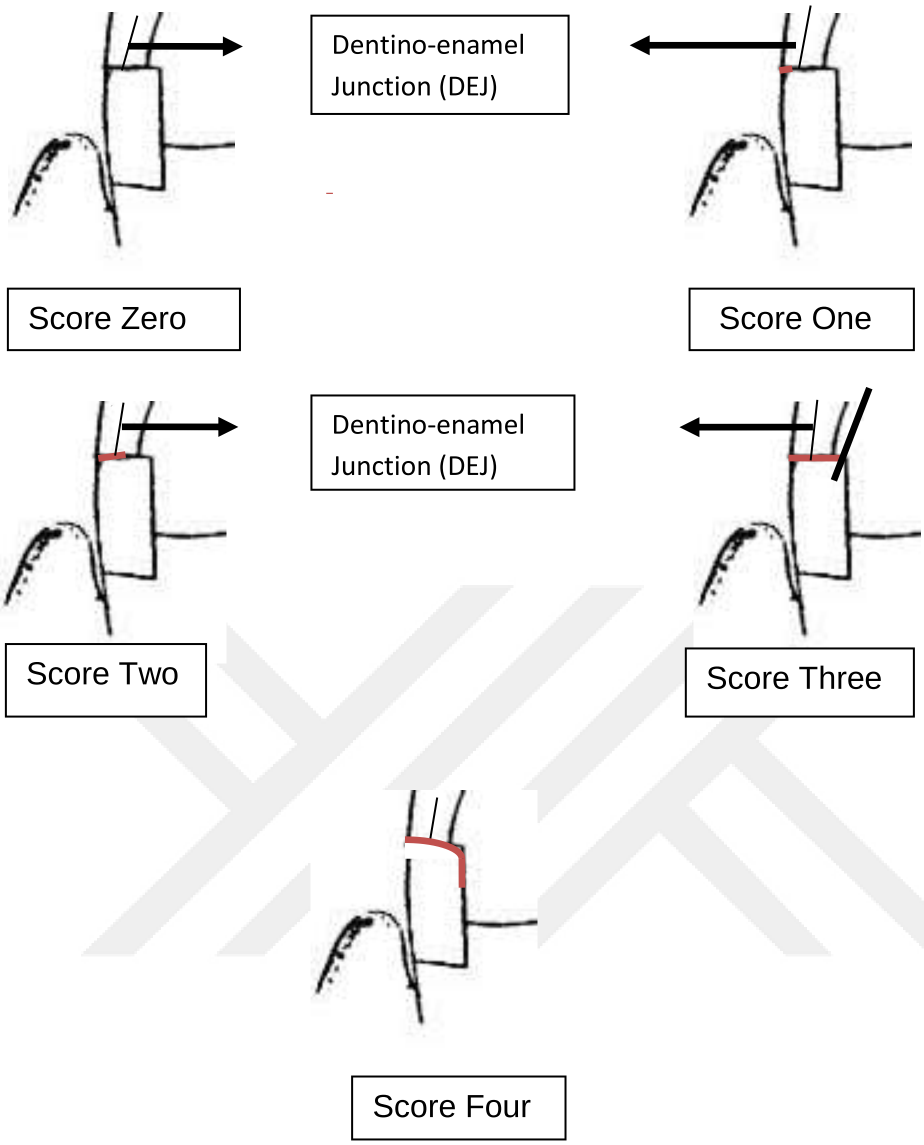


Fig.22: Diagramatic distribution of microleakage scores at occlusal margin

Table.4. Scores followed to determine microleakage extent for Gingival Margin

Score	Definition
0	No dye penetration
1	Dye penetration that extended less than or up to ½ of the gingival wall
2	Dye penetration greater than ½ or up to ¾ of the gingival wall
3	Dye penetration greater than ¾ of the gingival wall or up to the junction of gingival and axial wall.
4	Dye penetration beyond the junction of the gingival and axial wall in pulpal direction.

