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Tensile Bond Strengthof ResinComposite andCeramics

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I. Introduction

Buonocoreexplainedtheacidification of theenamelwithliquidsolution in liquid form in 1955 andtheformation of resintagswiththepenetration of resinmonomersintotheresultingmicroporositiesandtheformation of a micromechanicalbondafterpolymerization. Theenamelbindingtechnique has becomestandardandaccepted, andproblemswithdentinbindinghavebeenexperienced. However, withthedevelopment of variousbondingsystems, there has been a significantimprovement in bindingtodentine (Kugeland Ferrari 2000). Dentaladhesiveshavemanyclassifications in thescientificliterature. Functionalbasedclassification; It is presentedtocontainthree main groups of adhesives: total-etchoretchandrinseadhesives, self-etchadhesivesandglass-ionomeradhesives (Van Meerbeek et al 2003).

Afterintroducingtheacidenamelrougheningtechniquetoincreaseadhesiontotheenamel, Buonocore has seen an incredibleimprovement in thebonding of dentaladhesivesandresinstoenamelanddentine in 40 years. Whilethefirstdentaladhesiveswereattachedonlytoenamel, theyshowedlittleornoconnectiontothedentine. Subsequentgenerations, whilemaintaining a strongenamelconnection, alsoincreasedthebondstrength of dentintocoverthedentinmargins. Theuse of adhesivetechniqueswithresincomposites has beenusedfortherestoration of decayedorbrokenteeth, as well as forfillingerosionandabrasiondefects in thecervicalareas. Inaddition, modern adhesivetechniquesallowthecorrection of non-aestheticshapes, positions, proportionsorcolorsbyaddingrestorativematerialstothetooth.

Productionprocessesandcapacity of CAD / CAM systemscontinuetoimprove. Despitethemethod of obtainingrestorationbyabradingtheblocks, themethod of creatingrestorationbyaddingthematerialcontinuestoprogress in thiscontext. As porcelainblocksarepreparedbefore, CAD / CAM systemsareexpectedto be usedmorewidely in thefutureduetotheiradvantagessuch as lesserror in baking of thematerialandnoneedforlaboratoryoperations (Çelik 2012).

Ouraim in thisstudy is; Tocomparebondstrength of compositeandporcelainlaminaterestorations in in vitroconditions.

II. Materials and methods

Forthebondstrength test, 55newlyextractedupperhumanincisorswereused. Teethwerecleanedwiththehelp of pumiceandrubber. Inmoldspreparedwithsiliconeimpressionmaterial, teethwereembedded in autopolymerizingacrylic (Meliodent; HeraeusKulzer, Hanau, Germany). Laminate burs wereusedforlaminatepreparation (Meisinger, Düsseldorf, Germany). First, thedepth of preparationwasdeterminedwithdepthdetermination burs (834-016, 834-021 Meisinger, Düsseldorf, Germany). Later, a labialpreparationwasmadewith burs thatcut at a depth of 0.5mm. Theincisaloverlapwasfinishedwiththepreparation. Thesamples, whosepreparationswerecompleted, were sent tothelaboratory. LaminatedveneerswerepreparedusingE.max CAD andEmpress CAD porcelainblocks. Thecompatibility of thelaminateveneerswiththeteethwaschecked. Theincompatibleveneerswereadaptedandmadereadyto be glued. Beforeapplyingtheveneers, 37% phosphoricacidwasappliedtothetoothsurfacesfor 15 secondsaccordingtothemanufacturer'sinstructions. Teethwerewashedanddried. Panavia F 2.0 (Liquid A, Liquid B, Panavia F 2.0 KurarayDental, Japan) andporcelainsampleswereg luedonebyoneaccordingtothemanufacturer'sinstructions.

Forthebondstrength test, 50 newlyextractedhumanupperincisorswerecollected. Teethwerecleanedandkept in saline. Laminatepreparationwas done as prepared in porcelainsamples. Beforeapplyingrestorativematerials, 37% phosphoricacidwasappliedtothetoothsurfacesfor 15 secondsaccordingtothemanufacturer'sinstructions. Teethwerewashedanddried. Inthefirstgroup, Clearfil® SE Bond (KurarayCo, Japan) wasappliedandpolymerizedaccordingtotheadhesivecompany'sinstructions. Restoration is completedwithFiltek Ultimate (3M ESPE, St Paul, USA) compositeresin. Inthesecondgroup, All Bond SE (BISCO, Schamburg, USA) adhesiveresinwasappliedaccordingtothemanufacturer'sinstructionsandtherestorationwascompletedwiththeAllPurpose Body (BISCO, Schamburg, USA) compositeresin.

