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Clinical Outcomes of Porcelain versus Indirect Composite Laminate Veneers: A Systematic Review.

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LIST OF SYMBOLS AND ACRONYMS

- **Bis-GMA**: Bisphenol A-Glycidyl Methacrylate.
- **IDS**: Immediate Dentin Sealing.
- **HAP**: Hydroxyapatite.
- **CAD**: Computer-Aided Design.
- **CAM**: Computer-Aided Manifacturing.
- **wt%**: Weight Percent.
- **μm**: Micrometer.
- **nm**: Nanometer.
- **USPHS**: United States Public Health Service.

ABSTRACT

Title: Clinical Outcomes of Porcelain versus Indirect Composite Laminate Veneers. A Systematic review.

Background*:* Given the increasing popularity of this type of restoration and the advances that have been taking place in terms of biomaterials, the present study aims to systematically review and compare the clinical performances of glass-ceramic (feldspathic, leucite-reinforced, lithium disilicate-reinforced) and indirect composite veneers according to the modified USPHS criteria used for clinical evaluation of laminate veneers.

Methods*:* Following the recommended methods for systematic reviews and meta-analyses (PRISMA), an electronic search was performed in the MEDLINE Complete and Scopus databases to identify all relevant articles published until March 2022. Studies were excluded based on the following exclusion criteria: 1) In vitro studies; 2) Case reports; 3) Systematic reviews; 4) Literature reviews; 5) Studies published in 2010 or before; 6) Studies in languages other than English. Studies were included based on the following inclusion criteria 1) Human studies; 2) Randomized Controlled Trials; 3) Studies with at least a year of follow-up; 4) Patients treated with laminate veneers; 5) Cohort studies; 6) Studies that assess clinical outcomes according to the USPHS criteria. The risk of bias of the selected studies was assessed according to the Critical Appraisal Skills Program (CASP), in an attempt to confirm and evaluate their quality, validity and relevance.

Results*:* Eleven papers assessing the clinical performance of indirect composite and glass-ceramic veneers complied with the inclusion criteria. All the included papers consist in either randomized controlled trials or simple longitudinal clinical studies (prospective or retrospective)**.** The sample size of population ranges from 10 to 104 participants, while the number of veneers under assessment from 36 to 384 and the follow-up period of the studies goes from 1 up to 11 years. Results of studies with matching follow-up periods were compared for each USPHS criterium (marginal adaptation, color match and fracture of restoration). Ceramic veneers seem to show better quality of survival compared to indirect composite laminate veneers in relation to the aforementioned clinical parameters.

Discussion: Limitations of the present review included: discrepancies amongst the studies regarding follow-up times, clinical settings, restorations' rating methods and participants' inclusion criteria. Nevertheless, feldspathic and leucite-reinforced laminate veneers showed significantly better quality of survival in the long term (up to 10 years) compared to indirect composite veneers, while across shorter follow-up periods (up to 3 years), such imbalance is less evident. The biggest difference in terms of survival quality was noted for marginal adaptation, one of the key factors for success of all fixed dental prostheses.

Conclusions*:* Ceramic veneers generally perform better in terms of marginal adaptation, color match and fracture of restoration compared to indirect composite laminate veneers over large follow-up periods, while across shorter observation spells, differences regarding quality of survival are less noticeable. Feldspathic porcelain veneers perform better in terms of marginal adaptation, color match and fracture of restoration compared to indirect composite veneers over large follow-up periods (up to 10 years), while across shorter observation spells of up to 3 years, differences regarding quality of survival are less noticeable. Leucite-reinforced porcelain veneers perform better in terms of marginal adaptation, color match and fracture of restoration compared to indirect composite veneers over large follow-up periods (up to 10 years), while across shorter observation spells of up to 3 years, differences regarding quality of survival are less noticeable. Due to the discrepancy in follow-up times, clinical performance of lithium disilicate-reinforced and indirect composite veneers could not be compared directly. Further in vivo clinical studies investigating survival quality of indirect composite veneers over comparable observation spells are required.

