

IARA DE OLIVEIRA NOGUEIRA

**DIFERENTES TÉCNICAS DE REPARO DE CERÂMICAS VÍTREAS
COM RESINA COMPOSTA AFETAM A SOBREVIVÊNCIA DA
RESTAURAÇÃO E A RESISTÊNCIA DE UNIÃO DO REPARO? UMA
REVISÃO SISTEMÁTICA E META-ANÁLISE**

**Faculdade de Odontologia
Universidade Federal de Minas Gerais
Belo Horizonte
2022**

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Dissertação apresentada ao Colegiado de Pós-Graduação em Odontologia da Faculdade de Odontologia da Universidade Federal de Minas Gerais, como requisito parcial à obtenção do grau de Mestre em Odontologia - área de concentração em Clínica Odontológica.

Orientador: Prof. Dr. Rodrigo Richard da Silveira
Coorientadora: Profa. Dra. Cláudia Silami de Magalhães

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Diferentes técnicas de reparo de cerâmicas vítreas com resina composta afetam a sobrevida da restauração e a resistência de união do reparo? Uma revisão sistemática e meta-análise.

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“A persistência é o caminho do êxito”

Charles Chaplin

RESUMO

As cerâmicas vítreas apresentam uma combinação de propriedades estética e mecânica satisfatórias, as quais viabilizam o seu uso na maioria das restaurações indiretas. No entanto, estes materiais estão sujeitos a falhas em sua estrutura, e podem lascar, trincar ou fraturar. O procedimento de reparo parece ser um recurso importante para a manutenção e aumento da sobrevida dessas restaurações na cavidade bucal. Porém, a falta de consenso no protocolo clínico ainda gera bastante confusão entre os profissionais. Portanto, objetivou-se avaliar, por meio de uma revisão sistemática e meta-análise, a influência dos diferentes tratamentos de superfície empregados no reparo de cerâmicas vítreas com resinas compostas. Buscas computadorizadas foram realizadas nas bases de dados *PubMed*, *Scopus*, *Web of Science* e *Embase*. Foi utilizada uma combinação de termos *MeSH* e termos livres com operadores booleanos OR e AND, seguindo as regras de sintaxe de cada base de dados. Uma busca complementar no *Google Scholar* e no *OpenGrey* também foi realizada, e não houve restrição de idioma ou ano de publicação. Após a identificação dos registros em cada base de dados, os resultados de busca foram exportados para o *Rayyan QCRI*. As etapas de identificação, seleção, elegibilidade e inclusão dos estudos foram realizadas respeitando-se o *PRISMA statement*. A qualidade metodológica dos estudos incluídos foi avaliada seguindo as Diretrizes da Ferramenta de Risco de Viés (*OHAT Risk of Bias Rating Tool for Human and Animal Studies*). Os resultados das meta-análises foram fornecidos pela diferença das médias com intervalo de confiança de 95%. A heterogeneidade estatística foi avaliada pelo I^2 , e o modelo randômico foi utilizado. A busca identificou 5.037 estudos e 165 foram avaliados quanto à elegibilidade. Finalmente, 123 estudos *in vitro* foram incluídos na revisão sistemática e 48 na meta-análise. Considerando as diferentes cerâmicas vítreas, os diferentes testes de resistência de união utilizados, e o envelhecimento ou não dos corpos de prova, 37 meta-análises evidenciaram o efeito de protocolos de reparo, incluindo apenas a aplicação de um sistema adesivo; a utilização do silano associado ao adesivo, precedidos ou não do ácido fluorídrico (AF), abrasão a ar (AA) com partículas de óxido de alumínio, jateamento (J) com partículas de trióxido de alumínio revestidas com sílica, ponta diamantada (PD) ou irradiação a laser (IL). Para as cerâmicas feldspáticas, AF, AA, J ou PD melhoram a retenção micromecânica do reparo; a aplicação do silano é essencial para a superfície condicionada com AF, porém o uso do adesivo é facultativo quando o silano é aplicado. Para as cerâmicas reforçadas com leucita ou com dissilicato de lítio, os resultados foram insuficientes para sugerir outro tratamento além do AF, seguido da aplicação de silano e adesivo.

Palavras-chave: Cerâmica. Reparação de restauração dentária. Revisão sistemática.

ABSTRACT

Do different protocols affect the success rate or bond strength of glass-ceramics repaired with composite resin? A systematic review and meta-analysis

Glass-ceramics have a combination of satisfactory aesthetic and mechanical properties, which possibility their indication for most indirect restorations. However, these materials are subject to structural failures, and can chip, crack or fracture. The repair procedures seem to be an important resource to keep and increase the restorations survival in the oral cavity. However, the lack of consensus on the clinical repair protocol still generates a lot of confusion among professionals. Therefore, the objective was to evaluate, through a systematic review and meta-analysis, the influence of different treatments used in glass-ceramics surfaces to repair with composite resins. Computerized searches were performed in PubMed, Scopus, Web of Science and Embase databases. A combination of MeSH and free terms with the Boolean operators OR and AND, following the syntax rules of each database was used. A complementary search on Google Scholar and OpenGrey was also performed, and there were no restrictions on language or publication year. After identifying the records in each database, the search results were exported to the Rayyan QCRI. The identification, selection, eligibility and inclusion steps of studies were carried out respecting the PRISMA statement. The included studies methodological quality was assessed following the OHAT Risk of Bias Rating Tool for Human and Animal Studies. The results of meta-analysis were provided in mean difference and 95% confidence interval. Statistical heterogeneity was assessed with the I^2 , and the random effect model was used. The search identified 5037 studies and 165 were assessed for eligibility. Finally, 123 in vitro studies were included in the systematic review and 48 in the meta-analysis. Considering different glass-ceramics, bond strength tests, and the specimens aging or not, 37 meta-analyses showed the effect of repair protocols including only an adhesive system application; silane plus adhesive system alone or preceded by hydrofluoric acid (HF), air abrasion (AA) with aluminum oxide particles, sandblasting (SB) with aluminum trioxide particles coated with silica, diamond bur (DB) or laser irradiation (LI). For feldspathic ceramics, HF acid, AA, SB, or DB improve repair micromechanical retention; applying silane is essential to HF conditioned surface, but adhesive is facultative when silane is applied. For leucite and lithium disilicate-reinforced ceramics, the results were insufficient to suggest another treatment besides HF acid plus silane and adhesive application.

Keywords: Ceramics. Dental restoration repair. Systematic review.

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LISTA DE ABREVIATURAS E SIGLAS

PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
PICOs	Patient or Population, Intervention, Control or Comparison, Outcome, and Study design
DeCS	Descritores em Ciências da Saúde
MeSH	Medical Subject Headings
QCRI	Qatar Computing Research Institute
MPa	Megapascal
SD	Standard Deviation
OHAT	Office of Health Assessment and Translation
NR	Não Relatado
AF	Ácido Fluorídrico
Al ₂ O ₃	Óxido de Alumínio
SiO ₂	Sílica

LISTA DE SÍMBOLOS

±	Mais ou menos
p	Probabilidade de significância
q25	Percentil 25
q75	Percentil 75
I ²	Medida estatística de heterogeneidade
++	Definitivamente baixo risco
+	Provavelmente baixo risco de viés
–	Provavelmente alto risco de viés
--	Definitivamente alto risco de viés
%	Porcentagem

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1 CONSIDERAÇÕES INICIAIS

Na prática diária da clínica odontológica observa-se uma crescente demanda por restaurações estéticas de cerâmicas em reabilitações que variam desde a recuperação de dentes unitários parcialmente comprometidos, até reabilitações extensas que visam substituir dentes perdidos. Em muitos casos estes materiais têm sido indicados com o objetivo de melhorar contorno, forma e cor dos dentes naturais, estimulando o desenvolvimento dos sistemas cerâmicos com diferentes proporções de fases vítrea e cristalina, a fim de garantir um equilíbrio entre as propriedades mecânicas e estabilidade de cor (CARDENAS *et al.*, 2017; CARRABBA *et al.*, 2017; SUNDFELD NETO *et al.*, 2015).

Em relação à sua composição, as cerâmicas podem ser classificadas como vítreas (feldspáticas, reforçadas por leucita ou por dissilicato de lítio), infiltradas (alumina, alumina e magnésio, alumina e zircônia) e policristalinas (alumina e zircônia). A quantidade de cristais na matriz vítrea influencia diretamente a translucidez da cerâmica. Portanto, quanto maior o número de cristais na matriz vítrea, menor a translucência da cerâmica e quanto menos partículas infiltradas, maior a translucência (HELVEY *et al.*, 2014).

As cerâmicas vítreas, principalmente as reforçadas por dissilicato de lítio, tem sido amplamente indicada para diversos tipos de reabilitações, devido à capacidade de reproduzir os principais fenômenos ópticos observados na dentição natural e por apresentar resistência à flexão melhorada (FASBINDER *et al.*, 2010; ROMANINI-JUNIOR *et al.*, 2018). Outra vantagem dos materiais cerâmicos é a sua biocompatibilidade para a realização de restaurações dentárias (PIEGER, SALMAN e BRIDA, 2014). Esta característica está intimamente relacionada à sua capacidade de manter a cor e a textura por períodos prolongados, apresentando alta estabilidade química e resistência à abrasão, principalmente quando comparadas às resinas compostas.

Estudos clínicos têm demonstrado bons resultados na utilização de restaurações cerâmicas (RINKE *et al.*, 2020; VAN DEN BREEMER *et al.*, 2021), e o desenvolvimento dos materiais de cimentação adesiva foram essenciais para se obter longevidade e retenção prolongadas na cavidade bucal. Para a execução da cimentação é necessário o tratamento das superfícies do substrato dentário e da

superfície interna da restauração, que também dependerá das características do sistema cerâmico, somado às peculiaridades dos agentes cimentantes, para assim garantir o sucesso clínico do procedimento reabilitador (AMARAL *et al.*, 2014).

No entanto, os materiais cerâmicos estão sujeitos a falhas em sua estrutura, e podem, por consequência, lascar, apresentarem trincas ou até mesmo fraturar (FERRARI *et al.*, 2014; QUINN *et al.*, 2014). Dentre as possíveis causas de falhas tem-se a fadiga em decorrência de sobrecarga oclusal; heterogeneidade na espessura do material, causada muitas vezes por preparos cavitários inapropriados; presença de microporosidades geradas pelo condicionamento ácido excessivo na superfície interna da restauração ou até mesmo pelo método de processamento da cerâmica. Além disso, a incompatibilidade dos coeficientes de expansão térmico-linear entre o *coping* e a cerâmica, quando há diferença na composição e na temperatura de fundição desses materiais também podem colaborar para a presença de falhas e consequentemente fraturas das restaurações cerâmicas (SAILER *et al.*, 2007; TAN *et al.*, 2004).

O reparo intraoral de cerâmicas fraturadas consiste em um procedimento pouco invasivo, uma vez que é possível manter a restauração danificada e repará-la, geralmente com resina composta. É um procedimento que apresenta aplicabilidade para a maioria dos casos de lascamentos e de fraturas passíveis de reparo, porém é necessário um tratamento de superfície prévio da cerâmica e da estrutura dental remanescente, quando presente. Na década de 80 teve-se o início das publicações sobre a temática (DIAZ-ARNOLD *et al.*, 1989; FERRANDO *et al.*, 1983; MATSUMURA *et al.*, 1989; PRATT *et al.*, 1989), e em 1990, com o estudo *in vitro* de Kondo e colaboradores, foi possível observar um alto nível de resistência de união no reparo de cerâmicas utilizando resina composta, quando o condicionamento da superfície cerâmica com ácido fluorídrico foi associado previamente às etapas do uso do silano e do adesivo.

Entre as vantagens de se reparar restaurações cerâmicas fraturadas ou lascadas tem-se a preservação do maior volume e integridade marginal da restauração e da estrutura dentária remanescente, além de ser um procedimento de execução rápida e menos oneroso para o paciente (CARRABBA *et al.*, 2017). No entanto, algumas desvantagens como a possível redução na longevidade da restauração reparada em comparação com a original e as dificuldades de manuseio do campo operatório, devem ser consideradas (RESTON *et al.*, 2008).

Dentre os métodos mais comumente utilizados e relatados na literatura para o tratamento de superfície das cerâmicas vítreas que sofrerão reparo tem-se o condicionamento utilizando-se ácido fluorídrico (AF), jateamento com óxido de alumínio (Al_2O_3) ou empregando-se partículas de sílica (SiO_2), e a associação ou não destes métodos com protocolos químicos de união, como o uso do silano e/ou sistemas adesivos (AL-THAGAFI *et al.*, 2016; AL-TURKI *et al.*, 2020). Outros estudos têm avaliado os benefícios no reparo de cerâmicas vítreas gerados pela irradiação por laser (TOKAR, POLAT e OZTURK, 2019) e até mesmo a utilização de materiais alternativos aos protocolos convencionais, como por exemplo, um novo composto de resina fluída autoadesiva (CARRABA *et al.*, 2017).

Até o momento, encontram-se disponíveis na literatura estudos de revisão sistemática e meta-análise que avaliaram a sobrevida de restaurações de cerâmicas vítreas (BUSTAMANTE-HERNÁNDEZ *et al.*, 2020; ZOU, BAI e XIANG, 2021), ou então que avaliaram a resistência de união do reparo em nanocerâmicas de resina e em cerâmicas infiltradas por polímeros (MOURA *et al.*, 2021), e também em metalocerâmicas (SHIRANI, KIANIPOUR e RAHBAR *et al.*, 2020). No entanto, não se encontram evidências na literatura de desenhos de estudos semelhantes que foram conduzidos e que avaliaram a sobrevida ou a resistência de união do reparo em cerâmicas vítreas.

Sendo assim, o reparo em cerâmicas parece ser um recurso importante para a manutenção e sobrevida dessas restaurações na cavidade bucal. Porém, a falta de consenso sobre o assunto e o aumento da frequência com que os profissionais têm se deparado com a necessidade de executarem este tipo de procedimento, somados à dificuldade na escolha da técnica ideal para sua execução, podem colaborar para confusões na prática clínica. Portanto, faz-se necessário buscar a evidência científica disponível para a realização do reparo em cerâmicas vítreas, e comparar as implicações clínicas das diferentes técnicas empregadas.

2 OBJETIVOS

2.1 Objetivos gerais

Avaliar, por meio de uma revisão sistemática de estudos laboratoriais e de ensaios clínicos randomizados, a influência das diferentes técnicas empregadas no reparo de superfícies de cerâmicas vítreas com resinas compostas sobre a resistência de união do reparo e a sobrevida das restaurações cerâmicas.

2.2 Objetivos específicos

Revisar, sistematicamente, estudos laboratoriais que avaliaram a resistência de união entre cerâmicas vítreas e materiais de reparo, usando diferentes técnicas.

Revisar, sistematicamente, estudos clínicos randomizados que avaliaram a taxa de sucesso de restaurações de cerâmica vítrea submetidas ao procedimento de reparo, usando diferentes técnicas.

Avaliar quantitativamente, por meio de meta-análise, os dados coletados, a partir da análise da homogeneidade metodológica dos estudos que foram incluídos na revisão sistemática.

Indicar a técnica de reparo que promova maior taxa de sucesso para restaurações e resistência de união em superfícies de cerâmicas vítreas.

3 METODOLOGIA EXPANDIDA

3.1 Protocolo da revisão sistemática

A revisão sistemática foi conduzida de acordo com a declaração dos *Preferred Reporting Items for Systematic Reviews and Meta-Analysis* (PRISMA Statement) (PAGE *et al.*, 2021) e com a abordagem de *Patient or Population, Intervention, Control or Comparison, Outcome, and Study design* (PICOs) (MILLER e FORREST, 2001). Além disso, foi realizado o registro na base de dado *International Prospective Register of Systematic Reviews* (PROSPERO) (CRD42021236448). O PRISMA Statement disponibiliza um *checklist* com 27 itens, o qual foi consultado para o desenvolvimento da revisão sistemática.

3.2 Critérios de elegibilidade

A abordagem PICOs foi utilizada com o intuito de orientar a formulação da seguinte pergunta de pesquisa: “Diferentes técnicas de reparo com resina composta empregadas em superfícies de cerâmicas vítreas afetam a taxa de sucesso ou a resistência de união da superfície reparada?”. O Quadro 1 apresenta o delineamento da estratégia utilizada para formulação da pergunta de pesquisa.

Para a inclusão dos artigos na revisão sistemática, foram estabelecidos os seguintes critérios: estudos clínicos randomizados e/ou estudos laboratoriais que compararam diferentes técnicas de reparo em cerâmicas vítreas com relação à taxa de sucesso do reparo e/ou à resistência de união da superfície reparada. Não foi imposto nenhuma restrição com relação ao ano ou idioma de publicação dos estudos, uma vez que tal decisão foi importante para minimizar a exclusão de artigos sobre a temática em questão. Em contrapartida, foi determinado que seriam excluídos resumos de congressos, cartas ao editor, estudos clínicos não randomizados (comparando somente uma técnica antes e depois), opiniões de *experts*.

Quadro 1 – Delineamento da PICO *question*

PERGUNTA	As diferentes técnicas de reparo com resina composta empregadas em superfícies de cerâmicas vítreas afetam a taxa de sucesso ou a resistência de união da superfície reparada?
População/paciente/materiais	Indivíduos com restauração em cerâmicas vítreas ou superfícies de cerâmica vítreas com necessidade de reparo
Intervenção/Exposição	Um tipo de técnica (tratamento de superfície) empregada para o reparo
Controle/Comparação	Outro tipo de técnica (tratamento de superfície) empregada para o reparo
Outcome (desfecho)	Taxa de sucesso do reparo e/ou a resistência de união da superfície reparada com resina composta
Study design (desenho de estudo)	Estudos clínicos randomizados e/ou estudos laboratoriais

Fonte: Elaborado pelo autor, 2022

3.3 Fontes de informação

Buscas computadorizadas foram realizadas nas bases de dados *PubMed*, *Scopus*, *Web of Science* e *Embase*. A justificativa para a eleição destas bases eletrônicas se deve ao fato de apresentarem uma grande cobertura e indexação de revistas da área odontológica e médica. Uma busca da literatura cinzenta no *OpenGrey* e no *Google Scholar* também foram realizadas, limitando-se às 200 primeiras referências localizadas por ordem de relevância (HADDAWAY *et al.*, 2015). Por último, uma busca manual na lista de referência dos artigos incluídos foi realizada para identificar estudos que não tenham sido recuperados nas buscas eletrônicas. Os autores de estudos identificados nas fontes de informação sem a devida disponibilidade do artigo foram contatados via e-mail e/ou *ResearchGate*.

3.4 Estratégias de busca

A PICO *question* auxilia na escolha dos descritores e dos termos específicos obtidos a partir da formulação da pergunta de pesquisa. Os termos em inglês foram selecionados pela consulta ao DeCS (Descritores em Ciências da Saúde), por meio da Biblioteca Virtual em Saúde. Posteriormente, a indexação dos mesmos foi conferida no *Medical Subject Headings (MeSH)*, que é uma ferramenta que disponibiliza um vocabulário controlado, utilizado para indexação de artigos no *PubMed*. Após a seleção dos termos de busca e de seus respectivos sinônimos, estes foram combinados com operadores booleanos *AND* e *OR*, respeitando-se as regras de sintaxe específica para cada base de dados.

O Quadro 2 apresenta as estratégias de busca realizadas para cada base de dados. A elaboração da estratégia de busca se iniciou pelo *PubMed*, seguindo os passos descritos anteriormente para obtenção dos termos. A associação de termos *MeSH* e seus sinônimos a alguns termos livres foi realizada, tendo em vista que alguns termos relevantes não apresentam indexação no *MeSH*. Algumas alterações na estratégia que foi utilizada no *PubMed* foram realizadas para ajustes às demais base de dados.

Quadro 2 – Estratégias de busca utilizadas nas bases de dados eletrônicas

BASE DE DADOS	ESTRATÉGIA DE BUSCA
PubMed	((ceramic OR ceramics OR “glass ceramic” OR “glass ceramics” OR “dental porcelain” OR “dental porcelains” OR porcelain OR porcelains OR “lithia disilicate” OR “lithium disilicate” OR e.max OR feldspathic OR leucite OR “leucite-nucleated glass” OR Empress) AND (“dental prosthesis repair” OR repair OR repairability OR fix OR “ceramic failure” OR “ceramic fracture” OR delamination) AND (“bond strength” OR shear OR microshear OR “micro shear” OR tensile OR microtensile OR longevity OR “life span” OR “life spans” OR lifespan OR lifespans OR “success rate” OR survival))
Scopus	(TITLE-ABS-KEY (ceramic OR ceramics OR “glass ceramic” OR “glass ceramics” OR “dental porcelain” OR “dental porcelains” OR porcelain OR porcelains OR “lithia disilicate” OR “lithium disilicate” OR e.max OR feldspathic OR leucite OR “leucite-nucleated glass” OR Empress) AND TITLE-ABS-KEY (“dental prosthesis repair” OR repair OR repairability OR fix OR “ceramic failure” OR “ceramic fracture” OR delamination) AND TITLE-ABS-KEY (“bond strength” OR shear OR microshear OR “micro shear” OR tensile OR

	microtensile OR longevity OR "life span" OR "life spans" OR lifespan OR lifespans OR "success rate" OR survival))
Web of Science	TS=(ceramic OR ceramics OR "glass ceramic" OR "glass ceramics" OR "dental porcelain" OR "dental porcelains" OR porcelain OR porcelains OR "lithia disilicate" OR "lithium disilicate" OR e.max OR feldspathic OR leucite OR "leucite-nucleated glass" OR Empress) AND TS=("dental prosthesis repair" OR repair OR repairability OR fix OR "ceramic failure" OR "ceramic fracture" OR delamination) AND TS=("bond strength" OR shear OR microshear OR "micro shear" OR tensile OR microtensile OR longevity OR "life span" OR "life spans" OR lifespan OR lifespans OR "success rate" OR survival)
Embase	(ceramic OR ceramics OR 'glass ceramic' OR 'glass ceramics' OR 'dental porcelain' OR 'dental porcelains' OR porcelain OR porcelains OR 'lithia disilicate' OR 'lithium disilicate' OR e.max OR feldspathic OR leucite OR 'leucite-nucleated glass' OR Empress) AND ('dental prosthesis repair' OR repair OR repairability OR fix OR 'ceramic failure' OR 'ceramic fracture' OR delamination) AND ('bond strength' OR shear OR microshear OR 'micro shear' OR tensile OR microtensile OR longevity OR 'life span' OR 'life spans' OR lifespan OR lifespans OR 'success rate' OR survival)

Fonte: Elaborado pelo autor, 2022

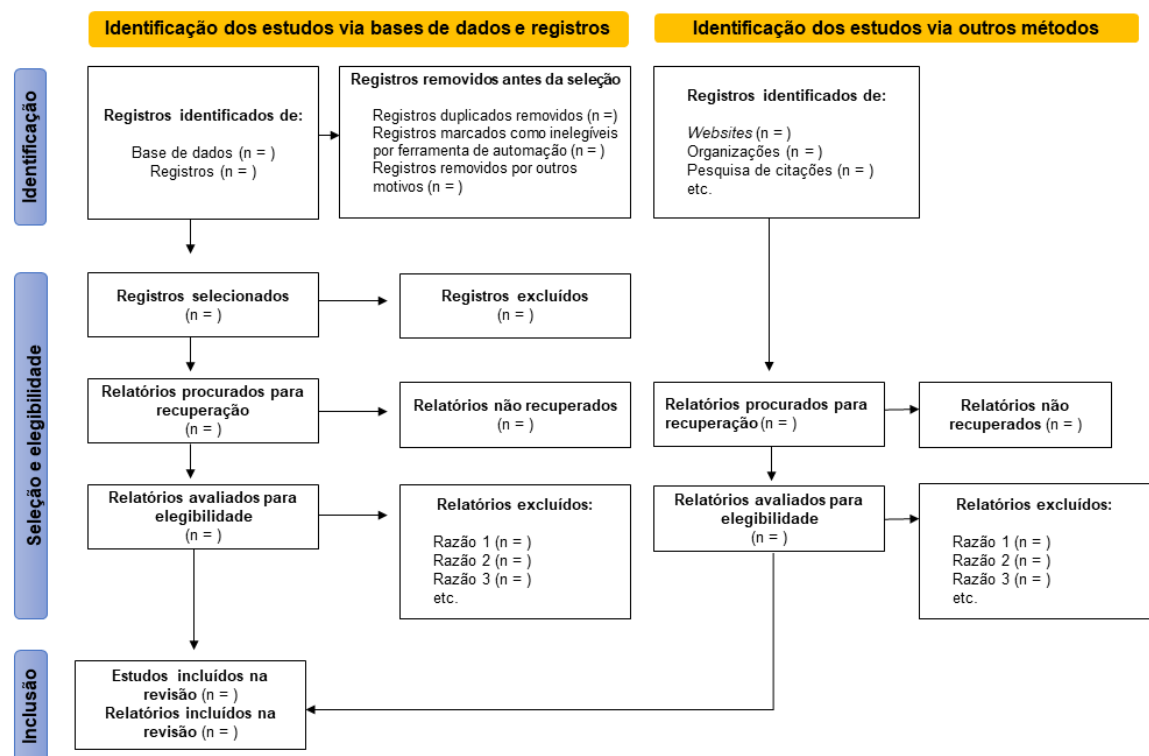
3.5 Seleção de estudos

A última atualização da busca e identificação dos artigos ocorreu em março de 2022. Após a identificação dos artigos em cada base de dados, os resultados de busca foram exportados para o aplicativo *Rayyan* QCRI (OUZZANI *et al.*, 2016), disponível gratuitamente na *internet*. Dentre os pontos positivos deste aplicativo, foi a possibilidade da remoção de duplicatas, a seleção dos artigos de forma cega entre os revisores, além da viabilidade de comparação dos resultados de seleção dos artigos (inclusões, exclusões e dúvidas) pelos revisores envolvidos. Após a remoção de duplicatas, os títulos e resumos de todas as referências foram analisados, de forma independente, por dois revisores, de acordo com critérios de elegibilidade previamente estabelecidos para a seleção de textos completos elegíveis à leitura. Em caso de divergências na seleção, uma discussão entre os revisores foi realizada. Persistindo a divergência, um terceiro revisor foi acionado.

Os textos completos das referências cujos títulos e resumos potencialmente preencheram os critérios de elegibilidade foram recuperados e avaliados de forma independente pelos mesmos dois revisores. Somente a partir da

leitura na íntegra dos textos que se chegou ao número final de artigos que foram incluídos na revisão sistemática. O *PRISMA Statement* (PAGE *et al.*, 2021) disponibiliza um fluxograma informativo com a descrição das etapas de identificação, seleção, elegibilidade e inclusão dos estudos, as quais foram respeitadas durante a execução da revisão sistemática (FIGURA 1).

Figura 1 – Fluxograma informativo com as diferentes fases da revisão sistemática



Fonte: PRISMA 2020 *Statement*

3.6 Extração dos dados

Dois revisores, de forma independente, executaram a extração dos dados dos estudos selecionados por meio de tabela no Microsoft Word 2016. Quaisquer divergências foram resolvidas mediante discussão, e nos casos de não resolução, um terceiro revisor foi consultado. Nos casos de dificuldade para obtenção de dados dos artigos selecionados, o contato com os autores dos estudos via e-mail e/ou *ResearchGate* foi realizado.

Dos artigos incluídos na revisão sistemática, os seguintes dados foram extraídos para posterior análise: último nome do primeiro autor; ano de publicação; país de origem em que o estudo foi conduzido; marca comercial e classificação da cerâmica reparada; marca comercial e tipo de resina composta utilizada no reparo; as técnicas e os materiais empregados no tratamento de superfície para o reparo; e o número amostral de cada grupo de interesse.

Considerando a possibilidade de inclusão de ensaios clínicos randomizados e de estudos laboratoriais, outros dados foram considerados importantes de serem extraídos, de forma mais específica para cada desenho de estudo. A duração do acompanhamento (meses) e a taxa de sobrevida do reparo são dados relevantes para os estudos de ensaio clínico. Em contrapartida, para os estudos laboratoriais, os seguintes dados são importantes para a análise do desfecho primário (resistência de união do reparo): valores médios de resistência de união em megapascal (MPa) e de seu respectivo desvio padrão ($\pm$ SD), ou valores da mediana acompanhado do intervalo interquartil ou do intervalo de confiança; tipo de teste laboratorial empregado; informação com relação a qualquer procedimento de envelhecimento do substrato e/ou das amostras (armazenamento em água, termociclagem e número de ciclos). Para a análise do desfecho secundário (análise do modo de falha), dados referentes à maior prevalência dos tipos de falha também foram considerados relevantes.

3.7 Avaliação do risco de viés

A qualidade metodológica de cada estudo incluído foi avaliada por dois revisores, de maneira independente.

Para os estudos clínicos randomizados, a ferramenta Cochrane foi indicada, incluindo os seguintes critérios de avaliação: geração da sequência aleatória, alocação oculta, mascaramento de participantes e pessoal, mascaramento do avaliador do desfecho, relato incompleto dos resultados (perdas ou atrição), relato seletivo do desfecho avaliado e outras fontes de viés (ausência de cálculo amostral). Em cada estudo, cada item pode ser classificado como alto risco de viés, baixo risco de viés e risco de viés não claro (HIGGINS & GREE, 2011).

Por outro lado, para os estudos laboratoriais, a avaliação do risco de viés foi realizada seguindo as Diretrizes da Ferramenta de Risco de Viés (OHAT *Risk of Bias Rating Tool for Human and Animal Studies*) (OHAT, 2015). Essa ferramenta contempla 11 itens, apresentados sob a forma de perguntas. De acordo com a resposta (ausência ou presença) associada à forma de sua descrição no artigo, cada item recebeu a classificação preconizada pela diretriz: (++) definitivamente baixo risco de viés, quando houver evidências diretas de práticas de baixo risco de viés; (+) provavelmente baixo risco de viés, quando houver evidências indiretas de práticas de baixo risco de viés ou quando as práticas não colaborarem diretamente para o viés dos resultados; (-) ou (NR, de não relatado) provavelmente alto risco de viés, quando houver evidências indiretas de práticas de alto risco de viés ou quando as informações fornecidas forem insuficientes (ou não relatadas); (--) definitivamente alto risco de viés, quando houver evidências diretas de práticas de alto risco de viés.

Dentre os 11 critérios sugeridos, o 11º é apresentado como livre para que os pesquisadores reflitam sobre possíveis parâmetros que podem ser incluídos, com o intuito de contribuir na avaliação da validade interna do desenho de estudo. A ferramenta ainda sugere que os critérios sejam personalizados de acordo com a pergunta de pesquisa específica. Desta forma, após adaptação, os seguintes critérios foram utilizados para análise do risco de viés: 1- O nível de exposição (técnica de reparo) foi adequadamente randomizado? 2- A alocação das amostras foi adequadamente ocultada? 3- A seleção das amostras do estudo resultou em grupos de comparação apropriados? 4- O desenho ou a forma de análise do estudo foi responsável por importantes fatores de confusão? 5- As condições experimentais foram idênticas entre os grupos de estudo? 6- Os avaliadores foram mascarados em relação aos grupos do estudo? 7- As análises dos resultados foram reportadas de forma completa (ausência de atrito ou de exclusão)? 8- Podemos confiar na caracterização da exposição (técnica de reparo)? 9- Podemos confiar na avaliação dos desfechos (sobrevida e/ou resistência de união)? 10- Todos os desfechos medidos foram relatados? 11- Houve avaliação do modo de falha das amostras (desfecho secundário)? As perguntas de 1 a 10 foram respondidas seguindo as orientações de resposta disponíveis na ferramenta (OHAT, 2015). A resposta à pergunta 11 seguiu a seguinte dinâmica: modo de falha relatado e adequadamente descrito nos resultados (++); modo de falha relatado e incompletamente descrito nos

resultados (+); modo de falha relatado, porém sem apresentação dos resultados (-); modo de falha não realizado/não relatado (--).

3.8 Medidas de sumarização

As medidas de sumarização dos resultados da comparação dos diferentes tipos de técnica de reparo de cerâmicas vítreas com relação à taxa de sucesso do reparo e/ou a resistência de união da superfície reparada foram a diferença das médias, intervalo de confiança e valor de p .

3.9 Análise quantitativa dos resultados

Os dados referentes aos resultados extraídos foram analisados por meio de um programa de software (*Review Manager v5.4; the Cochrane Collaboration*). Os valores da média e do desvio padrão da resistência de união, bem como o número amostral de cada grupo de comparação foram utilizados para calcular a diferença das médias, com um intervalo de confiança de 95%. Para os estudos cujos dados foram exibidos em mediana e intervalo interquartil ($q25 - q75$), a média e o desvio padrão foram determinados da seguinte forma (WAN *et al.*, 2014):

$$mean = \frac{q25 + median + q75}{3}$$

$$standard\ deviation = \frac{q75 - q25}{1.35}$$

A heterogeneidade estatística também foi avaliada por meio da estatística I^2 . Para todas as análises quantitativas o efeito randômico foi utilizado (BROCKWELL e GORDON, 2001).

4 ARTIGO

Do different protocols affect the success rate or bond strength of glass-ceramics repaired with composite resin? A systematic review and meta-analysis.

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ABSTRACT

Statement of problem. Intraoral repairing technique increases survival rate of the all-ceramic restorations avoiding unnecessary replacement. However, adhesion between ceramics and composite resin repair is the main issue.

Purpose. The aim of this systematic review and meta-analysis was to analyze the influence of different protocols used for repairing glass-ceramic surfaces with composite resins.

Material and methods. PubMed, Scopus, ISI Web of Science, and Embase electronic databases were searched to select studies comparing bond strength values or survival rate of repaired glass-ceramic with composite resins using different surface treatment protocols. No publication year or language restriction was applied. Data sets of all included studies were extracted, and the mean differences and 95% confidence interval were calculated by using the random effect model (Rev Man 5.4)

Results. The search identified 5037 studies and 165 were assessed for eligibility. Only studies that evaluated the repair bond strength presented the eligibility criteria. Finally, 123 in vitro studies were included in the systematic review and 48 in the meta-analysis. Considering different glass-ceramics, bond strength tests, and the specimens aging or not, 37 meta-analyses showed the effect of repair protocols including only adhesive (A) system application; silane (S) plus A system alone or preceded by hydrofluoric (HF) acid, air abrasion (AA), sandblasting (SB), diamond bur (DB) or laser irradiation (LI).

Conclusions. For feldspathic ceramics, HF acid, AA, SB, or DB improve repair micromechanical retention; applying S is essential to HF conditioned surface, but A use is facultative when silane is applied. For leucite and lithium disilicate-reinforced ceramics, the results were insufficient to suggest another treatment besides HF acid plus silane and adhesive application.

CLINICAL IMPLICATIONS

The association of mechanical and chemical surface treatments improves the bond strength of composite resin repaired glass-ceramics. The ideal clinical protocol should consider the cost-benefit of each technique, in addition to the care of the remaining oral and dental tissues.

INTRODUCTION

Metal-free indirect materials have been widely used due to the increasing demand of highly esthetic restoration, their favorable optical and mechanical properties, and consequently a broader scope of clinical indications.^{1,2}

Various ceramic materials (glass-ceramics, polycrystalline, or reinforced ceramics) and different fabrication techniques (CAD/CAM or the traditional manufacturing processes) allow the obtaining of all-ceramic restoration. However, they still exhibit the possibility of developing chipping, cracks, or fractures.^{3,4} The ceramics failure may be inevitable when occlusal forces and parafunctional habits combine with ceramic fragility, inappropriate restoration design, lack of adhesive bond, or ceramics internal defects.⁵

Fractured restorations can be repaired or replaced, but to repair a fractured ceramic restoration is less expensive, less invasive and less time consuming than replacement procedures.⁶ Since the 1980s, composite resins have been suggested as a restorative material to repair fractured or chipped ceramic,⁷⁻¹⁰ but an adequate pretreatment of the ceramic surface is essential to achieve long-term bonding of composite resin to ceramic and high success rates of the repair.

Mechanical and chemical bonding protocols are generally recommended to enhance the adhesion of composite resins to ceramic restorations. Several repair systems based on different pretreatment techniques were reported.^{3-6,11,12} However, the ideal protocol treatment for repairing the fractured ceramic (DEGIRMENCI et al., 2022) is still controversial. The

ceramic pretreatment with hydrofluoric (HF) acid,^{4,6,12-16} grinding with a diamond bur (DB),^{6,11,13,17} air abrasion (AA) with aluminum oxide particles (Al_2O_3),^{4,5,18} sandblasting (SB) with aluminum trioxide particles coated with silica (SiO_2 -coated Al_2O_3 particles),^{4,13,11,18} or laser irradiation (LI),^{6,11,13,18} followed by the silane (S) coupling agent application, associated or not with an adhesive (A) system, could be used for this purpose.¹⁹⁻²¹

Recent systematic review and meta-analysis evaluated the bond strength of the repair in resin nanoceramics and polymer-infiltrated ceramics²² and in metal-ceramics.²³ Despite this, the summarized evidence for the repair survival rates or bond strength in glass-ceramics is lacking. Therefore, this systematic review and meta-analysis aimed to assess in vitro studies and randomized clinical trials to analyze the influence of different protocols used for repairing glass-ceramic surfaces with composite resins.

MATERIAL AND METHODS

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement.²⁴ The protocol was registered at the International Prospective Register of Systematic Reviews (PROSPERO) database (CRD42021236448).

The inclusion criteria for studies selection were randomized clinical trials and/or laboratory studies that compared different protocols for repairing glass-ceramics considering the repair success rate or the bond strength of the repaired surface. The population, intervention, comparison, outcome, study design (PICO) question was: Do different protocols affect the success rate or bond strength of glass-ceramics repaired with composite resin? Specifically, 'P' (population) refers to the individuals' glass-ceramic restoration or glass-ceramic materials, 'I' (intervention) refers to the surface treatment protocols for the repair, 'C' (comparison/control) refers to the different surface treatment protocols for the repair, 'O' (outcome) refers to the repair success rate and/or to the bond strength of the

composite resin and the repaired ceramic surface , and ‘s’ (study design) refers to randomized clinical studies and/or in vitro studies.

Searches in PubMed, Scopus, Web of Science and Embase databases were performed in March 2022 to identify potential studies that meet the eligibility criteria. Searches in OpenGrey and Google Scholar were also performed and limited to the first 200 references that appeared in order of relevance.²⁵ Finally, the reference lists of the included articles were manually screened to identify any missed references from the computerized searches. The search strategies for each database are outlined in Supplemental Table 1.

Literature reviews, case reports, congress abstracts, letters to the editor, and expert opinions were excluded from this review. There were no restrictions on language or publication year.

The retrieved references were exported to Rayyan QCRI,²⁶ an online software available for free. After removing duplicates, all titles and abstracts were independently analyzed and selected by two authors (I.O.N. and C.N.B.P.), who applied the eligibility criteria. The references, whose titles and abstracts did not meet the eligibility criteria were excluded straight away. When the title and abstract did not provide enough information for a decision on inclusion/exclusion, the final decision was based on the full-text analysis. If the full text is unavailable or relevant information is missing, the authors were contacted by e-mail or ResearchGate. A third reviewer (RRS) resolved disagreements on eligibility criteria.