Thesamples, whoserestorationswerecompleted, werestored at 37 ºC in theovenfor 24 hours. Theteeth, theroots of whichwereseparated 2mm belowthecement-enameljoint, wereg luedtotheacrylicblockswiththeircrowns on top. Rodscontaining~1.25-mm dentin-adhesiveinterfacewereobtainedsothattheteethwereperpendiculartotheadhesivesurface in thelow-speedsectioningdevicewith a diamondseparator. Thethickness of therodswasmeasuredagainwith a digitalcaliper. On average, 4-5 stickswereobtainedfromeachtooth. Theresultingrodscyanoacrylateadhesive (Patex Henkel, Turkey) on themicrotensile test apparatus (Micro Tensile Tester is Bisco, USA) placedBencunmultigluedtothe T apparatus. Tensile strengthwasapplied at a speed of 1mm / minuntilfractureoccurredbetweenthetoothandthecomposite. Theforce at whichthebreakageoccurredwasrecorded in Newton andthebreakageareawascalculatedusing a digitalcaliper. Refractionvalues in MPawerecalculatedusingtheformulabelow.

Afterthebonding test, thesurfaces of allsampleswereexaminedunder a stereomicroscope at x40 magnification. Fracturetypes; Itwasclassified as (1) adhesive break betweendentinandbonding, (2) mix break, (3) cohesive break in dentin, (4) cohesive break in composite (PriceandHall 1999, Can-Karabulut 2009).Thebondstrength test wasevaluatedbyOneway ANOVA andTukey HSD tests.

III. Results

Theaverage, standarddeviation, maximumand minimum values of themicro-tensile bondstrengthtests of fourmaterials. Inourstudy, thehighestmicrotensilebondstrengthwasfound in Filtek Ultimate (26.69 ± 6.67 MPa)(Table 1). A statisticallysignificantdifferencewasobservedbetweenthegroups (p = 0,000; p <0.05). Intheadvancedanalysisconductedtoseethedifferencebetweenthegroups, Filtek Ultimate andAelitemicrotensilebondstrengthvalues werefoundstatisticallysignificantcomparedtoothermaterials (p <0.05), but therewasnostatisticallydifferencebetweenthem (p = 0.061; p> 0.05)(Table 1). But Filtek Ultimate (26.69 ± 6.67) had higherbondstrengththanAelite (20.92 ± 12.09). Empress (6.71 ± 4.14) had higherbondstrengththanE.max (3.64 ± 2.11)(Table 1), but therewasnostatisticallydifferencebetweenthetwomaterials (p = 0.776; p> 0.05). E.maxwasfoundtohavethelowestbondstrengthamongallmaterials (3,64 ± 2,11)(Table 1). Whenwelook at thedifferencebetweenmaterials as compositesandporcelain, it wasseenthattherewas a highdegree of difference (p = 0,000; p <0.05). As a result, thebondstrength of compositematerialswasfoundto be higherthanthebondstrength of porcelainmaterials (Graphic1). Allfructuretypesaresummarizedregardless of theadhesivetype, themostobservedtype of fructurewasfoundto be adhesivetypefracture. Fracturebeforetestingwasonlyseen in E.maxrestorationsandthesesampleswere not used. Adhesivefracturetypewasgenerallyobserved in porcelain (Empress: 58%, E.max: 72%) andcomposites (Filtek Ultimate: 69%, Aelite: 73%). Cohesivefracturesweremorecommon in AeliteandFiltek Ultimate thanEmpressandE.max.

IV. Discussion

Compositesproduced in 1970s havebeenthemostpreferredmaterial in aestheticrestorationsfrompasttopresent. Theyhavebeenwidelyusedfortheiraestheticproperties, attachmenttothetoothstructure, andeasyandfastapplication.

Today, it is claimedthataestheticrestorationsusingporcelainmaterialarebetter in terms of biologicalcompatibilitythanothers (Wendt et al 1992). Inaddition, it is knownthatporcelain is preferredforbothanteriorandposteriorrestorationsduetoitsadvantagessuch as betterabrasionresistancethancompositeresins, nopolymerizationshrinkagewhenusingporcelainblocks (BaunanandHeideman 1991, Rykke 1992, HornbrookandCrispin 1994). However, therearemajordisadvantagessuch as theconstruction of porcelainrestorationsrequireprecisionandlong time, theyarefragile, theyweartheoppositetooth (El-Mowafy 2000).

Laboratorytestscontributetoclinicalevaluationsbyallowingthedevelopmentandinitialevaluation of restorativematerials.Ourhypothesiswasacceptedthatcompositelaminaterestorationswillshowhigherbondstrengththanporcelainlaminaterestorations.