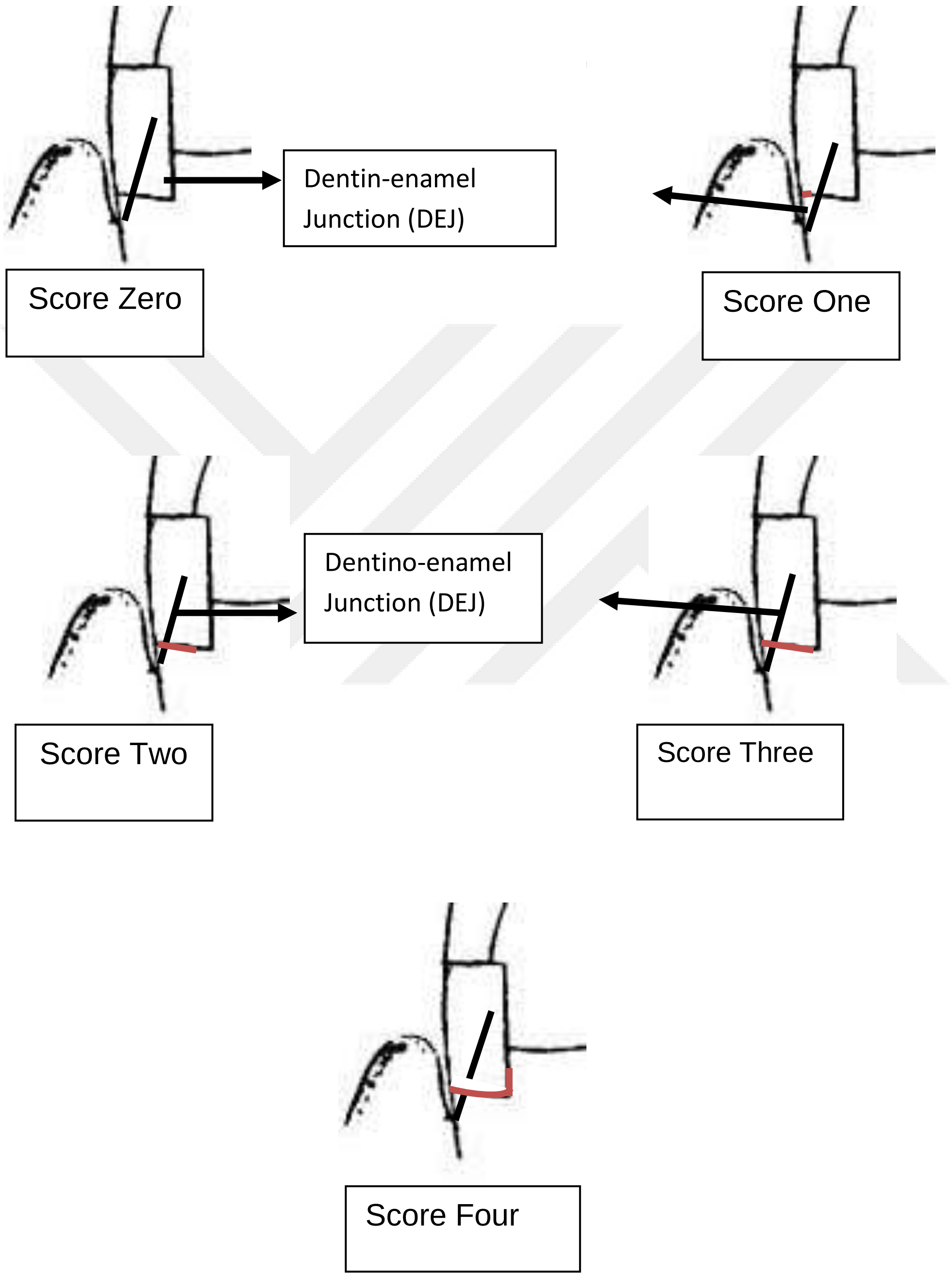


Fig.23: Diagramatic distribution of microleakage scores at gingival margin

4. STATISTICAL ANALYSIS

4.1 Power Analysis

To determine the sample size needed for the present study, statistical power analysis was conducted based on the prior pilot data. In order to achieve significant results.