The same reviewers (ION and CNBP) independently extracted the following data: author and publication year; country where the study was conducted; trademark/type of glass-ceramic; trademark/type of composite resin (regular or flowable); surface treatment protocols; sample size per group.

The follow-up interval (months) and the repair survival rate were considered to assess the clinical trial studies. From the laboratory studies, the following data were extracted as

well: substrate/specimens storage/aging (water storage time, thermocycling, and the number of thermic cycles); for the primary outcome, the bond strength values (mean or median) in megapascal (MPa), standard deviations ($\pm$ SD), confidence interval (CI) or interquartile range (IQR) for each group; for the secondary outcome, information on the predominate failure mode was obtained.

The methodological quality of each included study was independently assessed by two reviewers (ION and CSM). The Cochrane Collaboration Tool was selected to assess the risk of bias according to the parameters of the previous systematic review,²⁷ in the case of randomized controlled clinical trials or controlled clinical trials. The methodological quality of each in vitro study included was performed following the Guidelines proposed in the Office of Health Assessment and Translation (OHAT) Risk of Bias Rating Tool for Human and Animal Studies.²⁸ Eleven OHAT criteria were assessed as follows: (1) Was exposure level adequately randomized? (2) Was allocation to study groups adequately concealed? (3) Did the selection of study samples result in appropriate comparison groups? (4) Did the study design or analysis account for important confounding variables? (5) Were experimental conditions identical across study groups? (6) Were the research personnel blinded to the study group? (7) Were outcome data complete reported (without attrition or exclusion from analysis)? (8) Can we be confident in the exposure characterization? (9) Can we be confident in the outcome assessment? (10) Were all measured outcomes reported? (11) Was failure mode assessment performed? The answer to each question was recorded as (++) definitely low risk of bias; (+) probably low risk of bias; (-) or (NR) probably high risk of bias; (--) definitely high risk of bias.

Data of studies with methodological homogeneity were aggregated in meta-analysis of continuous outcomes. The mean and the standard deviation of the outcome assessed as well as the sample size of each group were used for calculation of meta-analysis. For the studies

whose data were exhibited in median and interquartile range ($q25 - q75$), the mean and the standard deviation were determined accordingly.²⁹

$$mean = \frac{q25 + median + q75}{3}$$

$$standard\ deviation = \frac{q75 - q25}{1.35}$$

The results of meta-analysis were provided in mean difference and 95% confidence interval. Statistical heterogeneity was assessed with the I^2 . In all meta-analysis, the random effect model was used.³⁰

RESULTS

Figure 1 summarizes the study identification, screening, and inclusion in the review. In total, 5023 studies were identified from the databases. After the first review process and removal of duplicates, 3491 titles and abstracts were analyzed. Subsequently, 3330 records were excluded because they did not meet the inclusion criteria, leaving 161 reports. These full texts were sought for retrieved, but seven reports were not retrieved. From the reports assessed for eligibility, 34 were excluded based on specific criteria. Additionally, a total of 14 records were identified via other Google Scholar and citation searching. From these records, 11 were assessed for eligibility, but only three were included in the review. Therefore, 123 in vitro studies^{1-21,31-132} fulfilled the selection criteria and were included in this review.

Supplemental Table 2 presents the data extracted from the studies. The included studies were published from 1983 to 2022. This review considered five different substrates, including feldspathic ceramics,^{1,2,4,6-12,14-21,33,35,36,38,39,42-44,46,52-55,57-62,64-66,72,73,75,76,79,82-85,87,88,92-96,98,100,101,103,105,106,108,109,111-132} leucite-reinforced glass-ceramics,^{11,41,49,50,56,64,68,69,74,77,78,80,81,87,89,90,91,97,99,104,107,108} and lithium disilicate-reinforced glass-ceramics,^{3,5,11,13,19,31-34,45,47,48,50,51,59,64,67,70,71,78,86,88,96,102,104,107,110} zirconia-reinforced

lithium silicate glass-ceramics^{3,12,37,47,51} and fluorapatite -reinforced glass-ceramics.^{35,40,46,97,104} Shear bond strength tests were the most prevalent test used to evaluate the outcome,^{1,2,7,9-11,13,14,16-19,32,34,35,37-39,41,43-48,50-52,54,55,60-63,65-67,72,73,75,77-86,88,89,91-95,99,101-103,106,108-121,123-128,130,132} followed by the microtensile,^{3,4,6,12,20,49,57-59,64,70,71,76,87,90,97,98,100,104,107} microshear^{15,21,31,33,36,42,53,56,68,69} and tensile bond strength tests.^{5,8,40,74,96,105,122,129,131} The sample sizes ranged from 1 to 40 experimental units.

Most frequently reported surface treatment protocols included only an A system application; S in association with an A system; HF acid followed by S and A; AA with Al₂O₃ particles, S and A; SB with SiO₂-coated Al₂O₃ particles, S and A; DB, S and A; erbium, chromium-doped yttrium, scandium, gallium and garnet (Er,Cr:YSGG) LI, S and A.

In addition, in 87 studies, the specimens were submitted to an aging procedure,^{3-10,13,14,16,20,21,31,34,35,37,39,40,41,44-51,53-55,57-60,62-66,71-73,75,76,78-80,83-85,87-93,96-98,101-103,105-113,115-120,122-127,129-131} such as storage (ranging from 3 days to 3 months) in distilled, deionized or flavoring water, artificial saliva, salad sauce, relative humidity, or thermocycling (ranging from 500 to 20,000 cycles). Also, from these, 21 studies even implemented the association of storage with thermocycling.^{10,41,45,54,57,58,66,72,85,92,93,106,109,115,116,118,119,123,125-127} On the other hand, 17 studies performed substrate aging procedures previously to the repair,^{5,6,11,18-20,32,33,35-39,51,64,69,74} such as storage in distilled water or artificial saliva ranging from 21 days to 5 years, in situ aging, or thermocycling (ranging from 500 to 12,000 cycles). From these, only eight also executed specimens aging after the repair.^{5,6,20,35,37,39,51,64} Furthermore, 91 studies performed failure mode assessment,^{2,3,6,7,9-21,31-40,42,44-48,50-52,55-58,60-66,68-74,76,79,80,83,86,87,89-91,93,98,100-102,104-109,111-114,118-129,131} and from these, 29 did not adequately report the results,^{6,7,11,15,18-20,32,46,57,72,74,76,80,86,98,100,102,104,105,111,114,119,120,123,124,126,127,131} and one did not report the data.¹⁴

Supplemental Table 3 shows the risk of bias assessment. None included study had reported the concealment of study group allocation. Reporting complete outcome data was the

second least described criterion. Also, most studies did not report the exposure level randomization. On the other hand, reporting all measured outcomes received the highest number of (++). Most studies were categorized as definitely low risk of bias (++) for confidence in the exposure characterization and failure mode assessment. Also, most studies were categorized as probably low risk of bias (+) for appropriate comparison groups, controlling confounding variables, standardized experimental conditions across study groups, and confidence in the outcome assessment. Blinding the research personnel to the study group had the highest prevalence of probably high risk of bias (-). Finally, the criteria 1 to 10 had none or up to four studies categorized as definitely high risk of bias (--).

After data extraction, the included studies were grouped according to the bond strength test applied and the type of glass-ceramic to homogenize the comparisons between them. In addition, the aging of specimens or not was also considered to establish the main comparisons.

Despite the attempt to contact the authors, some studies could not be included in meta-analysis due to the absence of relevant numerical data, such as the sample size or incomplete or inconsistent bond strength values reported. Subsequently, after considering all possible comparisons among the included studies in the systematic review, 48 papers were selected for the meta-analysis.^{4,7,11,13,14,16,34,44-48,60-62,64,65,68,69,71-73,75,76,78,82,84,86,87,90-93,95,103,106,108,112,115-117,119,121,123,125,127,128,132}

The quantitative analysis for the feldspathic ceramics specimens submitted to the shear test (Fig. 2) showed that the surface pretreatments with HF acid in aged specimens (MD, 6.96 [95% CI: 2.18, 11.74], $p=0.004$, $I^2=96\%$), or with AA in non-aged (MD, 4.24 [95% CI: 1.06, 7.42], $p=0.009$, $I^2=90\%$) and aged specimens (MD, 7.09 [95% CI: 1.05, 13.13], $p=0.02$, $I^2=94\%$), or with Er,Cr:YSGG LI in non-aged specimens (MD, 8.63 [95% CI: 4.33, 12.92], $p<0.0001$, $I^2=54\%$) rendered significantly higher repair bond strengths than their

respective control groups (S plus A). However, the use of DB (MD, 3.57 [95% CI: -0.89, 8.03], $p=0.12$, $I^2=84\%$) or HF acid (MD, 4.38 [95% CI: -2.69, 11.45], $p=0.22$, $I^2=97\%$), both followed by S and A, in non-aged specimens, showed no statistically significant difference from the control group. In addition, when two types of surface treatments were compared (Fig.3), the treatment with HF prior to S plus A application in non-aged specimens was statistically higher than AA (Al_2O_3) (MD, 1.23 [95% CI: 0.51, 1.96], $p=0.0009$, $I^2=15\%$). For the aged specimens, both protocols were similar (MD, 0.86 [95% CI: -2.91, 4.63], $p=0.65$, $I^2=99\%$). The comparison between DB and AA (Al_2O_3) in non-aged (MD, -0.26 [95% CI: -11.33, 10.81], $p=0.96$, $I^2=94\%$) and aged specimens (MD, 1.78 [95% CI: -0.60, 4.17], $p=0.14$, $I^2=68\%$) as well as between AA (Al_2O_3) and SB with SiO_2 -coated Al_2O_3 particles in aged specimens (MD, -0.11 [95% CI: -3.29, 3.08], $p=0.95$, $I^2=88\%$), both followed by S plus A application, showed no statistically significant difference. Finally, the use of HF acid significantly increased the microtensile bond strength, in aged specimens, compared to SB (MD, 9.97 [95% CI: 3.14, 16.79], $p=0.004$, $I^2=85\%$). However, the shear bond strength was significantly higher for SB compared to HF etching (MD, 4.03 [95% CI: 3.27, 4.78], $p<0.00001$, $I^2=0\%$).

The S applied as an intermediate step in the feldspathic ceramics surface treatment (Fig.4) after HF etching and followed by an A system application showed significantly higher values of shear bond strength, in aged specimens, compared to its non-use (MD, 2.67 [95% CI: 1.70, 3.64], $p<0.00001$, $I^2=31\%$). In contrast, the S application after AA (Al_2O_3) showed no statistical difference for non-aged specimens (MD, 3.39 [95% CI: 0.03, 6.75], $p=0.05$, $I^2=97\%$). Still, the use of an A system after treatment with HF acid and silane, in non-aged (MD, 0.03 [95% CI: -1.33, 1.39], $p=0.97$, $I^2=0\%$) and aged specimens (MD, 1.58 [95% CI: -1.47, 4.62], $p=0.31$, $I^2=59\%$) or after the use of AA (Al_2O_3) and S, in non-aged (MD, -0.50 [95% CI: -2.03, 1.02], $p=0.52$, $I^2=0\%$) and aged specimens (MD, 0.34 [95% CI: -1.32, 2.01],

$p=0.69$, $I^2=0\%$), did not significantly influence the repair shear bond strength. The additional use of HF acid, after AA and before the S and A application improved the shear bond strength of non-aged specimens (MD, 1.49 [95% CI: 0.37, 2.61], $p=0.009$, $I^2=50\%$), but not for those aged (MD, 3.31 [95% CI: -1.99, 8.61], $P=0.22$, $I^2=98\%$). Using HF acid after DB and prior to S and the A application did not affect the shear bond strength for aged specimens (MD, 1.90 [95% CI: -3.70, 7.50], $p=0.51$, $I^2=93\%$) (Fig.5).

The quantitative analysis for leucite-reinforced ceramics (Fig. 6) showed no statistically significant difference on the shear bond strength for using DB (MD, 2.55 [95% CI: -1.20, 6.29], $p=0.18$, $I^2=68\%$) or SB (SiO_2 -coated Al_2O_3) (MD, 2.90 [95% CI: -6.92, 12.71], $p=0.56$, $I^2=92\%$) prior S and A application compared to the use of S and A only, both in aged specimens. Furthermore, DB and SB did not differ when they were compared (Fig. 6 – C) (MD, 5.93 [95% CI: 0.06, 11.80], $p=0.05$, $I^2=92\%$). Finally, the use of HF acid showed higher microshear bond strength than SB prior to S and A application for non-aged specimens (MD, 3.12 [95% CI: 1.17, 5.06], $p=0.002$, $I^2=0\%$). In the microtensile test, for aged specimens, there was no statistical difference between these protocols (MD, 4.44 [95% CI: -10.65, 19.53], $p=0.56$, $I^2=98\%$).

For lithium disilicate-reinforced ceramics, considering the use of S and an A system (Fig. 7), the quantitative analysis showed that the preconditioning with HF acid (MD, 10.56 [95% CI: 7.92, 13.21], $p<0.00001$, $I^2=0\%$) or with AA (Al_2O_3) (MD, 9.42 [95% CI: 7.43, 11.42], $p<0.00001$, $I^2=0\%$) significantly increased the shear bond strength values for non-aged specimens, while there was no statistical difference when Er,Cr:YSGG LI was used (MD, 0.36 [95% CI: -12.99, 13.70], $p=0.96$, $I^2=98\%$). Furthermore, when HF acid and AA (Al_2O_3) were compared (Fig.8), there was no statistically significant difference in shear bond strength for non-aged specimens (MD, 1.65 [95% CI: -1.35, 4.65], $p=0.28$, $I^2=0\%$). For aged specimens, the previous HF acid application presented higher shear bond strength compared

to SB (MD, 2.91 [95% CI: 0.78, 5.04], $p=0.007$, $I^2=0\%$) or Er,Cr:YSGG LI (MD, 3.62 [95% CI: 2.09, 5.15], $p<0.00001$, $I^2=0\%$). For aged specimens SB had significantly higher shear bond strength compared to DB (MD, 7.19 [95% CI: 1.60, 12.79], $p=0.01$, $I^2=94\%$), but this difference was not found in studies that performed microtensile tests (MD, 2.24 [95% CI: -9.61, 14.08], $p=0.71$, $I^2=95\%$). Finally, in non-aged specimens, using S as an intermediate step between HF etching and A application significantly increased the shear bond strength when compared to its non-use (MD, 8.18 [95% CI: 3.83, 12.52], $p=0.0002$, $I^2=85\%$) (Fig. 9).

DISCUSSION

This systematic review and meta-analysis aimed to assess in vitro studies and randomized clinical trials to determine the influence of different protocols for repairing glass-ceramic surfaces with composite resins. However, only in vitro studies were included. The only clinical trial retrieved was excluded because the authors did not report the results of ceramic repair survival separately for the metallic and ceramic substrates.¹³³ Although the laboratory studies cannot reproduce the complex oral environment variables, the bond strength tests are useful to estimate the composite repaired ceramic durability. The variety of protocols and materials reported in the literature about glass-ceramics repair highlights the importance of identifying a treatment with the best cost-effectiveness for both dentist and patient.

The data extracted from 123 studies indicated a high diversity in the mechanical and chemical methods for preparing the ceramic surfaces, which made it difficult to compare the results directly^{1-21,31-132}. The most used protocols included AA with Al_2O_3 particles, SB with SiO_2 -coated Al_2O_3 particles, both with different particle sizes; roughening the surface with DB; different types of LI (Er,Cr:YSGG; Nd-YAG; Er:YAG; CO_2 ; LAS, Er:YAG; Sapphire); HF acid conditioning in different concentrations and application times; silanization and different types of A systems (hydrophobic or hydrophilic). A self-etching primer (Monobond

Etch & Prime) was also tested in some studies as an alternative to HF acid conditioning.^{5,31,44} Etching with phosphoric acid was also widely used as a cleaning agent within a treatment protocol. This intermediate step does not bring any ceramic surface modification.^{49,56} Among the resin materials used, most studies applied conventional or flowable composite resin, and a self-adhesive flowable composite resin was also tested. The resin material type was not considered as a variable to homogenize the studies comparison in the quantitative analysis. When the ceramic surface receives an adequate treatment, regardless the composite resin type used, the specimens obtained a high level of bond strength values.^{72,62,101} The interaction between the composite resin and ceramic surface is more related to the surface treatment applied than to the type of composite resin used.⁷⁶

From the included studies in this review, 48 papers were selected for the meta-analysis,^{4,7,11,13,14,16,34,44-48,60-62,64,65,68,69,71-73,75,76,78,82,84,86,87,90-93,95,103,106,108,112,115-117,119,121,123,125,127,128,132} as they allowed the most homogeneous comparisons and adequately described the sample size and bond strength values size. The ceramic surface pretreatment protocols varied according to the ceramic material. For the quantitative analysis, comparisons between different surface treatments were obtained for feldspathic ceramics, leucite-reinforced, and lithium disilicate-reinforced glass-ceramics. Furthermore, the bond strength of the composite resin to the different substrates was examined, considering whether the specimens were aging, as most studies have suggested that thermal cycling leads to diminished bond strength values of the composite resin.^{5,11,31,35,39,45,46,55,57,80,88}

Recent studies have shown that different acid etching protocols produce superficial and internal alterations on ceramics' microstructural configuration, and protocols of greater time and concentration are related to internal glass-dissolution and the lessening of ceramic strength.¹³⁴⁻¹³⁶ The concentration range was between 2.5% to 11%, with a higher concentration prevalence of 5% and 9.5%. The HF acid conditioning time also presented a

large variation, even when comparing the same ceramic type. The more recent studies tended to use shorter exposure times and lower acid concentration,^{3,4,6,12,15,33,36,40,41,44,45,50,51} in contrast to older ones.^{117,119,121,122,124,127-129,132} The included studies did not allow the evaluation by meta-analysis of the variable HF acid concentration and exposure time concerning the different ceramics. Although HF is frequently applied as a pretreatment method for ceramic repair in dental clinical practice, it is potentially toxic and may cause acid burns with serious damage to body tissues.^{137,138} For this reason, several repair systems and protocols have been reported as an alternatives technique for intraoral repair.

As mentioned, AA with Al₂O₃ particles is also used to increase the micromechanical repair retention. The AA quantitative analysis did not consider the air pressure and the particles size, which ranged from 10.2µm to 150µm, with a predominance of 50µm particles.

Considering the feldspathic ceramics aged specimens, surface pretreatment with HF acid or AA with Al₂O₃ followed by S and A application increased the bond strength of the composite repair. The two treatments did not differ, despite the HF application presenting superior values of immediate bond strength. However, in the long-term, AA use contributed to increasing the values. This way, the professional can choose one or another treatment for repairing feldspathic ceramics with composite resin.

Some studies investigated the interaction of LI on different ceramics surface,¹³⁹⁻¹⁴¹ in addition to the possible benefit of this treatment prior to repair with composite resin.^{2,6,11,13,18,21,32-34,46-48,53,61,65,67,73,75,77,79,80,99} The Er,Cr:YSGG LI was the predominant type of lasers tested in the included studies,^{2,11,13,18,34,46-48,53} and contributed to increase the feldspathic repair bond strength, in association with the use of S and an A system. However, the results obtained from the meta-analyses come from non-aged specimens as the same outcome could not be assessed for the aged specimens. The repair's long-term stability is important to determine the technique's cost-benefit.

SB with SiO₂-coated Al₂O₃ particles is another ceramic surface treatment tested in some included studies.^{3,4,11,13,18,20,34,36,37,39,52,59,64,66-69,71,73,74,76,78,87,88,90,91,93,96,106,108,110,115} The surface partially coated with silica becomes more reactive to chemical resin bonding through the S, in addition to the micromechanical adhesion created by the altered micro-retentive surface topology.^{4,142} For meta-analysis, the air pressure and the particles size (ranged from 25µm to 45µm, with a greater predominance of 30µm particles) used were not take into account.

The results of quantitative analyzes for feldspathic ceramics that compared HF acid versus SB were divergent in relation to the test used (Fig.3 – F and G). For the shear test, the result was favorable to the use of SB, while for microtensile test the result was favorable to the use of HF acid. Although the low heterogeneity ($I^2=0\%$) of the studies that performed the shear test, it must be taken into account the number of included studies (only 2),^{73,108} in addition to the bond strength test conformation, which contributes to the predominance of cohesive failures,¹²² a fact that was verified in data extraction.

Furthermore, the non-significant effect of the comparisons DB versus AA (non-aged and aged specimens) and AA and SB (aged specimens) for feldspathic ceramics suggested that the pretreatment with SB or DB followed by S and A application preserves the bond stability between ceramic and composite resin. Therefore, for feldspathic ceramics, SB with SiO₂-coated Al₂O₃ particles and DB could be treatment alternatives to HF acid and AA conditioning.

The meta-analyses also suggested that using of S as an intermediate step to HF acid and A is relevant to the repair bond stability of feldspathic ceramics. S application appears to be an essential component for the ceramic repair procedure, modifying its surface structure, rendering it more reactive with the composite, and enabling chemical adhesion with the inorganic filler and the organic matrix.¹⁰³ However, the use of an A system after the HF or

AA application associated with S did not improve the bond strength values compared to its non-use, regardless of the type of A system used. Although the use or not of an adhesive system was not frequently evaluated among the included studies,^{14,46,119} its use has also been questioned prior to resin cementation.¹⁴³⁻¹⁴⁷ Recently, in a systematic review and meta-analysis, similar results were obtained when evaluating the use or not of an adhesive layer as a clinical step in the glass-ceramics surface treatment prior to cementation.¹⁴⁸ The included studies in this systematic review did not allow the meta-analysis of the types of adhesive systems in either hydrophobic or hydrophilic forms concerning the stability of composite resins bonded to ceramic surfaces, as the adhesive composition may be a possible confounding variable.

Additionally, the quantitative analysis of feldspathic ceramics repair bond strength comparing the use or not of HF acid after AA or DB and prior S and A application suggested that the use of HF after AA increased the immediate bond strength. However, no significant difference was observed in the long-term (aged specimens), even when used after DB. Probably, the association of two treatments that increase the micromechanical repair retention may have contributed to weakening the ceramic structure and, consequently, could not considerably improve the bond stability. Therefore, simplifying and reducing the clinical steps for ceramic repair without compromising the quality of bond stability is always desirable.¹⁴⁶

Compared to the studies that evaluated feldspathic ceramics bond strength repair with composite resin, the number of included studies for quantitative analysis of leucite-reinforced,^{64,68,69,78,87,90,91} and lithium disilicate-reinforced glass-ceramics^{11,13,34,45,47,48,64,71,78,86} was lower.

For leucite-reinforced glass-ceramics, the quantitative analysis of the included studies showed that previous DB and SB conditioning did not improve the long-term shear bond

strength values. Also, when compared, both treatments behaved equally (Fig. 6 – C). For lithium disilicate-reinforced glass-ceramic, similar results were observed when comparing the two treatments submitted to the microtensile test (Fig. 8 – E).

Moreover, for leucite-reinforced glass-ceramic, HF etching followed by S and A application increased the immediate microshear bond strength values compared to SB with SiO₂-coated Al₂O₃ particles. In long-term HF did not improve bond stability when the microtensile test was applied (Fig. 6 – E). Oppositely, in aged specimens, HF acid increased the shear bond strength for lithium disilicate- reinforced glass-ceramics. Thus, for felspathic and leucite-reinforced glass-ceramics, the use of SB may be an alternative to the use of HF acid. However, for lithium disilicate-reinforced glass-ceramics, this statement cannot be made.

In addition, for lithium disilicate-reinforced glass-ceramics, despite the immediate bond strength results being favorable to the use of HF or AA prior to S and A, the Er,Cr:YSGG LI did not influence the bond strength values. The lack of studies with aged specimens makes it impossible to assess the bond stability of these treatments.

Although immediate bond strength values are essential, the main concern is the bond durability. For lithium disilicate-reinforced glass-ceramics, when comparing the use of HF versus AA, followed by S and A application, the quantitative analysis was possible only in non-aged specimens and presented no difference between the protocols. Meanwhile, the comparison between HF conditioning and Er,Cr:YSGG LI favored the use of HF acid to increase the long-term bond stability. However, it was found more comparisons between non-aged specimens than for the aged ones for this type of ceramic. Therefore, HF acid can be a clinical step in the surface treatment of lithium disilicate-reinforced ceramic once it can improve the micromechanical retention and repair bond durability.

Finally, for the lithium disilicate-reinforced ceramics repaired with composite resin, the using S as an intermediate step between HF etching and A application was confirmed as indispensable.

The risk of bias assessment of the included studies highlighted customary drawbacks of in vitro studies. Among them, reports absence about concealment of study group allocation, incomplete outcome reporting about the exclusion of the specimen's pre-test failure or specimens' test failure from analyses; lack of report about blinding the research personnel to the study group, and also lack of description about the exposure level randomization. Still, most studies were careful to report all measured outcomes, allow for adequate comparison between groups, control for confounding variables, standardize experimental conditions across study groups, and probably be confident in the outcome assessment.

However, in vitro studies commonly present a lack on standardization of procedures, and sample size calculation, leading to heterogeneity and underpowered results when compared. Additionally, the large volume of included studies contributed to the high variability of the materials tested, surface-conditioning methods, and types of tests applied. Unfortunately, all extracted data could not be submitted to meta-analysis, as the included studies did not compare all surface treatments for the same ceramic or make the exact comparisons between them.

CONCLUSION

Based on the findings of this systematic review and meta-analysis, the following conclusions were drawn:

1. The combination of HF acid, AA with Al_2O_3 particles, SB with SiO_2 -coated Al_2O_3 particles, or DB plus silane, associated or not with an adhesive system application, improves the bond strength of composite resin repaired glass-ceramics.

2. For feldspathic ceramics, AA with Al_2O_3 particles, SB with SiO_2 -coated Al_2O_3 particles, or DB are alternative methods to HF etching to improve micromechanical retention. A silane coupling agent application is essential to improve the bond strength stability of etched glass-ceramics to composite resins, but an adhesive layer application is a facultative surface treatment when the silane is applied.
3. For leucite-reinforced ceramic, despite the quantitative results suggest the use of SB with SiO_2 -coated Al_2O_3 comparable to the use of HF acid conditioning, but further studies are necessary to support this claim.
4. For lithium disilicate-reinforced ceramic, it was not found an alternative to HF acid conditioning, but silane is an essential step.

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TABLES

Supplemental Table 1. Search strategy in PubMed, Scopus, Web of Science, and Embase

Databases	Literature search strategy
PubMed	((ceramic OR ceramics OR “glass ceramic” OR “glass ceramics” OR “dental porcelain” OR “dental porcelains” OR porcelain OR porcelains OR “lithia disilicate” OR “lithium disilicate” OR e.max OR feldspathic OR leucite OR “leucite-nucleated glass” OR Empress) AND (“dental prosthesis repair” OR repair OR repairability OR fix OR “ceramic failure” OR “ceramic fracture” OR delamination) AND (“bond strength” OR shear OR microshear OR “micro shear” OR tensile OR microtensile OR longevity OR “life span” OR “life spans” OR lifespan OR lifespans OR “success rate” OR survival))
Scopus	(TITLE-ABS-KEY (ceramic OR ceramics OR “glass ceramic” OR “glass ceramics” OR “dental porcelain” OR “dental porcelains” OR porcelain OR porcelains OR “lithia disilicate” OR “lithium disilicate” OR e.max OR feldspathic OR leucite OR “leucite-nucleated glass” OR Empress) AND TITLE-ABS-KEY (“dental prosthesis repair” OR repair OR repairability OR fix OR “ceramic failure” OR “ceramic fracture” OR delamination) AND TITLE-ABS-KEY (“bond strength” OR shear OR microshear OR “micro shear” OR tensile OR microtensile OR longevity OR “life span” OR “life spans” OR lifespan OR lifespans OR “success rate” OR survival))
Web of Science	TS=(ceramic OR ceramics OR “glass ceramic” OR “glass ceramics” OR “dental porcelain” OR “dental porcelains” OR porcelain OR porcelains OR “lithia disilicate” OR “lithium disilicate” OR e.max OR feldspathic OR leucite OR “leucite-nucleated glass” OR Empress) AND TS=(“dental prosthesis repair” OR repair OR repairability OR fix OR “ceramic failure” OR “ceramic fracture” OR delamination) AND TS=(“bond strength” OR shear OR microshear OR “micro shear” OR tensile OR microtensile OR longevity OR “life span” OR “life spans” OR lifespan OR lifespans OR “success rate” OR survival)
Embase	(ceramic OR ceramics OR ‘glass ceramic’ OR ‘glass ceramics’ OR ‘dental porcelain’ OR ‘dental porcelains’ OR porcelain OR porcelains OR ‘lithia disilicate’ OR ‘lithium disilicate’ OR e.max OR feldspathic OR leucite OR ‘leucite-nucleated glass’ OR Empress) AND (‘dental prosthesis repair’ OR repair OR repairability OR fix OR ‘ceramic failure’ OR ‘ceramic fracture’ OR delamination) AND (‘bond strength’ OR shear OR microshear OR ‘micro shear’ OR tensile OR microtensile OR longevity OR ‘life span’ OR ‘life spans’ OR lifespan OR lifespans OR ‘success rate’ OR survival)

Supplemental Table 2. Data extraction from the included studies in systematic review

Author/Year	Country	Trade Mark of Glass-Ceramic	Type of Glass-Ceramic	Resin-Based Material	Surface Treatment Protocol	Sample Number per Group	Substrate Storage/ Aging	Specimens Storage/ Aging	Primary Outcome: Bond Strength Test/Bond strength value (MPa)/ $\pm$ SD or CI or IQR	Secondary Outcome: Highest %/ prevalence of Failure Mode
da Cunha et al, 2022	Brazil	Cerec blocs	Feldspathic	Composite resin (Filtek Z350 XT)	5% HF for 20s + adhesive (Scotchbond Universal) light-cured for 20s	16	Non-aged	Non-aged	μ TBS/17.2 MPa/ $\pm$ 3.83	87.5% adhesive
					5% HF for 40s + adhesive				μ TBS/13.03 MPa/ $\pm$ 5.47	87.5% adhesive
					5% HF for 60s + adhesive				μ TBS/12.82 MPa/ $\pm$ 3.23	68.75% adhesive
		Vita Suprinity	Zirconia reinforced lithium silicate glass ceramic		5% HF for 20s + adhesive	μ TBS/15.83 MPa/ $\pm$ 3.99	93.75% adhesive			
					5% HF for 40s + adhesive	μ TBS/21.66 MPa/ $\pm$ 5.65	87.5% adhesive			
					5% HF for 60s + adhesive	μ TBS/14.50 MPa/ $\pm$ 3.72	56.25% adhesive			
Degirmenci et al, 2022	Turkey	Cerec blocs	Feldspathic	Composite resin (G-aenial Anterior)	Diamond bur + silane (G-Multi Primer) + adhesive (G-Premio Bond) light-cured for 10s	15	Non-aged Distilled water for 5 years	Non-aged	SBS/12.05 MPa/ $\pm$ 4.9 SBS/9.97 MPa/ $\pm$ 5.1	48.3% adhesive (overall)
					40% phosphoric acid for 5s + silane + adhesive				SBS/13.85 MPa/ $\pm$ 6.3 SBS/11.71 MPa/ $\pm$ 3.6	
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles for 15s + silane + adhesive				SBS/15.13 MPa/ $\pm$ 4.3 SBS/14.82 MPa/ $\pm$ 5.6	
					Er,Cr:YSGG laser (2.78 μ m, 4W, 14 Hz, for 20s) + silane + adhesive				SBS/24.97 MPa/ $\pm$ 6.8 SBS/25.75 MPa/ $\pm$ 4.9	
		IPS e.max CAD	Lithium disilicate	Diamond bur + silane (G-Multi Primer) + adhesive	SBS/13.73 MPa/ $\pm$ 3.5 SBS/13.53 MPa/ $\pm$ 3.5	65% adhesive (overall)				

											MEPs: Self-etching ceramic primer (Monobond Etch and Prime) + adhesive (Heliobond)	LC	Non-aged 5,000 thermal cycles	TBS/33.8 MPa/±5.9 TBS/13.7 MPa/±5.9	
												RC		TBS/31.1 MPa/±5.9 TBS/25.3 MPa/±7.0	
												OC		TBS/0.2 MPa/±0.4 -----	
											NoPT: Adhesive (Heliobond)	LC	Non-aged 5,000 thermal cycles	TBS/10.8 MPa/±5.2 TBS/5.9 MPa/±8.4	
												RC		TBS/6.1 MPa/±2.6 TBS/0.3 MPa/±0.5	
	OC	TBS/0.1 MPa/±0.1 -----													
Bayraktar et al, 2021	Turkey	Vita Mark II	Feldspathic	Composite resin (Z250)	Diamond bur + silane (Ceramic Primer II) + adhesive (Single Bond Universal) light-cured for 10s	30	10,000 thermal cycles	10,000 thermal cycles	μTBS/3.02 MPa/±2.75	Predominately adhesive					
					9% HF for 60s + silane + adhesive				μTBS/18.73 MPa/±3.76	Predominately adhesive					
					Nd-YAG laser (1064 nm, 3W, 20Hz, for 20s) + silane + adhesive				-----	100% pre-test failure (loss)					
					Er:YAG laser (2940 nm, 3W, 20 Hz, for 20s + silane + adhesive				-----	100% pre-test failure (loss)					
					Er, Cr:YSGG laser (2780 nm, 3W, 20 Hz, for 20s) + silane + adhesive				-----	100% pre-test failure (loss)					
Schellenberg and Özcan, 2021	Switzerland	Creation	Feldspathic	Composite resin (Empress Esthetic Enamel)	9.6% HF for 120s + silane (Monobond Plus) + adhesive (Heliobond) light-cured for 10s	10	Non-aged	500 thermal cycles	SBS/11.0 MPa/ ±3.7	Not informed					

					9.6% HF for 120s + silane (Clearfil Ceramic Primer Plus)				SBS/7.4 MPa/ ± 3.4	
					9.6% HF for 120s + silane (Z-prime Plus)				SBS/5.9 MPa/ ± 2.1	
Sismanoglu et al, 2021	Turkey	Vitablocs Mark II	Feldspathic	Low viscosity Composite resin (Filtek Ultimate Flowable, 3M ESPE)	9% HF(Ultradent) for 60s + silane + adhesive (Clearfil Universal Bond) light-cured for 20s	8	Non-aged	Non-aged	μ SBS/24.9 MPa/unclear	+/-65% cohesive
Tang et al, 2021	China	Shofu	Feldspathic	Composite resin (Filtek Z350)	Abrasion with diamond bur + adhesive (Single Bond Universal) light-cured for 20s	10	Non-aged	Non-aged	SBS/13.04 MPa/ ± 2.18	90% cohesive ceramic
				Composite resin (Tetric N- Ceram)	Abrasion with diamond bur + silane (Monobond-N) + adhesive (Heliobond)				SBS/15.45 MPa/ ± 2.66	
Ueda et al, 2021	Japan	IPS e.max CAD	Lithium disilicate	Composite resin (Clearfil APX)	Silicon carbide abrasive paper for 3 min + Self-etching primer (Monobond Etch&Prime, Ivoclar)	36	Non-aged	Non-aged 5,000 thermal cycles	μ SBS/25.5 MPa/ ± 10.7	79.4% adhesive
									μ SBS/24.0 MPa/ ± 7.3	85.8% adhesive
					Silicon carbide abrasive paper for 3 min + 40% phosphoric acid for 15s + adhesive (Clearfil Universal Bond) light-cured for 10s				μ SBS/0.8 MPa/ ± 0.7 -----	100% adhesive 100% adhesive
					Silicon carbide abrasive paper for 3 min + adhesive (Bondmer Lightless: A+B)				μ SBS/30.7 MPa/ ± 8.5 μ SBS/17.9 MPa/ ± 7.5	92.4 adhesive 92.5 adhesive
Valian et al, 2021	Iran	Ceramco 3	Feldspathic		9.5% HF for 120s + silane (Bis-Silane Parts A & B;	10	Non-aged	5,000 thermal cycles	μ SBS/13.3 MPa/ ± 9.9	91.7 adhesive
									μ SBS/3.0 MPa/ ± 1.4	75.5 adhesive

				Composite resin (Filtek Z250)	Bisco) + adhesive (Porcelain Bond; Bisco) light-cured for 20s									
					9.5% HF for 120s + adhesive (Single Bond Universal) light-cured for 20s								SBS/11.39 MPa/ ±1.21	100% mixed
					9.5% HF for 120s + silane (Bis-Silane Parts A & B; Bisco) + adhesive (Single Bond Universal) light-cured for 20s								SBS/14.08 MPa/ ±1.39	80% mixed
					9.5% HF for 120s + adhesive (All Bond Universal) light-cured for 20s								SBS/11.21 MPa/ ±0.71	100% mixed
					9.5% HF for 120s + silane (Bis-Silane Parts A & B; Bisco) + adhesive (All Bond Universal) light-cured for 20s								SBS/13.92 MPa/ ±1.62	70% mixed
					9.5% HF for 120s + adhesive (FuturaBond Universal) light-cured for 20s								SBS/12.27 MPa/ ±1.59	100% mixed
					9.5% HF for 120s + silane (Bis-Silane Parts A & B; Bisco) + adhesive (FuturaBond Universal) light-cured for 20s								SBS/13.66 MPa/ ±1.61	90% mixed
Al Deeb, 2020	Saudi Arabia	IPS e.max Press	Lithium disilicate	Low viscosity composite resin (Multicore flow, Ivoclar)	Diamond bur + silane + adhesive (Heliobond) light-cured for 10s Er,Cr:YSGG laser (2.78 μm, 3.75 W, 15 Hz, for 60s) + adhesive light-cured for 10s	10	Non-aged	Thermal cycles (no. of cycles not informed)	SBS/12.27 MPa/±2.11	60% adhesive				
									SBS/13.52 MPa/±2.68	80% adhesive				