KEYWORDS

- *Porcelain Laminate Veneers.*
- *Indirect Composite Veneers.*
- *USPHS Criteria.*
- *Marginal Adaptation.*
- *Color Match.*
- *Fracture of Restoration.*

1 INTRODUCTION

Although cultural wisdom warns us not to judge a book by its cover, “first impression is the last impression” has never been an anachronistic rhetorical saying, but rather a clear-cut motto virtually everyone lives by when getting ready for a job interview, a romantic date or a simple night out with friends. In this regard, the good old “dress to impress” tactic might come to our aid at times but will just not do the job by itself. As a matter of fact, dental appearance has proven to have remarkable influence on the perception of individuals we meet for the first time, to the point an ideal smile might as well affect your chances of finding a job (1–3). Furthermore, the rise of social media over the last couple decades has contributed to amplify dissatisfaction with facial looks amongst the population and the demand for cosmetic dentistry has been growing steadily (4,5). Nowadays, laminate veneers are amongst the most popular, increasingly requested procedures in dental offices for solving smile imperfections and there are two main materials that can be used for their fabrication: particulate filled resins or dental glass ceramics. The present systematic review aims to compare the clinical performances of glass-porcelain and indirect composite laminate veneers.

1.1 HISTORY OF DENTAL VENEERS AND THE EVOLUTION OF ADHESIVE DENTISTRY

First introduced back in 1938 by Charles Pincus as a temporary measure to improve smile esthetic in the context of the film industry, laminate veneers have nowadays established themselves as one of the preferred fixed restorative treatment choices by both patients and professionals for an extraordinary wide range of clinical scenarios (6). Given their tooth-bonding nature, this increase in popularity is largely to be credited to the steady advances concerning adhesion that have been taking place in dentistry through the decades. In this regard, worthy of mention are the introduction of the enamel-etching method by Michael Buonocore on one hand and the development of bonding resins by Richard Bowen on the other, both occurring at the turn of the 1950s and the 1960s (7).

Dr. Buonocore's findings revolutionized the dental field forever as he was the first one to suggest the use of phosphoric acid on enamel in order to improve mechanical retention of restorative materials (8). Rafael L. Bowen developed the bisphenol A-glycidyl methacrylate (Bis-GMA), a methacrylate monomer that, along with the advances in filler technology and the introduction of light initiation of resin monomers, allowed for fabrication of dental composites with superior physical and mechanical properties (9). In the late 1970s, resin cements based on Bis-GMA were introduced to the profession and the "game" changed forever as the main requirements for the development of the porcelain veneer technique had finally been fulfilled: the ability to acid-etch both enamel and porcelain to increase retention by creating microscopically rough surfaces plus the availability of resin cements that could be used for bonding the restorations (10). Fast-forward to the 1980s and porcelain veneers slowly began to be considered a credible restorative option thanks to the inputs given by the works of HR Horn and John Calamia who first described their use to cover the buccal surface of anterior teeth as a definitive restoration technique (7). Their dental preparation guidelines included at the time:

- Slight modification of labial enamel to reduce bulges.
- Shallow chamfer 0.5mm incisal or occlusal to the cervical lines of the tooth in the gingival enamel.
- Slight incisal overlap to ensure that the restoration's margins are not subjected to occlusal forces.
- Proximal preparation terminated facial to the contact areas (11).

To this day, the key for suitable retention of laminate veneers is to attempt maintaining the preparation within the enamel structure (10). However, the findings in the 1980s regarding the so called "hybrid" or "smear" layer (a transitional interphase created by the interpenetration of resin monomers into the hard tissues), paved the way for the possibility of higher preparation depths (12,13). The information that had become available regarding the hybrid layer consequently led to the introduction of the Immediate Dentin Sealing concept (IDS), consisting in applying a dentin-bonding agent to freshly cut dentin when it is exposed during tooth preparation for indirect

restorations (13). IDS was introduced in the early 1990s by Pashley and colleagues and it is based on the notion that when tooth structure removed, exposure of dentin tubules of some degree is almost inevitable thus leaving them vulnerable to bacterial contamination during impression-taking, rinsing, drying, function and removal of provisional materials (in conventional procedures, dentin sealing takes place at the bonding stage of the definitive restoration) (14).