Since theexperimentsrelatedtodentalmaterialsare time consuming, difficultand in somecasesimpossibletoperformdirectly in vivoconditions, theseproblemsweretriedto be eliminatedbycreatingexperimentalmechanismsthatmimicthe oral environment. Forthispurpose, agingmethodssuch as thermalcycle, watersoakingandloadapplicationareused (Arcoria et al 1990). Thermalcycle is theprocess of restorationandimitation of temperaturechanges in whichtheteethareexposed in themouth (Arcoria et al 1990, Atta et al 1990, Wendt et al 1992). Inthermalcycleprocess, watertemperaturesvarybetween 4 ° C-5 ° C and 50 ° C-60 ° C. Thesamplesarekeptalternately in thesewaterbathsfor 20-60 secondsandthisprocess is repeatedbetween 500-20.000 cycles (Arcoria et al 1990). Inourstudy, thermalcycle test wasappliedtothesamples in ordertoensurecompatibilitywiththe oral environment.

Thermalcycleswereappliedtoallsamples 500 times at 5 ± 1 ° C and 55 ± 1 ° C. Teethwerekept at eachtemperaturefor 1 minute.

Shear test is one of themostfrequentlyusedmethods in theliteraturetoevaluatethebondstrength of restorativematerials (Özcan et al 2007). However, someresearchersprefermodified tensile teststopreventtheformation of irregularinterfaceforces (El Zohairy et al 2003). Inthe tensile tests, however, the form andgeometry of thesamplesaffecttheresults. Tensile testingandsheartestingmethodsmay not giverealinformationaboutthebondstrength of materialsaloneduetotheirregularforcedistributionduringforceloading (Azer et al 2000). Inaddition, it wasreported in theseteststhatthebreakage model maycausecohesivebreaksandmaycauseerroneousresults. Inmicrotensiletests, it is saidthattheforcedistribution is morehomogeneous, thereforethetypes of fracturearemoreadhesives (Amaral et al 2006). Forthisreason, wepreferredthemicrotensile test method in ourstudy. Inthisstudy, All Bond SE, one of theadhesivesusedwithAelitecomposite, is a single-stage self-etchadhesivefromthesamecompany. OnestudyfoundthatAll Bond SE has higherbondstrengththanClearfil S 3 (Hass et al 2011). Inanotherstudy, it wasreportedthatAll Bond SE providesgoodattachmenttothenear-rootdentine (Onay et al. 2010). Inanotherstudy, it wasstatedthattheotheradhesiveClearfil SE Bond weusewithFiltek Ultimate has highbondstrengthespeciallywhenroughenedtotheenamel (ILie et al 2006). Inmanystudies, Clearfil SE Bond has beenreportedtobind not onlytoenamel but alsosuperficialanddeepdentine (O'Keefeand Powers 2001, Perdigao et al 2001, Kaaden et al 2002, Nikaido et al 2002). ManyresearchersevenacceptClearfil SE Bond as thegoldstandardbecause of itshighconnection in dentine (De Munck et al 2009, Mine et al 2009, Sarr et al 2010, Van Meerbeek et al 2010). We can say thatcompositelaminaterestorationshavegoodbondstrengthandadhesivesareused. Dündar et al (2007) foundthattheporcelainbindingvalues obtainedbyshear test methodarehigherthanthebindingvalues obtainedbymicrotensile test method. However, theysaidthatmorehomogeneousresultswereobtainedwiththemicrotensile test method. Theobtainedmicrotensilebindingstrengthsarebetween 9-15 Mpa. Theseresultsaresimilartoourstudy. Theporcelainbondstrengthsobtained in ourstudy (IPS Empress; 6 ± 4 Mpaand IPS E.max; 3 ± 2 Mpa) are as lowbindingvalues. Accordingtotheresultsobtained, thebondstrength of IPS Empresswasfoundhigherthan IPS E.max. Inaddition, theresultsobtainedwiththemicrotensile test methodwerehigherfor IPS Empressthan IPS E.max, whereastheshear test method had theoppositebondstrengthfortheopposite IPS E.max. Therefore, although it is saidthatmorehomogeneousresultsareobtainedwiththemicrotensile test method, shear test may be a moresuitablemethodtomeasurethebondstrength of IPS E.max.

Thebondstrengthresultsweobtained in compositesamples (20-26 MPa) arehigherthanporcelainsamples (3-6 MPa). In a studyrelatedtoPanavia F andotherresincements (Variolink 2, Rely X Unicem, Rely X ARC), it has beenreportedthat, althoughresincementshavesimilarchemicalproperties, theirphysicalpropertiesdifferandpolymerizationmethods can createdifferences (Kumbuloglu et al 2005). Mak et al (2002) found in theirstudythatClearfil SE Bond has a higherbondstrength in dentinethanPanavia F andstatedthatthereasonforthismay be thatPanavia F containsmorefillers. InanotherstudywithPanavia F, thelowestbondstrengthcomparedtootherresincements (Choice, Rely X) wasobserved in Panavia F (16.1MPa) (Mak et al 2002). As a reason, it wasconcludedthattheconcentration of acidicmonomers of the ED primer in it wasduetoexcessiveconcentration. It has beenstatedthatmostacidicmonomersmayhavelowbondstrengthduetotheirnon-polymerization. Inthisstudy, theresincementusedmay be thefactorcausingthebondstrength of porcelainlaminaterestorationscomparedtocompositelaminaterestorations.