					Nd-YAG laser (1064 nm, 3W, 10Hz, for 60s) + adhesive light-cured for 10s				SBS/11.88 MPa/±1.98	90% adhesive
					9.5% HF for 60s + silane + adhesive light-cured for 10s				SBS/19.57 MPa/±3.58	50% cohesive
					Sandblasted with SiO ₂ -coated Al ₂ O ₃ particles (CoJet system) + silane + adhesive light-cured for 10s				SBS/16.44 MPa/±3.82	50% cohesive
Al-Turki et al, 2020	Saudi Arabia	Vitablocs Mark II	Feldspathic	Composite resin (Tetric-N-Collection, Ivoclar)	Control group: no treatment	12	Non-aged	500 thermal cycles	μTBS/11.1 MPa/±1.7	Not assessed
					5% HF for 90s + silane + adhesive (Tetric N-Collection, Ivoclar) light-cured for 20s				μTBS/27.8 MPa/±3.3	
					Sandblasted with 45μm SiO ₂ -coated Al ₂ O ₃ particles for 20s + silane + adhesive				μTBS/12.2 MPa/±4.3	
					Air abrasion with 50 μm Al ₂ O ₃ + silane + adhesive				μTBS/12.3 MPa/±2.1	
Barutcigil and Kirmali, 2020	Turkey	IPS e.max Press	Lithium disilicate	Composite resin (Grandio DC; Voco)	Control group: adhesive (Single Bond Universal, 3M ESPE)	10	2,500 thermal cycles	Non-aged	SBS/10.09 MPa/±0.94	Adhesive
					9.6% HF for 60s + adhesive				SBS/12.92 MPa/±1.17	Mixed
					37% phosphoric acid for 60s + adhesive				SBS/8.15 MPa/±1.15	Adhesive
					Er, Cr:YSGG Laser (2.78 μm, 1W, 10 Hz, 20s) + adhesive				SBS/9.64 MPa/±1.69	Adhesive
					Er, Cr:YSGG Laser (2.78 μm, 2W, 10 Hz, 20s) + adhesive				SBS/10.45 MPa/±0.96	Adhesive

					G5: Er, Cr:YSGG Laser (2.78 μ m, 3W, 10 Hz, 20s) + adhesive				SBS/12.30 MPa/ $\pm$ 1.25	Mixed
Baiomy et al, 2020	Egypt	Ceramco PFZ	Feldspathic	Composite resin (Clearfil AP- X Esthetics)	Air abrasion with 50 μ m Al ₂ O ₃ + phosphoric acid for 15s + silane Sandblasted with SiO ₂ - coated Al ₂ O ₃ particles (CoJet system) + phosphoric acid for 15s + silane Er,Cr:YSGG laser (2780nm, 3W, 50Hz, for 50s) + phosphoric acid for 15s + silane Sandblasted with SiO ₂ - coated Al ₂ O ₃ particles + Er,Cr:YSGG laser + phosphoric acid for 15s + silane	5	1000 thermal cycles	Non-aged	SBS/ Unclear	Predominately mixed
Falah and Ameer, 2020	Iraq	Cerec CPC	Feldspathic	Composite resin (Tetric EvoCeram; Ivoclar)	Ceramic repair system (Ivoclar): silane (Monobond Plus) + adhesive (Heliobond) Scotch Bond Universal Adhesive (3M ESPE) Palfique universal bond (Tokuyama)	8	500 thermal cycles	Non-aged	SBS/6.80 MPa/ $\pm$ 1.60 SBS/7.07 MPa/ $\pm$ 2.29 SBS/10.96 MPa/ $\pm$ 2.08	59.7 mixed (overall)
		IPS e.max CAD	Lithium disilicate		Ceramic repair system (Ivoclar) Scotch Bond Universal Adhesive (3M ESPE) Palfique universal bond (Tokuyama)				SBS/9.24 MPa/ $\pm$ 2.31 SBS/11.14 MPa/ $\pm$ 1.50 SBS/12.64 MPa/ $\pm$ 1.37	

Gul and Altinok-Uygun, 2020	Turkey	Vitablocs Mark II	Feldspathic	Composite resin (Tetric EvoCeram, Ivoclar)	Control group: bonding agent (without mentioning which adhesive system)	20	5,000 thermal cycles	5,000 thermal cycles	μ TBS/18.24 MPa/ not informed	Adhesive
					34.5% phosphoric acid + bonding (without mentioning which adhesive system)				μ TBS/22.48 MPa/ not informed	Adhesive
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles (CoJet System) + adhesive (without mentioning which adhesive system)				μ TBS/21.00 MPa/ not informed	Adhesive
					Z-Prime Plus (Bisco): 9.5% HF for 90s + primer				μ TBS/21.72 MPa/ not informed	Adhesive
					GC Repair: Ceramic Primer II + adhesive (G-Premio Bond) light-cured for 10s				μ TBS/21.92 MPa/ not informed	Adhesive
					Cimara system (Voco): Diamond bur + silane + opaquer liquid light-cured for 20s				μ TBS/26.20 MPa/ not informed	Mixed
					Porcelain repair (Ultradent): 9% HF for 90s + silane + adhesive (Peak Universal Bond) applied for 15s				μ TBS/26.10 MPa/ not informed	Mixed
					Clearfil Repair System (Kuraray): 40% phosphoric acid + silane + adhesive (SE Bond) light-cured for 10s				μ TBS/25.66 MPa/ not informed	Mixed = adhesive
Hakimaneh et al, 2020	Iran	Kuraray Noritake Dental	Feldspathic	Composite resin (Tetric N-Ceram; Ivoclar Vivadent)	11% HF for 60s + silane + adhesive (Margin Bond; Coltene) light cured for 20s	18	Non-aged	3,000 thermal cycles	μ SBS/ 21.06 MPa/ $\pm$ 8.92	66.6% adhesive
					Silane + CO ₂ laser (1.8 W, 10 Hz, for 15s) + adhesive	18			μ SBS/ 9.02 MPa/ $\pm$ 4.55	66.6% adhesive
					CO ₂ laser (1.8 W, 10 Hz, for 15s) + silane + adhesive	17			μ SBS/ 5.76 MPa/ $\pm$ 1.86	58.8% adhesive

					Silane + Er:YAG laser (5W, 20 Hz, 250 mJ, for 30s) + adhesive	16			μ SBS/ 23.31 MPa/ ± 7.31	56.2% adhesive
					Er:YAG laser (5W, 20 Hz, 250 mJ, for 30s) + silane + adhesive	19			μ SBS/ 12.08 MPa/ ± 7.23	63.1% adhesive
					Diamond bur + 11% HF for 60s + silane + adhesive	17			μ SBS/ 14.46 MPa/ ± 6.42	58.8% adhesive
Kilinc et al, 2020	Turkey	Vitablocs Mark II	Feldspathic	Composite resin (Filtek Z550, 3M ESPE)	Control group: adhesive (Single Bond Universal, 3M ESPE) light-cured for 20s	11	Non-aged	Non-aged	μ SBS/13.18 MPa/ ± 1.19	90% adhesive
					Air abrasion with 50 μ m Al ₂ O ₃ for 20s + adhesive (Single Bond Universal, 3M ESPE) light-cured for 20s				μ SBS/16.5 MPa/ ± 0.75	70% adhesive
					5% HF for 60s + adhesive light-cured for 20s				μ SBS/17.91 MPa/ ± 0.66	50% mixed
					Er, Cr:YSGG laser (2780 nm wavelengths, 2W power, 20 mHz frequency) + adhesive light-cured for 20s				μ SBS/16.75 MPa/ ± 2.07	70% adhesive
					Control group: adhesive (Single Bond Universal, 3M ESPE) light-cured for 20s		Thermal cycles (no. of cycles not informed)	Non-aged	μ SBS/10.79 MPa/ ± 0.84	100% adhesive
					Air abrasion with 50 μ m Al ₂ O ₃ for 20s + adhesive (Single Bond Universal, 3M ESPE) light-cured for 20s				μ SBS/13.28 MPa/ ± 0.86	80% adhesive
					5% HF for 60s + adhesive light-cured for 20s				μ SBS/15.45 MPa/ ± 0.57	50% mixed
					Er, Cr:YSGG laser (2780 nm, 2W, 20 mHz) + adhesive light-cured for 20s				μ SBS/14.03 MPa/ ± 0.94	80% adhesive

		IPS e.max CAD	Lithium disilicate	Composite resin (Filtek Z550, 3M ESPE)	Control group: adhesive (Single Bond Universal, 3M ESPE) light-cured for 20s	11	Non-aged	Non-aged	μ SBS/12.16 MPa/ ± 0.63	80% adhesive
					Air abrasion with 50 μ m Al ₂ O ₃ for 20s + adhesive (Single Bond Universal, 3M ESPE) light-cured for 20s				μ SBS/16.71 MPa/ ± 1.54	70% adhesive
					5% HF for 60s + adhesive light-cured for 20s				μ SBS/17.55 MPa/ ± 0.76	80% mixed
					Er, Cr:YSGG laser (2780 nm, 2W, 20 mHz) + adhesive light-cured for 20s				μ SBS/16.18 MPa/ ± 2.38	70% adhesive
					Control group: no treatment		Thermal cycles (no. of cycles not informed)	Non-aged	μ SBS/10.83 MPa/ ± 0.86	100% adhesive
					Air abrasion with 50 μ m Al ₂ O ₃ for 20s + adhesive (Single Bond Universal, 3M ESPE) light-cured for 20s				μ SBS/14.32 MPa/ ± 0.98	80% adhesive
					5% HF for 60s + adhesive light-cured for 20s				μ SBS/15.61 MPa/ ± 1.31	50% mixed
					Er, Cr:YSGG laser (2780 nm, 2W, 20 mHz) + adhesive light-cured for 20s				μ SBS/13.94 MPa/ ± 1.64	70% adhesive
Maawadh et al, 2020	Saudi Arabia	IPS Emax Press	Lithium disilicate	Composite resin (Clearfil Majesty Esthetic; Kuraray)	Er,Cr:YSGG laser (2790nm, 3.75W, 30 Hz, for 120s) + adhesive (Peak Universal Bond; Ultradent) light-cured for 15s	10	Non-aged	Thermal cycles (no. of cycles not informed)	SBS/15.26 MPa/ ± 0.65	60% adhesive
					Photodynamic therapy using Methylene blue (100mg/L) photosensitizer, activated by a diode laser (1.5W, 810nm, for 30s) + adhesive light-cured for 15s				SBS/12.18 MPa/ ± 1.08	70% adhesive
					9.6% HF for 60s + silane + adhesive light-cured for 15s				SBS/20.57 MPa/ ± 3.58	80% cohesive

				composite resin (Filtek Ultimate Flowable Restorative, 3M ESPE)	Universal, 3M ESPE) light-cured for 20s					
					9% HF for 60s +silane + adhesive light-cured for 20s			μ SBS/23.97 MPa/ $\pm$ 3.15	50% mixed	
					Air abrasion with 50 μ m Al ₂ O ₃ + silane + adhesive light cured for 20s			μ SBS/28.31 MPa/ $\pm$ 1.38	50% adhesive	
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles (CoJet system) + silane +adhesive light- cured for 20s			μ SBS/24.87 MPa/ $\pm$ 1.58	50% adhesive	
					Control group: adhesive light-cured for 20s			μ SBS/6.29 MPa/ $\pm$ 1.25	87.5% adhesive	
					9% HF for 60s + adhesive light-cured for 20s			μ SBS/16.35 MPa/ $\pm$ 4.16	50% adhesive	
					Air abrasion with 50 μ m Al ₂ O ₃ + adhesive light-cured for 20s			μ SBS/10.48 MPa/ $\pm$ 1.08	62.5% adhesive	
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles (CoJet system) + adhesive light-cured for 20s			μ SBS/12.69 MPa/ $\pm$ 1.37	62.5% adhesive	
Veríssimo et al, 2020	Brazil	Vita Suprinity/ Vita Zahnfabrik	Zirconia reinforced lithium silicate glass ceramic	Composite resin (Z350XT, 3M ESPE)	Diamond bur + universal adhesive (Single Bond Universal) light-cured for 20s	10	Non-aged	10,000 thermal cycles	-----	100% pre-test failure (loss)
					Diamond bur + silane + convencional adhesive (Ambar) light-cured for 20s				SBS/4.81 MPa/ $\pm$ 1.5	100% adhesive
					10% HF for 20s + silane + conventional adhesive, light-cured for 20s				SBS/14.27 MPa/ $\pm$ 5.9	90% adhesive
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles (CoJet system) + silane +				SBS/4.71 MPa/ $\pm$ 2.0	100% adhesive

					conventional adhesive, light-cured for 20s					
					Air abrasion with 50 μm Al_2O_3 + silane + conventional adhesive, light-cured for 20s					SBS/9.51 MPa/ ± 4.4 100% adhesive
					Diamond bur + Universal Adhesive light-cured for 20s					<i>In situ</i> aging for 60 days 10,000 thermal cycles ----- 100% pre-test failure (loss)
					Diamond bur + silane + conventional adhesive, light-cured for 20s					SBS/7.49 MPa/ ± 2.9 90% adhesive
					10% HF for 20s + silane + conventional adhesive, light-cured for 20s					SBS/9.73 MPa/ ± 4.8 100% adhesive
					Sandblasted with 30 μm SiO_2 -coated Al_2O_3 particles (CoJet system) + silane + conventional adhesive, light-cured for 20s					SBS/1.41 MPa/ ± 2.4 70% pre-test failure (loss) / 100% adhesive
					Air abrasion with 50 μm Al_2O_3 + silane + conventional adhesive, light-cured for 20s					SBS/0.17 MPa/ ± 0.3 70% pre-test failure (loss) /100% adhesive
Çinar and Kirmali, 2019	Turkey	Noritake CZR	Feldspathic	Composite resin (GrandioSo, Voco)	Diamond bur + Clearfil repair system: 40% phosphoric acid + silane (Clearfil SE Bond Primer + Clearfil Porcelain Bond Activator) + adhesive (Clearfil SE Bond) light-cured for 10s	15	Non-aged	Non-aged	SBS/13.06 MPa/ ± 2.55	100% cohesive
							3,000 thermal cycles		SBS/12.39 MPa/ ± 1.85	
							6,000 thermal cycles		SBS/12.17 MPa/ ± 2.93	
							12,000 thermal cycles		SBS/11.50 MPa/ ± 1.79	
Flury et al, 2019	Switzerland	Vitablocs Mark II	Feldspathic	Composite resin (Filtek	Sandblasted with 25 μm SiO_2 -coated Al_2O_3 particles (CoJet Prep) + silane +	15	3 months water storage	Non-aged	SBS/23.9 MPa/ ± 5.0	46.7% mixed

				Z250, 3M ESPE)	adhesive (OptiBond FL Adhesive) light-cured for 10s			Distilled water for 1 year	SBS/8.9 MPa/±4.6	86.7% adhesive
					Sandblasted with 25 µm SiO ₂ -coated Al ₂ O ₃ particles (CoJet Prep) + universal adhesive (Scotchbond Universal) light-cured for 10s				SBS/12.45 MPa/±4.9	86.7% adhesive
									SBS/5.6 MPa/±2.3	100% adhesive
Hwang et al, 2019	Republic of Korea	IPS e.max Ceram	Fluorapatite	Composite resin (Filtek Z250, 3M ESPE)	5% HF for 20s + silane + adhesive (Heliobond) light-cured for 10s	15	Non-aged	Non-aged	TBS/11.3 MPa/±3.9	100% mixed
								Distilled water for 7 days storage + 1,000 thermal cycles	TBS/10.3 MPa/±3.3	
Kazak et al, 2019	Turkey	IPS-Empress CAD	Leucite	Composite resin (Filtek Z250, 3M ESPE)	5% HF for 60s + silane + adhesive (Heliobond) light-cured for 10s	8	Non-aged	Artificial saliva for 24h + pomegranate flavored mineral water for 24h	SBS/23.57 MPa/±6.17	Not assessed
								Artificial saliva for 24h + salad sauce for 24h	SBS/13.89 MPa/±3.35	
								Artificial saliva for 24h + distilled water for 24h	SBS/13.89 MPa/±3.35	
				Composite resin (Aelite Aesthetic Enamel, BISCO)				Artificial saliva for 24h + pomegranate flavored mineral water for 24h	SBS/18.43 MPa/±6.78	

				Composite resin (Tetric N-Ceram Bulk- Fill, Ivoclar)				Artificial saliva for 24h+salad sauce for 24h	SBS/19.52 MPa/±3.06		
								Artificial saliva for 24h + distilled water for 24h	SBS/20.93 MPa/±5.10		
								Artificial saliva for 24h +pomegranate flavored mineral water for 24h	SBS/20.31 MPa/±6.07		
								Artificial saliva for 24h+salad sauce for 24h	SBS/21.47 MPa/±5.74		
								Artificial saliva for 24h + distilled water for 24h	SBS/25.54 MPa/±8.74		
								Composite resin (Clearfil Majesty Esthetic, Kuraray)	Artificial saliva for 24h +pomegranate flavored mineral water for 24h		SBS/22.55 MPa/±5.64
								Artificial saliva for 24h+salad sauce for 24h	SBS/19.27 MPa/±5.35		
								Artificial saliva for 24h + distilled water for 24h	SBS/16.81 MPa/±5.39		
Suárez-Moya et al, 2019	Colombia	Vitablocs TriLuxe	Feldspathic	Composite resin (Filtek	Air abrasion with 50 µm Al ₂ O ₃ + universal adhesive	10	Non-aged	Non-aged	µSBS/5.61 MPa/±1.29	80% adhesive	

				Z350 XT, 3 M ESPE)	(Single Bond Universal, 3M ESPE) light-cured for 10s					
					Air abrasion with 50 µm Al ₂ O ₃ + conventional adhesive (Adper Single Bond 2) light-cured for 10s			µSBS/4.57 MPa/±1.68	60% adhesive	
					Air abrasion with 50 µm Al ₂ O ₃ + silane + universal adhesive (Single Bond Universal)			µSBS/10.94 MPa/±4.71	60% cohesive	
					Air abrasion with 50 µm Al ₂ O ₃ + silane + conventional adhesive (Adper Single Bond 2)			µSBS/10.64 MPa/±4.84	40% mixed	
					Air abrasion with 50 µm Al ₂ O ₃ + 9.6% HF for 90s + silane + universal adhesive (Single Bond Universal)			µSBS/15.38 MPa/±7.03	80% cohesive	
					Air abrasion with 50 µm Al ₂ O ₃ + 9.6% HF for 90s + silane + conventional adhesive (Adper Single Bond 2)			µSBS/10.18 MPa/±4.33	70% adhesive	
Tokar et al, 2019	Turkey	VITA VMK Master	Feldspathic	Composite resin (Tetric N-Ceram)	Silane + adhesive (Heliobond) light-cured for 10s	10	Non-aged	Non-aged	SBS/249.33 not informed /±57.19	100% adhesive
					Diamond bur + Er,Cr:YSGG laser (2.78µm, 6W, 20 Hz, for 140µs) + silane + adhesive (Heliobond) light-cured for 10s				SBS/132.25 not informed /±47.06	
					Diamond bur + Er,Cr:YSGG laser (2.78µm, 6W, 20 Hz, for 200µs) + silane + adhesive (Heliobond) light-cured for 10s				SBS/149.70 not informed /±46.28	

Yadav et al, 2019	Turkey	Ceramco 3	Feldspathic	Composite resin (Clearfil ST opaque)	Diamond bur + Clearfil repair system: 40% phosphoric acid + silane (Clearfil SE Bond Primer + Clearfil Porcelain Bond Activator)	20	Non-aged	Non-aged	SBS/29.35 MPa/±1.53	Not assessed
					Diamond bur + Shofu repair system (CeraResin Bond 1, as a silane + CeraResin Bond 2, as an adhesive)				SBS/26.84 MPa/±2.07	
Yildirim et al, 2019	Turkey	Vitablocs Mark II	Feldspathic	Composite resin (Tetric Evo Ceram, Ivoclar)	5% HF for 20s + silane + adhesive (HelioBond, Ivoclar) light-cured for 20s	12	Non-aged	5,500 thermal cycles	SBS/17.54 MPa/±2.98	75% cohesive
					Self-etching primer (Monobond Etch&Prime, Ivoclar) + adhesive				SBS/12.75 MPa/±2.33	50% adhesive
					Air abrasion with 50 µm Al ₂ O ₃ + silane + adhesive				SBS/13.98 MPa/±3.34	41.6% adhesive
					Air abrasion with 50 µm Al ₂ O ₃ + Self-etching primer + adhesive				SBS/14.68 MPa/±3.41	50% cohesive
AlRabiah et al, 2018	Saudi Arabia	IPS e.max CAD	Lithium disilicate	Composite resin (Tetric ceram, Ivoclar)	5% HF for 20s + adhesive (Scotchbond)	10	Non-aged	Non-aged Distilled water for 3 months + 5,000 thermal cycles	SBS/12.1 MPa/±1.2 SBS/6.2 MPa/±1.1	100% mixed
					5% HF for 20s + silane + adhesive (Scotchbond)				SBS/18.3 MPa/±1.5 SBS/10.5 MPa/±1.4	
					5% HF for 20s + adhesive (All -Bond)				SBS/12.0 MPa/±1.4 SBS/8.4 MPa/±1.0	
					5% HF for 20s + silane + adhesive (All-Bond)				SBS/20.3 MPa/±2.0 SBS/11.7 MPa/±1.6	
					5% HF for 20s + adhesive (Futura U)				SBS/10.6 MPa/±1.5 SBS/7.4 MPa/±1.3	

			T4					SBS/15.3 MPa/±4.5 SBS/10.7 MPa/±3.8	
			T5					SBS/11.8 MPa/±1.4 SBS/9.2 MPa/±2.5	
			T6					SBS/7.5 MPa/±3.0 SBS/6.3 MPa/±2.0	
			T7					SBS/2.6 MPa/±0.4 SBS/1.8 MPa/±0.0	
			T8					SBS/2.9 MPa/±0.7 SBS/2.8 MPa/±1.2	
IPS e.max Ceram	Fluorapatite	Composite resin (Clearfil Majesty ES- 2-A2)	T1	7	Non-aged	Non-aged 5,000 thermal cycles		SBS/16.4 MPa/±3.6 SBS/14.6 MPa/±5.3	Adhesive
			T2					SBS/13.9MPa/±2.0 SBS/11.4 MPa/±2.6	
			T3					SBS/9.7 MPa/±6.3 SBS/7.9 MPa/±3.7	
			T4					SBS/14.4 MPa/±3.7 SBS/15.1 MPa/±6.3	
			T5					SBS/14.2 MPa/±5.0 SBS/11.6 MPa/±3.7	
			T6					SBS/8.0 MPa/±2.1 SBS/6.9 MPa/±4.2	
			T7					SBS/3.3 MPa/±1.5 SBS/2.4 MPa/±3.2	
			T8					SBS/4.1 MPa/±1.5 SBS/3.5 MPa/±2.9	
Vita VM11	Feldspathic	Composite resin (Clearfil Majesty ES- 2-A2)	T1	7	Non-aged	Non-aged 5,000 thermal cycles		SBS/15.9 MPa/±2.5 SBS/16.4 MPa/±3.6	Adhesive
			T2					SBS/12.8MPa/±2.8 SBS/10.6 MPa/±3.6	
			T3					SBS/10.9 MPa/±3.5	

									SBS/7.8 MPa/±0.4					
T4									SBS/14.7 MPa/±3.0 SBS/13.7 MPa/±7.1					
T5									SBS/12.1 MPa/±7.0 SBS/11.3 MPa/±2.1					
T6									SBS/6.9 MPa/±6.8 SBS/6.6 MPa/±6.1					
T7									SBS/4.2 MPa/±3.2 SBS/3.8 MPa/±0.4					
T8									SBS/3.9 MPa/±5.0 SBS/3.3 MPa/±3.7					
Ataol and Ergun, 2018 (b)	Turkey	IPS e.max CAD	Lithium disilicate	Composite resin (Clearfil Majesty ES-2-A2)	T1: 9% HF for 90s + silane (Ultradent) + adhesive (Clearfil Universal Bond)	7 7	Non-aged	Non-aged 5,000 thermal cycles	SBS/14.4 MPa/±6.4 SBS/12.0 MPa/±6.2	100% / 57.1 adhesive				
					T2: Air abrasion with 50 µm Al ₂ O ₃ + silane (Ultradent) + adhesive (Clearfil Universal Bond)	7 2			SBS/12.8MPa/±1.9 SBS/11.6 MPa/±1.1	100% adhesive				
					T3: Er,Cr:YSGG laser (2.94µm, 3W, 50 Hz) + silane (Ultradent) + adhesive (Clearfil Universal Bond)	6 3			SBS/9.7 MPa/±2.8 SBS/8.1 MPa/±1.2	100% adhesive				
					T4: 9% HF for 90s + silane (Clearfil Ceramic Primer)	7 7			SBS/13.2 MPa/±8.6 SBS/12.9 MPa/±4.9	71.4% / 85.7% adhesive				
					T5: Air abrasion with 50 µm Al ₂ O ₃ + silane (Clearfil Ceramic Primer)	7 7			SBS/11.6 MPa/±4.2 SBS/8.7 MPa/±1.3	100% adhesive				
					T6: Er,Cr:YSGG laser (2.94µm, 3W, 50 Hz) + silane (Clearfil Ceramic Primer)	4 3			SBS/5.2 MPa/±2.6 SBS/3.5 MPa/±1.7	100% adhesive				
					T7: silane (Ultradent) + adhesive (Clearfil Universal Bond)	2 1			SBS/2.5 MPa/±1.7 SBS/1.5 MPa/±0.0	100% adhesive				

					T8: silane (Clearfil Ceramic Primer)	4 2			SBS/2.3 MPa/±2.0 SBS/1.6 MPa/±0.5	100% adhesive
	Vita Suprinity	Zirconia reinforced lithium silicate glass ceramic	Composite resin (Clearfil Majesty ES-2-A2)	T1	7 7	Non-aged	Non-aged 5,000 thermal cycles	SBS/15.8 MPa/±2.9 SBS/13.6 MPa/±3.6	85.7% / 71.4% adhesive	
				T2	7 2			SBS/10.5 MPa/±6.3 SBS/10.1 MPa/±0.5	85.7% / 100% adhesive	
				T3	2 0			SBS/9.6 MPa/±0.5 -----	100% adhesive 100% pre-test failure (loss)	
				T4	7 7			SBS/12.7 MPa/±11.6 SBS/12.0 MPa/±5.1	71.4% / 100% adhesive	
				T5	7 6			SBS/10.6 MPa/±3.9 SBS/10.6 MPa/±5.4	85.7% / 100% adhesive	
				T6	4 0			SBS/9.5 MPa/±1.5 -----	100% adhesive 100% pre-test failure (loss)	
				T7	1 1			SBS/2.8 MPa/±0.0 SBS/1.2 MPa/±0.0	100% adhesive	
				T8	4 1			SBS/2.7 MPa/±2.0 SBS/1.6 MPa/±0.0	100% adhesive	
Ebrahimi et al, 2018	Iran	IPS e.max Press	Lithium disilicate	P90 silorane-based composite resin (3M ESPE)	Silane + self-etch silorane system: primer and adhesive (Silorane Adhesive system, 3M ESPE)	17	Non-aged	500 thermal cycles	SBS/7.6 MPa/±2.07	100% adhesive
					9.5% HF for 60s + silane + self-etch silorane system: primer and adhesive				SBS/10.32 MPa/±2.90	76.4% adhesive

					Nd:YAG laser (1064µm, 4.5W, 15 Hz, 30 mJ for 60s) + silane + self-etch silorane system: primer and adhesive				SBS/6.16 MPa/±1.43	100% adhesive
					Nd:YAG laser (1064 µm, 6 W, 20 Hz, 300 mJ, for 60s) + silane + self-etch silorane system: primer and adhesive				SBS/5.93 MPa/±1.22	100% adhesive
					Er,Cr:YSGG laser (2.78 µm, 1.5W, 15 Hz, 300 mJ for 60s) + silane + self-etch silorane system: primer and adhesive				SBS/6.73 MPa/±1.78	100% adhesive
					Er,Cr:YSGG laser (2.78 nm, 6W, 15 Hz,300 mJ for 60s) + silane + self-etch silorane system: primer and adhesive				SBS/7.76 MPa/±1.98	100% adhesive
Kameyama et al, 2018	Japan	IPS-Empress CAD	Leucite	Composite resin (Herculite XRV, Kerr)	40% phosphoric acid for 5s (K etchant gel) + adhesive (Clearfil SE Bond) light-cured for 40s	8	Non-aged	Distilled water for one week	µTBS/4.4 MPa/±9.0	Not assessed
					40% phosphoric acid for 5s + silane (Clearfil SE Bond Primer + Clearfil Porcelain Bond Activator) + adhesive				µTBS/44.3 MPa/±6.0	
					40% phosphoric acid + atmospheric-pressure plasma (150 W, spot diameter 4 mm, gas flow rate 6 L/min) for 10s + adhesive				µTBS/1.6 MPa/±5.4	
					40% phosphoric acid + Irradiated with UV light (19 mW/cm ² , 185 nm, 254 nm and 365 nm) for 60min + adhesive				µTBS/3.1 MPa/±7.8	

					40% phosphoric acid + atmospheric-pressure plasma + silane + adhesive				μ TBS/40.8 MPa/ $\pm$ 6.2	
					40% phosphoric acid + Irradiated with UV light + silane + adhesive				μ TBS/35.5 MPa/ $\pm$ 12.1	
Karci et al, 2018	Turkey	IPS-Empress CAD	Leucite	Composite resin (Tetric N Ceram, Ivoclar)	5% HF for 60s + silane + adhesive (Heliobond) light- cured for 10s	9	Non-aged	5,000 thermal cycles	SBS/10.52 MPa/ $\pm$ 1.0	55.6% cohesive
				Self- adhesive flowable composite material (Nova Compo SF, Imicryl)	5% HF for 60s				SBS/10.95 MPa/ $\pm$ 1.06	
		IPS e.max CAD	Lithium disilicate	Tetric N Ceram, Ivoclar	5% HF for 20s + silane + adhesive (Heliobond) light- cured for 10s				SBS/8.09 MPa/ $\pm$ 1.09	66.6% cohesive
				Nova Compo SF, Imicryl	5% HF for 20s				SBS/7.53 MPa/ $\pm$ 1.05	
Üstün et al, 2018	Turkey	IPS e.max CAD	Lithium disilicate	Composite resin (Tetric N Ceram, Ivoclar)	9% HF for 20s + 40% phosphoric acid for 5s + silane (Monobond S) + adhesive (Heliobond) light- cured for 10s	10	5,000 thermal cycles	5,000 thermal cycles	SBS/14.9 MPa/ $\pm$ 1.95	100% adhesive
				Composite resin (Filtek Z250, 3M ESPE)	9% HF for 20s + 40% phosphoric acid for 5s + silane (Clearfil SE Bond Primer + Clearfil Porcelain Bond Activator) + adhesive (Clearfil SE Bond) light- cured for 10s				SBS/16.56 MPa/ $\pm$ 1.65	100% adhesive

		Vita Suprinity	Zirconia reinforced lithium silicate glass ceramic	Tetric N Ceram, Ivoclar	9% HF for 20s + 40% phosphoric acid for 5s + silane + adhesive light-cured for 10s				SBS/14.26 MPa/±1.98	50% cohesive composite 50% adhesive
				Filtek Z250, 3M ESPE	9% HF for 20s + 40% phosphoric acid for 5s + silane + adhesive light-cured for 10s				SBS/14.37 MPa/±1.37	100% adhesive
Carraba et al, 2017	Italy	Vitablocs Mark II	Feldspathic	Self-adhesive flowable composite resin (Vertise Flow; Kerr)	Air abrasion with 100 µm Al ₂ O ₃	10	Non-aged	Non-aged	SBS/5.35 MPa/±3.94	60% adhesive
					9% HF for 120s				SBS/19.8 MPa/±2.78	100% cohesive ceramic
					Air abrasion with 100 µm Al ₂ O ₃ + 9% HF for 120s				SBS/17.60 MPa/±1.77	60% cohesive ceramic
					Air abrasion with 100 µm Al ₂ O ₃				SBS/2.32 MPa/±1.84	100% adhesive
					Air abrasion with 100 µm Al ₂ O ₃ + adhesive (Optibond Solo Plus)				SBS/5.36 MPa/±2.04	60% mixed
					9% HF for 120s				SBS/12.96 MPa/±2.56	80% mixed
					9% HF for 120s + adhesive (Optibond Solo Plus)				SBS/13.99 MPa/±2.48	60% cohesive ceramic
					Air abrasion with 100 µm Al ₂ O ₃ + 9% HF for 120s				SBS/14.20 MPa/±2.67	100% cohesive
					Air abrasion with 100 µm Al ₂ O ₃ + 9% HF for 120s + adhesive (Optibond Solo Plus)				SBS/14.70 MPa/±3.38	60% cohesive ceramic
					Sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles (CoJet System) + silane + adhesive (Visio Bond)				SBS/9.55 MPa/±4.02	60% mixed
				Low viscosity composite	Air abrasion with 100 µm Al ₂ O ₃ + 9% HF for 120s + Porcelain Repair Kit,				SBS/8.59 MPa/±3.27	60% mixed

				resin (PermaFlo, Ultradent)	Ultradent (silane + adhesive: Peak Universal Bond)					
Ghavam et al, 2017	Tebran	Ceramico	Feldspathic	Self- adhesive flowable composite resin (Vertise Flow; Kerr)	9.5% HF for 90s + silane Er,Cr:YSGG laser (2780nm, 4W, 20 Hz) Air abrasion with 50 µm Al ₂ O ₃ + 9.5% HF for 90s + silane Er,Cr:YSGG laser (2780nm, 4W, 20 Hz) + 9.5% HF for 90s + silane	10	Non-aged	1,000 thermal cycles	µSBS/8.56 MPa/±6.41 µSBS/10.50 MPa/±4.72 µSBS/12.80 MPa/±4.36 µSBS/13.38 MPa/±2.86	Not assessed
Kocaagaoglu et al, 2017	Turkey	Vitablocs Mark II	Feldspathic	Composite resin (GrandioSo; Voco)	Diamond bur + BISCO Intraoral Repair Kit (9.5% HF for 90s + porcelain primer + porcelain bonding resin light-cured for 10s) Diamond bur + Cimara Repair System (silane + adhesive light-cured for 40s) Diamond bur + Clearfil Repair System (40% phosphoric acid for 5s + silane + adhesive light- cured for 40s)	10	Non-aged	1,200 thermal cycles + distilled water for 7 days	SBS/12.82 MPa/±2.72 SBS/11.74 MPa/±4.63 SBS/10.87 MPa/±2.40	Not assessed
Ödemiş and Yanikoglu, 2017	Turkey	VMK 95	Feldspathic	Composite resin (Ceram X, Dentsply)	9.5% HF + silane Air abrasion with 50 µm Al ₂ O ₃ + silane Air abrasion with 50 µm Al ₂ O ₃	5	Non-aged	Non-aged 5,000 thermal cycles	SBS/19.7 MPa/±0.76 SBS/14.0 MPa/±1.0 SBS/15.9 MPa/±0.74 SBS/11.4 MPa/±0.42 SBS/9.4 MPa/±0.42 SBS/8.4 MPa/±0.42	90% adhesive 90% adhesive 100% adhesive
				Composite resin	9.5% HF + silane				SBS/23.7 MPa/±0.76 SBS/17.1 MPa/±1.03	70% adhesive

			(Grandio, Voco)	Air abrasion with 50 μ m Al_2O_3 + silane				SBS/16.6 MPa/ $\pm$ 0.65 SBS/13.6 MPa/ $\pm$ 0.42	80% adhesive
				Air abrasion with 50 μ m Al_2O_3				SBS/13.4 MPa/ $\pm$ 0.42 SBS/10.7 MPa/ $\pm$ 0.45	100% adhesive
	IPS Classic	Feldspathic	Ceram X, Dentsply	9.5% HF + silane	5	Non-aged	Non-aged 5,000 thermal cycles	SBS/22.7 MPa/ $\pm$ 0.84 SBS/17.0 MPa/ $\pm$ 1.0	60% adhesive
				Air abrasion with 50 μ m Al_2O_3 + silane				SBS/18.8 MPa/ $\pm$ 0.57 SBS/13.8 MPa/ $\pm$ 0.57	90% adhesive
				Air abrasion with 50 μ m Al_2O_3				SBS/10.2 MPa/ $\pm$ 0.27 SBS/8.9 MPa/ $\pm$ 0.89	100% adhesive
			Grandio, Voco	9.5% HF + silane				SBS/26.8 MPa/ $\pm$ 0.67 SBS/20.2 MPa/ $\pm$ 1.2	50% mixed
				Air abrasion with 50 μ m Al_2O_3 + silane				SBS/19.8 MPa/ $\pm$ 1.57 SBS/16.3 MPa/ $\pm$ 0.57	60% adhesive
				Air abrasion with 50 μ m Al_2O_3				SBS/16.3 MPa/ $\pm$ 0.57 SBS/12.4 MPa/ $\pm$ 0.74	100% adhesive
Sattabanasuk et al, 2017	Thailand	IPS Empress Esthetic	Leucite	Composite resin (Filtek Z350 XT, 3 M ESPE)	10	Non-aged	Non-aged	μ SBS/7.60 MPa/ $\pm$ 1.05	96.6% adhesive
				Silicon carbide abrasive paper + 37% phosphoric acid for 15s + adhesive (Adper Scotchbond Multi-Purpose)				μ SBS/8.80 MPa/ $\pm$ 1.84	100% adhesive
				Silicon carbide abrasive paper + 37% phosphoric acid for 15s + adhesive (Scotchbond Universal Adhesive)				μ SBS/21.83 MPa/ $\pm$ 2.91	93.3% mixed
				Silicon carbide abrasive paper + 37% phosphoric acid for 15s + silane + adhesive (Adper Scotchbond Multi-Purpose)				μ SBS/19.22 MPa/ $\pm$ 2.20	86.6% mixed
				Silicon carbide abrasive paper + 37% phosphoric acid for 15s + silane + adhesive (Scotchbond Universal Adhesive)					

						Silicon carbide abrasive paper + 37% phosphoric acid for 15s + 5% HF for 60s + adhesive (Adper Scotchbond Multi-Purpose)		μ SBS/14.15 MPa/ $\pm$ 2.18	96.6% adhesive	
						Silicon carbide abrasive paper + 37% phosphoric acid for 15s + 5% HF for 60s + adhesive (Scotchbond Universal Adhesive)		μ SBS/13.17 MPa/ $\pm$ 2.49	93.3% adhesive	
						Silicon carbide abrasive paper + 37% phosphoric acid for 15s + 5% HF for 60s + silane + adhesive (Adper Scotchbond Multi-Purpose)		μ SBS/22.62 MPa/ $\pm$ 3.66	73.3% mixed	
						Silicon carbide abrasive paper + 37% phosphoric acid for 15s + 5% HF for 60s + silane + adhesive (Scotchbond Universal Adhesive)		μ SBS/19.98 MPa/ $\pm$ 3.38	73.3% mixed	
Al-Thagafi et al, 2016	Egypt	Vita Suprinity	Zirconia reinforced lithium silicate glass ceramic	Composite resin (Tetric EvoCeram, Ivoclar)	Control: No treatment	15	Non-aged	5,000 thermal cycles	μ TBS/10.5 MPa/ $\pm$ 2.1	80% adhesive
					5% HF for 60s + silane				μ TBS/27.1 MPa/ $\pm$ 1.4	93.3% mixed
					5% HF for 60s + silane +adhesive (Heliobond) light-cured for 20s				μ TBS/31.2 MPa/ $\pm$ 3.7	73.3% mixed
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles (CoJet)				μ TBS/33.1 MPa/ $\pm$ 2.4	80% mixed
		IPS e.max CAD	Lithium disilicate	Control: No treatment	μ TBS/10.7 MPa/ $\pm$ 2.1				93.3% adhesive	
				5% HF for 60s + silane	μ TBS/22.4 MPa/ $\pm$ 5.7				80% mixed	
				5% HF for 60s + silane +adhesive (Heliobond) light-cured for 20s	μ TBS/28.3 MPa/ $\pm$ 4.0				86.7% mixed	

					Sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles (CoJet)				µTBS/30.5 MPa/±4.9	80% mixed
Bergoli et al, 2016	Brazil	HeraCeram	Feldspathic	Composite resin (Charisma, Heraeus Kulzer)	10% HF for 20s + Signum Ceramic Bond (Bond I + Bond II)	8	Non-aged	Non-aged Distilled water for 1 week + 6,000 thermal cycles	µTBS/13.1 MPa/±2.5 µTBS/8.6 MPa/±1.4	Predominately adhesive
					Rubber tips (low-speed handpiece) + Signum Ceramic Bond (Bond I + Bond II)				µTBS/11.5 MPa/±5.1 µTBS/7.1 MPa/±1.1	
					Signum Ceramic Bond (Bond I + Bond II)				µTBS/7.2 MPa/±1.1 µTBS/0.6 MPa/±0.0	
Corazza et al, 2016	Brazil	Vitablocs Mark II	Feldspathic	Composite resin (TPH, Dentsply)	10% HF for 60s + silane adhesive (2.0 Adper Single Bond) light-cured for 20s	6	Non-aged	Non-aged	µTBS/14.4 MPa/±1.3	61.9% adhesive 51.3% adhesive
								6,000 thermal cycles (blocks)	µTBS/31.6 MPa/±2.9	
								6,000 thermal cycles (sticks)	µTBS/25.7 MPa/±2.3	53.7% adhesive
								6,000 thermal cycles + distilled water for 6 months (blocks)	µTBS/13.1 MPa/±0.6	61.6% adhesive
Duzyol et al, 2016	Turkey	Vitablocs Mark II	Feldspathic	Composite resin (Filtek Z550, 3M ESPE)	Diamond bur + silane + adhesive (Single Bond Universal)	40	Non-aged	Distilled water for one week	µTBS/26.4 MPa/±11.6	Not assessed
					Diamond bur + 5% HF for 5 min				µTBS/22.4 MPa/±5.3	

					Diamond bur + Air abrasion with 50 μm Al ₂ O ₃					μTBS/22.3 MPa/±6.0
					Diamond bur + Sandblasted with 30 μm SiO ₂ -coated Al ₂ O ₃ particles (CoJet)					μTBS/22.0 MPa/±2.6
					Diamond bur + silane + adhesive (Single Bond Universal)					-----
					Diamond bur + 5% HF for 5 min					μTBS/29.8 MPa/±4.6
					Diamond bur + Air abrasion with 50 μm Al ₂ O ₃					-----
					Diamond bur + Sandblasted with 30 μm SiO ₂ -coated Al ₂ O ₃ particles (CoJet)					μTBS/23.3 MPa/±14.0
Moravej-Salehi et al, 2016	Iran	Ceramco 3	Feldspathic	Composite resin (AELITETM All Purpose Body)	9.5% HF for 2min + silane + adhesive (D/E Resin, Bisco)	10	Non-aged	5,000 thermal cycles	SBS/15.27 MPa/±3.63	90% cohesive
					Air abrasion with 50 μm Al ₂ O ₃ (pressure of 2 bars for 10s) + silane + adhesive				SBS/14.11 MPa/±3.36	60% cohesive
					Air abrasion with 50 μm Al ₂ O ₃ (pressure of 3 bars for 10s) + silane + adhesive				SBS/15.07 MPa/±3.98	70% cohesive
					Air abrasion with 50 μm Al ₂ O ₃ (pressure of 4 bars for 10s) + silane + adhesive				SBS/15.76 MPa/±3.51	90% cohesive
Uzun et al, 2016	Turkey	Cerabien Zr	Feldspathic	Composite resin (Grandio SO)	Diamond bur + silane + adhesive (Cimara Zircon-Adhesive) light-cured for 20s	10	Non-aged	Non-aged	SBS/42.3 MPa/±11.3	90% cohesive
					Air abrasion with 50 μm Al ₂ O ₃ + silane + adhesive light-cured for 20s				SBS/25.2 MPa/±5.9	70% adhesive

					LAS, Er:YAG laser (2940nm, 2W, 10 Hz, for 10s) + silane + adhesive light-cured for 20s				SBS/27.6 MPa/±5.6	60% adhesive
Kocaoglu and Gürbulak, 2015	Turkey	Vitablocs Mark II	Feldspathic	Composite resin (Clearfil ST OPAQUER)	Air abrasion with 50 µm Al ₂ O ₃ + Clearfil repair system (40% phosphoric acid+ silane: Clearfil SE Bond Primer + Clearfil Porcelain Bond Activator + adhesive: Clearfil SE Bond)	10	Non-aged	1,200 thermal cycles	SBS/11.55 MPa/±0.75	80% adhesive
				Low-viscosity composite resin (GrandioSO Caps, Voco)	Air abrasion with 50 µm Al ₂ O ₃ + Cimara zircon repair system (silane + adhesive)				SBS/9.90 MPa/±1.46	80% adhesive
Mohammadi et al., 2015	Iran	Ceramco	Feldspathic	Composite resin (Filtek Z250, 3M ESPE)	T1: Air abrasion with 50 µm Al ₂ O ₃ + 37% phosphoric acid for 2min + silane + adhesive (Adper Single Bond 2) light cured for 20s	26	Non-aged	500 thermal cycles	SBS/19.18 MPa/±9.11	57.6% mixed
					T2: Air abrasion with 50 µm Al ₂ O ₃ + 37% phosphoric acid for 2min + silane + adhesive (Clearfil SE Bond) light-cured for 20s				SBS/10.48 MPa/±8.95	80.7% adhesive
					T3: Air abrasion with 50 µm Al ₂ O ₃ + 37% phosphoric acid for 2min + silane + adhesive (Silorane Adhesive System) light-cured for 20s				SBS/21.33 MPa/±6.66	53.8% mixed
				Filtek silorane (3M ESPE)	T1				SBS/17.64 MPa/±7.33	42.3% mixed

										T2	SBS/11.63 MPa/±5.98	80.7% adhesive
										T3	SBS/19.78 MPa/±8.57	50% mixed
Neis et al, 2015	Brazil	Vita VM7	Feldspathic	Composite resin (Filtek Z350, 3M ESPE)	T1: 37% phosphoric acid for 30s + silane + adhesive (Adapter Single Bond 2) light-cured for 20s	5	Distilled water for 3 months	10,000 thermal cycles	μTBS/9.0 MPa/±10.0	95.3% adhesive		
					T2: Diamond bur + 37% phosphoric acid for 30s + silane + adhesive light-cured for 20s				μTBS/13.9 MPa/±1.99	89.8% adhesive		
					T3: 10% HF for 90s + 37% phosphoric acid for 30s + silane + adhesive light-cured for 20s				μTBS/14.4 MPa/±4.44	87.7% adhesive		
					T4: Sandblasted with 45μm SiO ₂ -coated Al ₂ O ₃ particles + 37% phosphoric acid for 30s + silane + adhesive light-cured for 20s				-----	100% adhesive		
		IPS Empress	Leucite	Filtek Z350, 3M ESPE	T1	5	Distilled water for 3 months	10,000 thermal cycles	μTBS/17.9 MPa/±3.4	94.8% adhesive		
					T2				μTBS/22.4 MPa/±4.4	91.3 % adhesive		
					T3: 10% HF for 60s (the difference)				μTBS/3.7 MPa/±0.4	91.8% adhesive		
					T4				μTBS/21.7 MPa/±2.5	95.5% adhesive		
		IPS e.max Press	Lithium disilicate	Filtek Z350, 3M ESPE	T1	5	Distilled water for 3 months	10,000 thermal cycles	μTBS/4.6 MPa/±1.3	93.3% adhesive		
					T2				μTBS/4.4 MPa/±2.6	93.9% adhesive		
					T3: 10% HF for 20s (the difference)				μTBS/21.1 MPa/±5.2	96.5% adhesive		

					T4				μ TBS/8.5 MPa/ $\pm$ 5.5	96.4% adhesive
Sadeghi et al, 2015	Iran	VITA Zahnfabrik	Feldspathic	Composite resin (Point 4; Kerr Italia)	(Unconditioned group) Diamond bur + silane + adhesive (OptiBond XTR) light-cured for 10s	12	Non-aged	1,500 thermal cycles	SBS/3.76 MPa/ $\pm$ 0.89	75% adhesive
					Diamond bur + 9% HF for 90s + silane + adhesive				SBS/12.19 MPa/ $\pm$ 3.04	66.7% adhesive
					Diamond bur + Er:YAG laser (2W, 100mJ, 2.94 μ m, 20 Hz, for 20s) + silane + adhesive				SBS/1.96 MPa/ $\pm$ 0.76	66.7% adhesive
					Diamond bur + Er:YAG laser (3W, 150mJ, 2.94 μ m, 20 Hz, for 20s) + silane + adhesive				SBS/2.23 MPa/ $\pm$ 0.60	58.3% adhesive
					Diamond bur + Er:YAG laser (4W, 200mJ, 2.94 μ m, 20 Hz, for 20s) + silane + adhesive				SBS/2.93 MPa/ $\pm$ 0.47	50% adhesive
					Diamond bur + Er:YAG laser (5W, 250mJ, 2.94 μ m, 20 Hz, for 20s) + silane + adhesive				SBS/8.00 MPa/ $\pm$ 2.22	91.7% adhesive
Yoo et al, 2015	Republic of Korea	Vintage MP	Feldspathic	Composite resin (AELITE All-Purpose Body, Bisco)	Diamond bur + 4% HF for 5min + silane + adhesive (ONE-STEP Plus, Bisco) light-cured for 10s	5	Non-aged	1,000 thermal cycles + distilled water for 8 days	SBS/16.28 MPa/ $\pm$ 4.50	100% mixed
					Air abrasion with 50 μ m Al ₂ O ₃ + 4% HF for 5min + silane + adhesive light-cured for 10s				SBS/25.85 MPa/ $\pm$ 3.51	80% mixed
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles (CoJet) + silane + adhesive light-cured for 10s				SBS/16.23 MPa/ $\pm$ 1.16	60% mixed

Erdemir et al, 2014	Turkey	IPS e.max CAD	Lithium disilicate	Self-adhesive flowable composite resin (Vertise Flow; Kerr)	No surface treatment	16	Non-aged	Non-aged	SBS/1.36 MPa/±1.86	Not assessed
					Sandblasted with 30µm SiO ₂ -coated Al ₂ O ₃ particles (CoJet) + silane (ESPE-Sil)				SBS/5.36 MPa/±2.58	
					9.6% HF for 20s + silane (Ultradent)				SBS/6.82 MPa/±4.4	
					Er:YAG laser (2940 nm, 300 mJ, 20Hz, 6w, for 20s) + silane (Ultradent)				SBS/0.91 MPa/±1.48	
					Diamond bur + silane (Ultradent)				SBS/0.82 MPa/±0.48	
Kanat et al, 2014	Turkey	IPS InLine PoM	Leucite	Composite resin (Arabesk Top, VOCO)	Silane + adhesive (Solobond M, VOCO) light-cured for 10s	5	Non-aged	Non-aged	µSBS/4.0 MPa/±0.8	60% cohesive composite
					9.5% HF for 60s + silane + adhesive				µSBS/8.1 MPa/±2.6	40% adhesive 40% cohesive composite
					Sandblasted with 30µm SiO ₂ -coated Al ₂ O ₃ particles (CoJet) + silane + adhesive				µSBS/5.0 MPa/±1.7	100% adhesive
				Composite resin (Filtek Z250, 3M ESPE)	Silane + adhesive (Adper Scotchbond Multi-Purpose, 3M ESPE) light-cured for 10s				µSBS/3.9 MPa/±0.7	60% cohesive composite
					9.5% HF for 60s + silane + adhesive				µSBS/7.6 MPa/±2.2	80% cohesive composite
					Sandblasted with 30µm SiO ₂ -coated Al ₂ O ₃ particles (CoJet) + silane + adhesive				µSBS/4.7 MPa/±1.0	100% adhesive
				Composite resin (Tetric EvoCeram, Ivoclar)	Silane + adhesive (Heliobond, Ivoclar) light-cured for 10s				µSBS/4.1 MPa/±0.7	40% adhesive 40% cohesive composite

					9.5% HF for 60s + silane + adhesive				$\mu\text{SBS}/4.1 \text{ MPa}/\pm 0.8$	40% adhesive 40% mixed
					Sandblasted with 30 μm SiO ₂ -coated Al ₂ O ₃ particles (CoJet) + silane + adhesive				$\mu\text{SBS}/6.3 \text{ MPa}/\pm 0.8$	100% adhesive
Lee et al, 2014	USA	Creation AV	Feldspathic	Composite resin (Filtek Supreme Plus; 3M ESPE)	35% phosphoric acid + silane + adhesive (Single Bond 2) light-cured for 10s	12	Non-aged	Non-aged	SBS/30.47 MPa/ ± 6.77	Not assessed
Zaghloul et al, 2014	Egypt	Cerec CAD CAM	Leucite	Composite resin (Filtek Z350 XT, 3M ESPE)	Diamond bur + 30% phosphoric acid + adhesive (Single Bond Universal) light-cured for 10s	10	Distilled water for 60 days	Non-aged	$\mu\text{SBS}/6.34 \text{ MPa}/\pm 2.21$	100% adhesive
					Diamond bur + 30% phosphoric acid + silane + adhesive light-cured for 10s				$\mu\text{SBS}/6.72 \text{ MPa}/\pm 1.91$	100% adhesive
					3% HF for 90s + adhesive + light-cured for 10s				$\mu\text{SBS}/5.72 \text{ MPa}/\pm 2.18$	100% adhesive
					3% HF for 90s + silane + adhesive light-cured for 10s				$\mu\text{SBS}/24.45 \text{ MPa}/\pm 7.35$	50% cohesive ceramic
					Sandblasted with 30 μm SiO ₂ -coated Al ₂ O ₃ particles (CoJet system) + adhesive light-cured for 10s				$\mu\text{SBS}/7.14 \text{ MPa}/\pm 2.06$	90% adhesive
					Sandblasted with 30 μm SiO ₂ -coated Al ₂ O ₃ particles (CoJet system) + silane + adhesive light-cured for 10s				$\mu\text{SBS}/20.18 \text{ MPa}/\pm 2.84$	50% adhesive/ 50% mixed
Colares et al, 2013	Brazil	IPS e.max CAD	Lithium disilicate	Composite resin (Filtek Z250, 3M ESPE)	9.5% HF for 20s + silane (23°C) + adhesive (Adper Single Bond 2) light-cured for 10s	33	Non-aged	Non-aged	$\mu\text{TBS}/32.14 \text{ MPa}/\pm 7.98$	90.3% mixed
					9.5% HF for 20s + silane (45 $\pm$ 5°C) + adhesive	32			$\mu\text{TBS}/35.0 \text{ MPa}/\pm 7.77$	96.8% mixed

						Air abrasion with 50 μm Al_2O_3 + silane (45 $\pm$ 5°C) + adhesive	20		$\mu\text{TBS}/18.36 \text{ MPa}/\pm 5.17$	100% mixed
						Air abrasion with 50 μm Al_2O_3 + silane (23°C) + adhesive	0		-----	100% pre-test failure (loss)
Huang et al, 2013	China	IPS Empress 2	Lithium disilicate	Composite resin (Ceram X Mono, Dentsplay)	Diamond bur + adhesive (XP Bond) light-cured for 20s	15	Non-aged	5,000 thermal cycles	$\mu\text{TBS}/4.5 \text{ MPa}/\pm 2.9$	100% adhesive
					Diamond bur + 37% phosphoric acid for 60s + adhesive				$\mu\text{TBS}/5.2 \text{ MPa}/\pm 3.0$	100% adhesive
					Diamond bur + 9.6% HF for 30s + adhesive				$\mu\text{TBS}/30.7 \text{ MPa}/\pm 6.5$	93% cohesive composite
					Diamond bur + silane + adhesive				$\mu\text{TBS}/11.5 \text{ MPa}/\pm 3.0$	100% adhesive
					Diamond bur + 37% phosphoric acid for 60s + silane + adhesive				$\mu\text{TBS}/9.7 \text{ MPa}/\pm 2.2$	100% adhesive
					Diamond bur + 9.6% HF for 30s + silane + adhesive				$\mu\text{TBS}/32.0 \text{ MPa}/\pm 8.2$	80% cohesive composite
					Sandblasted with 30 μm SiO_2 -coated Al_2O_3 particles + adhesive				$\mu\text{TBS}/1.7 \text{ MPa}/\pm 0.7$	100% adhesive
					Sandblasted with 30 μm SiO_2 -coated Al_2O_3 particles + 37% phosphoric acid for 60s + adhesive				$\mu\text{TBS}/1.7 \text{ MPa}/\pm 0.6$	100% adhesive
					Sandblasted with 30 μm SiO_2 -coated Al_2O_3 particles + 9.6% HF for 30s + adhesive				$\mu\text{TBS}/27.2 \text{ MPa}/\pm 4.5$	66% cohesive composite
					Sandblasted with 30 μm SiO_2 -coated Al_2O_3 particles + silane + adhesive				$\mu\text{TBS}/1.7 \text{ MPa}/\pm 0.9$	100% adhesive

					Sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles + 37% phosphoric acid for 60s + silane + adhesive				µTBS/1.7 MPa/±1.1	100% adhesive
					Sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles + 9.6% HF for 30s + silane + adhesive				µTBS/29.2 MPa/±5.5	86% cohesive
Jain et al, 2013	India	Duceram	Feldspathic	Composite resin (Tetric EvoCeram, Ivoclar)	Diamond bur + Ceramic repair system: 37% phosphoric acid + silane + adhesive (Heliobond) light-cured for 20s	10	Non-aged	500 thermal cycles + distilled water for 7 days	SBS/9.47 MPa/ ±1.41	100% cohesive (overall)
				Composite resin (Clearfil APX)	Diamond bur + Clearfil repair system: 40% phosphoric acid + silane (Clearfil SE Bond Primer + Clearfil Porcelain Bond Activator) + adhesive (Clearfil SE Bond) light-cured for 20s				SBS/14.03 MPa/ ±2.32	
				Composite resin (Filtek Z350 XT, 3 M ESPE)	Diamond bur + porcelain repair system: 37% phosphoric acid + silane + adhesive (Single Bond 2) light-cured for 20s				SBS/14.41 MPa/ ±3.96	
				Tetric EvoCeram, Ivoclar	Air abrasion with 50 µm Al ₂ O ₃ + Ceramic repair system	10	Non-aged	500 thermal cycles + distilled water for 7 days	SBS/14.03 MPa/ ±2.54	
				Clearfil APX	Air abrasion with 50 µm Al ₂ O ₃ + Clearfil repair system				SBS/14.64 MPa/ ±2.28	
				Filtek Z350 XT, 3 M ESPE	Air abrasion with 50 µm Al ₂ O ₃ + porcelain repair system				SBS/14.86 MPa/ ±3.10	
Saraç et al, 2013	Turkey	Vita Zahnfabrik	Feldspathic	Composite Resin	Control: no treatment	15	Non-aged	500 thermal-cycles	SBS/5.56 MPa/ ±0.40	86.6% adhesive

				(Reflexions, Bisco)	4% HF for 5 min + silane + adhesive (One-Step, Bisco) light-cured for 10s				SBS/13.71 MPa/ ±0.48	100% cohesive
					Er:YAG laser (2W, 10 Hz, 200 mJ, for 10s) + silane + adhesive light-cured for 10s				SBS/10.73 MPa/ ±0.90	100% cohesive
					CO ₂ laser (10.6 µm, 3 W, 1,000 Hz, for 160 ms) + silane + adhesive light-cured for 10s				SBS/12.99 MPa/ ±1.06	100% cohesive
					Air abrasion with 50 µm Al ₂ O ₃ + silane + adhesive light-cured for 10s				SBS/16.88 MPa/ ±1.18	100% cohesive
					Sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles (CoJet system) + silane + adhesive light-cured for 10s				SBS/17.73 MPa/ ±1.50	100% cohesive
Blum et al, 2012	United Kingdom	Cerana	Leucite	Composite resin (Arabesk Top)	Cimara system: diamond bur + silane + opaquer LC + opaquer adhesive light-cured for 20s	40	Artificial saliva for 21 days + 1,000 thermal cycles	Non-aged	TBS/3.7 MPa*/ ±1.6	Predominately adhesive (overall)
				Composite resin (Tetric EvoCeram, Ivoclar)	Ceramic repair system: diamond bur + 37% phosphoric acid for 15s + silane + adhesive (Heliobond) light-cured for 20s				TBS/2.7 MPa*/ ±1.1	
				Composite resin (Nanosit)	Clearfil system: diamond bur + 40% phosphoric acid (K etchant gel) for 5s+ silane (Clearfil SE Bond Primer + Clearfil Porcelain Bond Activator) + adhesive (Clearfil SE Bond) light-cured for 10s				TBS/4.1 MPa*/ ±1.5	
					Cojet repair system: sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles				TBS/5.2 MPa*/ ±1.1	

					+ silane + adhesive (Visio Bond) light-cured for 20s					
					Control: No treatment			-----		100% pre-test failure (loss)
Predrazzi et al, 2012	Brazil	Ceramco 3	Feldspathic	Not informed	Ti: Sapphire Laser (760 mW) + silane + adhesive light-cured for 20s	10	Non-aged	1,000 thermal cycles	SBS/11.25 MPa/ ±3.10	Not assessed
					Ti: Sapphire Laser (760 mW) + 37% phosphoric acid for 15s + silane + adhesive light-cured for 20s				SBS/12.32 MPa/ ±2.65	
					Ti: Sapphire Laser (900 mW) + silane + adhesive light-cured for 20s				SBS/14.02 MPa/ ±2.38	
					Ti: Sapphire Laser (900 mW) + 37% phosphoric acid for 15s + silane + adhesive light-cured for 20s				SBS/13.44 MPa/ ±2.07	
					37% phosphoric acid for 15s + silane + adhesive light-cured for 20s				SBS/9.91 MPa/ ±2.18	
					10% HF for 120s silane + adhesive light-cured for 20s				SBS/12.74 MPa/ ±2.67	
Queiroz et al, 2012	Brazil	Vitablocs Mark II	Feldspathic	Composite resin (W3D Master, Wilcos)	Cojet repair system (sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles) + silane + adhesive (Scotchbond Multipurpose)	40	Non-aged	7,000 thermal cycles	µTBS/28.97 MPa/ ±9.3	Predominately mixed
				Composite resin (Filtek Supreme, 3M)	Cojet + silane + adhesive				µTBS/27.14 MPa/ ±9.9	
				W3D Master	10% HF for 60s + silane + adhesive				µTBS/29.60 MPa/ ±10.6	

											Filtek Supreme	10% HF for 60s + silane + adhesive							μTBS/33.77 MPa/ ±10.6	
											W3D Master	10% HF for 60s + Metal/Zirconia Primer + adhesive							μTBS/13.84 MPa/ ±5.5	
											Filtek Supreme	10% HF for 60s + Metal/Zirconia Primer + adhesive							μTBS/14.94 MPa/ ±6.2	
											W3D Master	10% HF for 60s + Clearfil Ceramic Primer + adhesive							μTBS/18.67 MPa/ ±6.1	
											Filtek Supreme	10% HF for 60s + Clearfil Ceramic Primer + adhesive							μTBS/19.45 MPa/ ±7.9	
											W3D Master	10% HF for 60s + Alloy Primer + adhesive							μTBS/15.31 MPa/ ±5.2	
											Filtek Supreme	10% HF for 60s + Alloy Primer + adhesive							μTBS/16.51 MPa/ ±4.7	
											W3D Master	10% HF for 60s + V-primer + adhesive							μTBS/11.03 MPa/ ±3.7	
Filtek Supreme	10% HF for 60s + V-Primer + adhesive							μTBS/18.01 MPa/ ±7.8												
Tarcin et al, 2012	Turkey	Vitablocs, Vita Zahnfabrik	Leucite	Low-viscosity composite resin (Aelite Flo LV; Bisco)	36% phosphoric acid + silane + total etch adhesive (One-Step Plus, Bisco) light-cured for 20s	10	Non-aged	Non-aged	SBS/5.72 MPa/ ±0.98	Not assessed										
					Silane + self-etch adhesive (All-Bond SE, Bisco) light-cured for 20s				SBS/9.79 MPa/ ±2.55											
					Er:YAG laser (2W, 10 Hz, 200 mJ, for 20s) + total etch adhesive				SBS/7.48 MPa/ ±1.33											
					Er:YAG laser (2W, 10 Hz, 200 mJ, for 20s) + silane + self-etch adhesive				SBS/12.05 MPa/ ±1.85											

					Air abrasion with 50 µm Al ₂ O ₃ for 15s + total etch adhesive				SBS/9.53 MPa/ ±4.26	
					Air abrasion with 50 µm Al ₂ O ₃ for 15s + silane + self-etch adhesive				SBS/11.99 MPa/ ±3.30	
Külünk and Şinasi Saraç, 2011	Turkey	IPS Empress Esthetic	Leucite	Composite resin (Tetric ceram, Ivoclar)	Ceramic repair system: diamond bur + 37% phosphoric acid for 15s + silane + adhesive (Heliobond) light-cured for 20s	8	Non-aged	1,500 thermal cycles	SBS/6.55 MPa/ ±0.5	Not assessed
					Clearfil repair system: 40% phosphoric acid + silane (Clearfil SE Bond Primer + Clearfil Porcelain Bond Activator) + adhesive (Clearfil SE Bond) light-cured for 10s				SBS/7.72 MPa/ ±0.42	
					CoJet system: sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive (Vision Bond, 3M ESPE) light-cured for 20s				SBS/15.26 MPa/ ±0.5	
		IPS Empress 2	Lithium disilicate		Ceramic repair system				SBS/3.85 MPa/ ±0.27	
					Clearfil repair system				SBS/5.17 MPa/ ±0.63	
					CoJet system				SBS/13.74 MPa/ ±0.46	
Akyıl et al, 2010	Turkey	Vita VMK	Feldspathic	Composite resin (Arabesk Top)	Silane	12	Non-aged	1,000 thermal cycles	SBS/5.83 MPa/ ±1.22	100% adhesive
					9.5% HF for 120s + silane				SBS/15.21 MPa/ ±2.54	75% cohesive
					Er:YAG laser (2940 nm, 3W, 10 Hz, 300 mJ, for 60s) + silane				SBS/3.96 MPa/ ±0.55	100% adhesive

					Nd:YAG laser (1064 nm, 1.0 W, 10 Hz, 100 mJ for 60s) + silane				SBS/6.08 MPa/ ± 1.33	100% adhesive
					Er:YAG laser (2940 nm, 3W, 10 Hz, 300 mJ, for 60s) + 9.5% HF for 120s + silane				SBS/12.74 MPa/ ± 2.22	66.6% adhesive
					Nd:YAG laser (1064 nm, 1.0 W, 10 Hz, 100 mJ for 60s) + 9.5% HF for 120s + silane				SBS/12.59 MPa/ ± 1.95	75% adhesive
Chen et al, 2010	Japan	GH-I Ceramic block	Leucite	Composite resin (Lite-Fil II A, Shofu)	Air abrasion with 50 μm Al_2O_3 for 15s	5	Non-aged	Non-aged 2,000 thermal cycles	SBS/0.26 MPa/ $\pm$ not informed -----	Unclear
					Air abrasion with 50 μm Al_2O_3 for 15s + CO_2 laser (10,600 nm wavelengths)				SBS/0.05 MPa/ $\pm$ not informed -----	
					Air abrasion with 50 μm Al_2O_3 for 15s + silane				SBS/8.2 MPa/ $\pm$ not informed SBS/3.6 MPa/ $\pm$ not informed	
					Air abrasion with 50 μm Al_2O_3 for 15s + silane + CO_2 laser (10,600 nm wavelengths)				SBS/9.7 MPa/ $\pm$ not informed SBS/7.7 MPa/ $\pm$ not informed	
Fahmy and Mohsen, 2010	Egypt	Vita Omega	Leucite	Low viscosity composite resin (Filtek Flowable, 3M ESPE) + composite resin (Filtek Z250, 3M ESPE)	Air abrasion with 50 μm Al_2O_3 + 9% HF for 120s + silane + adhesive (Single Bond 2) light-cured for 10s	5	Non-aged	Non-aged	SBS/7.5 MPa/ ± 1.5	Not assessed
Meshramkar and Sajjan, 2010	India	VMK 95	Feldspathic	Composite resin (trade	Air abrasion with 50 μm Al_2O_3 for 10s	7	Non-aged	Non-aged	SBS/3.66 MPa/ ± 0.61	Not assessed

				mark not informed)	35% phosphoric acid for 15s					SBS/3.59 MPa/ ± 0.41	
					8% HF for 240s					SBS/5.90 MPa/ ± 0.50	
					Air abrasion with 50 μm Al_2O_3 for 10s + silane + adhesive (Scotchbond) light-cured for 10s					SBS/6.24 MPa/ ± 1.06	
					Air abrasion with 50 μm Al_2O_3 for 10s + adhesive system (Clearfil liner bond 2V)					SBS/7.54 MPa/ ± 0.77	
					35% phosphoric acid for 15s + adhesive (Scotchbond) light-cured for 10s					SBS/7.60 MPa/ ± 0.95	
					35% phosphoric acid for 15s + adhesive system (Clearfil liner bond 2V)					SBS/9.73 MPa/ ± 0.92	
					8% HF for 240s + adhesive (Scotchbond) light-cured for 10s					SBS/9.24 MPa/ ± 0.69	
					8% HF for 240s + adhesive system (Clearfil liner bond 2V)					SBS/9.78 MPa/ ± 0.91	
Güler et al, 2009	Turkey	VMK 95	Feldspathic	Composite resin (Filtek Z250, 3M ESPE)	Air abrasion with 50 μm Al_2O_3 for 5s + 9.6% HF for 120s + silane + self-etching adhesive (Adper Prompt L-Pop)	10	Non-aged	1,000 thermal cycles		SBS/2.90 MPa/ ± 0.54	100% adhesive
					Air abrasion with 50 μm Al_2O_3 for 5s + 9.6% HF for 120s + silane + 1-bottle light-curing adhesive (Quadrant Uni 1 Bond)					SBS/6.36 MPa/ ± 0.76	70% adhesive
					Air abrasion with 50 μm Al_2O_3 for 5s + 9.6% HF for					SBS/8.41 MPa/ ± 0.59	50% mixed

					120s + silane + bonding agent (Te-Econom)					
					Air abrasion with 50 µm Al ₂ O ₃ for 5s + 9.6% HF for 120s + silane + filled universal dental adhesive (One-Step Plus)			SBS/9.69 MPa/ ±0.72	60% mixed	
					Air abrasion with 50 µm Al ₂ O ₃ for 5s + 9.6% HF for 120s + silane + bonding agent (Prime & Bond NT)			SBS/9.63 MPa/ ±0.83	50% mixed	
					Air abrasion with 50 µm Al ₂ O ₃ for 5s + 9.6% HF for 120s + silane + Highest filled single component adhesive (PQ 1)			SBS/11.72 MPa/ ±0.77	100% cohesive ceramic	
Lundvall et al, 2009	Norway	Hera-ceram	Feldspathic	Composite resin (Charisma, Heraeus Kulzer)	9% HF for 60s + silane (Bis-Silane, Bisco) + adhesive (Porcelain Bonding Resin, Bisco)	10	Non-aged	5,000 thermal cycles	SBS/19.0 MPa/ ±5.0	Not assessed
					9% HF for 60s + adhesive				SBS/13.14 MPa/ ±2.2	
					9% HF for 60s + silane (Silane, Ultradent products) + adhesive				SBS/13.8 MPa/ ±5.4	
					35% phosphoric acid for 180s + silane (Bis-Silane, Bisco) + adhesive				SBS/6.6 MPa/ ±5.9	
					15% hydrochloric acid for 300s + silane (Bis-Silane, Bisco) + adhesive				SBS/0.8 MPa/ ±1.8	
					15 % potassium fluoride/hydrogen fluoride for 180s + silane (Bis-Silane, Bisco) + adhesive				SBS/18.3 MPa/ ±7.1	

Yesil et al, 2009	Turkey	Ceramco	Feldspathic	Composite resin (Filtek Z250, 3M ESPE)	Air abrasion with 50 μm Al_2O_3 + adhesive (Ceramics microbond, Seramco)	3	Non-aged	200 thermal cycles + distilled water for 7 days storage	SBS/9.40 MPa/ ± 6.19	Not assessed
					Air abrasion with 50 μm Al_2O_3 + adhesive (Clearfil bond, Kuraray)				SBS/5.16 MPa/ ± 7.35	
					Air abrasion with 50 μm Al_2O_3 + adhesive (Single Bond, 3M ESPE)				SBS/5.76 MPa/ ± 4.49	
					Air abrasion with 50 μm Al_2O_3 + self-etching adhesive (Adper Prompt L-Pop)				SBS/13.65 MPa/ ± 3.64	
Panah et al, 2008	Iran	IPS Empress 2	Lithium disilicate	Composite resin (Tetric Ceram)	Adhesive (Heliobond) light-cured for 20s	10	Non-aged	Non-aged	SBS/4.10 MPa/ ± 3.06	Predominately adhesive
					Air abrasion with 50 μm Al_2O_3 for 15s + adhesive				SBS/7.56 MPa/ ± 4.11	Predominately adhesive/mixed
					9.6% HF for 30s + adhesive				SBS/14.04 MPa/ ± 2.60	Predominately adhesive/mixed
					Silane + adhesive				SBS/14.58 MPa/ ± 2.14	Predominately adhesive/mixed
					Air abrasion with 50 μm Al_2O_3 for 15s + 9.6% HF for 30s + adhesive				SBS/15.56 MPa/ ± 3.36	Predominately adhesive/mixed
					Air abrasion with 50 μm Al_2O_3 for 15s + silane adhesive				SBS/23.02 MPa/ ± 4.17	Predominately adhesive/mixed
					9.6% HF for 30s + silane adhesive				SBS/24.70 MPa/ ± 4.43	Predominately adhesive/mixed
					Air abrasion with 50 μm Al_2O_3 for 15s + 9.6% HF for 30s + silane + adhesive				SBS/26.00 MPa/ ± 3.71	Predominately adhesive/mixed

Boscato et al, 2007	Brazil	IPS Empress I	Leucite	Composite resin (Filtek Z250, 3M ESPE)	9.5% HF for 60s + silane + adhesive (Single Bond) light-cured for 20s	5	Non-aged	Distilled water for 7 days	μ TBS/29.8 MPa/ $\pm$ 4.5	100% adhesive
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive light-cured for 20s				μ TBS/24.6 MPa/ $\pm$ 5.6	
		VITA VM7	Feldspathic		9.5% HF for 60s + silane + adhesive (Single Bond) light-cured for 20s				μ TBS/22.3 MPa/ $\pm$ 4.0	
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive light-cured for 20s				μ TBS/15.7 MPa/ $\pm$ 6.9	
Kim et al, 2007	Republic of Korea	Duceram Plus	Feldspathic	Composite resin (Z100, 3M ESPE)	Air abrasion with 50 μ m Al ₂ O ₃ for 5s + adhesive (One step, Bisco) light-cured for 20s	10	Non-aged	Non-aged 1,200 thermal cycles	SBS/22.2 MPa/ $\pm$ 5.3 SBS/16.9 MPa/ $\pm$ 3.9	Not assessed
					Air abrasion with 50 μ m Al ₂ O ₃ for 5s + 4% HF for 5min + adhesive				SBS/26.0 MPa/ $\pm$ 6.3 SBS/19.1 MPa/ $\pm$ 5.6	
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive				SBS/26.9 MPa/ $\pm$ 7.4 SBS/21.7 MPa/ $\pm$ 6.0	
		IPS Empress 2	Lithium disilicate		Air abrasion with 50 μ m Al ₂ O ₃ for 5s + adhesive				SBS/21.5 MPa/ $\pm$ 4.2 SBS/14.0 MPa/ $\pm$ 3.0	
					Air abrasion with 50 μ m Al ₂ O ₃ for 5s + 4% HF for 5min + adhesive				SBS/21.2 MPa/ $\pm$ 4.5 SBS/16.6 MPa/ $\pm$ 4.4	
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive				SBS/26.4 MPa/ $\pm$ 5.0 SBS/23.9 MPa/ $\pm$ 5.5	
Kukiattrakoon and	Thailand	IPS Empress I	Leucite	Composite resin (Filtek	Silane + adhesive system (Scotchbond Multi-Purpose:	9	Non-aged	Non-aged	SBS/7.61 MPa/ $\pm$ 1.03	100% adhesive

Thammasitboon, 2007				Z250, 3M ESPE)	primer + adhesive) light- cured for 10s					
					1.23% APF (acidulated phosphate fluoride) gel for 1 min + silane + adhesive system					
					1.23% APF gel for 2 min + silane + adhesive system					
					1.23% APF gel for 3 min + silane + adhesive system					
					1.23% APF gel for 4 min + silane + adhesive system					
					1.23% APF gel for 5 min + silane + adhesive system					
					1.23% APF gel for 6 min + silane + adhesive system					
					1.23% APF gel for 7 min + silane + adhesive system					
					1.23% APF gel for 8 min + silane + adhesive system					
					1.23% APF gel for 9 min + silane + adhesive system					
					1.23% APF gel for 10 min + silane + adhesive system					
					9.6% HF for 4min + silane + adhesive system					
de Melo et al, 2007	Brazil	Vita Omega 900	Leucite	Composite resin (Filtek Z250, 3M ESPE)	6% HF for 60s + silane + adhesive (Single Bond) light-cured for 20s	5	Non-aged	Distilled water for 7 days	μ TBS/10.19 MPa/ $\pm$ 3.1	100% adhesive
					CoJet system: Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive light-cured for 20s				μ TBS/10.17 MPa/ $\pm$ 3.1	