1.2 ADHESION TO DENTAL SUBSTRATES – AN OVERVIEW

The word “adhesion” comes from the Latin *adhaerere*, which means “to stick to” (15). In order to achieve long-lasting adhesion within the oral environment, there are a few requirements that must be fulfilled:

- The liquid adhesive must wet the solid adherent to permit structural interaction.
- The stress concentration at the interface must be reduced.
- The interface must be protected from the oral environment (16).

Dental adhesives mainly consist of resin monomers that make the resin-dental substrate interaction achievable by enhancing wettability to the dental hard tissues on one hand and allowing interaction and co-polymerization with the restorative material on the other (17). It goes without saying, in order to understand the bonding process, a certain degree of knowledge regarding the dental substrates is of outmost importance.

1.2.1 ENAMEL BONDING

Enamel is the hardest tissue in the human body and, for the most part (roughly 95% by weight), is made of inorganic molecules organized in the form of carbonated hydroxyapatite (HAP), with only 1% of soft organic matrix and 4% of water (18). Despite its exceptional strength and toughness, enamel is acellular thus cannot regenerate (18). The use of phosphoric acid allows us to effectively remove the biofilm that covers it at its natural state, but most importantly transforms the smooth enamel into an irregular surface and increases its surface-free energy (19). This allows for penetration of the

bonding agent with consequent diffusion and interlocking of the resin monomers (17). In order for this process to take place, the etched surface must be dry since, in a moist environment, water and saliva (amongst other components) would compete with the resin adhesive resin in forming a bond with the enamel surface, a race that the bonding agent would not win (20).

1.2.2 DENTIN BONDING

Dentin, on the contrary, is an intrinsically humid, more organic, softer substrate that undergoes ununiform changes with age in terms of thickness and permeability. It is composed by HAP (roughly 50% by volume) that envelopes collagen (30%) and water (20%) (17). While bonding to the highly mineralized enamel is obtained with relative ease thanks to the acid-etch technique, adhesion to dentin has continued to be a challenge due to the dynamic compositional differences and the complex histology of this substrate (21). In fact, the significant presence of fluid within the inter-tubular area (making dentin an intrinsically moist hard tissue), the reduction in permeability occurring due to the aging process or as a result of aggressive stimuli, as well as the existence of odontoblastic processes and intra-tubular collagen fibers within its structure, are all factors that contribute to render bonding to dentin a quite difficult task, especially when it comes to its deeper layers (21). In addition to the compositional differences, enamel hydroxyapatite crystallites are larger and have a more regular and parallel oriented arrangement, whereas the dentin ones are smaller and are arranged in a crisscross pattern within the organic matrix, thus making it harder to establish a micro-mechanical interlocking with it but facilitating chemical bonding (21).

1.3 PORCELAIN LAMINATE VENEERS

Porcelain laminate veneers typically consist of thin shells of porcelain, the fitted surface of which has been etched with hydrofluoric acid and coated with a silane coupling agent before being bonded to the acid-etched enamel using a resin-based cement (10). While in the 1980s indications were limited to restoration of slight tooth shape and/or color alterations, provision of dental veneers has today become common

practice in dental clinics as the range of clinical situations treated with procedure has continued to expand over the years (7).

1.3.1 INDICATIONS FOR PORCELAIN LAMINATE VENEERS

Magne and Belser (*Bonded Porcelain Restorations in the Anterior Dentition-a Biomimetic Approach*, 2002) presented a classification of the indications for porcelain veneers, which is described in the following table (Table 1) (22):

Table 1. Indications for Porcelain Veneers.