Inthisstudy, thetypes of refractionwereshown as adhesive, cohesiveormixed. Fracturebeforetestingwasonlyseen in E.maxrestorations. Adhesivefracturetypewasgenerallyobserved in porcelain (Empress: 58%, E.max: 72%) andcomposites (Filtek Ultimate: 69%, Aelite: 73%). Cohesivefracturesweremorecommon in AeliteandFiltek Ultimate thanEmpressandE.max. Generally, cohesivefracturesareseen at higherbondstrengths (Sarr et al 2010). Inthisstudy, we can say thatthebondstrength of compositerestorations is betterthanfracturetypes. Thelow rate of cohesivefractures of porcelainrestorationsandespeciallythepre-test fracture in E.maxrestorationsmay be duetotheforceappliedduringthepreparation of test samples. Itcausesthesamplesto break beforeandduringthe test as a result of defectsthatoccurwhilepreparingsamples at thedentine-adhesive-porcelaininterface (Tanumiharja et al 2000). Theforceexertedduringtheacquisition of samplesmayhavecausedprematuredisruption of thebinding of morefragileporcelain.

Conclusion

In general, it wasfoundthatcompositelaminaterestorationswerebondedhigherthanporcelainlaminaterestorations. Thebondstrength of thematerialswasFiltek Ultimate, Aelite, IPS Empress, IPS E.max, fromhighesttolowestrespectively.

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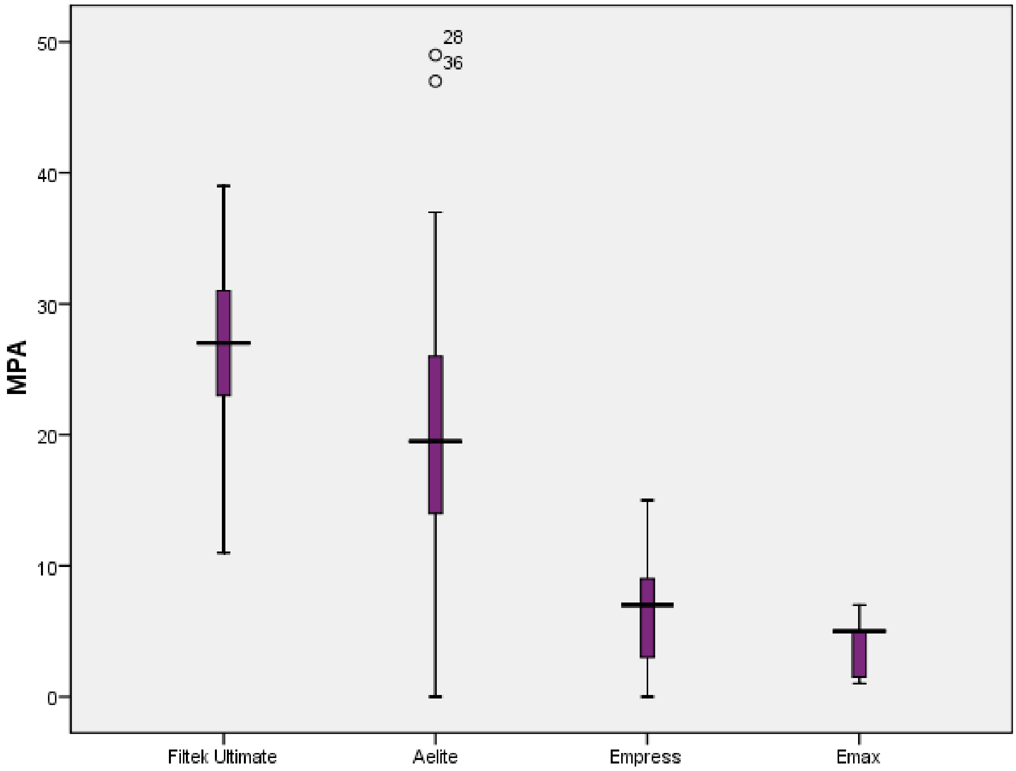
Table 1. Materialsbondstrength (Mpa).

Material	N	Mean±SD	Minimum	Maximum
Filtek Ultimate	26	26,69±6,67	11	39
Aelite	26	20,92±12,09	0	49
Empress	17	6,71±4,14	0	15
E.max	11	3,64±2,11	1	7

Graphic 1. Bonding strength of restorative materials.



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