Schmage et al, 2007	Germany	Vita Omega 900	Leucite	Composite resin (Charisma, Heraeus Kulzer)	CoJet system: sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive (Visio-Bond) light-cured for 20s	5	Non-aged	5,000 thermal cycles	SBS/17.8 MPa/ ±3.6	100% cohesive
				Composite resin (Pertac Hybrid, 3M Espe)					SBS/12.5 MPa/ ±2.6	80% adhesive
				Charisma	Silistor system: carborundum K1 bur + silane + adhesive (Silibond) light-cured for 20s				SBS/23.1 MPa/ ±5.8	60% cohesive
				Pertac Hybrid					SBS/11.7 MPa/ ±2.4	100% adhesive
				Charisma Pertac Hybrid	Carborundum bur + Cimara system: silane + opaquer liquid light-cured for 20s				SBS/14.1 MPa/ ±3.1 SBS/12.0 MPa/ ±3.1	80% cohesive 60% cohesive
				Charisma	Diamond bur + Ceramic repair system: 37% phosphoric acid + silane + adhesive (Heliobond) light-cured for 20s				SBS/15.1 MPa/ ±1.0	80% adhesive
				Pertac Hybrid					SBS/8.1 MPa/ ±1.3	80% adhesive
Yesil et al, 2007	Turkey	Ceramco	Feldspathic	Composite resin (Valux Plus, 3M ESPE)	Air abrasion with 50 µm Al ₂ O ₃ for 15s + silane + adhesive (Clearfil SE Bond)	7	Non-aged	300 thermal cycles + distilled water for 7 days storage	SBS/9.99 MPa/ ±2.55	Not assessed
					Diamond bur + silane + adhesive (Clearfil SE Bond)				SBS/10.04 MPa/ ±2.32	
dos Santos et al, 2006	Brazil	Noritake Super	Feldspathic	Composite resin	Air abrasion with 50 µm Al ₂ O ₃ + Clearfil repair system: 40% phosphoric	10	Non-aged	5,000 thermal cycles+ Distilled	SBS/16.91 MPa/±2.22	80% cohesive ceramic

		Porcelain EX-3	(Clearfil AP-X)	acid + silane (Primer + Bond Activator) + adhesive (SE Bond)				water for 8 days		
			Composite resin (Z100, 3M ESPE)	Sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles + silane (ESPE-Sil) + adhesive (Vision Bond)					SBS/19.54 MPa/±3.77	100% cohesive
				Air abrasion with 50 µm Al ₂ O ₃ + phosphoric acid + silane + adhesive (Scotchbond Multi-Purpose Plus)					SBS/21.05 MPa/±3.22	100% cohesive
				Sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles + phosphoric acid + silane + adhesive (Scotchbond Multi-Purpose Plus)					SBS/16.18 MPa/±1.71	80% cohesive ceramic
Güler et al, 2006	Turkey	VMK 95	Feldspathic	Composite resin (Filtek Z250, 3M ESPE)	G0: Conventional adhesive (Single Bond) light-cured for 20s	7	Non-aged	Non-aged	SBS/10.48 MPa/ ±0.89	Not assessed
					G0: Self-etching adhesive (AdheSE, Ivoclar) light-cured for 20s				SBS/9.33 MPa/ ±0.92	
					G 30: 9.6% HF for 30s + rinsed/dried for 20s + conventional adhesive				SBS/11.17 MPa/ ±0.99	
					G 30: 9.6% HF for 30s + rinsed/dried for 20s + self-etching adhesive				SBS/9.49 MPa/ ±1.17	
					G 30+30: 9.6% HF for 30s (rinsed/dried for 20s) + 9.6% HF for 30s (rinsed/dried for 20s) + conventional adhesive				SBS/13.82 MPa/ ±0.54	
					G 30+30: 9.6% HF for 30s (rinsed/dried for 20s) + 9.6% HF for 30s (rinsed/dried for 20s) + self-etching adhesive				SBS/13.33 MPa/ ±0.97	

Güler et al, 2005	Turkey	VMK 95	Feldspathic	Composite resin (Arabesk Top, Voco)	G 60: 9.6% HF for 60 (rinsed/dried for 20s) + conventional adhesive	12	Non-aged	Non-aged	SBS/13.52 MPa/ ±0.46
					G 60: 9.6% HF for 60 (rinsed/dried for 20s) + self-etching adhesive				SBS/13.03 MPa/ ±0.54
					G 60+60: 9.6% HF for 60s (rinsed/dried for 20s) + 9.6% HF for 60s (rinsed and dried for 20s) + conventional adhesive				SBS/15.42 MPa/ ±0.79
					G 60+60: 9.6% HF for 60s (rinsed/dried for 20s) + 9.6% HF for 60s (rinsed and dried for 20s) + self-etching adhesive				SBS/14.96 MPa/ ±0.80
					G 120: 9.6% HF for 120s (rinsed/dried for 20s) + conventional adhesive				SBS/15.07 MPa/ ±0.75
					G 120: 9.6% HF for 120s (rinsed/dried for 20s) + self-etching adhesive				SBS/14.84 MPa/ ±0.75
					G 180: 9.6% HF for 180s (rinsed/dried for 20s) + conventional adhesive				SBS/12.39 MPa/ ±0.60
					G 180: 9.6% HF for 180s (rinsed/dried for 20s) + self-etching adhesive				SBS/12.01 MPa/ ±0.91
					Air abrasion with 50 µm Al ₂ O ₃ for 5s + adhesive (Prime&Bond NT) light-cured for 20s				SBS/5.37 MPa/ ±0.88
					Air abrasion with 110 µm Al ₂ O ₃ for 5s + adhesive				SBS/6.88 MPa/ ±0.25
					9.6% HF for 120s + adhesive				SBS/8.41 MPa/ ±1.26

					Silane + adhesive				SBS/4.09 MPa/ ± 0.75	
					Air abrasion with 50 μm Al_2O_3 for 5s + silane + adhesive				SBS/10.55 MPa/ ± 0.63	
					Air abrasion with 110 μm Al_2O_3 for 5s + silane + adhesive				SBS/7.96 MPa/ ± 0.93	
					9.6% HF for 120s + silane + adhesive				SBS/11.97 MPa/ ± 0.47	
					Air abrasion with 50 μm Al_2O_3 for 5s + 9.6% HF for 120s + silane + adhesive				SBS/12.34 MPa/ ± 0.62	
					Air abrasion with 110 μm Al_2O_3 for 5s + 9.6% HF for 120s + silane + adhesive				SBS/9.87 MPa/ ± 1.09	
Kim et al, 2005	Republic of Korea	Duceram Plus	Feldspathic	Composite resin (Z100, 3M ESPE)	Air abrasion with 50 μm Al_2O_3 for 5s + silane + adhesive (One step, Bisco) light-cured for 10s	10	Non-aged	Distilled water for 3 days	TBS/14.8 MPa/ ± 2.2	Not assessed
					Air abrasion with 50 μm Al_2O_3 for 5s + 4% HF for 5min + silane + adhesive				TBS/18.9 MPa/ ± 2.4	
					Sandblasted with 30 μm SiO_2 -coated Al_2O_3 particles + silane + adhesive				TBS/13.1 MPa/ ± 2.3	
		IPS Empress 2	Lithium disilicate		Air abrasion with 50 μm Al_2O_3 for 5s + silane + adhesive				TBS/12.9 MPa/ ± 2.0	
					Air abrasion with 50 μm Al_2O_3 for 5s + 4% HF for 5min + silane + adhesive				TBS/17.7 MPa/ ± 2.5	
					Sandblasted with 30 μm SiO_2 -coated Al_2O_3 particles + silane + adhesive				TBS/11.7 MPa/ ± 1.2	

Oh and Shen, 2005	USA	IPS Eris	Fluorapatite	Composite resin (Tetric ceram, Ivoclar	Silicon carbide abrasive paper + flame cleaning + adhesive (Heliobond) light- cured for 20s	20	Non-aged	Deionized water for 7 days	-----	Not assessed
					Air abrasion with 50 μm Al_2O_3 + flame cleaning + adhesive				$\mu\text{TBS}/4.6 \text{ MPa}/\pm 1.7$	
					5% HF for 120s + flame cleaning + adhesive				$\mu\text{TBS}/4.3 \text{ MPa}/\pm 2.4$	
					Air abrasion with 50 μm Al_2O_3 + 5% HF for 120s + flame cleaning + adhesive				$\mu\text{TBS}/11.2 \text{ MPa}/\pm 2.8$	
					Silicon carbide abrasive paper + steam cleaning + adhesive				-----	
					Air abrasion with 50 μm Al_2O_3 + steam cleaning + adhesive				$\mu\text{TBS}/2.6 \text{ MPa}/\pm 0.8$	
					5% HF for 120s + steam cleaning + adhesive				$\mu\text{TBS}/3.1 \text{ MPa}/\pm 1.3$	
					Air abrasion with 50 μm Al_2O_3 + 5% HF for 120s + steam cleaning + adhesive				$\mu\text{TBS}/9.3 \text{ MPa}/\pm 1.3$	
		IPS Empress	Leucite		Silicon carbide abrasive paper + flame cleaning + adhesive				-----	
					Air abrasion with 50 μm Al_2O_3 + flame cleaning + adhesive				$\mu\text{TBS}/4.9 \text{ MPa}/\pm 1.5$	
					5% HF for 120s + flame cleaning + adhesive				$\mu\text{TBS}/16.6 \text{ MPa}/\pm 4.0$	
					Air abrasion with 50 μm Al_2O_3 + 5% HF for 120s + flame cleaning + adhesive				$\mu\text{TBS}/19.4 \text{ MPa}/\pm 3.0$	

					Silicon carbide abrasive paper + steam cleaning + adhesive				-----	
					Air abrasion with 50 μm Al_2O_3 + steam cleaning + adhesive				$\mu\text{TBS}/2.8 \text{ MPa}/\pm 1.1$	
					5% HF for 120s + steam cleaning + adhesive				$\mu\text{TBS}/10.5 \text{ MPa}/\pm 1.5$	
					Air abrasion with 50 μm Al_2O_3 + 5% HF for 120s + steam cleaning + adhesive				$\mu\text{TBS}/13.5 \text{ MPa}/\pm 3.3$	
El Zohairy et al, 2004	The Netherlands	Vitablocs Mark II	Feldspathic	Low viscosity composite resin (Tetric Flow, Ivoclar)	No treatment	Unclear	Non-aged	Non-aged Distilled water for 7 days	-----	100% pre-test failure (loss)
								Distilled water for 28 days	-----	
					8% HF for 60s + silane				$\mu\text{TBS}/28.7 \text{ MPa}/\pm 5.9$ $\mu\text{TBS}/20.2 \text{ MPa}/\pm 4.3$ $\mu\text{TBS}/19.4 \text{ MPa}/\pm 2.7$	Unclear 80% adhesive 90% adhesive
					8% HF for 60s + silane + adhesive (Syntac Single-Component) light-cured for 20s				$\mu\text{TBS}/24.7 \text{ MPa}/\pm 7.1$ $\mu\text{TBS}/13.5 \text{ MPa}/\pm 4.1$ $\mu\text{TBS}/12.3 \text{ MPa}/\pm 4.1$	Unclear Unclear 100% adhesive
					8% HF for 60s + silane + adhesive (Visio Bond) light-cured for 20s				$\mu\text{TBS}/18.2 \text{ MPa}/\pm 3.9$ $\mu\text{TBS}/21.0 \text{ MPa}/\pm 3.2$ $\mu\text{TBS}/21.5 \text{ MPa}/\pm 2.4$	90% adhesive 80% adhesive 90% adhesive
					37% phosphoric acid for 120s + silane				$\mu\text{TBS}/11.0 \text{ MPa}/\pm 2.6$ $\mu\text{TBS}/4.6 \text{ MPa}/\pm 2.3$ $\mu\text{TBS}/3.0 \text{ MPa}/\pm 2.0$	100% adhesive 100% adhesive 100% adhesive
					37% phosphoric acid for 120s + silane + adhesive (Syntac Single-Component) light-cured for 20s				$\mu\text{TBS}/26.2 \text{ MPa}/\pm 3.7$ $\mu\text{TBS}/0.4 \text{ MPa}/\pm 1.3$ -----	Unclear 100% adhesive 100% pre-test failure (loss)
					37% phosphoric acid for 120s + silane + adhesive				$\mu\text{TBS}/20.8 \text{ MPa}/\pm 4.2$ $\mu\text{TBS}/15.7 \text{ MPa}/\pm 3.4$	100% adhesive 100% adhesive 100% adhesive

					(Visio Bond) light-cured for 20s				μ TBS/14.6 MPa/ $\pm$ 2.0	
Sazak-Öveçoğlu et al, 2004	Turkey	Finesse, Dentsply	Leucite	Low viscosity Composite resin (Admira Flow, Voco)	Nd:YAG laser for 5s (80mJ, 20 Hz) + silane + adhesive (Admira Bond) light-cured for 20s	Not informed	Non-aged	Non-aged	SBS/4.09 MPa/ $\pm$ 3.48	Not assessed
					Air abrasion with 50 μ m Al ₂ O ₃ for 5s + silane + adhesive (Admira Bond)				SBS/6.72 MPa/ $\pm$ 1.86	
					9.6% HF for 120s + silane + adhesive (Admira Bond)				SBS/4.91 MPa/ $\pm$ 2.86	
				Low viscosity composite resin (Tetric Flow, Ivoclar)	Nd:YAG laser for 5s (80mJ, 20 Hz) + silane + adhesive (Excite) light-cured for 20s				SBS/5.04 MPa/ $\pm$ 0.88	
					Air abrasion with 50 μ m Al ₂ O ₃ for 5s + silane + adhesive (Excite)				SBS/5.64 MPa/ $\pm$ 2.86	
					9.6% HF for 120s + silane + adhesive (Excite)				SBS/4.98 MPa/ $\pm$ 3.42	
El Zohairy et al, 2003	The Netherlands	Vitablocs Mark II	Feldspathic	Low viscosity composite resin (Tetric Flow, Ivoclar)	No treatment	10	Non-aged	Non-aged	-----	100% pre-test failure (loss)
					Adhesive (Syntac Single-Component) light-cured for 20s				-----	
					3.8% HF for 120s + silane				μ TBS/28.7 MPa/ $\pm$ 5.9	68% mixed (overall)
					3.8% HF for 120s + silane + adhesive				μ TBS/24.7 MPa/ $\pm$ 7.1	
Knight et al, 2003	USA	VITA VMK	Feldspathic	Composite resin (Amelogen)	9.5% HF for 60s + silane + adhesive (PQ1) light-cured for 20s	10	Non-aged	Distilled water for 7 days	SBS/23.78 MPa/ $\pm$ 6.87	100% cohesive
				Composite resin (Prodigy)	9.5% HF for 60s + silane + adhesive (Optibond FL) light-cured for 30s				SBS/21.13 MPa/ $\pm$ 8.47	

				Amelogen	9.6% HF for 4min + silane + adhesive (PQ1) light-cured for 20s				SBS/24.48 MPa/ ±2.42	
				Prodigy	9.6% HF for 4min + silane + adhesive (Optibond FL) light-cured for 30s				SBS/24.80 MPa/ ±6.37	
Kumbuloglu et al, 2003	Finland	IPS Empress 2	Lithium disilicate	Composite resin (Tetric N Ceram)	Ceramic repair sytem: 37% phosphoric acid for 15s + silane + adhesive (Heliobond) light-cured for 20s	10	Non-aged	Non-aged 6,000 thermal cycles	SBS/7.0 MPa/ ±5.7 SBS/2.5 MPa/ ±1.8	Predominately adhesive
				Composite resin (Arabesk Top)	Cimara system: diamond bur + silane + opaquer liquid light-cured for 20s				SBS/0.6 MPa/ ±1.4 -----	
				Composite resin (Charisma)	Silistor system: carborundum K1 bur + silane + adhesive (Silibond) light-cured for 40s				SBS/3.5 MPa/ ±2.6 SBS/0.2 MPa/ ±0.9	
Kussano et al, 2003	Brazil	IPS Classic	Feldspathic	Composite resin (Z100)	Abrasion with diamond bur + adhesive (Scotchbond Multi-Purpose Plus) light-cured for 20s	10	Non-aged	Distilled water for 7 days	SBS/4.71 MPa/ ±1.06	Not assessed
					Abrasion with diamond bur + diamond bur mechanical retentions with a wheel-shaped diamond bur + adhesive				SBS/4.81 MPa/ ±0.61	
					Abrasion with diamond bur + 35% phosphoric acid for 60s + silane + adhesive				SBS/11.76 MPa/ ±1.45	
					Abrasion with diamond bur + 4% HF for 4min + silane + adhesive				SBS/11.07 MPa/ ±1.83	
Oh and Shen, 2003	USA	IPS Eris	Fluorapatite	Composite resin (Tetric N Ceram)	Silicon carbide abrasive paper + adhesive	20	Non-aged	Non-aged	-----	Unclear

Robin et al, 2002	USA	IPS Empress	Leucite	(Heliobond) light-cured for 20s	10	Non-aged	Non-aged	TBS/7.5 MPa**/ 5.6 – 10.0 (CI)	80% adhesive (overall)
				Air abrasion with 50 μm Al ₂ O ₃ + adhesive					
				5% HF for 120s + adhesive					
				Air abrasion with 50 μm Al ₂ O ₃ + 5% HF for 120s + adhesive					
				Silicon carbide abrasive paper + adhesive (Heliobond) light-cured for 20s					
				Air abrasion with 50 μm Al ₂ O ₃ + adhesive					
		EXC (Experimental core ceramic)	Lithium disilicate	5% HF for 120s + adhesive					
				Air abrasion with 50 μm Al ₂ O ₃ + 5% HF for 120s + adhesive					
				Silicon carbide abrasive paper + adhesive (Heliobond) light-cured for 20s					
				Air abrasion with 50 μm Al ₂ O ₃ + adhesive					
				5% HF for 120s + adhesive					
				Air abrasion with 50 μm Al ₂ O ₃ + 5% HF for 120s + adhesive					

					Air abrasion with 110 µm Al ₂ O ₃ for 10s + silane + adhesive (Prime and Bond) light-cured for 20s		Non-aged	Non-aged	TBS/20.4 MPa**/ 16.1 – 25.6 (CI)	
					Air abrasion with 110 µm Al ₂ O ₃ for 10s + silane + adhesive (Prime and Bond) light-cured for 20s		Non-aged	1,000 thermal cycles	TBS/28.0 MPa**/ 21.4 – 36.2 (CI)	
Haselton et al, 2001	USA	VMK 68	Feldspathic	Composite resin (Tetric Ceram)	CoJet system: sandblasted with 30 µm SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive (Visio Bond) light-cured for 20s	10	Non-aged	300 thermal cycles + distilled water for 8 days	SBS/22.4 MPa/ ±5.6	100% cohesive ceramic
					Ceramic repair system: Air abrasion with 50 µm Al ₂ O ₃ for 15s + 37% phosphoric acid for 15s + silane + adhesive (Heliobond) light-cured for 20s				SBS/18.3 MPa/ ±4.2	
Della Bona et al, 2000	USA	IPS Empress	Leucite	Composite resin (Z100, 3M ESPE)	9.6% HF for 120s + adhesive (Scotchbond Multi-Purpose Plus) light-cured for 10s	20	Non-aged	Distilled water for 30 days	µTBS/9.9 MPa/ ±1.2	100% adhesive
					4% APF (acidulated phosphate fluoride) gel for 120s + adhesive				-----	
					Silane + adhesive				µTBS/27.2 MPa/±4.8	
					9.6% HF for 120s + silane + adhesive				µTBS/20.6 MPa/±3.0	
					4% APF gel for 120s + silane + adhesive				µTBS/13.6 MPa/±4.5	
		IPS Empress II	Lithium disilicate		9.6% HF for 120s + adhesive				µTBS/41.7 MPa/±6.7	
					4% APF gel for 120s + adhesive				µTBS/19.1 MPa/±2.6	

Silane + adhesive									μ TBS/30.1 MPa/ $\pm$ 5.3	
9.6% HF for 120s + silane + adhesive									μ TBS/56.1 MPa/ $\pm$ 4.1	
4% APF gel for 120s + silane + adhesive									μ TBS/36.9 MPa/ $\pm$ 3.9	
Frankenberger et al, 2000	Germany	IPS Empress	Leucite	Composite resin (Pertac II)	5% HF for 60s + silane + adhesive (Visio Bond) light-cured for 20s	15	Non-aged	1,150 thermal cycles	SBS/15.8 MPa/ $\pm$ 4.2	
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ Particles + silane + adhesive (Visio Bond) light-cured for 20s				SBS/12.7 MPa/ $\pm$ 2.7	
		Vitablocs Mark II	Feldspathic		5% HF for 60s + silane + adhesive (Visio Bond) light-cured for 20s				SBS/11.2 MPa/ $\pm$ 2.2	
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive (Visio Bond) light-cured for 20s				SBS/15.3 MPa/ $\pm$ 1.6	
		VMK 68	Feldspathic	Composite resin (Estilux Posterior)	5% HF for 60s + silane + adhesive (Heliobond) light-cured for 20s				SBS/11.2 MPa/ $\pm$ 2.5	
					Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive (Heliobond) light-cured for 20s				SBS/15.3 MPa/ $\pm$ 3.9	
Kelsey et al, 2000	USA	Ceramco II	Feldspathic	Composite resin (Clearfil APX)	Air abrasion with 50 μ m for 10s	10	Non-aged	Non-aged Deionized water for 30 days + 1,000 thermal cycles	SBS/9.0 MPa/ $\pm$ 1.7 SBS/2.4 MPa/ $\pm$ 1.4	
					Air abrasion with 50 μ m for 10s + 40% phosphoric acid for 5s + silane (Clearfil				SBS/16.8 MPa/ $\pm$ 3.3 50% adhesive/cohesive ceramic	

					Porcelain Bond Activator + Clearfil Photo Bond Activator) + adhesive (Clearfil Photo Bond Universal) light-cured for 10s				SBS/17.4 MPa/ ± 3.8	100% cohesive cohesive ceramic
					Air abrasion with 50 μm for 10s + 40% phosphoric acid for 5s + silane (Clearfil SE Bond Primer + Clearfil Porcelain Bond Activator) + adhesive (Clearfil Universal Bond) light-cured for 10s				SBS/24.0 MPa/ ± 2.7	100% cohesive ceramic
									SBS/16.6 MPa/ ± 3.5	100% cohesive ceramic
					Air abrasion with 50 μm for 10s + 37% phosphoric acid for 15s + silane (Scotchbond Ceramic Primer) + adhesive (Single Bond) light-cured for 10s				SBS/12.2 MPa/ ± 1.0 SBS/3.3 MPa/ ± 2.2	100% adhesive 100% adhesive
Rosentritt et al, 2000	Germany	IPS Empress II	Lithium disilicate	Composite resin (Tetric Ceram)	No treatment	10	Non-aged	Non-aged 6,000 thermal cycles	SBS/2.0 MPa*/ ± 1.0 -----	Not assessed
					Diamond bur + silane + adhesive (Heliobond)				SBS/18.0 MPa*/ ± 7.0 SBS/3.0 MPa*/ ± 1.0	
					Sandblasted with 30 μm SiO ₂ -coated Al ₂ O ₃ particles + silane + adhesive (Visio Bond)				SBS/5.0 MPa*/ ± 3.0 SBS/3.0 MPa*/ ± 1.0	
					5% HF + silane + adhesive (Heliobond)				SBS/18.0 MPa*/ ± 6.0 SBS/11.0 MPa*/ ± 3.0	
					Silistor system: carborundum K1 bur + silane + adhesive (Silibond)				SBS/16.0 MPa*/ ± 5.0 SBS/3.0 MPa*/ ± 2.0	
Berry et al, 1999	USA	VMK 68	Feldspathic	Dual cure composite resin	Silicon carbide abrasive papers + silane (Cerinat Prime: one-mix)	10	Non-aged	Non-aged	SBS/4.38 MPa/ ± 4.43	Predominately adhesive

(Mirage, FLC)	Distilled water for one week	SBS/8.12 MPa/ ± 1.88	Predominately cohesive ceramic
	Distilled water for one month	SBS/6.70 MPa/ ± 2.77	Predominately cohesive ceramic
	Distilled water for three months	SBS/8.46 MPa/ ± 1.80	Predominately adhesive
Silicon carbide abrasive papers + silane (Mirage: one-mix)		SBS/8.25 MPa/ ± 4.25	Predominately adhesive
		SBS/14.82MPa/ ± 4.63	Predominately cohesive ceramic
		SBS/16.21MPa/ ± 3.91	Predominately cohesive ceramic
		SBS/22.37 MPa/ ± 4.10	Predominately cohesive ceramic
Silicon carbide abrasive papers + silane (Mirage: two-mix)		SBS/11.59 MPa/ ± 5.49	Predominately adhesive
		SBS/16.24 MPa/ ± 2.86	Predominately cohesive ceramic
		SBS/16.00 MPa/ ± 2.53	Predominately cohesive ceramic
		SBS/17.16 MPa/ ± 2.00	Predominately cohesive ceramic
Silicon carbide abrasive papers + silane (Fusion: two-mix)		SBS/8.62 MPa/ ± 5.20	Predominately adhesive
		SBS/14.36 MPa/ ± 6.21	Predominately cohesive ceramic
		SBS/16.70 MPa/ ± 2.70	Predominately cohesive ceramic
		SBS/23.90 MPa/ ± 4.20	Predominately cohesive ceramic

Leibrock et al, 1999	Germany	Vita Omega 68	Feldspathic	Composite resin (Z100)	Diamond bur + 35% phosphoric acid for 15s + silane (Keramic primer) + adhesive (Scotchbond Multi-purpose Adhesive)	10	Non-aged	Non-aged 2,400 thermal cycles + 480,000 occlusal loading	SBS/15.6 MPa*/ 12.2(Q1), 18.4(Q3) SBS/14.5 MPa*/ 11.9(Q1), 16.7(Q3)	80% cohesive ceramic
				Composite resin (Tetric)	Diamond bur + 32% phosphoric acid for 60s + silane (Monobond S) + adhesive (Heliobond)				SBS/15.7 MPa*/ 11.7(Q1), 19.0(Q3) SBS/14.3 MPa*/ 9.8(Q1), 16.5(Q3)	80% cohesive ceramic 90% cohesive ceramic
				Composite resin (Charisma)	Silistor system: Diamond bur + carborundum K1 bur + silane (Silicer) + adhesive (Silibond)				SBS/10.6 MPa*/ 9.5(Q1), 12.5(Q3) SBS/9.0 MPa*/ 7.2(Q1), 9.8(Q3)	50% cohesive ceramic/mixed 60% mixed
				Composite resin (Ultrafine, Kerr)	Air abrasion with 110 µm Al ₂ O ₃ + 35% phosphoric acid for 60-90s + silane (Porcelain repair primer) + adhesive (Command)				SBS/6.9 MPa*/ 5.0(Q1), 12.9(Q3) SBS/10.0 MPa*/ 5.1(Q1), 12.2(Q3)	60% mixed 50% cohesive ceramic/mixed
				Composite resin (Bisfil M)	Diamond bur + air abrasion with 110 µm Al ₂ O ₃ + 8% HF for 3-4min + silane (Porcelain primer) + adhesive system (All Bond 2: primer A and B + bonding resin)				SBS/17.4 MPa*/ 16.5(Q1), 18.6(Q3) SBS/8.7 MPa*/ 8.2(Q1), 11.6(Q3)	80% cohesive ceramic 50% cohesive ceramic/mixed
				Composite resin (Bisfil M)	Diamond bur + air abrasion with 110 µm Al ₂ O ₃ + 32% phosphoric acid for 10min + silane (Porcelain primer) + adhesive system (All Bond 2: primer A and B + bonding resin)				SBS/11.3 MPa*/ 8.3(Q1), 13.1(Q3) SBS/6.5 MPa*/ 4.6(Q1), 7.2(Q3)	60% cohesive ceramic
				Composite resin (Microfill)	Diamond bur + 9% HF for 60s + silane + adhesive system (primer: Permagen A and B + bonding resin)				SBS/14.1 MPa*/ 11.5(Q1), 17.5(Q3) SBS/12.2 MPa*/ 8.8(Q1), 15.5(Q3)	70% cohesive ceramic 60% cohesive ceramic

Chadwick et al, 1998	Scotland	Matchmaker Dentin Porcelain	Feldspathic	Composite resin (Prisma TPH)	Silicon carbide abrasive paper + air abrasion with 150 µm Al ₂ O ₃ for 5s + 35% phosphoric acid for 15s + silane + adhesive (Scotchbond Multi-Purpose Plus) light-cured for 10s	19	Non-aged	Distilled water for one week	SBS/12.44 MPa/ ±4.82	94.73% cohesive ceramic
					Silicon carbide abrasive paper + air abrasion with 150 µm Al ₂ O ₃ for 5s + 8% HF for 4min + silane + adhesive (One Step, Bisco) light-cured for 10s	20			SBS/16.28 MPa/ ±4.33	100% cohesive ceramic
					Silicon carbide abrasive paper + air abrasion with 150 µm Al ₂ O ₃ for 5s + 32% phosphoric acid for 2min + silane + adhesive (Pulpdent Corporation)	20			SBS/13.80 MPa/ ±3.40	85% cohesive ceramic
Chen et al, 1998	Japan	VMK 68	Feldspathic	Composite resin (Clearfil APX)	Adhesive without silane (Clearfil New Bond)	8	Non-aged	Non-aged	SBS/3.0 MPa/ ±0.4	Predominately adhesive
					Adhesive with silane (Clearfil Porcelain Bond)				SBS/25.2 MPa/ ±4.2	
					2,5% HF for 30s + adhesive without silane				SBS/30.2 MPa/ ±4.1	Predominately adhesive
					2,5% HF for 30s + adhesive with silane				SBS/36.0 MPa/ ±4.9	Predominately cohesive ceramic
					2,5% HF for 60s + adhesive without silane				SBS/28.1 MPa/ ±4.0	Predominately adhesive
					2,5% HF for 60s + adhesive with silane				SBS/36.4 MPa/ ±4.6	Predominately cohesive ceramic
					2,5% HF for 90s + adhesive without silane				SBS/30.5 MPa/ ±4.4	Predominately adhesive
					2,5% HF for 90s + adhesive with silane				SBS/35.0 MPa/ ±5.1	Predominately cohesive ceramic
					2,5% HF for 120s + adhesive without silane				SBS/25.3 MPa/ ±3.7	Predominately adhesive

2,5% HF for 120s + adhesive with silane	SBS/35.0 MPa/ ± 5.1	Predominately cohesive ceramic
2,5% HF for 150s + adhesive without silane	SBS/35.4 MPa/ ± 4.4	Predominately adhesive
2,5% HF for 150s + adhesive with silane	SBS/37.4 MPa/ ± 6.1	Predominately cohesive ceramic
2,5% HF for 180s + adhesive without silane	SBS/26.5 MPa/ ± 3.4	Predominately adhesive
2,5% HF for 180s + adhesive without silane	SBS/33.4 MPa/ ± 4.2	Predominately cohesive ceramic
5% HF for 30s + adhesive without silane	SBS/18.8 MPa/ ± 4.0	Predominately adhesive
5% HF for 30s + adhesive with silane	SBS/32.9 MPa/ ± 5.5	Predominately cohesive ceramic
5% HF for 60s + adhesive without silane	SBS/19.7 MPa/ ± 1.6	Predominately adhesive
5% HF for 60s + adhesive with silane	SBS/31.3 MPa/ ± 4.4	Predominately cohesive ceramic
5% HF for 90s + adhesive without silane	SBS/21.9 MPa/ ± 2.3	Predominately adhesive
5% HF for 90s + adhesive with silane	SBS/31.5 MPa/ ± 3.2	Predominately cohesive ceramic
5% HF for 120s + adhesive without silane	SBS/19.9 MPa/ ± 2.8	Predominately adhesive
5% HF for 120s + adhesive with silane	SBS/32.2 MPa/ ± 4.9	Predominately cohesive ceramic
5% HF for 150s + adhesive without silane	SBS/32.0 MPa/ ± 2.3	Predominately adhesive
5% HF for 150s + adhesive with silane	SBS/30.5 MPa/ ± 3.2	Predominately cohesive ceramic
5% HF for 180s + adhesive without silane	SBS/23.4 MPa/ ± 4.5	Predominately adhesive

					5% HF for 180s + adhesive without silane				SBS/34.3 MPa/ ± 4.6	Predominately cohesive ceramic
Proano et al, 1998	Germany	VMK 68	Feldspathic	Composite resin (Charisma)	Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles + silane (Silicer) + adhesive (Silibond)	7	Non-aged	Distilled water for 3 days	SBS/12.6 MPa/ ± 3.5	Not assessed
								2,000 thermal cycles + distilled water for 28 days	SBS/12.9 MPa/ ± 2.6	
				Composite resin (Visio Fil)	Sandblasted with 30 μ m SiO ₂ -coated Al ₂ O ₃ particles + silane (ESPE-Sil) + adhesive (Visio Bond)				SBS/10.3 MPa/ ± 2.3	
									SBS/11.6 MPa/ ± 2.3	
				Composite resin (Charisma)	Air abrasion with 30 μ m Al ₂ O ₃ + silane (Silicer) + adhesive (Silibond)				SBS/14.2 MPa/ ± 4.2	
									SBS/12.4 MPa/ ± 2.5	
Shahverdi et al, 1998	Turkey	VMK 68	Feldspathic	Composite resin (Charisma)	Air abrasion with 50 μ m Al ₂ O ₃ for 60s + 5% HF for 60s + adhesive (Bond II, Kulser)	22	Non-aged	Non-aged	SBS/10.84 MPa/ ± 0.52	Not assessed
								Distilled water for 30 days + 200 thermal cycles	SBS/10.00 MPa/ ± 0.62	
					Carborundum K1 bur + silane (Silicer) + adhesive (Bond II)				SBS/17.54MPa/ ± 0.51 SBS/11.04MPa/ ± 0.46	
					Air abrasion with 50 μ m Al ₂ O ₃ for 60s + 5% HF for 60s + silane (Monobond S) + adhesive (Bond II)				SBS/25.57MPa/ ± 1.38 SBS/25.20MPa/ ± 0.58	
					5% HF for 60s + silane (Monobond S) + adhesive (Bond II)				SBS/23.50MPa/ ± 0.73 SBS/22.79MPa/ ± 0.57	
					Air abrasion with 50 μ m Al ₂ O ₃ for 60s + silane (Monobond S) + adhesive (Bond II)				SBS/18.45MPa/ ± 0.47 SBS/16.93MPa/ ± 0.75	

Chung and Hwang, 1997	China	Biobond porcelain system	Feldspathic	Composite resin (Heliomolar)	Silicon carbide abrasive paper + silane (Silanit) + adhesive (Heliobond)	10	Non-aged	Distilled water for 7 days	SBS/8.0 MPa/ ± 4.6	Not assessed
					Air abrasion with 50 μm Al_2O_3 for 20s + silane + adhesive				SBS/7.2 MPa/ ± 1.4	
					9.5% HF for 4min + silane + adhesive				SBS/8.1 MPa/ ± 2.5	
				Composite resin (Clearfil)	Silicon carbide abrasive paper + silane (Liner-M) + adhesive (Superbond C&B)				SBS/9.7 MPa/ ± 1.2	
					Air abrasion with 50 μm Al_2O_3 for 20s + silane + adhesive				SBS/7.9 MPa/ ± 2.6	
					9.5% HF for 4min + silane + adhesive				SBS/6.8 MPa/ ± 2.0	
				Composite resin (Charisma)	Silicon carbide abrasive paper + silane (Silistor) + adhesive (Silibond)				SBS/6.6 MPa/ ± 1.1	
					Air abrasion with 50 μm Al_2O_3 for 20s + silane + adhesive				SBS/8.8 MPa/ ± 1.9	
					9.5% HF for 4min + silane + adhesive				SBS/9.5 MPa/ ± 1.3	
				Composite resin (Conquest)	Silicon carbide abrasive paper + silane (Optec) + adhesive (Universal; Pentron)				SBS/8.3 MPa/ ± 1.1	
					Air abrasion with 50 μm Al_2O_3 for 20s + silane + adhesive				SBS/14.3 MPa/ ± 2.2	
					9.5% HF for 4min + silane + adhesive				SBS/7.3 MPa/ ± 1.8	

				Composite resin (Z100)	Silicon carbide abrasive paper + silane (Scotchprime) + adhesive (Scotchbond)					SBS/12.7 MPa/ ±2.1		
					Air abrasion with 50 µm Al ₂ O ₃ for 20s + silane + adhesive					SBS/16.2 MPa/ ±2.9		
					9.5% HF for 4min + silane + adhesive					SBS/14.7 MPa/ ±2.7		
					Composite resin (TPH)					Silicon carbide abrasive paper + silane (Prime & Bond) + adhesive (Prime & Bond)		SBS/12.0 MPa/ ±2.0
					Air abrasion with 50 µm Al ₂ O ₃ for 20s + silane + adhesive					SBS/16.8 MPa/ ±1.8		
					9.5% HF for 4min + silane + adhesive					SBS/16.8 MPa/ ±2.1		
Eikenberg and Shurtleff, 1996	USA	Excelco	Feldspathic	Composite resin (Prisma APH)	Abrasion with diamond bur + silane (Fusion) + adhesive (Prisma Universal Bond) light-cured for 40s	20	Non-aged	Ambient humidity for 7 months + 500 thermal cycles Saline for 7 months + 500 thermal cycles	SBS/26.0 MPa/ ±4.41	55% mixed		
									SBS/5.0 MPa/ ±4.74	80% adhesive		
					Abrasion with diamond bur + silane (Scotchprime) + adhesive				SBS/36.13MPa/±3.64	55% cohesive ceramic		
									SBS/13.18MPa/±5.77	60% adhesive		
					Abrasion with diamond bur + silane (Command) + adhesive				SBS/25.87MPa/±3.34	55% mixed		
									SBS/18.05MPa/±5.54	45% adhesive		
Kupiec et al, 1996	USA	Ceramco II	Feldspathic	Composite resin (Prisma TPH)	Air abrasion with 50 µm Al ₂ O ₃ + silane + primer (ProBond primer) + adhesive (ProBond	10	Non-aged	Non-aged Distilled water for 3 months +	SBS/14.0 MPa/ ±1.6 SBS/13.6 MPa/ ±2.3	100% cohesive ceramic		

	adhesive) light-cured for 10s	2,500 thermal cycles	
	Air abrasion with 50 µm Al ₂ O ₃ + silane + adhesive	SBS/16.6 MPa/ ±1.2 SBS/11.6 MPa/ ±1.5	100% cohesive ceramic
	Air abrasion with 50 µm Al ₂ O ₃ + silane	SBS/14.6 MPa/ ±2.0 SBS/13.8 MPa/ ±2.2	100% cohesive ceramic
	Air abrasion with 50 µm Al ₂ O ₃ + primer + adhesive	SBS/9.6 MPa/ ±1.7 SBS/5.5 MPa/ ±0.8	30% / 0 cohesive ceramic
	Air abrasion with 50 µm Al ₂ O ₃ + primer	SBS/8.3 MPa/ ±1.8 SBS/6.1 MPa/ ±1.0	30% / 0 cohesive ceramic
	Air abrasion with 50 µm Al ₂ O ₃ + adhesive	SBS/10.7 MPa/ ±1.3 SBS/2.3 MPa/ ±0.6	60% / 0 cohesive ceramic
	Air abrasion with 50 µm Al ₂ O ₃ + silane + primer	SBS/15.5 MPa/ ±2.9 SBS/13.4 MPa/ ±2.1	90% cohesive ceramic
	Air abrasion with 50 µm Al ₂ O ₃	SBS/7.4 MPa/ ±1.5 SBS/2.4 MPa/ ±1.3	0
	8% HF for 4 min + silane + primer (ProBond primer) + adhesive (ProBond adhesive) light-cured for 10s	SBS/14.1 MPa/ ±1.7 SBS/14.6 MPa/ ±1.6	100% cohesive ceramic
	8% HF for 4 min + silane + adhesive	SBS/16.0 MPa/ ±2.0 SBS/12.4 MPa/ ±2.2	100% cohesive ceramic
	8% HF for 4 min + silane	SBS/14.4 MPa/ ±1.8 SBS/15.1 MPa/ ±3.1	100% cohesive ceramic
	8% HF for 4 min + primer + adhesive	SBS/13.9 MPa/ ±2.6 SBS/12.1 MPa/ ±1.7	60% cohesive ceramic
	8% HF for 4 min + primer	SBS/14.4 MPa/ ±2.6 SBS/12.5 MPa/ ±2.3	100% /30% cohesive ceramic
	8% HF for 4 min + adhesive	SBS/13.7 MPa/ ±1.8 SBS/10.9 MPa/ ±1.7	60% / 10% cohesive ceramic