In result of power analysis that is done in the study, when we take effect size: 1.071 for microleakage at gingival wall, identified sample number for each group is determined as minimum n: 4 (G*Power 3.0 program was used)

4.2 Statistical Calculation

During the assessment of the data obtained in the study, IBM SPSS 22 (IBM SPSS, Turkey) program was used for statistical analysis. Chi-Square test, Fisher's Exact and Mc Nemar test were used for comparison of qualitative data, Significance was evaluated at a level of $p<0.05$.

5. RESULTS

The percentage of microleakage for Occlusal and Gingival margins to each material are displayed in Table.5.

For Occlusal margin: there is no any statistically significant of microleakage between occlusal margins for all groups, ($p= 0.581$; $p>0.05$) Nanocomposite and Conventional Glass Ionomer groups no any microleakage was evident at occlusal margin while in group of Compomer 28.6% and 14.3% in Carbomer group at score 1 microleakage was observed.

For Gingival margin: there is no statistically significant of microleakage between gingival margins of the groups, ($p=0.321$; $p>0.05$) in group of Nanocomposite 14.3% of the group and 28.6% in Carbomer group at score 1 was observed while in Compomer group 14.3% of the group score 2 was observed.

Occlusal versus Gingival Margins for each group: there is no statistically difference between the occlusal and gingival margins of each group, Nanocomposite material group ($p=1.000$; $p>0.05$), Compomer material group ($p=1.000$; $p>0.05$), Conventional Glass Ionomer al group ($p=1.000$; $p>0.05$) and Carbomer material group ($p=1.000$; $p>0.05$).

Table.5. Comparison of microleakage percentage at occlusal and gingival walls for all groups

Material	Nanocomposite		Compomer		Convenional Glass Ionomer		Carbomer		[1] P
n=7	n	%	n	%	n	%	n	%	
Occlusal									
Score 0	7	(100%)	5	(71.4%)	7	(100%)	6	(85.7%)	0.581
Score 1	0	(0%)	2	(28.6%)	0	(0%)	1	(14.3%)	
Gingival									
Score 0	6	(85.7%)	6	(85.7%)	7	(100%)	5	(71.4%)	
Score 1	1	(14.3%)	0	(0%)	0	(0%)	2	(28.6%)	0.321
Score 2	0	(0%)	1	(14.3%)	0	(0%)	0	(0%)	
Occlusal versus Gingival [2]P	1.000		1.000		1.000		1.000		

[1]Chi-Square test and Fisher's Exact Test [2] Mc Nemar Test

There is no statistically significant difference between group A (Bonding materials) and group B (Non-bonding materials) of microleakage at occlusal margin. (p=1.000; p>0.05) when14.3% of group A was observed at score 1 the 7.1% of group B at score 1 of microleakage was also observed and there is no statistically significant difference between group A and group B of microleakage at gingival margin. (p=1.000; p>0.05) when 7.1% of group A was observed at score 1 and 7.1 % at score 2 at gingival margin also at group B 14.3% of score 1 was observed.

Table.6. Comparison of microleakage at occlusal and gingival walls for Group A (Bonding Materials) and Group B (Non Bonding Materials)

	Group A (Nanocomposite + Compomer)		Group B (Conventional Glass Ionomer+ Carbomer)		P
n=7	n	%	n	%	
Occlusally					
Score 0	12	85.7%	13	(92%)	1.000
Score 1	2	14.3%	1	(7.1%)	
Gingivally					
0	12	85.7%	12	85.7%	1.000
1	1	7.1%	2	14.3%	
2	1	7.1%	0	0%	

P by Ficher’s Exact Test

6. DISCUSSION

Increase aesthetic demand lead to bonded restorations have been the common choice for the aesthetic restorations cervical (coronal) areas lesions in teeth whatever caries or non caries lesions but in the same time the microleakage at margins of restorations is still a major concern in most of dental restorations materials used in oral cavity, reducing microleakage is essential to increase the longevity of the restorations minimize the microleakage in the treatment of carious or non caries lesions have become the most important objective of modern day research.

In order to overcome problems associated with marginal gaps, clinicians should follow technical guidelines accurately and only apply the most high-quality materials when constructing restorations and prostheses in order to achieve maximum marginal compatibility as Lucas ME et al. in 2003 reported the maintenance of a marginal seal over a long period of time is extremely important for avoiding or at least decreasing clinical problems such as the discoloration of margins due to microleakage, secondary caries, hypersensitivity, pulp pathology,[60]also Majety K, Pujar M. in 2011observed the integrity of the marginal seal is essential to increase the longevity of the restoration.[61]

This study evaluate the microleakage with using four different adhesives restoration materials with two different bonding mechanisms (two steps self- etching bond materials and self-bonding materials) by each two material follow same mechanism.

All of which demonstrated dye penetration (leakage) at both the enamel (occlusal) and dentin (gingival) margins, Fisher’s Exact, Chi-Square test and Mc Nemar test were used for comparison of qualitative data between materials and enamel margin compared to dentin margin, no significantly leakage was exhibited of the adhesive groups.

6.1. Effect of microleakage evaluation:

Microleakage was and still problem for most of adhesive materials, It is the most important property that has been used in assessing the point of success of any restorative material used in restoring tooth, the relationship between marginal leakage in restorations and the type of its adhesion has been extensively studied in both laboratory and clinical studies, Perdigão J et al. in 2012 and Farmer SN et al. in 2014 reported microleakage has been explored widely in the literatures [(62) (63)] microleakage studies provide the most proper screening methods can determining whether adhesive systems will be clinically acceptable or no.

Taylor M J. et al. in 1992 reported the microleakage evaluation is required to develop techniques and materials that reduce or delay damage caused by failure of restorative marginal sealing.[(50)] and Raskin A et al. in 2001 said clinicians and researchers used microleakage as a measure for assessing the performance of restorative materials in the oral environment.[(64)]also Yammazaki PCV et al. in 2006 said microleakage evaluation is the method most commonly used for assessing the sealing efficiency of a restorative system.[(65)]

6.2. Effect of in vitro study:

Laboratory or in vitro microleakage studies are well accepted method of screening the marginal microleakage efficiency and as a measure by which the performance of a restorative material can be predicted when absence of definitive clinical data, it allows to testing of anticipated variables for a better understanding of material behavior and provide the beneficial data of new dental materials made even with presenting some limitations when compared to clinical conditions, Söderholm KJ in 1991 reported laboratory tests can estimate material's sealing ability and clinical significance presumes invasion of bacteria through dental substrates restorative material interface,[(66)] Bertrand MF in 2006 and Sungurtekin E in 2010 observed in vitro microleakage studies are a valuable means of evaluating clinical restorative materials and techniques on their ability to reduce and perhaps eliminate microleakage.[(67)(68)] and Medić, V. et al. at 2010 performed in vitro evaluation of microleakage remains an essential method in the initial screening of dental materials and acts as an indicator of the theoretical amount of leakage that may or may not occur in vivo,[(69)] also M. A. Vargas et al. in 1994 and P. Bradna et al. in 2008 laboratory experiments have permitted comparison between different bonding materials it have pointed statistical differences between different adhesive systems,[70][71], while Schneider et al. in 2000 concluded that during preparation of vital dentin the formation of a hybrid layer makes the microleakage did not differ significantly in vital and non-vital dentin, [72] furthermore, Fabianelli, A. in 2004 said it is impossible to perform the clinical screening at the same speed as the laboratory tests, the clinical trials more complicated in sample selection and making and takes at least 1–2 years whilst the laboratory test can be done within one week, therefore inevitable that there grows a significant time lag between laboratory and clinical experience about a new material or procedure as results were in conformity with literature where laboratory studies show many defects whilst the materials perform clinically relatively satisfactory.[73] also Bauer JG in 1984 and Khoroushi M in 2012 reported that therefore the absence of clinical data, laboratory microleakage studies are a well-accepted method of screening adhesive restorative materials for adequate marginal adaptation.[74][75] because clinical evaluations are expensive, time consuming and require ethical approval.