					8% HF for 4 min + silane + primer				SBS/14.7 MPa/ ± 2.7 SBS/13.5 MPa/ ± 2.0	80% / 100% cohesive ceramic
					8% HF for 4 min				SBS/14.5 MPa/ ± 3.1 SBS/12.2 MPa/ ± 2.8	90% / 10% cohesive ceramic
					Air abrasion with 50 μm Al_2O_3 + 8% HF for 4 min + silane + primer (ProBond primer) + adhesive (ProBond adhesive) light-cured for 10s				SBS/16.6 MPa/ ± 1.8 SBS/15.2 MPa/ ± 1.6	100% cohesive ceramic
					Air abrasion with 50 μm Al_2O_3 + 8% HF for 4 min + silane + adhesive				SBS/15.9 MPa/ ± 1.7 SBS/12.3 MPa/ ± 1.1	100% / 90% cohesive ceramic
					Air abrasion with 50 μm Al_2O_3 + 8% HF for 4 min + silane				SBS/17.0 MPa/ ± 3.3 SBS/13.5 MPa/ ± 2.8	100% cohesive ceramic
					Air abrasion with 50 μm Al_2O_3 + 8% HF for 4 min + primer + adhesive				SBS/13.3 MPa/ ± 1.9 SBS/13.3 MPa/ ± 3.1	60% cohesive ceramic
					Air abrasion with 50 μm Al_2O_3 + 8% HF for 4 min + primer				SBS/13.8 MPa/ ± 2.4 SBS/12.7 MPa/ ± 2.3	100%/ 50% cohesive ceramic
					Air abrasion with 50 μm Al_2O_3 + 8% HF for 4 min + adhesive				SBS/15.3 MPa/ ± 1.6 SBS/12.3 MPa/ ± 1.2	100% / 30% cohesive ceramic
					Air abrasion with 50 μm Al_2O_3 + 8% HF for 4 min + silane + primer				SBS/16.9 MPa/ ± 2.8 SBS/13.8 MPa/ ± 2.0	100% cohesive ceramic
					Air abrasion with 50 μm Al_2O_3 + 8% HF for 4 min				SBS/13.6 MPa/ ± 4.2 SBS/12.6 MPa/ ± 2.4	70% / 20% cohesive ceramic
Pameijer et al, 1996	USA	Vita VMK	Feldspathic	Composite resin (Amelogen)	Air abrasion with 50 μm Al_2O_3 + 9.5% HF + silane (Scotch Prime) + primer	10	Non-aged	Non-aged 800 thermal cycles	SBS/13.65 MPa/ ± 2.5 SBS/6.8 MPa/ ± 1.9	Predominately cohesive ceramic

					(Permagen A and B) + adhesive (Permagen)				SBS/15.66 MPa/ ± 7.2 SBS/9.4 MPa/ ± 2.8	
					Air abrasion with 50 μm Al_2O_3 + 9% HF + silane (Ultradent) + primer (Permagen A and B) + adhesive (Permagen)					
Van der Vyver et al, 1996	South Africa	Vitablocs Mark II	Feldspathic	Composite resin (Z100)	10% phosphoric acid for 15s + silane (Scotchprime) + adhesive (Scotchbond Multi-Purpose) light-cured for 10s	20	Non-aged	Non-aged	SBS/22.6 MPa/ ± 6.5	85% cohesive ceramic
				Composite resin (Tetric)	Air abrasion with 50 μm Al_2O_3 for 5s + 32% phosphoric acid for 5-10s + silane (Primer A and B) + adhesive (All Bond 2) light- cured for 20s				SBS/17.1 MPa/ ± 4.1	75% cohesive ceramic
				Composite resin (Herculite XRV)	Air abrasion with 50 μm Al_2O_3 for 5s + 9.6% HF for 4min + silane (Ultradent) + adhesive (Optibond) light- cured for 30s				SBS/17.1 MPa/ ± 2.3	75% cohesive ceramic
				Composite resin (Prisma APH)	Air abrasion with 50 μm Al_2O_3 for 5s + Etch-free (4- META) + C&B Metabond + adhesive (Prisma Universal Bond 3) light- cured for 10s				SBS/25.8 MPa/ ± 4.2	90% cohesive ceramic
				Composite resin (Prisma APH)	9.6% HF for 2 min + silane (Mirage) + adhesive (Mirage Bond) light-cured for 20s				SBS/13.1 MPa/ ± 3.9	70% cohesive ceramic
				Composite resin (Prisma APH)	4% APF for 2min + silane (Mirage) + adhesive (Mirage Bond) light-cured for 20s				SBS/6.0 MPa/ ± 2.1	100% adhesive
					Air abrasion with 50 μm Al_2O_3 for 5s + silane (Silicoup A and B) +				SBS/16.4 MPa/ ± 3.7	70% cohesive ceramic

				Composite resin (Charisma)	adhesive (Silibond) light-cured for 20s				SBS/18.3 MPa/ ± 5.2	70% cohesive ceramic
				Composite resin (Lite-Fil II)	Air abrasion with 50 μm Al_2O_3 for 5s + silane (Imperva primer) + adhesive (Imperva Bond Adhesive) light-cured for 10s					
Della Bona and Van Noort, 1995	Brazil	VMK 68	Feldspathic	Composite resin (Prisma APH)	9.6% HF for 2min + silane + adhesive (Prisma Universal Bond 3) light-cured for 10s	10	Non-aged	Distilled water for 3 days	TBS/13.46 MPa/ ± 2.18	100% adhesive
					4% APF for 2min + silane + adhesive (Prisma Universal Bond 3) light-cured for 10s				TBS/13.43 MPa/ ± 4.46	
Thurmond et al, 1994	USA	Ceramco	Feldspathic	Low-viscosity composite resin (Bis-Fil, Bisco)	Bonding agent bottle (All Bond 2)	10	Non-aged	Non-aged Distilled water for 3 months + 2,500 thermal cycles	SBS/10.6 MPa/ ± 2.3 SBS/1.8 MPa/ ± 1.6	Adhesive Not informed
					Air abrasion with 50 μm Al_2O_3 + 32% phosphoric acid + silane + bonding agent bottle (All Bond 2)				SBS/22.4 MPa/ ± 5.7 SBS/13.4 MPa/ ± 4.3	
					Adhesive system (All Bond 2: primer A and B + bonding agent)				SBS/13.9 MPa/ ± 2.0 SBS/0.1 MPa/ ± 0.1	Adhesive Not informed
					Silane + adhesive system (All Bond 2: primer A and B + bonding agent)				SBS/25.0 MPa/ ± 4.4 SBS/0.9 MPa/ ± 0.8	
					Diamond bur + 32% phosphoric acid + silane + bonding agent bottle (All Bond 2)				SBS/16.4 MPa/ ± 4.7 SBS/9.3 MPa/ ± 2.6	60% cohesive ceramic Not informed
					8% HF + bonding agent bottle (All Bond 2)				SBS/23.4 MPa/ ± 4.2	
										70% cohesive ceramic

									SBS/7.7 MPa/ ±1.7	Not informed		
					8% HF + silane + bonding agent bottle (All Bond 2)				SBS/22.7 MPa/ ±4.9	100% cohesive ceramic		
									SBS/9.6 MPa/ ±1.9	Not informed		
					Air abrasion with 50 µm Al ₂ O ₃ + 8% HF + silane + bonding agent bottle (All Bond 2)				SBS/20.9 MPa/ ±4.5	100% cohesive ceramic		
									SBS/17.4 MPa/ ±2.0	60% cohesive ceramic		
					Air abrasion with 50 µm Al ₂ O ₃ + bonding agent bottle (All Bond 2)				SBS/13.2 MPa/ ±3.2	10% cohesive ceramic		
									SBS/11.8 MPa/ ±4.8	Not informed		
					Air abrasion with 50 µm Al ₂ O ₃ + 32% phosphoric acid + adhesive system (All Bond 2: primer A and B + bonding agent				SBS/17.0 MPa/ ±3.0	Not informed		
									SBS/2.3 MPa/ ±1.1	Not informed		
Tylka and Steward, 1994	USA	Will-Ceram	Feldspathic	Composite resin (Command, Kerr)	1.23% APF for 10min + silane	17	Non aged	Deionized water for one week	SBS/ 287.5 MPa/ ±87.50	Predominately cohesive		
					9.5% HF for 5 min + silane	17			SBS/ 300 MPa/ ±87.50			
		Biobond porcelain system			1.23% APF for 10min + silane	10			SBS/ 275 MPa/ ±75.0			
					9.5% HF for 5 min + silane	8			SBS/ 325 MPa/ ±75.0			
Appeldoorn et al, 1993	USA	Ceramco II	Feldspathic	Composite resin (Bis-Fil)	Air abrasion with 50 µm Al ₂ O ₃ + 32% phosphoric acid for 30s + silane (Porcelain primer) + adhesive (All-Bond 2) light-cured for 20s	10	Non-aged	Non-aged Distilled water for 3 months + 2,500 thermal cycles	SBS/22.3 MPa/ ±3.5 SBS/17.0 MPa/ ±3.0	100% / 90% cohesive ceramic		
				Composite resin (Clearfil Photo-Anterior)	Air abrasion with 50 µm Al ₂ O ₃ + 40% phosphoric acid for 5s + adhesive (Clearfil Porcelain Bond)				SBS/18.5 MPa/ ±4.7 SBS/20.7 MPa/ ±1.7	100% cohesive ceramic		

				Composite resin (Bis-Fil)	Etch-free (4-META) + C&B Metabond + adhesive (Bisco Dentin/Enamel) light-cured for 20s				SBS/23.5 MPa/ ±5.3 SBS/18.4 MPa/ ±1.6	40% / 20% cohesive ceramic
				Composite resin (Heliomolar)	Diamond bur + 37% phosphoric acid for 60s + silane (Monobond-S) + adhesive (Heliobond) light-cured for 20s				SBS/14.1 MPa/ ±1.4 SBS/12.6 MPa/ ±1.1	100% / 40% cohesive ceramic
				Composite resin (Herculite XRV)	Diamond bur + 37% phosphoric acid for 60s + silane (Porcelain repair primer) + adhesive (Bondlite) light-cured for 20s				SBS/15.1 MPa/ ±2.1 SBS/15.4 MPa/ ±2.1	100% / 90% cohesive ceramic
				Composite resin (Silux-Plus)	37% phosphoric acid for 60s + silane (Scotchprime) + adhesive (Scotchbond 2) light-cured for 20s				SBS/15.1 MPa/ ±1.7 SBS/14.9 MPa/ ±1.7	100% cohesive ceramic
				Composite resin (Multifil VS)	Carborundum K1 bur + silane (Silicer)+ adhesive (Silibond) light-cured for 90s				SBS/12.2 MPa/ ±2.5 SBS/4.2 MPa/ ±1.0	90% / 0 cohesive ceramic
Diaz-Arnold et al, 1993	USA	VMK 68	Feldspathic	Composite resin (Herculite XR)	30% phosphoric acid + silane (All-Bond ceramic primer) + adhesive (All-Bond 2)	10	Non-aged	300 thermal cycles + distilled water for 35 days	SBS/18.1 MPa/ ±1.8	Cohesive ceramic
					37% phosphoric acid for 15s + silane (Activator-catalyst Universal Bond)				SBS/18.5 MPa/ ±3.8	Cohesive ceramic
					9.5% HF + silane (Prilane) + adhesive (Adper Scotchbond Multi-Purpose) light-cured for 10s				SBS/11.5 MPa/ ±3.1	Adhesive
					Etch-free (4-META + silane) + adhesive (Metabond)				SBS/17.0 MPa/ ±3.5	Cohesive ceramic

					10% maleic acid + silane (Scotchprime) + adhesive (Adper Scotchbond Multi-Purpose) light-cured for 10s				SBS/17.7 MPa/ ± 2.9	Cohesive ceramic
					7% HF + silane (Ultradent) + adhesive (Adper Scotchbond Multi-Purpose) light-cured for 10s				SBS/17.2 MPa/ ± 3.1	Cohesive ceramic
Suliman et al, 1993	USA	VMK 68	Feldspathic	Composite resin (Prisma APH)	Diamond bur + silane + adhesive (Amalgabond)	5	Non-aged	Distilled water for one week + 500 thermal cycles	SBS/9.79 MPa/ ± 2.32	Predominately cohesive
					9.6% HF for 2min + silane + adhesive (Amalgabond)				SBS/16.20 MPa/ ± 3.01	Predominately cohesive
					Air abrasion with 50 μm Al_2O_3 + silane + adhesive (Amalgabond)				SBS/9.52 MPa/ ± 1.24	Predominately cohesive
					Diamond bur + 9.6% HF for 2min + silane + adhesive (Amalgabond)				SBS/18.11 MPa/ ± 2.09	Predominately cohesive
					Diamond bur + silane + adhesive (All-Bond 2) light-cured for 20s				SBS/16.10 MPa/ ± 2.44	Predominately cohesive
					9.6% HF for 2min + silane + adhesive (All-Bond 2)				SBS/14.28 MPa/ ± 3.28	Predominately cohesive
					Air abrasion with 50 μm Al_2O_3 + silane + adhesive (All-Bond 2)				SBS/13.74 MPa/ ± 6.22	Predominately adhesive
					Diamond bur + 9.6% HF for 2min + silane + adhesive (All-Bond 2)				SBS/15.79 MPa/ ± 3.69	Predominately adhesive
					Diamond bur + silane + adhesive (Clearfil Porcelain Bond)				SBS/16.98 MPa/ ± 6.24	Predominately cohesive
					9.6% HF for 2min + silane + adhesive (Clearfil Porcelain Bond)				SBS/19.72 MPa/ ± 7.73	Predominately cohesive

					Air abrasion with 50 μm Al_2O_3 + silane + adhesive (Clearfil Porcelain Bond)				SBS/16.86 MPa/ ± 4.70	Predominately cohesive
					Diamond bur + 9.6% HF for 2min + silane + adhesive (Clearfil Porcelain Bond)				SBS/17.66 MPa/ ± 7.05	Predominately cohesive
Wolf et al, 1993	USA	Ceramco II	Feldspathic	Composite resin (Herculite XRV)	9.5% HF for 30s + silane + adhesive (Scotchbond 2)	5	Non-aged	Non-aged	SBS/15.0 MPa/ ± 6.0	100% adhesive
					9.5% HF for 60s + silane + adhesive				SBS/20.0 MPa/ ± 6.0	80% adhesive
					9.5% HF for 150s + silane + adhesive				SBS/27.0 MPa/ ± 6.0	100% adhesive
					9.5% HF for 300s + silane + adhesive				SBS/25.0 MPa/ ± 5.0	60% adhesive
					Air abrasion with 10.2 μm Al_2O_3 + 37% phosphoric acid for 60s + silane + adhesive				SBS/12.0 MPa/ ± 5.0	100% adhesive
					Air abrasion with 33.5 μm Al_2O_3 + silane + adhesive				SBS/11.0 MPa/ ± 4.0	100% adhesive
					Air abrasion with 48 μm Al_2O_3 + silane + adhesive				SBS/14.0 MPa/ ± 4.0	100% adhesive
					Air abrasion with 78 μm Al_2O_3 + silane + adhesive				SBS/7.0 MPa/ ± 5.0	100% adhesive
					Air abrasion with 50 μm Al_2O_3 + silane + adhesive				SBS/19.0 MPa/ ± 2.0	60% adhesive
Wolf et al, 1992	USA	Ceramco II	Feldspathic	Composite resin (Herculite XR)	9.5% HF for 5 min + silane (Universal Catalyst Activator)	5	Non-aged	Non-aged 1,000 thermal cycles	TBS/20.0 MPa/ ± 5.1 TBS/12.5 MPa/ ± 2.4	60% / 100% cohesive ceramic
					9.5% HF for 5 min + silane (Porcelain Liner M)				TBS/12.8 MPa/ ± 3.6 TBS/8.5 MPa/ ± 1.1	60% / 80% cohesive ceramic

9.5% HF for 5 min + silane (Scotchprime)	TBS/17.2 MPa/ ± 4.0 TBS/11.0 MPa/ ± 2.9	80% cohesive ceramic
9.5% HF for 5 min + silane (Super-Bond C&B)	TBS/16.9 MPa/ ± 5.8 TBS/11.0 MPa/ ± 1.0	60% cohesive ceramic / 60% adhesive
Air abrasion with 50 μm Al_2O_3 for 3s + 40% phosphoric acid for 30s + silane (Universal Catalyst Activator)	TBS/23.4 MPa/ ± 5.1 TBS/12.5 MPa/ ± 2.4	80% / 60% cohesive ceramic
Air abrasion with 50 μm Al_2O_3 for 3s + 40% phosphoric acid for 30s + silane (Porcelain Liner M)	TBS/4.9 MPa/ ± 1.7 TBS/3.7 MPa/ ± 1.0	100% adhesive
Air abrasion with 50 μm Al_2O_3 for 3s + 40% phosphoric acid for 30s + silane (Scotchprime)	TBS/23.7 MPa/ ± 2.1 TBS/16.3 MPa/ ± 6.4	60% adhesive
Air abrasion with 50 μm Al_2O_3 for 3s + 40% phosphoric acid for 30s + silane (Super-Bond C&B)	TBS/20.4 MPa/ ± 6.0 TBS/12.0 MPa/ ± 1.8	60% / 100% adhesive
Silicon carbide abrasive paper + diamond bur + 40% phosphoric acid for 30s + silane (Universal Catalyst Activator)	TBS/23.5 MPa/ ± 3.6 TBS/12.9 MPa/ ± 4.6	60% / 80% cohesive ceramic
Silicon carbide abrasive paper + diamond bur + 40% phosphoric acid for 30s + silane (Porcelain Liner M)	TBS/7.9 MPa/ ± 2.3 TBS/4.6 MPa/ ± 1.0	100% / 80% adhesive
Silicon carbide abrasive paper + diamond bur + 40% phosphoric acid for 30s + silane (Scotchprime)	TBS/15.0 MPa/ ± 2.7 TBS/11.3 MPa/ ± 5.1	100% / 80% adhesive
Silicon carbide abrasive paper + diamond bur + 40% phosphoric acid for 30s + silane (Super-Bond C&B)	TBS/19.1 MPa/ ± 5.1 TBS/7.0 MPa/ ± 1.1	100% adhesive

Cooley et al, 1991	USA	Will-Ceram	Feldspathic	Not informed	Diamond bur + pumice + Etch-free (4-META) + C&B Metabond	20	Non-aged	Non-aged 800 thermal cycles	SBS/17.4 MPa/ ± 4.8 SBS/19.1 MPa/ ± 7.1	Not assessed
Gregory and Moss, 1990	USA	Not informed	Feldspathic	Composite resin (Concise)	Silicon carbide abrasive + silane (Scotchprime)	11	Non-aged	Distilled water for 28 days	TBS/21.51 MPa/ ± 4.07	52% adhesive (overall)
				Composite resin (Herculite)	Silicon carbide abrasive + silane (Porcelain Repair Liquid)				TBS/16.90 MPa/ ± 7.10	
				Composite resin (Silux Plus)	Silicon carbide abrasive + silane (Scotchprime)				TBS/6.39 MPa/ ± 3.49	
Kondo et al, 1990	Japan	Super Porcelain AAA	Feldspathic	Composite resin (Porcelite)	Control: silane (Ceramic primer) + adhesive (Bondlite)	4	Non-aged	Non-aged	SBS/ 6.81 MPa/ ± 2.43	Not assessed
					HF for 3min + silane (Ceramic primer) + adhesive (Bondlite)				SBS/ 13.16 MPa/ ± 2.33	
					2.5% HF for 5min + silane (Ceramic primer) + adhesive (Bondlite)				SBS/ 13.97 MPa/ ± 2.35	
					2% APF for 20min + silane (Ceramic primer) + adhesive (Bondlite)				SBS/ 12.06/ ± 2.91	
		Cosmotech Porcelain	Feldspathic		Control: silane (Ceramic primer) + adhesive (Bondlite)				SBS/ 7.28 MPa/ ± 1.29	
					HF for 3min + silane (Ceramic primer) + adhesive (Bondlite)				SBS/ 12.08 MPa/ ± 0.50	
Diaz-Arnold et al, 1989	USA	VMK 68	Feldspathic	Composite resin	Non-glazed + silane (Fusion)	12	Non-aged	Distilled water for 48h	SBS/ 11.35 MPa/ ± 3.73	91% cohesive ceramic

				(Comand Ultrafine)				Distilled water for 30 days	SBS/ 11.28 MPa/ ±5.04		
				Composite resin (Silux)	Non-glazed + silane (Scotchprime)				SBS/ 15.78 MPa/ ±3.83	100% cohesive ceramic	
									SBS/ 14.16 MPa/ ±4.56	Predominately adhesive	
				Composite resin (Ultra-Bond)	Non-glazed + silane (Cerinate prime)				SBS/ 4.96 MPa/ ±1.71	91% cohesive ceramic	
									SBS/ 2.89 MPa/ ±1.07	100% cohesive ceramic	
				Comand Ultrafine	Glazed + silane (Fusion)				SBS/0.89 MPa/ ±0.34 SBS/ 0.53MPa/ ±0.13	Predominately adhesive	
				Silux	Glazed + silane (Scotchprime)				SBS/15.66MPa/±5.17 SBS/11.64MPa/±3.55		
				Ultra-Bond	Glazed + silane (Cerinate prime)				SBS/0.76 MPa/ ±0.36 SBS/0.23 MPa/ ±0.22		
Matsumura et al, 1989	Japan	VMK 68	Feldspathic	Composite resin (Photo-Clearfil A)	Silicon carbide abrasive paper	3	Non-aged	Non-aged	0	100% adhesive	
								5,000 thermal cycles	-----	Pre-test failure	
								10,000 thermal cycles	-----	Pre-test failure	
								20,000 thermal cycles	-----	Pre-test failure	
								Silicon carbide abrasive paper + primer (F liquid)		0	100% adhesive
									-----	Pre-test failure	
									-----	Pre-test failure	
								Silicon carbide abrasive paper + primer (Z liquid)		SBS/14.1 MPa/ ±6.8	100% adhesive
									SBS/7.3 MPa/ ±3.5	100% adhesive	
									0	100% adhesive	
								Silicon carbide abrasive paper + primer (F + Z liquid)		-----	Pre-test failure
									SBS/15.4 MPa/ ±3.8	100% adhesive	
									SBS/4.0 MPa/ ±2.5	100% adhesive	
									0	100% adhesive	

		-----	Pre-test failure
Silicon carbide abrasive paper + adhesive (MMA- TBB)	SBS/6.3 MPa/ ± 1.2 0	----- -----	100% adhesive 100% adhesive Pre-test failure Pre-test failure
Silicon carbide abrasive paper + primer (F liquid) adhesive (MMA-TBB)	SBS/6.5 MPa/ ± 2.0 0	----- -----	100% adhesive 100% adhesive Pre-test failure Pre-test failure
Silicon carbide abrasive paper + primer (Z liquid) adhesive (MMA-TBB)	SBS/23.7 MPa/ ± 6.4 SBS/16.6 MPa/ ± 6.4 SBS/12.1 MPa/ ± 0.5 SBS/5.1 MPa/ ± 3.9		66.5 % cohesive ceramic 66.5% adhesive 100% adhesive 100% adhesive
Silicon carbide abrasive paper (F + Z liquid) + adhesive (MMA-TBB)	SBS/28.1 MPa/ ± 3.0 SBS/32.6 MPa/ ± 7.2 SBS/27.3 MPa/ ± 3.0 SBS/15.5 MPa/ ± 4.1		100 % cohesive ceramic 66.5 % cohesive ceramic 66.5 % mixed 100% adhesive
Silicon carbide abrasive paper + adhesive (4- META/MMA-TBB)	SBS/19.4 MPa/ ± 5.6 SBS/5.1 MPa/ ± 3.1 0	-----	33.5% adhesive 100% adhesive 100% adhesive Pre-test failure
Silicon carbide abrasive paper + primer (F liquid) + adhesive (4-META/MMA- TBB)	SBS/22.3 MPa/ ± 4.8 SBS/6.3 MPa/ ± 5.9 SBS/2.8 MPa/ ± 2.1 0		100% cohesive ceramic 100% adhesive 100% adhesive 100% adhesive
Silicon carbide abrasive paper + primer (Z liquid) +	SBS/25.2 MPa/ ± 2.1 SBS/27.5 MPa/ ± 7.0		33.5% adhesive 66.5 mixed

Pratt et al, 1989	Tex	Vita Porcelain	Feldspathic	Not informed	Porcelain Repair Kit with Scotchprime	10	Non-aged	Distilled water for 48h + 500 thermal cycles Distilled water for 3 months + 500 thermal cycles	adhesive (4-META/MMA-TBB)	SBS/11.6 MPa/ ±5.5 SBS/11.3 MPa/ ±2.4	100% adhesive 100% adhesive			
									Silicon carbide abrasive paper + primer (F + Z liquid) + adhesive (4-META/MMA-TBB)	SBS/29.8 MPa/ ±3.7	66.5 % cohesive ceramic			
										SBS/30.6 MPa/ ±7.5	100% cohesive ceramic			
										SBS/29.5 MPa/ ±4.6 SBS/17.1 MPa/ ±2.9	66.5% mixed 100% adhesive			
									Diamond bur + primer (F + Z liquid) + adhesive (4-META/MMA-TBB)	SBS/31.5 MPa/ ±4.1	100% cohesive ceramic			
										SBS/32.3 MPa/ ±1.3	66.5 % cohesive ceramic			
										SBS/31.8 MPa/ ±4.4	66.5 % cohesive ceramic			
										SBS/26.3 MPa/ ±5.3	66.5 % mixed			
									Diamond bur + 40% phosphoric acid for 30s+ primer (F + Z liquid) + adhesive (4-META/MMA-TBB)	SBS/33.8 MPa/ ±5.2	100% cohesive ceramic			
										SBS/35.1 MPa/ ±6.0	66.5 % cohesive ceramic			
										SBS/32.9 MPa/ ±7.6	100% cohesive ceramic			
										SBS/27.8 MPa/ ±4.2	33.5 % adhesive			
					Silanit					SBS/ 11.19 MPa/ Not informed	100% cohesive ceramic			
										SBS/ 6.19 MPa/ Not informed	60% cohesive ceramic			
										SBS/ 9.27 MPa/ Not informed	100% cohesive ceramic			
										SBS/ 2.15 MPa/ Not informed	100% adhesive			

					Porcelain Repair Bonding Agent (Den-Mat)				SBS/ 4.89 MPa/ Not informed	60% adhesive		
									SBS/ 2.97 MPa/ Not informed	90% adhesive		
					Enamelite 500				SBS/ 5.67 MPa/ Not informed	100% cohesive ceramic		
									SBS/ 2.31 MPa/ Not informed	50% /cohesive ceramic		
					Ceram-Etch				SBS/ 8.53 MPa/ Not informed	100% cohesive ceramic		
									SBS/ 1.41 MPa/ Not informed	100% adhesive		
					Porcelite				SBS/ 11.28 MPa/ Not informed	100% cohesive ceramic		
									SBS/ 1.71 MPa/ Not informed	100% adhesive		
Ferrando et al, 1983	USA	Will-Ceram	Feldspathic	Not informed	Enamelite 500	10	Non-aged	Distilled water for 1 week Distilled water for 4 weeks	TBS/9.72 MPa/ ±0.94	Not assessed		
				Composite resin (Adaptic)	Fusion				TBS/9.81 MPa/ ±1.03			
									TBS/4.49 MPa/ ±0.46			
									TBS/6.30 MPa/ ±0.79			
				Composite resin (Adaptic)	Composite resin only				TBS/1.15 MPa/ ±0.41			
									TBS/2.40 MPa/ ±0.50			
				Not Informed	Porcelain repair kit (Den-Mat)				TBS/0.67 MPa/ ±0.24			
									TBS/1.58 MPa/ ±0.60			
				Not informed	Cyano-Veneer				TBS/0.18 MPa/ ±0.04			
									TBS/0.29 MPa/ ±0.06			

SBS, shear bond strength; μ SBS, microshear bond strength; TBS, tensile bond strength; μ TBS, microtensile bond strength; MPa, megapascal; $\pm$ SD, standard deviation; CI, confidence interval; IQR, interquartile range; Q1, 25% percentile; Q3, 75% percentile; HF, hydrofluoric acid; Nd-YAG, neodymium-doped yttrium aluminum garnet laser conditioning; Er:YAG, erbium-doped yttrium aluminum garnet laser conditioning; Er,Cr:YSGG, erbium, chromium-doped yttrium, scandium, gallium and garnet laser conditioning; μ m, wavelength in micrometers; nm, wavelength in nanometers; W, laser output power in watts; mW, laser output power in milliwatts; Hz, laser repetition rate (frequency) in hertz; mHz, laser repetition rate (frequency) in millihertz; mJ, energy parameter in millijoule; mg/L, methylene blue photosensitizer concentration in milligrams per liter; L/min, atmospheric-pressure plasma gas flow rate in liters per minute; μ s, laser pulse duration in microsecond; UV, ultraviolet; CO₂, carbon dioxide; Al₂O₃, aluminum oxide; SiO₂, silica. * Median values; **There is no definition of statistical representation.

Supplemental Table 3. Qualitative synthesis (risk of bias assessment)

Study	(1) Was exposure level adequately randomized?	(2) Was allocation to study groups adequately concealed?	(3) Did selection of study samples result in appropriate comparison groups?	(4) Did the study design or analysis account for important confounding variables?	(5) Were experimental conditions identical across study groups?	(6) Were the research personnel blinded to the study group?	(7) Were outcome data complete reported (without attrition or exclusion from analysis)?	(8) Can we be confident in the exposure characterization?	(9) Can we be confident in the outcome assessment?	(10) Were all measured outcomes reported?	(11) Was failure mode assessment performed ?
Da Cunha et al, 2022	NR	NR	+	-	+	--	++	++	+	++	++
Degirmenci et al, 2022	+	NR	+	+	+	-	NR	++	+	++	+
Holler et al, 2022	NR	NR	+	+	+	--	++	++	+	++	--
Bayraktar et al, 2021	NR	NR	+	+	++	-	++	++	+	++	+
Schellenberg and Özcan, 2021	+	NR	+	+	++	-	+	++	+	++	-
Sismanoglu et al, 2021	NR	NR	+	-	+	-	NR	+	+	++	+
Tang et al, 2021	+	NR	+	-	++	-	NR	++	+	++	++
Ueda et al, 2021	+	NR	+	-	+	-	++	++	+	++	++
Valian et al, 2021	NR	NR	++	+	+	-	+	++	+	++	++
Al Deeb, 2020	NR	NR	+	-	+	-	NR	++	+	++	++
Al-Turki et al, 2020	+	NR	+	+	+	-	NR	++	+	++	--
Barutcigil and Kirmali, 2020	+	NR	+	+	+	-	NR	+	+	++	+
Baiomy et al, 2020	++	NR	+	+	++	-	NR	++	+	++	+
Falah and Ameer, 2020	NR	NR	+	-	-	-	NR	-	+	++	+
Gul and Altinok-Uygun, 2020	NR	NR	+	+	+	-	NR	-	-	+	+
Hakimaneh et al, 2020	+	NR	++	-	++	-	+	++	+	++	++
Kilinc et al, 2020	++	NR	+	+	+	-	NR	++	+	++	++
Maawadh et al, 2020	+	NR	+	-	+	-	NR	+	+	++	++
Sanal and Kilinc et al, 2020	+	NR	+	+	+	-	NR	+	+	+	++
Sismanoglu et al, 2020	+	NR	+	+	+	-	NR	++	+	++	++

Verissimo et al, 2020	+	NR	+	++	++	-	++	++	+	++	++
Çinar and Kirmali, 2019	NR	NR	+	+	+	-	NR	++	+	++	++
Flury et al, 2019	NR	NR	+	-	+	-	NR	++	+	++	++
Hwang et al, 2019	NR	NR	+	+	+	-	NR	++	+	++	++
Kazak et al, 2019	+	NR	+	+	++	-	NR	++	+	++	--
Suárez-Moya et al, 2019	++	NR	+	-	++	-	NR	++	+	++	++
Tokar et al, 2019	+	NR	+	-	+	-	NR	++	-	++	++
Yadav et al, 2019	NR	NR	+	-	+	-	NR	+	+	++	--
Yildirim et al, 2019	+	NR	++	-	++	-	NR	++	+	++	++
AlRabiah et al, 2018	NR	NR	+	-	+	-	NR	++	+	++	++
Ataol and Ergun, 2018 (a)	+	NR	+	+	+	-	-	+	+	++	+
Ataol and Ergun, 2018 (b)	NR	NR	+	+	+	-	-	++	-	++	++
Ebrahimi et al, 2018	+	NR	+	-	+	-	NR	++	+	++	++
Kameyama et al, 2018	+	NR	+	+	+	-	++	++	+	++	--
Karci et al, 2018	+	NR	+	+	+	-	NR	++	+	++	++
Üstün et al, 2018	+	NR	+	++	+	-	NR	++	+	++	++
Carraba et al, 2017	+	NR	+	+	+	-	NR	++	+	++	++
Ghavam et al, 2017	+	NR	+	+	+	-	NR	+	+	++	--
Kocaagaoğlu et al, 2017	NR	NR	+	+	+	-	NR	++	+	++	--
Ödzemir and Yanikoglu, 2017	+	NR	+	+	+	-	NR	++	+	++	++
Sattabanasuk et al, 2017	+	NR	++	+	+	-	NR	+	+	++	++
Al-Thagafi et al, 2016	NR	NR	++	+	+	-	NR	++	+	++	++
Bergoli et al, 2016	NR	NR	+	-	++	-	-	++	-	++	+
Corazza et al, 2016	+	NR	++	+	+	-	++	++	+	++	++
Duzyol et al, 2016	NR	NR	+	+	+	-	++	++	+	++	--
Moravej-Salehi et al, 2016	+	NR	++	+	+	-	NR	++	+	++	++

Uzun et al, 2016	NR	NR	+	+	+	-	NR	++	+	++	++
Kocaağaoğlu and Gürbulak, 2015	NR	NR	+	+	+	-	NR	++	+	++	++
Mohammadi et al, 2015	+	NR	+	-	+	-	NR	++	+	++	++
Neis et al, 2015	+	NR	+	+	++	-	NR	++	+	++	++
Sadeghi et al, 2015	+	NR	++	+	+	-	NR	++	+	++	++
Yoo et al, 2015	NR	NR	+	+	+	-	NR	++	+	++	++
Erdemir et al, 2014	+	NR	+	+	++	-	+	++	+	++	--
Kanat et al, 2014	+	NR	+	+	+	-	NR	++	+	++	++
Lee et al, 2014	NR	NR	+	-	+	-	NR	++	+	++	--
Zaghloul et al, 2014	NR	NR	+	-	+	-	NR	++	+	++	++
Colares et al, 2013	+	NR	+	-	+	-	-	++	-	++	++
Huang et al, 2013	NR	NR	+	-	+	-	++	+	+	++	++
Jain et al, 2013	NR	NR	+	-	+	-	NR	++	+	++	+
Saraç et al, 2013	NR	NR	+	+	+	-	NR	++	+	++	++
Blum et al, 2012	++	NR	+	-	+	-	NR	++	--	+	+
Predrazzi et al, 2012	NR	NR	-	--	-	-	NR	-	-	+	--
Queiroz et al, 2012	+	NR	++	+	-	-	NR	-	-	+	+
Tarcin et al, 2012	+	NR	+	-	++	-	NR	++	+	++	--
Külünk and Şinasi Saraç, 2011	+	NR	+	-	+	-	NR	++	+	++	--
Akyul et al, 2010	NR	NR	+	-	+	-	NR	++	+	++	++
Chen et al, 2010	NR	NR	+	+	+	-	NR	++	-	++	+
Fahmy and Mohsen, 2010	NR	NR	+	-	+	-	NR	++	+	++	--
Meshramkar and Sajjan, 2010	NR	NR	--	--	-	-	NR	-	-	++	--
Güler et al, 2009	+	NR	+	-	+	-	NR	+	+	++	++
Lundvall et al, 2009	NR	NR	-	-	+	-	++	+	+	++	--
Yesil et al, 2009	NR	NR	+	-	+	-	NR	-	-	++	--
Panah et al, 2008	NR	NR	++	+	+	-	++	++	+	++	+
Boscato et al, 2007	NR	NR	++	+	+	-	NR	++	+	++	++
Kim et al, 2007	-	NR	-	--	+	-	NR	+	-	++	--

Kukiattrakoon and Thammasitboon, 2007	NR	NR	+	+	+	-	NR	++	+	++	++
de Melo et al, 2007	+	NR	++	+	+	-	NR	++	+	++	++
Schmage et al, 2007	NR	NR	-	-	+	-	NR	++	-	++	++
Yesil et al, 2007	NR	NR	-	+	+	-	NR	++	+	++	--
dos Santos et al, 2006	NR	NR	+	+	+	-	NR	+	+	++	++
Güler et al, 2006	NR	NR	+	-	+	-	NR	++	+	++	--
Güler et al, 2005	NR	NR	+	-	+	-	NR	++	+	++	--
Kim et al, 2005	NR	NR	-	-	+	-	NR	++	+	++	--
Oh and Shen, 2005	NR	NR	++	+	+	-	NR	++	+	++	--
El Zohairy et al, 2004	NR	NR	+	+	+	-	NR	++	-	++	+
Sazak-Öveçoğlu et al, 2004	NR	NR	+	-	+	-	NR	++	-	++	--
El Zohairy et al, 2003	NR	NR	+	-	+	-	NR	++	+	++	+
Knight et al, 2003	+	NR	-	-	-	-	NR	++	-	++	++
Kumbuloglu et al, 2003	+	NR	+	+	+	-	NR	++	+	++	+
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Oh and Shen, 2003	NR	NR	+	-	+	-	NR	++	+	++	+
Robin et al, 2002	NR	NR	+	+	+	-	NR	++	+	+	+
Haselton et al, 2001	-	NR	-	-	+	-	NR	++	+	++	++
Della Bona et al, 2000	NR	NR	+	+	+	-	NR	++	+	++	++
Frankenberger et al, 2000	NR	NR	+	++	+	-	NR	++	+	++	++
Kelsey et al, 2000	NR	NR	+	++	+	-	NR	++	+	++	++
Rosentritt et al, 2000	NR	NR	-	-	+	-	NR	+	--	++	--
Berry et al, 1999	+	NR	++	+	+	-	NR	+	+	++	+
Leibrock et al, 1999	NR	NR	+	+	+	-	NR	+	+	++	++
Chadwick et al, 1998	+	NR	-	+	+	-	-	++	-	++	++

Chen et al, 1998	NR	NR	+	+	+	-	NR	++	+	++	+
Proano et al, 1998	NR	NR	+	+	+	-	NR	+	+	++	--
Shahverdi et al, 1998	+	NR	+	-	+	-	NR	+	+	++	--
Chung and Hwang, 1997	+	NR	+	+	+	+	NR	+	+	++	--
Eikenberg and Shurtleff, 1996	NR	NR	+	-	-	-	-	-	-	++	++
Kupiec et al, 1996	+	NR	+	+	+	-	NR	-	-	++	+
Pameijer et al, 1996	NR	NR	+	-	-	-	NR	-	-	++	+
Van der Vyver et al, 1996	+	NR	++	-	+	-	NR	++	+	++	++
Della Bona and Van Noort, 1995	+	NR	+	+	+	-	NR	+	+	++	++
Thurmond et al, 1994	NR	NR	+	+	+	-	NR	+	+	++	+
Tylka and Steward, 1994	NR	NR	+	-	+	-	-	+	--	++	+
Appeldoorn et al, 1993	NR	NR	+	+	+	-	NR	++	+	++	++
Diaz-Arnold et al, 1993	NR	NR	+	-	+	-	NR	+	+	++	+
Suliman et al, 1993	+	NR	+	+	+	-	NR	+	-	++	+
Wolf et al, 1993	NR	NR	+	-	+	-	NR	+	+	++	++
Wolf et al, 1992	NR	NR	+	+	+	-	NR	+	+	++	++
Cooley et al, 1991	NR	NR	+	-	+	-	NR	+	+	++	--
Gregory and Moss, 1990	+	NR	+	-	+	-	NR	+	-	++	+
Kondo et al, 1990	NR	NR	+	-	-	-	NR	-	-	++	--
Diaz-Arnold et al, 1989	NR	NR	++	+	+	-	NR	+	+	++	+
Matsumura et al, 1989	NR	NR	+	+	+	-	++	+	+	++	++
Pratt et al, 1989	NR	NR	-	-	-	-	NR	-	--	+	++
Ferrando et al, 1983	NR	NR	+	+	+	-	NR	-	-	+	--

(++) definitely low risk of bias; (+) probably low risk of bias; (-) or (NR) probably high risk of bias; (--) definitely high risk of bias

FIGURES

Figure 1. Flowchart of studies selection.

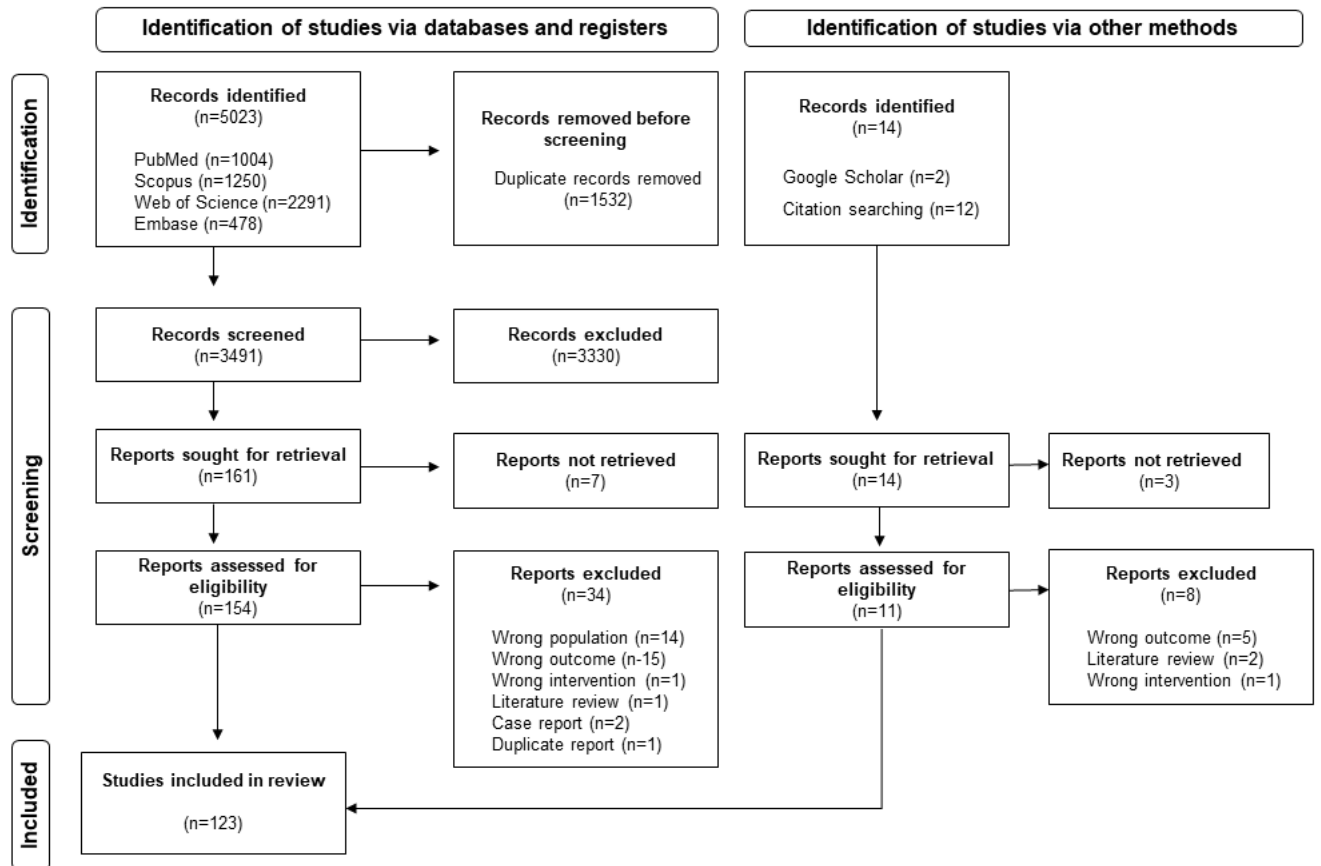
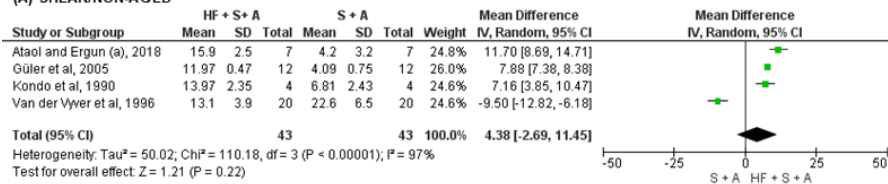
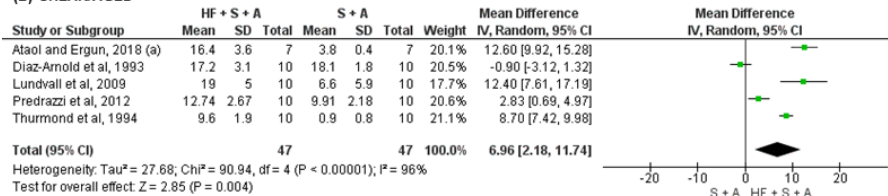


Figure 2. Comparison of feldspathic ceramic repair bond strength with composite resin after different surface treatments versus silane and adhesive application. HF: hydrofluoric acid; S: silane; A: adhesive; AA 50 μ m Al₂O₃: air abrasion with 50 μ m of aluminum oxide particles; Er,Cr:YSGG laser: erbium, chromium-doped yttrium, scandium, gallium and garnet laser; DB: diamond bur.

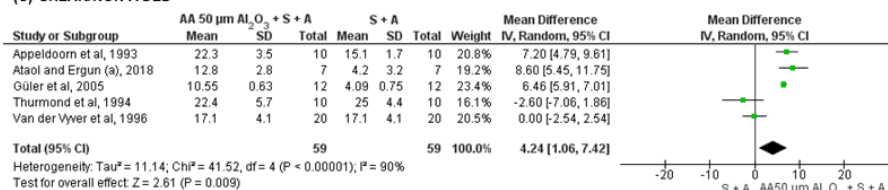
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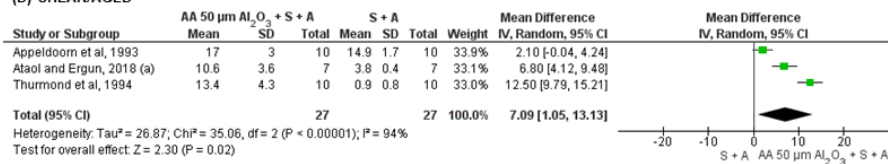
(B) SHEAR/AGED



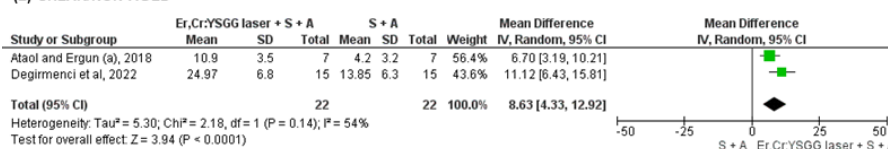
(C) SHEAR/NON-AGED



(D) SHEAR/AGED



(E) SHEAR/NON-AGED



(F) SHEAR/NON-AGED

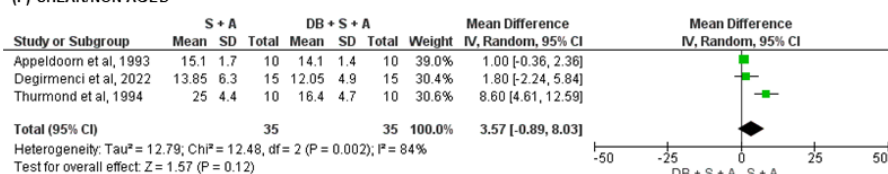
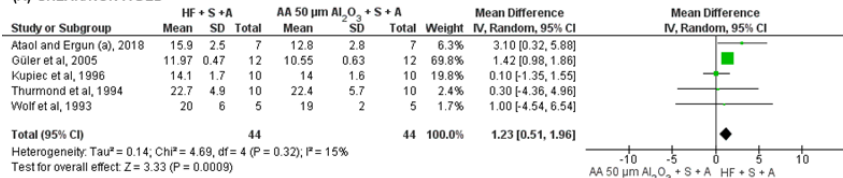
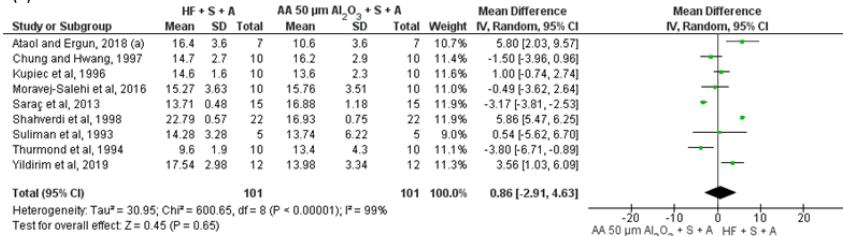


Figure 3. Comparison of feldspathic ceramic repair bond strength with composite resin between different surface treatments. HF: hydrofluoric acid; S: silane; A: adhesive; AA 50 μ m Al₂O₃: air abrasion with 50 μ m of aluminum oxide particles; DB: diamond bur; SB: sandblasting with aluminum trioxide particles coated with silica.

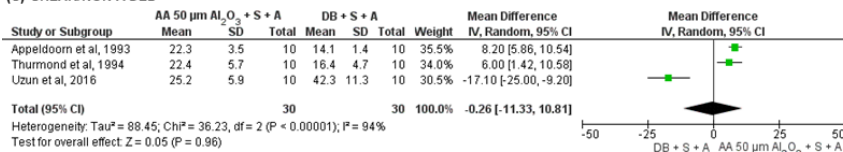
(A) SHEAR/NON-AGED



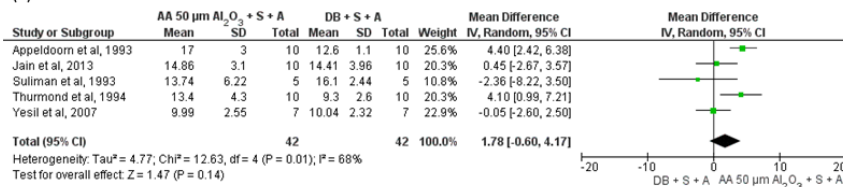
(B) SHEAR/AGED



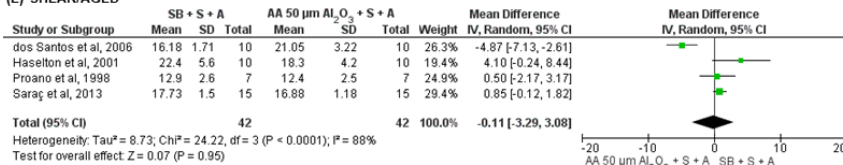
(C) SHEAR/NON-AGED



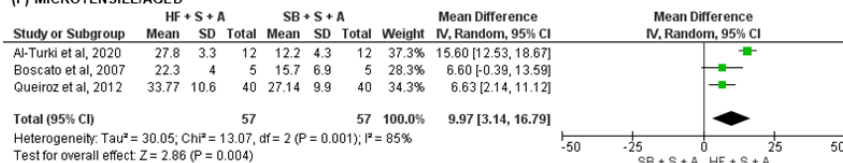
(D) SHEAR/AGED



(E) SHEAR/AGED



(F) MICROTENSILE/AGED



(G) SHEAR/AGED

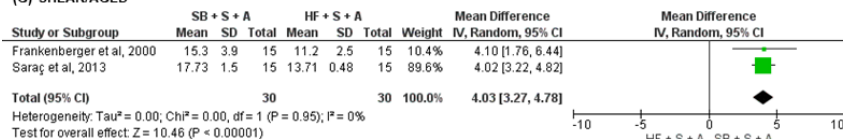


Figure 4. Evaluation of feldspathic ceramics repair bond strength with composite resin, comparing the use or not of silane (A, B and C) and adhesive (D, E and F) in two different surface treatments. HF: hydrofluoric acid; S: silane; A: adhesive; AA 50 μ m Al₂O₃: air abrasion with 50 μ m of aluminum oxide particles.

(A) SHEAR/AGED

Study or Subgroup	HF+S+A			HF+A			Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total			
Kupiec et al, 1996	14.6	1.6	10	12.1	1.7	10	28.8%	2.50 [1.05, 3.95]	
Lundvall et al, 2009	19	5	10	13.14	2.2	10	7.4%	5.86 [2.47, 9.25]	
Thurmond et al, 1994	9.6	1.9	10	7.7	1.7	10	25.7%	1.90 [0.32, 3.48]	
Valian et al, 2021	14.08	1.39	10	11.39	1.21	10	38.1%	2.69 [1.55, 3.83]	
Total (95% CI)			40			40	100.0%	2.67 [1.70, 3.64]	

Heterogeneity: Tau² = 0.30; Chi² = 4.36, df = 3 (P = 0.23); I² = 31%
Test for overall effect: Z = 5.39 (P < 0.00001)

(B) SHEAR/NON-AGED

Study or Subgroup	AA 50 μ m Al ₂ O ₃ + S + A			AA 50 μ m Al ₂ O ₃ + A			Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total			
Appeldoorn et al, 1993	22.3	3.5	10	18.5	4.7	10	17.7%	3.80 [0.17, 7.43]	
Güler et al, 2005	10.55	0.63	12	5.37	0.88	12	22.1%	5.18 [4.57, 5.79]	
Kupiec et al, 1996	14	1.6	10	9.6	1.7	10	21.4%	4.40 [2.95, 5.85]	
Meshramkar and Sajjan, 2010	6.24	1.06	7	7.54	0.77	7	21.9%	-1.30 [-2.27, -0.33]	
Thurmond et al, 1994	22.4	5.7	10	17	3	10	16.9%	5.40 [1.41, 9.39]	
Total (95% CI)			49			49	100.0%	3.39 [0.03, 6.75]	

Heterogeneity: Tau² = 13.19; Chi² = 125.26, df = 4 (P < 0.00001); I² = 97%
Test for overall effect: Z = 1.98 (P = 0.05)

(C) SHEAR/NON-AGED

Study or Subgroup	HF + S + A			HF + S			Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total			
Ataol and Ergun (a), 2018	15.9	2.5	7	14.7	3	7	22.0%	1.20 [-1.69, 4.09]	
Kupiec et al, 1996	14.1	1.7	10	14.4	1.8	10	78.0%	-0.30 [-1.83, 1.23]	
Total (95% CI)			17			17	100.0%	0.03 [-1.33, 1.39]	

Heterogeneity: Tau² = 0.00; Chi² = 0.81, df = 1 (P = 0.37); I² = 0%
Test for overall effect: Z = 0.04 (P = 0.97)

(D) SHEAR/AGED

Study or Subgroup	HF+S+A			HF+S			Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total			
Ataol and Ergun, 2018 (a)	16.4	3.6	7	13.7	7.1	7	18.3%	2.70 [-3.20, 8.60]	
Kupiec et al, 1996	14.6	1.6	10	15.1	3.1	10	45.3%	-0.50 [-2.66, 1.66]	
Schellenberg and Özcan, 2021	11	3.7	10	7.4	3.4	10	36.4%	3.60 [0.49, 6.71]	
Total (95% CI)			27			27	100.0%	1.58 [-1.47, 4.62]	

Heterogeneity: Tau² = 4.11; Chi² = 4.85, df = 2 (P = 0.09); I² = 59%
Test for overall effect: Z = 1.02 (P = 0.31)

(E) SHEAR/NON-AGED

Study or Subgroup	AA 50 μ m Al ₂ O ₃ + S + A			AA 50 μ m Al ₂ O ₃ + S			Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total			
Ataol and Ergun (a), 2018	12.8	2.8	7	12.1	7	7	7.5%	0.70 [-4.89, 6.29]	
Kupiec et al, 1996	14	1.6	10	14.6	2	10	92.5%	-0.60 [-2.19, 0.99]	
Total (95% CI)			17			17	100.0%	-0.50 [-2.03, 1.02]	

Heterogeneity: Tau² = 0.00; Chi² = 0.19, df = 1 (P = 0.66); I² = 0%
Test for overall effect: Z = 0.65 (P = 0.52)

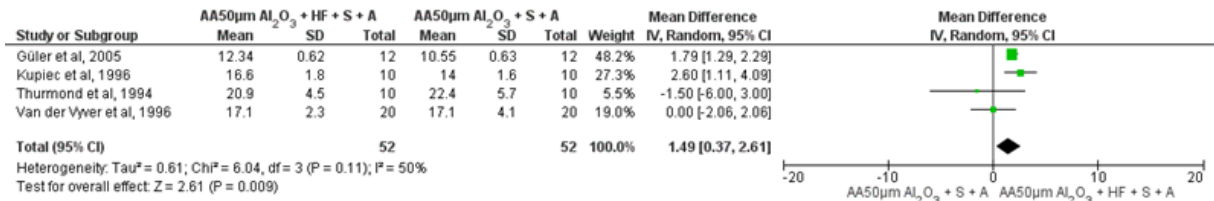
(F) SHEAR/AGED

Study or Subgroup	AA 50 μ m Al ₂ O ₃ + S			AA 50 μ m Al ₂ O ₃ + S + A			Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total			
Ataol and Ergun, 2018 (a)	11.3	2.1	7	10.6	3.6	7	29.0%	0.70 [-2.39, 3.79]	
Kupiec et al, 1996	13.8	2.2	10	13.6	2.3	10	71.0%	0.20 [-1.77, 2.17]	
Total (95% CI)			17			17	100.0%	0.34 [-1.32, 2.01]	

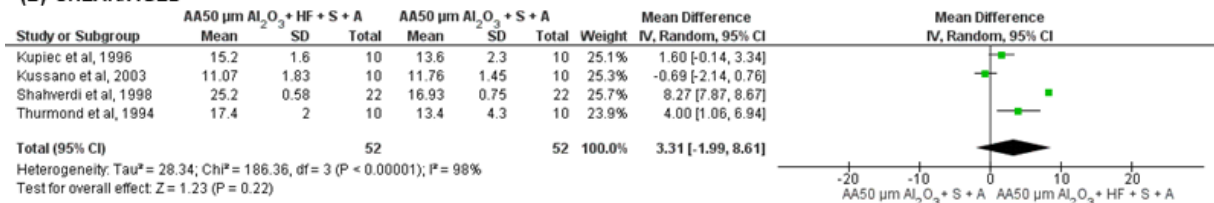
Heterogeneity: Tau² = 0.00; Chi² = 0.07, df = 1 (P = 0.79); I² = 0%
Test for overall effect: Z = 0.41 (P = 0.68)

Figure 5. Evaluation of feldspathic ceramics repair bond strength with composite resin, comparing the use or not of HF after AA or DB and prior silane and adhesive application. HF: hydrofluoric acid; S: silane; A: adhesive; AA 50 μ m Al₂O₃: air abrasion with 50 μ m of aluminum oxide particles; DB: diamond bur.

(A) SHEAR/NON-AGED



(B) SHEAR/AGED



(C) SHEAR/AGED

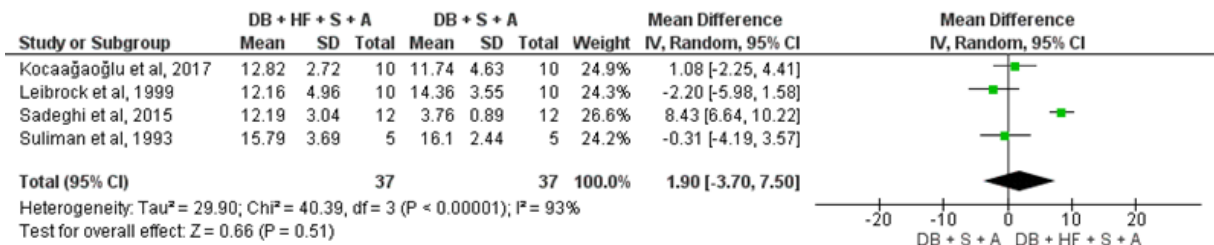
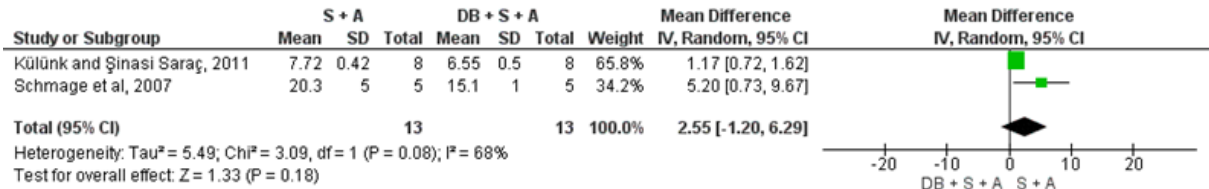
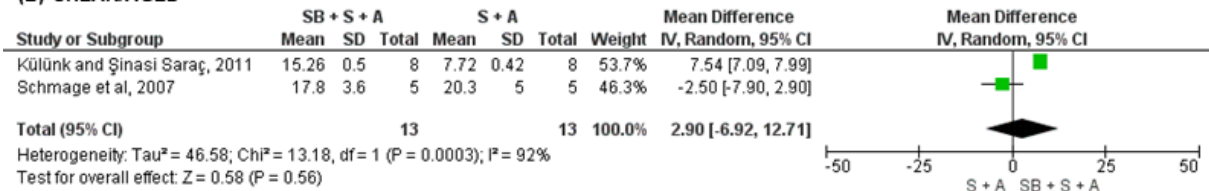


Figure 6. Comparison of leucite-reinforced ceramics repair bond strength with composite resin between different surface treatments. HF: hydrofluoric acid; S: silane; A: adhesive; SB: sandblasting with aluminum trioxide particles coated with silica; DB: diamond bur.

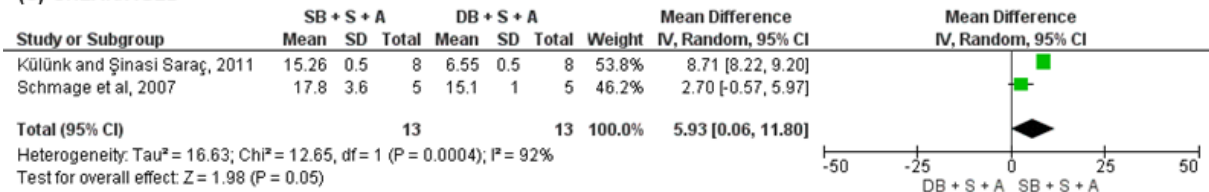
(A) SHEAR/AGED



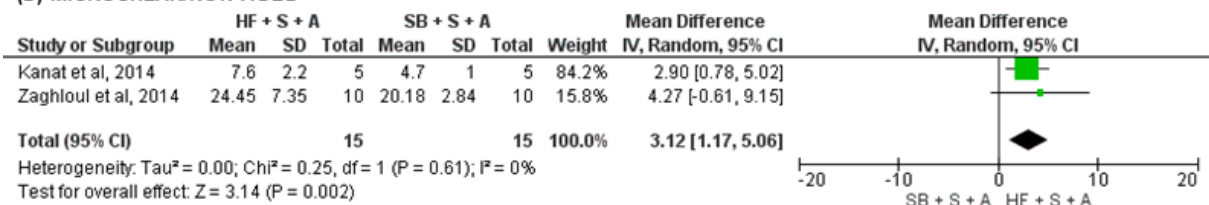
(B) SHEAR/AGED



(C) SHEAR/AGED



(D) MICROSHEAR/NON-AGED



(E) MICROTENSILE/AGED

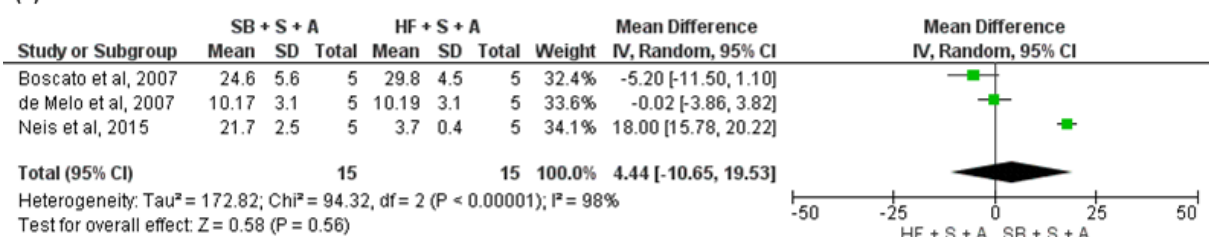
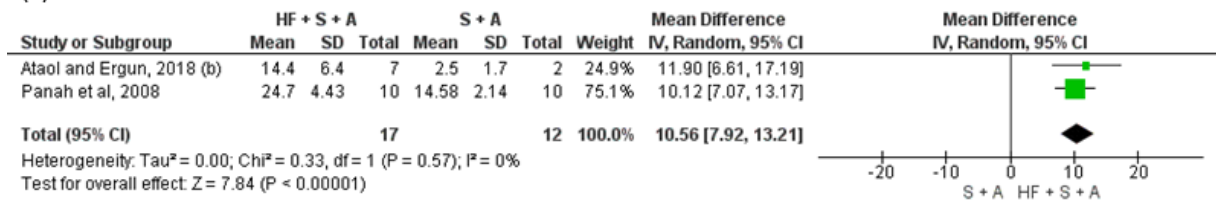
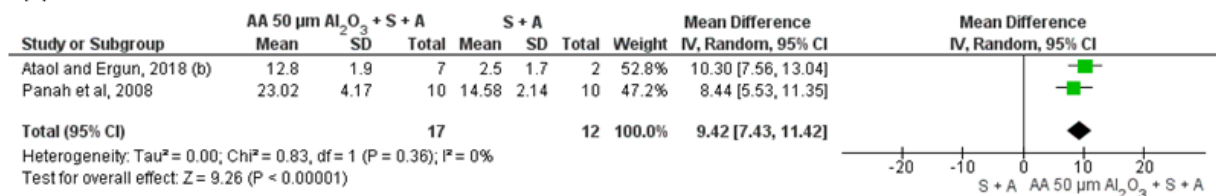


Figure 7. Comparison of lithium disilicate-reinforced ceramics repair bond strength with composite resin after different surface treatments versus silane and adhesive application. HF: hydrofluoric acid; S: silane; A: adhesive; AA 50 μ m Al₂O₃: air abrasion with 50 μ m of aluminum oxide particles; Er,Cr:YSGG laser: erbium, chromium-doped yttrium, scandium, gallium and garnet laser.

(A) SHEAR/NON-AGED



(B) SHEAR/NON-AGED



(C) SHEAR/NON-AGED

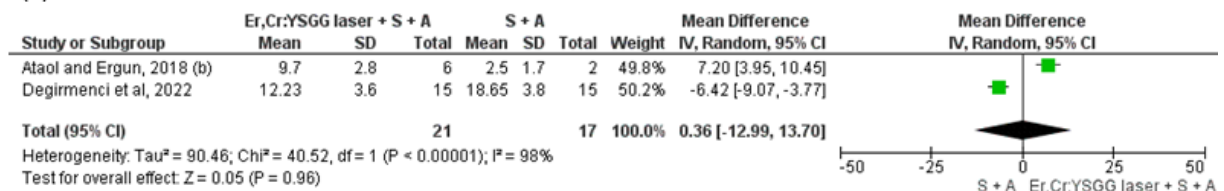
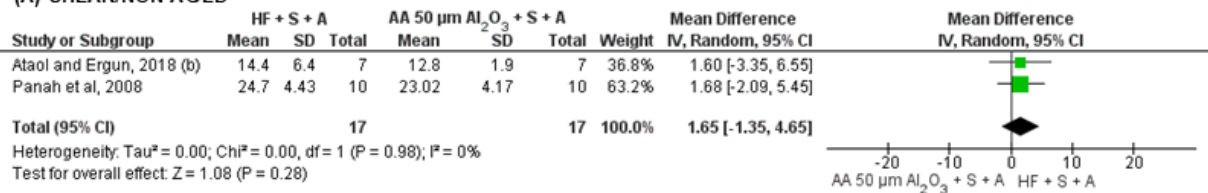
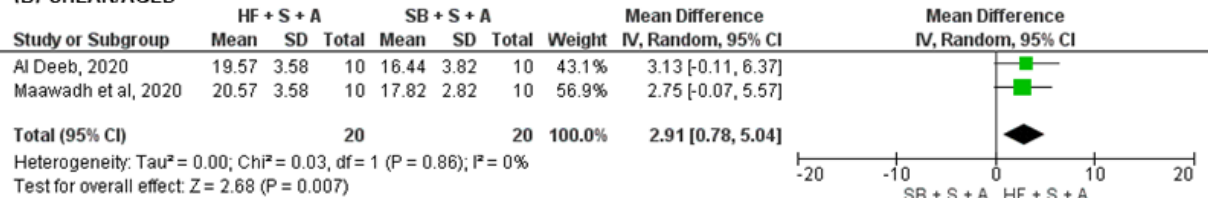


Figure 8. Comparison of lithium disilicate-reinforced ceramics repair bond strength with composite resin between different surface treatments. HF: hydrofluoric acid; S: silane; A: adhesive; SB: sandblasting with aluminum trioxide particles coated with silica; DB: diamond bur; AA 50 μ m Al₂O₃: air abrasion with 50 μ m of aluminum oxide particles; Er,Cr:YSGG laser: erbium, chromium-doped yttrium, scandium, gallium and garnet laser.

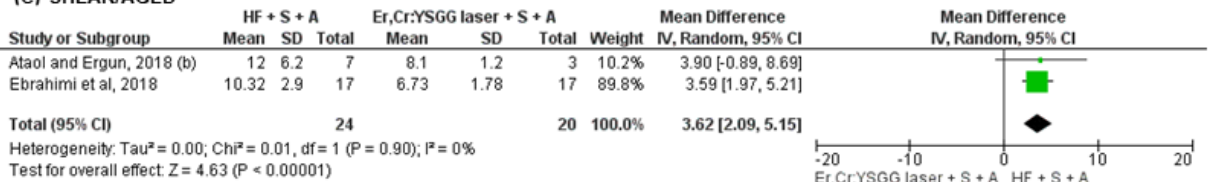
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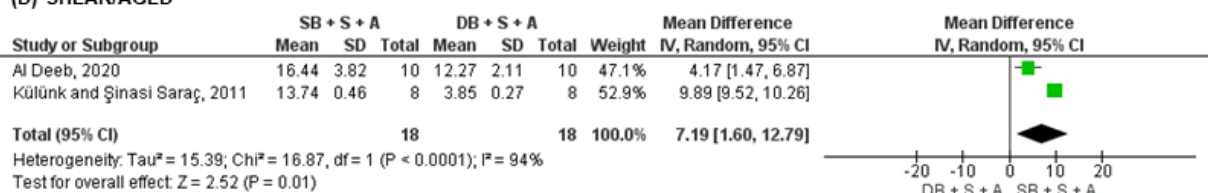
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(C) SHEAR/AGED



(D) SHEAR/AGED



(E) MICROTENSILE/AGED

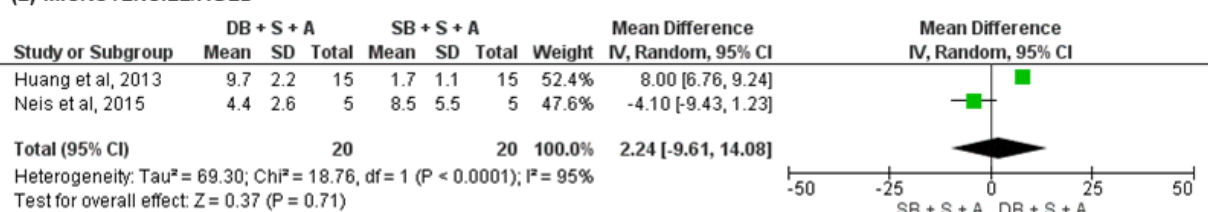
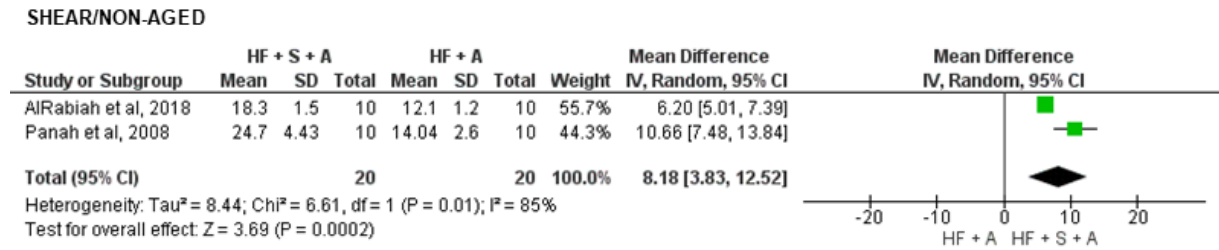


Figure 9. Evaluation of lithium disilicate-reinforced ceramics repair bond strength with composite resin, comparing the use or not of silane after HF etching followed by adhesive application. HF: hydrofluoric acid; S: silane; A: adhesive.



5 CONSIDERAÇÕES FINAIS

A combinação de tratamentos mecânicos e químicos colaboram para o aumento da resistência de união da cerâmica vítrea reparada com resina composta.

Com base nos resultados quantitativos, para as cerâmicas feldspáticas, o uso de abrasão a ar com partículas de Al_2O_3 , jateamento com partículas de Al_2O_3 revestidas com SiO_2 , ou desgaste com ponta diamantada são métodos alternativos ao AF para aumentar a retenção micromecânica do material de reparo. Além disso, a aplicação do silano é um passo fundamental para aumentar a estabilidade de união a longo prazo, enquanto o uso de um sistema adesivo é facultativo quando da aplicação prévia do silano. Para as cerâmicas reforçadas por leucita, o jateamento com partículas de Al_2O_3 revestidas com SiO_2 demonstrou resultados de resistência de união comparáveis ao AF, no entanto são necessários mais estudo para confirmar essa afirmação. Em contrapartida, para as cerâmicas reforçadas por dissilicato de lítio, os resultados não foram suficientes para sugerir um método que pudesse ser alternativo à utilização do AF.

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ANEXO

The Journal of Prosthetic Dentistry- 160



2013 Guia para a Preparação de Manuscritos

*The Journal of Prosthetic Dentistry*Atualizado em 2012 pelo Escritório de Publicação do *The Journal of Prosthetic Dentistry**Georgia Regents University, College of Dental Medicine, Augusta, GA*

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Nos seus 62 anos, *The Journal of Prosthetic Dentistry* tem sido a revista líder profissional dedicada exclusivamente à odontologia protética e restauradora. É a publicação oficial de 25 organizações de prostodônticos nos EUA e internacionalmente, servindo dentistas e protéticos em prática avançada. A revista apresenta artigos originais revisados por pares sobre as mais recentes técnicas, materiais dentários, e os resultados de investigação, com fotos a cor que ilustram procedimentos passo-a-passo.

O *Journal of Prosthetic Dentistry* está incluído no *Index Medicus* e *CINAHL*, e é o jornal más citado em prostodontia, pelo número de referências citados segundo o “Journal Citation Reports”® de 2011.

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Lista de verificação para submissão inicial

- Carta de submissão
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- O consentimento informado para fotografias de pacientes, se aplicável
- Um manuscrito em formato *Microsoft Word* que contém:
 - Página de título
 - Abstrato
 - Texto principal, (o próprio artigo)
 - Referências bibliográficas
 - Tabelas
 - Lendas de ilustrações, e
 - Figuras em formato TIFF (ver Orientações, páginas 11-13)

Orientações de Submissão

Obrigado pelo seu interesse em escrever um artigo para o *Journal of Prosthetic Dentistry*. No processo de publicação, como em odontologia, procedimentos precisos são essenciais. Sua atenção e complacência com as seguintes políticas ajudará a garantir o processamento atempado da sua submissão.

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Comprimento do manuscrito depende do tipo. Artigos de pesquisa e ciência clínicos gerais não deve exceder 10 a 12 páginas, escritos em espaço duplo (excluindo referências, legendas e tabelas). Relatórios Clínicos e Técnicas Dentárias não deve exceder 4 a 5 páginas, e conselhos dos nossos leitores não deve exceder 1 a 2 páginas. O comprimento varia de revisões sistemáticas.

Número de Autores

O número de autores é limitado a 4, inclusão *de mais de 4 deve ser justificada* na carta de submissão. (Contribuição de cada autor deve ser anotado) Caso contrário, autores acima de 4 serão listados nos agradecimentos.