However, according to Idriss S in 2007 should be pointed out that the results of microleakage studies carried out in vitro depend on a number of factors such as biological dentine properties, applied experimental model (teeth storage, teeth preparation, thermocycling, occlusal loading) and restorations properties,[76] also Ghazy, M. in 2010 reported this in the oral environment teeth are exposed to a multitude of challenges ranging from temperature and pH fluctuations related to the food being consumed to mechanical loading applied during mastication in addition to enzymes secreted to assist digestion, It is difficult in an in vitro set-up to simulate the cumulative effects of these challenges, therefore results of in vitro study by Ghazy must be interpreted with caution as clinical performance of the crowns in terms of microleakage might be worse than what is reported in this study,[77] and Bagis YH et al. in 2009, Aschenbrenner CM et al. in 2012 compared clinical studies and in vitro then reported clinical studies cannot be replaced by in vitro microleakage studies or used to solely predict clinical performance but they performed dye penetration may provide an easy, fast, and commonly applied screening method.[78][79]

6.3. Effect of use natural teeth and its cervical area:

In this study class V cavity design was chosen because it is easy to restore and is without any macromechanical undercut during preparation so the sealing ability of different restorations was easy compared just based on the bonding effects, the cavities were prepared in all specimens in such way that one of restoration margin was in the enamel (occlusal margin) and the other below the CEJ (gingival margin) to separately assess the microleakage in enamel and dentin margins.

The cervical lesions generally have margins that can terminate in three different tooth tissues, enamel, dentin or cement, the lack of a restorative material that is capable of equally binding powerfully to all three tissues makes the restoration of this kind of cavities difficult. (65)(80)(81) and a systematic approach to bonding at the cervical margins of class V restorations requires understanding of anatomy and histophysiology of the root dental structures as Schwartz R.S. et al. in 1996 and Kunzel W. et al. in 2000 reported,(82)(83) However, De Munck, J. in 2003 A shortcoming of using natural teeth for bonding experiments is that they may dry after their extraction.(84) but the teeth in this study were immersed in water immediately after their extraction and kept in distilled water just for one week throughout the test procedures.

6.4. Effect of select materials:

6.4.1. Effect of choose of adhesive system with Composite and Compomer:

Nevertheless, composite and compomer restoration is not able to bond to dental tissues, so the point of success depends on the adhesion of these restorative materials to hard tooth tissue, Giray, F. E et al. in 2014 reported one of the main properties of a good restorative material is its ability to resist leakage of bacterial fluid in and around the restoration,(85) also Davidson CL et al. in 1997, Ramos RP et al. in 2000 and Santhosh L et al. in 2008 all of them reported the using of appropriate adhesive systems can help to minimize the microleakage and prolong the longevity of the restoration.(86)(87)(88)

The adhesive systems used in this study is two step self-etch bond (Clearfil™ SE bond) as it is known saving time, reducing procedural errors and with their lower etching ability and decreasing the potential for iatrogenic damage to dental hard tissue are the most its advantages as Yuasa T et al. in 2010 mentioned.[89] and Amaral FL et al. in 2007 showed regarding to promoting adhesion of the composite or compomer to enamel and dentine a two-step self- etch adhesive was chosen Clearfil™ SE Bond, [90] about surface protection for both composite and compomer, unlike the latter two materials (Conventional Glass Ionomer, Carbomer) a hydrophobic polymer network is formed immediately after photopolymerization of the composite and compomer which maintains the surface integrity and provides adequate resistance against leakage in the absence of surface protection.