Formatação Geral

Todas as submissões devem ser enviadas através do sistema de EES em Microsoft Word ou num formato compatível com Microsoft Word usando páginas de 8.5 X 11 polegadas em tamanho. As seguintes especificações deve ser seguido:

- Times Roman, 12 pt
- Espaço duplo
- Justificado à esquerda
- Margens de 1 polegada (2,5cm) em todos os lados da página
- Tabulação de meia polegada (1,25cm)
- Cabeçalhos/rodapés deve ser livre de números de páginas ou qualquer outra informação
- Referências; não deve ser numerados automaticamente (formatado).
- Defina a linguagem em MS Word para Inglês (EUA).

Tipos de Artigos

Os artigos são classificados da seguinte maneira: Relatório de Pesquisa/Casos Clínicos, Relatório Clínico, Técnica Dentária, Revisão Sistemática, ou Concelhos dos Nossos Leitores. Seções necessárias para cada tipo de artigo são listados na ordem em que devem ser apresentados.

RELATÓRIO DE PESQUISA/ESTUDO CLÍNICO

O relatório da pesquisa não deve ser mais de 10-12 páginas digitadas em espaço duplo e deve ser acompanhado por não mais de 12 ilustrações de alta qualidade. Evite o uso de forma de esboço (ou seja enumerações e/ou frases ou parágrafos com marcadores). O texto deve ser escrito em frases completas e em forma de parágrafo.

- **Abstract (Abstrato):** (aproximadamente 250 palavras): Crie um resumo estruturado com os seguintes subseções: *Statement of the Problem* (Declaração do Problema), *Objective* (Objetivo), *Materials and Methods* (Métodos e Materiais), *Results* (Resultados) e *Conclusions* (Conclusões). O abstrato deve conter detalhes suficientes para descrever o experimento e os variáveis do projeto. O tamanho da amostra, os controles, o método de medição, standardização, confiabilidade examinador, e método estatístico utilizado com nível de significância associado deve ser descritos na seção de Materiais e Métodos. Valores reais devem ser fornecido na seção de Resultados.
- **Clinical Implications (Implicações Clínicas):** Em 2-4 frases, descreva o impacto dos resultados do estudo sobre prática clínica.
- **Introduction (Introdução):** Explique o problema completamente com precisão. Resuma a literatura relevante, e identifique qualquer viés em estudos anteriores. Declare claramente o objetivo do estudo e a hipótese da pesquisa no final da introdução. Observe que, numa profunda revisão da literatura, a maioria das referências (se não todas) devem ser citadas na seção Materiais e Métodos e/ou na Introdução.
- **Materials and Methods (Materiais e Métodos):** No parágrafo inicial, forneça uma visão geral do experimento. Forneça informações completas de todos os produtos de fabricação e instrumentos utilizados, entre parênteses ou em uma tabela. Descreva o que foi medido, como foi medido, e as unidades de medida utilizadas. Liste os critérios para julgamento quantitativo. Descreva o designo experimental e variáveis, incluindo critérios definidos para controlar variáveis, standardizar os testes, a alocação de espécimes/sujeitos a grupos (método de randomização), o tamanho total da amostra, controles, calibração dos examinadores, e confiabilidade de instrumentos e examinadores. Descreva como o tamanho das amostras foi determinada (por exemplo, com a análise de força (*power analysis*)). Evite o uso de números para identificar grupos. Em vez, use abreviações ou códigos que claramente indicaram as características do grupo e assim, os grupos serão mais significativo para o leitor. Os testes estatísticos e níveis de significância associado devem ser descrito no final desta seção.
- **Results (Resultados):** Descreva com precisão e brevemente, na mesma ordem que os testes foram descritos na seção de Materiais e Métodos. Para uma listagem extensa, os dados poderão ser apresentados em forma tabular ou forma gráfica para ajudar o leitor. Para 1-way ANOVA apresente *df*, e valores de *F* e *P* nas áreas apropriada no texto. Para todas as outras ANOVAs, de acordo com as orientações, forneça a tabela ANOVA. Descreva os resultados e as tendências mais significativas. Texto, tabelas e figuras não devem repetir ao outro. Resultados notados como significativos devem ser validados por dados atuais e valores *P*.

- **Discussion (Discussão):** Discuta os resultados do estudo, em relação à hipótese e a relevante literatura. A discussão deve começar por explicar se sim ou não há suporte a rejeitar a hipótese nula. Se os resultados não concordam com outros estudos e/ou com opiniões aceitas, declare como, e porquê os resultados são diferentes. Resultados concordantes com outros estudos também devem ser declarados. Identifique as limitações do seu estudo e sugere pesquisas futuras.
- **Conclusion (Conclusão):** Liste concisamente conclusões da pesquisa que possam ser retiradas do seu estudo, não simplesmente reafirmar os resultados. As conclusões devem ser pertinentes aos objetivos e justificadas pelos dados. Na maioria das situações, as conclusões são só verdade para a população do experimento. Todas as conclusões devem ser acompanhadas por análises estatísticas.
- **References (Referências):** Consulte a página 9 para obter mais orientações, página 22 para amostras.
- **Tables (Tabelas):** Construa tabelas de acordo com as orientações na página 11.
- **Legends for Illustrations (Legendas para as Ilustrações):** Descreva de forma concisa cada ilustração sem diretamente duplicar o texto. Consulte a página 13 para obter mais orientações; página 23 para a página de amostra de legendas.

RELATÓRIO CLÍNICO

O relatório clínico descreve os métodos do autor para cumprir um tratamento difícil de um paciente; não deve ser mais de 4 a 5 páginas, espaço duplo, e deve ser acompanhado por não mais do que 8 ilustrações de alta qualidade. Em algumas situações, o editor pode aprovar a publicação de figuras adicionais se contribuírem significativamente ao manuscrito.

- **Abstract (Abstrato):** Forneça um curto abstrato, sem estrutura, num parágrafo que brevemente resume o problema encontrado e tratamento administrado.
- **Introduction (Introdução):** Resuma a literatura relevante para o problema encontrado, incluindo referências de tratamentos e protocolos padrão. Por favor note que a maioria das referências, se não todas, devem ser citadas na introdução e/ou na seção Relatório Clínico.
- **Clinical Report (Relatório Clínico):** Descreva o paciente, o problema com o qual ele/ela apresentou, e qualquer história médica ou odontológica relevante. Descreva as várias opções de tratamento e as razões para tratamento escolhido. Descreva completamente o tratamento, a duração do período de acompanhamento, e melhorias notáveis resultado do tratamento. Esta seção deve ser escrita no passado e em forma de parágrafo.
- **Discussion (Discussão):** Comente sobre as vantagens e desvantagens do tratamento escolhido e descreva qualquer contraindicação do tratamento. Se o texto torna repetitivo, omita a discussão.
- **Summary (Sumário):** Resume brevemente o tratamento do paciente.
- **References (Referências):** Selecione e escreva referências bibliográficas de acordo com as orientações da página 10.
- **Legends for illustrations (Legendas para as ilustrações):** Descreva de forma concisa cada ilustração sem diretamente duplicar o texto principal.

TÉCNICA DENTÁRIA

Um artigo sobre uma técnica dentária deve ser apresentada num formato de passo-a-passo, um procedimento único, útil para profissionais de odontologia. Não deve ser mais de 4 a 5 páginas digitadas, em espaço duplo, e ser acompanhado por não mais de 8 ilustrações de alta qualidade. Em algumas

situações, o Editor poderá aprovar a publicação de imagens adicionais se contribuírem significativamente ao manuscrito.

- **Abstract (Abstrato):** Forneça um curto abstrato, sem estrutura, de um parágrafo que brevemente resuma a técnica apresentada.
- **Introduction (Introdução):** Resume a literatura relevante. Inclua referências a métodos e protocolos standardizados. Por favor note que a maioria das referências, se não todas, devem ser citadas na Introdução e/ou seção Técnica .
- **Technique (Técnica):** Num formato enumerado, passo-a-passo, descreva cada passo da técnica. O texto deve ser escrito em forma ativa, em vez de forma passiva (por exemplo, “Survey the diagnostic cast” em vez de “The diagnostic cast was surveyed.”) Inclua referências para as ilustrações acompanhadas.
- **Discussion (Discussão):** Comente sobre as vantagens e desvantagens da técnica, as situações onde possam ser aplicadas, e descreva qualquer contra-indicações da sua técnica. Evite alegações excessivas de eficácia. Se o texto torna-se repetitivo, omita a discussão.
- **Summary (Sumário):** Resume brevemente a técnica apresentada e suas vantagens principais.
- **References (Referências):** Selecione e escreva referências bibliográficas de acordo com as orientações da página 12.
- **Legends for illustrations (Legendas para as ilustrações):** Descreva de forma concisa cada ilustração sem diretamente duplicar o texto principal.

REVISÃO SISTEMÁTICA

O autor é aconselhado a desenvolver uma revisão sistemática no estilo e formato Cochrane. O Jornal está transacionando de revisões de literatura para revisões sistemáticas. Para mais informações sobre revisões sistemáticas, consulte www.cochrane.org.

Um exemplo de uma revisão sistemática:

Torabinejad M, Anderson P, Bader J, Brown LJ, Chen LH, Goodacre CJ, Kattadiyil MT, Kutsenko D, Lozada J, Patel R, Petersen F, Puterman I, White SN. Outcomes of root canal treatment and restoration, implant-supported single crowns, fixed partial dentures, and extraction without replacement: a systematic review. J Prosthet Dent 2007 Oct; 98(4):285-311.

A revisão sistemática consiste de:

- 1) Um abstrato – Um resumo usando um formato estruturado (Declaração do Problema, Objetivo, Material e Métodos e Materiais, Resultados, Conclusões).
- 2) Revisão do texto- Composta por uma introdução (estado da questão e objetivo), os métodos (Critérios de seleção, métodos de pesquisa, coleta e análise dos dados), resultados (descrição dos estudos, qualidade metodológica e análise dos resultados), discussão, conclusões dos autores, agradecimentos, e conflitos de interesse. As referências devem ser *avaliadas por pares* e seguindo o formato JPD (página 11).
- 3) As tabelas e figuras, se necessárias-- mostrando características dos estudos incluídos, especificação das intervenções em comparação, os resultados dos estudos incluídos, um registro dos estudos que foram excluídos e tabelas adicionais e números relevantes para a revisão.

Conselhos dos nossos leitores são breves relatórios sobre procedimentos úteis ou que economizam tempo. Devem ser limitado a 2 autores, não mais do que 250 palavras, e incluem não mais de 2 ilustrações de alta qualidade. Descreva o procedimento num formato numerado de passo-a-passo, escreva o texto em forma ativa, em vez de forma passiva (por exemplo, “Survey the diagnostic cast” em vez de “The diagnostic cast was surveyed.”)

Instruções de Formato

ARRANJO da PRIMEIRA PÁGINA – Página Título (*Title Page*)

Por favor, veja o exemplo da página título no Apêndice I (página 19).

- **Título:** O título deve definir a ideia do estudo, o conteúdo do estudo, e significado clínico. Utilize letra maiúscula apenas na primeira letra da primeira palavra. Não sublinhar o título. Abreviaturas ou nomes comerciais não deve ser usado no título. Palavras como ‘new’, ‘novel’, ou ‘simple’ não são recomendados para o título.
- **Autores:** Diretamente sobre o título, escreva os nomes e títulos dos autores. Liste somente os graus acadêmicos. Por favor não use denominações de associações.
- **Instituições:** Diretamente sobre os nomes dos autores, escreva a afiliação institucional e as cidades, estados ou países (se não os Estados Unidos) em que estas instituições são localizadas. Se necessário, inclua a tradução do nome da instituição. Se os autores não são afiliados com uma instituição, por favor, liste a cidade, estado ou país (se não os Estados Unidos), em que os autores vivem.
- **Apresentação/informações de suporte financeiro e títulos:** Se a pesquisa foi apresentada antes numa reunião, escreva o nome da organização, o local, e data da reunião. Se o trabalho foi apoiado por uma bolsa de estudo ou qualquer outro tipo de financiamento, forneça o nome da organização de suporte e o número de concessão. Liste os títulos acadêmicos (por exemplo, *Assistant Professor*) e afiliações departamental de todos os autores.
- **Informações de contato:** Liste o endereço para correspondência, telefone comercial, número de fax, e e-mail do autor onde receberá a correspondência.

ABSTRATO

- O abstrato deve ser escrito numa página separada do texto principal.
- O abstrato não deve incluir abreviaturas ou informações de fabricação.

TEXTO PRINCIPAL

The Journal of Prosthetic Dentistry- 9

Cabeçalhos

- Os cabeçalhos devem contribuir a clareza do artigo e mudança de uma seção para outra (por exemplo, da discussão para conclusões).
- O uso de subtítulos podem ser apropriados para seção de Materiais e Métodos, mas é geralmente desencorajado nos Resultados e Discussão.
- Todos os cabeçalhos devem ser alinhados com a margem esquerda. Cabeçalhos principais (por exemplo, "MATERIALS AND METHODS") devem ser escrito em letras maiúsculas, subtítulos (por exemplo, "Specimen preparation" deve ser escrito com a primeira letra maiúscula e o restante da frase em letras minúsculas.)

Informações de identificação de produto e sua manufatura

- Descreva produtos em termos genéricos. Imediatamente após a palavra, forneça as seguintes informações em parênteses: nome do produto e do fabricante; por exemplo: *"The impression was poured in Type IV stone (Denstone; Heraeus Kulzer) and related to each other with a fast setting vinyl polysiloxane occlusal registration material (Correct VPS Bite Registration; Jeneric/Pentron, Inc)."* Por favor, note que há um ponto e vírgula após o nome do produto. Nós já não exigimos a cidade e estado/País para cada fabricante que esta informação muda com tempo e é fácil de encontrar na rede.
- Não use símbolos de marca registrada, não são consistentes com estilo do Jornal.
- Use nomes de medicamentos genéricos; os nomes comerciais podem ser mencionados em parênteses na primeira menção.

Abreviaturas

- Se abreviaturas foram utilizadas, forneça a forma expandida na primeira menção e abreviar daí em diante, por exemplo, *"fixed dental prosthesis (FDP)"*.

Referências

Referências aceitáveis e a sua colocação no documento

- A maioria das referências, se não todas, devem ser citada na introdução e/ou na seção de Materiais e Métodos. Apenas aquelas referências que foram citadas anteriormente ou que se relacionam diretamente aos resultados do estudo podem ser citados na discussão.
- Só os artigos publicados que foram revisados por pares podem ser usado como referência. Manuscritos em preparação, manuscritos submetidos para consideração e teses não publicadas não são referências aceitáveis.
- Os abstratos são considerados observações não publicadas e não são permitidos como referência a não ser que estudos de acompanhamento foram publicados em revistas revisadas por pares.
- **A referência de publicações em língua estrangeira devem ser mantidas a um mínimo (não mais que 3). Estas referências são permitidas apenas quando o artigo original foi traduzido para Inglês.** O título traduzido deve ser citado e a língua original deve ser mencionada entre parênteses na citação ao final.
- Referências de livros didáticos devem ser mantidas a um mínimo; livros didáticos muitas vezes refletem as opiniões dos seus autores e/ou editores. Quando necessário, as edições mais recentes

dos livros didáticos devem ser utilizadas de preferência. Periódicos baseados em evidência científica são preferidos.

Formatação de Referências

- As referências devem ser identificadas no corpo do artigo, com números arábicos sobrescritos. O número da referência deve ser posto após o período no final da frase.
- A lista das referências completa deve ser em espaço duplo e em ordem numérica, deve seguir a seção de conclusões mas começar numa página separada. Apenas as referências citadas no texto devem aparecer na lista das referências.
- Formatação das referências devem acordar com o estilo **Vancouver**, conforme estabelecido no "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" (Ann Intern Med 1997;126:36-47).
- As referências devem ser numeradas manualmente.
- Liste até seis autores. Se houver sete ou mais, após o sexto nome, adicione *et al.*
- Nome do jornal será abreviado de acordo com **Cumulative Index Medicus**. Uma lista completa de abreviaturas está disponível através do site do PubMed: <http://www.ncbi.nlm.nih.gov/nlmcatalog/journals>
- Formato para artigos: forneça os sobrenomes e iniciais de todos os autores, o título do artigo, o nome do periódico; e, o ano, volume e números da página de publicação. Não utilize itálico, letras realçadas ou sublinhadas para qualquer parte da referência. Coloque um período após os iniciais do último autor, após o título do artigo, e no final da referência. Coloque um ponto e vírgula após o ano de publicação e uma vírgula após o volume. Números de emissão não são usados em estilo **Vancouver**.

Exemplo: Jones ER, Smith IM, Doe JQ. Uses of acrylic resin. J Prosthet Dent 1985; 53:120-9.

- Referências dos livros: A edição mais atual deve ser citada. Forneça os nomes e iniciais de todos os autores/editores, o título do livro, a cidade de publicação, a editora, o ano de publicação e os números da página consultadas. Não use itálico, letras realçadas ou sublinhadas para qualquer parte da referência.

Exemplo: Zarb GA, Carlsson GE, Bolender CL. Boucher's prosthodontic treatment for edentulous patients. 11th ed. St. Louis: Mosby; 1997. p. 112-23.

*Um exemplo de uma página de referências pode ser encontrado na página 21.

IMPORTANTE

As referências não devem ser submetidas em Endnote ou de qualquer outro software bibliográfico. Essa formatação não pode ser editada pela Oficina Editorial ou revisores, e devem ser suprimidos ou removidos do manuscrito antes de sua submissão. As referências não devem ser numeradas automaticamente.

TABELAS

- As tabelas devem complementar, e não duplicar, o texto.

- Todas as tabelas devem ser postas no final do manuscrito, após a lista de referências e antes das Legendas. Deve haver apenas uma tabela por página. Omita linhas horizontais e verticais. Omita qualquer sombreado ou cor.
- Não liste as tabelas em partes (por exemplo, Tables Ia, Ib, etc.) Cada tabela deve ter o seu próprio número. Numerar cada tabela na ordem em que são mencionadas no texto.
- Forneça uma legenda concisa que descreve o conteúdo da tabela. Crie nomes para cabeçalhos e colunas descritivos. Dentro de colunas, alinhar os dados de tal forma que os pontos decimais estejam numa linha reta. Use pontos decimais (períodos), e não vírgulas, para marcar lugares passados o número inteiro (por exemplo, 3.5 em vez de 3,5).
- Numa linha de baixo da tabela, defina qualquer abreviaturas utilizadas na tabela.
- Se uma tabela (ou qualquer dado dentro dela) foi publicado anteriormente; dê todo o crédito ao autor original no rodapé. Se necessário, obtenha permissão para reimprimir a tabela do autor /editor.
- As tabelas devem ser submetidas em *Microsoft Word* ou formato compatível. *Microsoft Word* é preferido. Se uma tabela foi criada em *Excel*, deve ser importada para um dos formatos referidos acima antes de submissão.

SUBMISSÃO DE IMAGENS ELECTRÔNICAS

Tipo de Arquivo

Todas as figuras devem ser enviadas arquivadas em *Tagged Image File Format (TIFF)*. As figuras não devem ser submetidas com *Microsoft Word*, *Corel Draw*, *Harvard Graphics*, *PowerPoint*, ou outros formatos de software de apresentação. Desenhos ou outros trabalhos de arte são melhores submetidos no formato original como *EPS (Encapsulated PostScript)*, *Adobe Illustrator*, *InDesign*, etc. **Antes de submissão, deve ser guardado como um .TIFF.**

Especificações do Arquivo da Imagem

Dimensões da figura deve ser ao mínimo de 4 × 6 polegadas (10 X 15 cm).

Todas as figuras devem ser do mesmo tamanho (o mesmo tamanho físico), a não ser que o tipo da imagem proíba ser do mesmo tamanho das outras figuras dentro do manuscrito, como no caso de uma radiografia panorâmica ou radiografias peri-apical, imagens SEM, ou gráficos e capturas de tela. Não marque nos rostos das figuras com letras ou números para indicar a ordem em que as figuras devem aparecer; tais legendas serão postas durante o processo de publicação.

Resolução

As fotos devem ser de qualidade profissional e de alta resolução. A seguir estão as orientações de resolução:

- Fotografias em preto-e-branco ou a cores devem ser criadas e guardadas no mínimo de 300 pontos por polegada (dpi). (Note: Uma imagem de 4X6 polegadas com uma resolução de 300 dpi será

aproximadamente 6 megabytes. Uma figura de menos de 300 dpi não deve ser aumentada artificialmente a 300 dpi, a qualidade e resolução resultante será pobre.

- Desenhos de linhas devem ser criados e guardado em 1200 dpi.
- Um trabalho artístico em combinação (uma ilustração que contem ambas fotografias e desenho delinha) deve ser criado e guardado em 600-1000 dpi.
- Claridade, contraste, e a qualidade deve ser uniforme entre as partes de uma figura multiparte, eentre todas as figuras dentro do manuscrito.
- Figuras compostas (várias imagens combinadas em um único composição) não são aceitáveis.Cada parte da imagem deve ser 4 × 6 polegadas, com 300 dpi.
- O fundo da imagem deve ser uniforme, sem textura, azul médio quando possível.

Texto dentro de imagens

Se texto é para aparecer dentro duma figura, versões marcadas e não marcadas devem ser fornecida. O texto que aparece nas versões marcadas devem ser em **fonte Ariel e ao mínimo 10 pt em tamanho**. O texto deve ser dimensionado para facilitar legibilidade, se a figura é reduzida para produção no Jornal. As letras devem ser em proporção com desenho, gráfico ou fotografia. O tamanho de fonte deve ser consistente entre cada figura, e para todas as figuras. Note que os títulos e subtítulos não devem aparecer no arquivo de figura, mas serão fornecidas no texto manuscrito (ver Legendas de Figuras, abaixo).

Se uma chave para uma ilustração requer obras de arte (linhas de tela, pontos, símbolos especiais), a chave deve ser incorporada no desenho, em vez de ser incluída na legenda. Todos os símbolos devam ser feitos profissionalmente, devem ser visível contra o fundo da imagem, e ser de proporção legível se a ilustração é reduzida para publicação.

Todas as fotografias de imagens de microscópicas devem ter uma barra de medida e unidade de medida na imagem.

Figuras em Cor

Ilustrações coloridas podem ser submetidas quando o seu uso aumenta consideravelmente o valor do manuscrito. **O editor tem a autoridade final para determinar se as ilustrações coloridas fornecem uma apresentação mais eficaz.** Geralmente, um máximo de 8 figuras são aceites para um relatório clínico e artigos de técnica dentária, e 2 figuras são aceites para conselhos para nosso leitores. Mas, o Editor pode aprovar a publicação de figuras adicionais, se elas contribuem significativamente para o manuscrito.

Figuras clínicas devem ser de cor equilibrada. Imagens coloridas devem ser em CMYK (Ciano/Magenta/Amarelo/Preto) formato de cor invés de RGB formato de cor (vermelho/verde/azul).

Gráficos

Os gráficos devem ser numerados como figuras e o enchimento nos gráficos de barras deve ser distinto e sólidos; sombreamento e desenhos devem ser evitada. Linhas grossas e sólidas devem ser usadas e em

letras realçadas e sólidas. **Fonte Times New Roman é o preferido.** Coloque letras num fundo branco e evite o reverso (letras brancas sobre um fundo escuro). **Imagens de 1200 dpi devem ser fornecidas, se forem preto e branco.**

A Jornal reserva o direito de uniformizar o formato dos gráficos e tabelas.

Nomeação de Arquivos

Cada figura deve ser numerados de acordo com a sua posição no texto (Figure 1, Figure 2, e assim), usando algarismos arábicos. Os arquivos das imagens electrónicas devem ser nomeados de modo que o número da figura e formato pode ser facilmente identificado. Por exemplo, figura 1 no formato TIFF deve ser nomeado *fig1.tif*. Figuras com várias componentes devem ser claramente identificáveis pelos nomes de arquivo: Figura 1A, Fig 1B, Fig 1C, *etc.*

No artigo, referência claramente cada ilustração, incluindo o seu número entre parênteses no final da frase apropriada antes de fechar pontuação. Por exemplo: "The sutures were removed after 3 weeks (Fig. 4)."

Legendas de Figuras

As legendas das figuras devem aparecer no texto do manuscrito numa página separada após as Referências e Tabelas e referências devem aparecer sobre o título "Legends". O estilo do Jornal requer que os artigos (*a*, *an*, *e the*) são omitidos nas legendas de figuras e tabelas.

Se uma ilustração é tirada de material já publicado, a legenda deve dar todo o crédito a autor original (consulte Permissões).

Os autores são obrigados a revelar se ilustrações foram modificados em qualquer forma.

PERMISSÕES

- Todo o material citado deve ser claramente marcado com aspas e uma referência numérica. Semais de 5 linhas são citados, uma carta de autorização deve ser obtida do autor e editor do material citado.
- Todos os manuscritos são submetidos para um software que identifica semelhanças entre omanuscrito submetidos e trabalhos anteriormente publicados.
- Se as citações são mais do que um parágrafo de comprimento, abra aspas no início de cada parágrafo e fecha aspas perto apenas no último parágrafo.
- Escreva todo o material citado exatamente como aparece na publicação original, sem alterações em ortografia ou pontuação. Indique o material omitido duma citação com reticências (três pontos) para omissão de material dentro de uma frase, 4 pontos para o material omitido após o fim duma frase.
- As fotografias que incluem os olhos dum paciente, o paciente deve assinar um consentimento autorizando o uso de seu/sua foto no Jornal. Se tal permissão não foi obtido, os olhos serão bloqueados com barras pretas na publicação.
- As ilustrações que são reimpressas ou emprestadas de outros artigos ou livros publicados não podem ser utilizados sem a permissão do autor original e editor. O autor do manuscrito deve garantir essa permissão e enviá-la para revisão. Na legenda da ilustração, forneça a citação completa da fonte original entre parênteses.

INTERESSE COMERCIAL EM EMPRESAS E/OU PRODUTOS

- Autores não podem diretamente ou indiretamente fazer reclame aos equipamentos, instrumentos ou produtos em que eles têm um investimento pessoal.
- Declarações e opiniões expressadas nos manuscritos são as dos autores e não necessariamente aqueles dos editores. Os editores não assumem qualquer responsabilidade por tais materiais. Os editores não garantem ou endossam qualquer produto ou serviço anunciado no jornal; os editores não garantem qualquer alegação feita pelo fabricante sobre esse produto ou serviço.
- Autores devem divulgar qualquer interesse financeiro que eles podem ter nos produtos mencionados no artigo. Esta divulgação deve ser mencionada após a seção das conclusões.

Orientações de Escrita

REGRAS GERAIS E SUGESTÕES

- Autores que sua língua materna não é inglês devem obter a assistência dum especialista em escrita científica e inglês antes de submeter seu manuscrito. Manuscritos que não contem os padrões de linguagem básica serão retornados antes de revisão.
- Jornal não usa linguagem na primeira pessoa (*I, we, us, our, etc.*). "*We conducted the study*" pode facilmente ser alterado para "*The study was conducted.*"
- Evite o uso de termos subjetivos, tais como "*extremely*", "*innovative*" etc.
- O Jornal utiliza a vírgula serial, uma vírgula que é posta antecede da conjunção antes do último artigo numa lista de três ou mais: "*The tooth was prepared with a diamond rotary instrument, carbide bur, and carbide finishing bur.*"
- Preferimos a forma não possessiva de epônimos: "*The Tukey Test*" em invés de "*Tukey's Test*", "*Down Syndrome*" em vez de "*Down's Syndrome*" assim por diante.
- Descreva os procedimentos experimentais, tratamentos, e resultados no tempo passivo. Tudo o resto deve ser escrito numa voz ativa.
- Descreva os dentes pelo seu nome (por exemplo, Maxillary right first molar), não seu número.
- Hífen não são usados para sufixos e prefixos comuns, a não ser que o seu uso é fundamental para compreender a palavra. Alguns prefixos com os quais nós não usamos hífen incluem: *pre-*, *non-*, *anti-*, *multi-*, *auto-*, *inter-*, *intra-*, *peri-*.
- Elimina o uso de *i.e.* ou *e.g.*; eles não são consistentes com o estilo do Jornal.
- É geralmente melhor paráfrase a informação numa publicação em vez de usar citações diretas. Parafraseando economiza espaço. A exceção é uma citação direta que é invulgarmente pontiagudo e concisa.
- As palavras compridas com abreviaturas padrões (como em *TMJ* para *temporomandibular joint*) são usadas frequentemente, use a palavra completa e forneça a abreviatura entre parênteses. Use a abreviatura de lá em frente. Acrônimos comuns devem ser definidos na primeira menção.
- Nós não usamos itálico para palavras estrangeiras como "*in vivo*", "*in vitro*"
- Abreviar unidades de medida sem um ponto no texto e nas tabelas (*9 mm*). Por favor, introduza um espaço não separável entre todos os números e suas unidades (*100mm, 25MPa*) exceto antes
% e °C. Nunca deve haver um hífen entre o número e a abreviatura ou símbolo, exceto quando em forma adjetiva (*100-mm span*).

- Escreva a palavra completa "*degree*" quando fala sobre angulos. Use o símbolo de grau somente para temperatura.
- Para os resultados estatísticos comuns P, α , β omita o zero antes do ponto decimal como não poder ser maior que 1.
- Nomes proprietários funcionam como adjetivos. Substantivo devem ser fornecido após o uso como em *Vaseline petroleum jelly*. Sempre quando possível, use apenas o termo genérico.

ALGUNS ELEMENTOS DO ESTILO DE ESCRITA EFICAZ

- *Palavras curtas*. Palavras curtas são preferíveis as palavras longas se a mais curta é igualmente precisa.
- *Palavras conhecidas*. Os leitores querem informações que eles podem compreender facilmente e rapidamente. Palavras simples, familiares fornecem clareza e impacto.
- *Palavras específicas, em invés de palavras gerais*. Termos específicos identificam o significado e criam "palavras fotos"; termos gerais podem ser difusos e aberta a interpretações variadas.
- *Abertura concisa*. Mergulhe no seu assunto no primeiro parágrafo do artigo.
- *Uso limitada de modificação de palavras e frases*. Verifique seus adjetivos, advérbios, e frases preposicionais. Se eles não são necessários, removê-los.
- *Repetição desnecessária*. Uma ideia pode ser repetida para dar ênfase — contanto que a repetição é eficaz.
- *Comprimento de frases*. Vinte palavras ou menos são recomendado. Frases sem coerência ou cheia de orações subordinadas e outros modificadores são difíceis de ler e podem causar que os leitores percam sua linha de raciocínio. Frases curtas devem, no entanto, ser equilibradas com aquelas pouco maiores para evitar a monotonia.
- *Parágrafos*. Separar seções longas em parágrafos, mas evite parágrafos de uma única frase.
- *Coibição*. Escritores que usam palavras extravagantes ou exageram sua proposição ou conclusões descredita de si mesmos. Os fatos falam por si.
- *Declare claramente as conclusões*. Se não sabe algo, diga.

TERMOS CENSURÁVEIS

A seguir são termos selecionados censuráveis e seus substitutos adequados. Para obter uma lista completa de terminologia protodôntica aprovadas, consulta a oitava edição do Glossary of Prosthodontic Terms (J Prosthet Dent 2005; 94:10-92).

Ou visite JPD <http://www.prosdent.org> e clique em Collections/Glossary of Prosthodontic Terms.

Incorreto	Correto
Alginate	Irreversible hydrocolloid
Bite	Occlusion
Bridge	Partial fixed dental prosthesis
Case	Patient, situation, or treatment as appropriate
Cure	Polymerize
Final	Definitive
Freeway space	Interocclusal distance
Full denture	Complete denture
Lower (teeth, arch)	Mandibular
Model	Cast
Modeling compound	Modeling plastic impression compound
Muscle trimming	Border molding

Overbite, overjet
 Periphery
 Post dam, postpalatal seal
 Prematurity
 Saddle
 Study model
 Upper (teeth, arch)
 X-ray, roentgenogram

Vertical overlap, horizontal overlap
 Border
 Posterior palatal seal
 Interceptive occlusal contact
 Denture base
 Diagnostic cast
 Maxillary
 Radiograph

Além disso, a palavra “*specimen*” deve ser usado em invés de “*sample*” quando se refere a um exemplo considerado típico de sua classe.

Orientações Adicionais de Terminologia

Acrylic

Uma forma adjetivo que requer um substantivo, como em *acrylic resin*.

Affect, Effect

Affect é um verbo; *effect* é um substantivo.

African American

É preferido sobre *Negro* ou *Black* em ambas formas adjetiva (*African American patients*) e substantivo (... *of whom 20% were African American*).

Average, mean, median

Mean e *average* são sinônimos. *Median* refere-se ao ponto médio dum intervalo de itens; o ponto médio tem muitos itens acima como abaixo.

Basic

Como *fundamental*, esta palavra é muitas vezes desnecessário. Um exemplo de uso desnecessário: *Dental Implants consist of two basic types: Subperiosteal and endosteal*.

Between, among

Use *between* quando duas coisas são envolvidas e *among* quando há mais de dois.

Biopsy

Esse substantivo não deve ser usado como um verbo. *A biopsy was performed on the tissue*, em vez de: *The tissue was biopsied*.

Centric

Um adjetivo que requer um substantivo, como em *centric relation*.

Currently, now, at present, etc.

Essas expressões são muitas vezes desnecessárias, como em: *This technique is currently being used*.

Data

Use forma plural, como em: *The data were...*

Employ

Não deve tornar-se numa variação de *use*; como em *This method is employed...*

Ensure

Preferido sobre *insure* no senso de ter certeza.

Fewer, less

Use *fewer* com substantivos que podem ser contados (*fewer patients were seen*) e *less* com substantivos que não podem ser contados (*less material was used*).

Following

After é preferido.

Imply, infer

O falador *implies*; o ouvinte *infers*.

Incidence

O número de casos de doença que ocorre num determinado tempo; muitas vezes é confundida com *prevalence* (o número total de casos numa doença numa determinada região).

Majority

Significa mais de metade, use *most* quando quer dizer quais todos.

Male, female

Para humanos adultos, use *men* e *women*. Para meninos, use *boys* e *girls*.

Must, should

Must significa que o curso de ação é essencial. *Should* é menos forte e significa que um curso de ação é recomendado.

Numbers

Soletrar números usados em títulos ou cabeçalhos e para os números no início duma frase. A versão escrita também pode ser preferível numa série de números consecutivos que podem confundir o leitor (por exemplo, 2 3.5-inch disks deve ser escrito *two 3.5-inch disks*). Em todos os outros casos, use algarismos árabes.

Orient

Forma própria: evite *orientate*.

Pathologic

Use em vez de *pathological*. Outras palavras em que o suffixo *-al* foi descontinuado incluem *biologic*, *histologic*, e *physiologic*.

Pathology

O estudo de doença; muitas vezes confundido com *pathosis* (o estado de doença).

Percent

Use o sinal de percentagem no texto, como em *The distribution of scores was as follows: adequate, 8%; oversized, 23%; and undersized, 69%*. Mas soletrar para quando a percentagem abre uma frase, como em *Twenty percent of the castings...*

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Prior to

Before é preferido.

Rare, infrequent, often not, etc.

Sempre que possível, esses termos vagos devem ser acompanhada por um número específico.

Rather

Como *very*, esta palavra deve ser evitada.

Regimen

Refer-se a um programa planejado para tomar medicação, dieta, exercício, etc. Não deve ser confundido com *regime*, ou seja, um system de governo ou gestão.

Symptomatology

A ciência ou o estudo dos sintomas; esta palavra não é um sinônimo para a palavra *symptoms*.

Technique

Preferida sobre *technic*.

Using

Evite o pendendo modificador em frases tais como *The impression was made using vinyl polysiloxane impression material*. Escreva em vez *with* ou *by using*.

Utilize

Use é preferido.

Vertical

O adjetivo que precisa um substantivo, como em *vertical relation*.

Via

Use *through*, *with*, ou *by means of*.

White

Preferido sobre *Caucasian*. Isso só é verdade se o paciente for da região do Cáucaso da Europa do leste. Se não, use o termo *white* para descrever o paciente.

Abreviaturas Aprovadas para Jornais Geralmente Citadas

Porque *The Journal of Prosthetic Dentistry* é publicada não só em forma escrita, mas também on-line, os autores devem usar as abreviaturas de PubMed padrão para títulos de periódicos. Se uma alternativa ou uma abreviações não é usada, as referências não serão ligadas na publicação on-line. Uma lista completa de abreviaturas padrões está disponível através do PubMed-site:

<http://www.ncbi.nlm.nih.gov/nlmcatalog/journals>.

Acta Odontologica Scandinavica	Acta Odontol Scand
American Journal of Orthodontics	Am J Orthod
Angle Orthodontist.....	Angle Orthod
British Dental Journal	Br Dent J
Cleft Palate Journal	Cleft Palate J
Dental Clinics of North America	Dent Clin North Am
Dental Digest	Dent Dig
Dental Practitioner and Dental Record	Dent Pract Dent Rec
Dental Progress	Dent Prog
Dental Survey.....	Dent Surv
International Dental Journal.....	Int Dent J
International Journal of Oral and Maxillofacial Implants	Int J Oral Maxillofac Implants
International Journal of Periodontics and Restorative Dentistry.....	Int J Periodontics Restorative Dent
International Journal of Prosthodontics	Int J Prosthodont
Journal of the American College of Dentists	J Am Coll Dent
Journal of the American Dental Association.....	J Am Dent Assoc
Journal of Dentistry for Children	J Dent Child
Journal of Dental Education.....	J Dent Educ
Journal of Dental Research	J Dent Res
Journal of Endodontics.....	J Endod
Journal of Oral Rehabilitation.....	J Oral Rehabil
Journal of Oral Surgery.....	J Oral Surg
Journal of Periodontology.....	J Periodontol
Journal of Prosthetic Dentistry.....	J Prosthet Dent
Journal of Prosthodontics.....	J Prosthodont
Oral Surgery, Oral Medicine, and Oral Pathology	Oral Surg Oral Med Oral Pathol
Quintessence International.....	Quintessence Int

Apêndice I – Amostra de Página de Título

Collagen tube containers in alveolar ridge augmentation

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[NOTE: Agradecimentos devem aparecer no final da página de título, em vez do texto do manuscrito.]

APÊNDICE II- AMOSTRA DA PÁGINA DE REFERÊNCIAS

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LEGENDS

Fig. 1. Device that simulated mandible with 2 implants and ball abutments. Vise clamping implantblocks at predetermined angulation; note angled blocks.

Fig. 2. Aluminum split mold overdenture analog, showing single spherical attachment embedded in acrylic resin in one of its receptacles.

Fig. 3. Graph showing retention values (peak loads), above x axis; and insertion values (valleyloads), below x axis. A, Maximum retention load (N). B, Minimum retention load (N). C, Maximum insertion load (N). D, Minimum insertion load (N).

Fig. 4. Peak retentive load (N) as function of cycle number.

Fig. 5. Scanning electron microscope image ($\times 100$ magnification) of Preci Clix attachments after cyclic testing. A, Group 0-0: Note even, circumferential, light wear. B, Group 15-15: Note permanent deformation on lateral aspect of plastic insert, uneven wear.