6.4.2. Effect of choose Conventional Glass Ionomer:

In this study GC Fuji IX GP Extra was used because is highly wide use in dental clinic in late time with its characteristic of the fastest setting glass ionomer on the market (about 2½ minute), this faster final set saves valuable chair time which provides improved stability against water which is an important feature in challenging oral environments and it contains glass filler known as Smart Glass, this filler elicits higher translucency, fluoride release, reactivity and a faster setting time, the increasing translucency allowed this product to be used in the aesthetic purpose and also useful for cervical restorations where the high fluoride release is important, the radio-opacity and reasonable aesthetics offer-up advantages in field and special needs dentistry and applications include not only restorative but also cementation, luting posts and crowns as well as in core build-up and adult and pediatric restorative situations and some specific uses such as attachment of orthodontic brackets or resin-bonded bridges.

Using surface conditioning in this study according to manufacturing instructions with advantage of effective adhesion, some studies support this study as Birkenfeld et al. in 1996, Yilmaz Y et al. in 2005 and El-Askary FS et al. in 2011 have reported the conditioning of the dental surfaces increases the glass ionomer’s bond strength and leads to better adhesion by formation of an undetectable morphologic unit with dental hard tissues and decreases the microleakage,[91][92][93] Castro, A. et

al. in 2002 reported the Fuji IX GP™, the improved conventional glass ionomer, behaved similarly to the composite resin when conditioning was used.[94]
According to Yilmaz Y et al. in 2005 it has been stated that the acidic nature of glass ionomer cements can partially dissolve the smear layer, therefore the smear layer should be either modified or completely dissolved and removed. [92]

Furthermore the developing in conventional glass ionomer the ionomer restorations are sensitive to hydration and dehydration during their initial setting because that the frequently protected by coating materials a nano-filled resin coating (G-coat Plus) used in this study which its application of surface protection seems to preserve the water balance in the system as Karaoğlanoğlu S et al. in 2009 performed, [95] also in the same time for carbomer the absence of surface protection results in significant reductions in the marginal sealing efficiency of both the conventional GIC and the glass carbomer cement.[39]

6.5. Effect of thermocycling:

In this study no thermal cycle was done, our study about effect of adhesion methods of dental restorations to dental hard tissues and preservation of standarzation between groups was preserved, Alani AH et al. in 1997 it is difficult to establish a relationship between different studies, since there is always some variation concerning the temperature levels used in the thermal water baths, amount of cycles and immersion times in each bath,[48] also not only thermocycling is standarzation point for comparing in microleakage studies the filling material used and the cavity preparation type also different and it will promote different results among similar studies as Deveaux E et al. in1999, Kubo S et al. in 2001, Li H, Burrow MF et al. in 2002, Yamazaki PCV et al. in 2006, Bagheri M et al. in 2008 [96][97][98][65][99]

In addition some past studies by Grossman ES et al. in 1990 , Hakimeh S et al. in 2000 and Ozel E et al. in 2008 pointed out that application of thermocycling (only), significantly increased the microleakage pattern.[100][101][102]

In the same time some studies like Barkmeier WW et al. in 1992, Oilo G et al. in 1993 and Alani AH et al. in 1997 reported the thermal cycle procedure is often employed in laboratory studies to evaluate the dental marginal sealing.[103][104][48]

6.6. Effect of water storage:

In this study was designed to evaluate the early microleakage after one week of water storage of different tooth colored materials, De Munck, J. in 2003 water storage is a common artificial aging technique in dental research, Hydrolysis due to the degradation of the interfacial boundary between resin and collagen has been attributed to a decrease in bonding effectiveness due to water storage. [84] therefore, the effects of the water storage on the microleakage results were expected to be zero or minimal.

Lucena-Martín, et al. in 2001and Martins, G. C.et al. in 2012 demonstrated no significance difference in microleakage value between thermocycling and untreated groups (water-stored) composite restored specimens.[105][106]

6.7. Effect of use dye penetration and microscopic evaluation:

In the current study the microleakage of different tooth colored restoration materials placed in class V cavities used a dye penetration test because highly sensitivity, accurate also the assessment of results required standardization.

Influence of the dye penetration and its measurement methodology and evaluation criteria on determining microleakage in dentin restorative interfaces has been obtained by Amarante de Camargo et al., in 2005. [59]

In examined the microleakage by Kidd EA in 1976 and Raskin A in 2001 and Lopes MB et al. in 2009 reported bond failure between the tooth and restoration interface are commonly assessed by dye penetration tests which is best criteria, [44] [64] [107] because it is easy to manipulate, economical and does not require any complex laboratory equipment as Sharma RD et al. 2011 reported, [108] Ahmed, W. M. in 2012 reported from his results, It does not chemically react or cause any destruction to the specimens and they are considered the oldest, most successful and most common method of detecting microleakage in vitro.[109]

Medić, V. et al. in 2010 reported the possibility of direct reading of the diffused marker under the microscope and simplicity of application is the most important advantages of the method with stained solutions include precision in assessment of marginal sealing (110) and according to Q Retief DH in1994 and Pilo R, Ben-Amar A in1999 the dye penetration and microscopic evaluation is a well-established method for in vitro microleakage testing. (111) (112)

In this study the basic fuchsine used because it is essential of select a suitable dye solution to be used with tooth structure and restorative materials tested also the basic fuchsine dye has nice contrast with the tooth structures, determining the microleakage score under the stereomicroscope is easy according to Güngör HC et al. in 2003, (113) and Heintze SD in 2007 and Sungurtekin E et al. in 2010 used dye 0.5% basic fuchsine because of its simplicity and reproducibility and they reported the most effective was used in their study because it is readily available, cheap, and non-toxic,(114)(115) also De Munk J et al. in 2004 and Behr M et al. in 2004 used basic fuchsine in several studies because it is a widely accepted and generally preferred method to assess microleakage. (116)(117)

In other side Coleman JA et al. in 2001 reported the disadvantage of this method is reflected in considerably smaller diameter of the marker particle in comparison to the bacterial toxin molecule and bacteria themselves,(118) thus some authors believe that the results obtained in this way are not clinically relevant, Raskin A, et al. in 2001 stated the clinical relevance of various in vitro tests, such as the evaluation of microleakage by dye penetration, as problematic different results of dye penetration in vitro seem to be affected by many factors and various test methods.(64)

Furthermore, the results of sparse comparative studies are varying but a direct correlation between the results of dye penetration studies and the clinical outcome appears to be difficult or affected by its composition as Piwowarczyk, A. in 2005, El Mowafy, O. et al. in 2007 and Schenke, F., et al. in 2008 reported a possible limitation of the experiment is that the results might be influenced by the dye chemical composition that was used. However, different dyes like fuchsine red, methylene blue, and silver nitrate did not lead to differences in the results obtained by earlier studies.(119)(120)(121)

6.8. Effect of cutting teeth:

In this study teeth inspected through single section at center of restorations as numerous studies did before Hakimeh S et al. in 2000, Raskin A et al. in 2003 Deliperi S et al. in 2004 utilize a single section through the center of the restoration (103) (122) (123) but Alani AH et al. in 1997 and Ermis B. in 2003 performed dye penetration measured on sections of restored teeth is the most common technique for evaluating microleakage at the tooth-restoration interface. (48)(124)

6.9. Discussion of results:

When analyzing the results of this study no statistically significant differences between study groups in the microleakage and the very low scores at the occlusal and gingival microleakage observed in most groups of this study are agreement with several other studies especially which newly developed adhesive systems were used microleakage occurred.

When comparing the group of self-etch bonding restored by composite and compomer with conventional glass ionomer group no differences showed, this coincidence with a comparable in vitro study by De Magalhaes C.S. et al. in 1999 which reported similar microleakage performances in Class V cavities of composite, compomer and traditional glass ionomer, (125) also when comparing occlusal and gingival margins of each group showed no statistically difference between it for all groups.

Study by Castro and Feigal in 2002 Fuji IX GP Extra, as this study in results observed the conventional glass ionomer, behaved similarly to the composite resin.(126) but Erdilek et al. 1997 and Wilder et al. in 2000 who concluded the composite resins provide a better seal than conventional glass ionomer restoration. (127) (128)

When compared microleakage between self bonding materials (carbomer and conventional glass ionomer) no statistical difference occurred (this agreement with study by Subramaniam, P. et al. in 2015 which reported non any statistical differences between groups of carbomer and conventional glass ionomer. [129]

Some studies agreement with this results like Poggio, C. et al. in 2013 [130] reported that the gingival margins exhibit greater leakage than the occlusal margins in class V restorations filled with multiple tooth colored restorations in vitro but also no significant differences in the enamel and gingival scores between tooth colored restoration groups.

Study by Atash, R., et al. in 2005 observed as this study no significant differences in the microleakage degree either on enamel or on cementum with compomer restoration. [131]

Study by Rebouk et al. in 2000 and Glasspooie et al. in 2002 showed no significant difference between the mean microleakage in enamel or dentinal margins for conventional glass ionomer, which could be due to similar mineral composition. [132][133] and Giray, F. E., in 2014 Fuji IX GP Extra chemically bonds to the tooth structure, has a coefficient of thermal expansion similar to that of the tooth. [86]

However, on other side some studies have shown that there is statistically significant difference in microleakage of these materials, this could be due to difference in experimental designs and testing methods used in these studies, study by Thornton et al. in1988 and study by Perdigão J. in 2010 about conventional glass ionomer the cervical margins presented a larger amount of microleakage which is in accordance with the common knowledge that the adhesion on enamel is more effective than on dentin as they present particularities on its composition for restorative materials are more frequently being placed with margins apical to the cement-enamel junction in conventional glass ionomer restorations.[134][135] another study by Tsunekawa et al. in 1992 for composite restorations compared microleakages at the occlusal and cervical (gingival) margins in, they reported higher levels of microleakage in the gingival margins in all groups of study.[136]

Study limitations

This study has the following limitations:

1. Some limitations of this study include the lack of an in vivo environment, In vitro studies do not reflect all the variables present in a patient mouth. In vitro study which provides important information when assessing biomaterials but does not replace clinical (in vivo) evaluations, In addition to that preserve the integrity of samples and to avoid the loss of samples.

2. It is difficult to entirely correlate laboratory findings with the clinical behavior of any restoration, in natural teeth pulp pressure and intertubular fluid have great influence on moisture level thus affecting to most of tooth colored restorations interface. Therefore, to find a correlation between clinical studies and lab measurements, further in vivo evaluation is suggested.

3. Standardization of extracted natural teeth is always difficult due to the variability of tooth sizes; this may affect the preparation design and dimensions.

4. Storage would also affect dentin variability and could affect the physical and mechanical properties of dentin.

5. The dye penetration method relies on randomly cutting the tooth without knowing if the section goes through the deepest dye penetration.

CONCLUSION

Within the limitations of this study, Scores of microleakage were obtained among most restorations of this study with basic fuchsine to treated class V cavities restored by using four different self-adhesive and self-bonding materials each of them generally accepted in the dental profession.

It can be concluded that when comparing the two step Clearfil SE bond when used with Kuraray Majesty ES-2 nanocomposite and DENTSPLY Dyract Extra Compomer no significant difference regarding microleakage with self-bond GC Fujii IX GP-Extra and GCP Dental Glass fill Carbomer difference in mode of adhesion to tooth structure.

Also the degree of microleakage in occlusal and gingival margins of each group no significant difference observed.

Thus clinicians can use all of these four restoration materials inside oral cavity to treat cervical area (class V) lesions or any other cavities because perfect sealing should be the plan of each clinical performance and the ideal restorative material should have a perfect and complete seal of the restoration’s margin when dye penetration scoring was performed at the cervical area, whilst also each specimen was evaluated by SEM observations.

However, with previous results long term clinical studies need to be carried out to substantiate the results of this study.

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DEDICATION

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