Magne P., Belser UC. (2002) (22)	**Type I: Teeth resistant to bleaching.** • Type IA: Tetracycline discoloration • Type IB: Teeth that are unresponsive to bleaching
	Type II: Major morphologic modification. • Type IIA: Conoid teeth. • Type IIB: Diastema or interdental triangles to be closed. • Type IIC: Augmentation of incisal length or facial prominence.
	Type III: Extensive restorations. • Type IIIA: Extensive coronal fracture. • Type IIIB: Extensive loss of enamel by erosion and wear. • Type IIIC: Generalized congenital malformations.

Over the decades, the exceptional spread in terms of their clinical use has gone hand in hand with the evolution of techniques and materials employed as, it goes without saying, a longer list of indications requires a broader range of restoration materials to choose from (7).

1.3.2 CLASSIFICATION OF DENTAL CERAMICS

Dental ceramics can exist in a glass form without crystalline phase, in a glass form with varying amount and types of crystalline phase, as a mostly crystalline material with small amounts of glass or in the form of a polycrystalline solid (a glass-free material) (23). Glass-based systems, also known as feldspars, contain silica dioxide (or quartz) as their basic component (46-66%) as well as alumina (11-17%) (7). Traditionally, veneers

were mostly made out of conventional feldspathic porcelain (without crystalline phase), a material which has proven to offer very good esthetic effect but low fracture resistance (7). In order to improve the latter aspect, over the decades new materials have been developed by adding or growing into the matrix of glass-based ceramics varying amounts of crystalline fillers, typically leucite or lithium disilicate (24). The shape and volume of those crystals contribute to roughly double flexural strength and fracture toughness, so much so that lithium disilicate glass ceramics are often used to manufacture the inner copings of the restorations which are then covered with a veneer porcelain (consisting of fluorapatite crystals in aluminosilicate glass) in order to improve esthetics (23).

Crystalline-based systems with glass fillers consist of a sintered crystalline matrix of a high-modulus material, in which there is a junction of the particles in the crystalline phase (composed of an alumina, alumina/zirconia or alumina/magnesia mixture) (24). This system has shown to possess tremendous flexural strength and was originally developed as an alternative to conventional metal-ceramics (23). If the crystalline-based ceramic is formed by directly sintering crystals without any intervening matrix, we get polycrystalline glass-free ceramics, which have the highest potential for strength and toughness (23).

It is key to stress that glass-based systems are etchable, thus easily bondable and for this reason very much suitable for porcelain laminate veneers fabrication; as opposed, crystalline-based systems are not etchable and thus more difficult to bond (23). However, some authors suggest the possible use of the latter ceramic type for veneers that are exposed to functional loading in both the mandibular static position and during excursive movements (7).

With regard to their processing technique, dental ceramics are generally classified into:

- Power/liquid glass-based systems.
- Machinable or pressable blocks of glass-based systems.

- CAD/CAM or slurry, die-processed, mostly crystalline (alumina or zirconia systems) (23).

The power/liquid version implies the use of a refractory die or platinum foil technique for fabricating porcelain laminate veneers carrying out the traditional layering technique, which allows for excellent esthetic results by permitting the application of several diverse levels of opacity within the same restoration. Nevertheless, this process is technique-sensitive, and manual mixing and layering of the porcelain may result in the incorporation of small voids which may cause crack lines or even fractures to occur over time (10,23). Pressed ceramic restorations, on the other hand, are fabricated using a method similar to injection molding and the resulting veneers have a high level of accuracy and minimal internal structural defects (superficial layers of power/liquid porcelain may be applied in order to optimize esthetics) (7). Not long ago, CAD-CAM veneers from glass-ceramic blocks have entered the picture and their popularity is increasingly growing. Despite showing remarkable strength qualities, they leave something to be desired on the esthetic front, since the color of many of the blocks available is of single opacity (25). However, multi-opacity blocks are becoming available and can help to overcome this limitation (10).

1.4 INDIRECT COMPOSITE VENEERS

While the porcelain veneering technique has been growing in popularity over the decades, the concept of indirect composite veneers was first introduced in dentistry over 30 years ago but then temporarily abandoned due to former technological limitations. Nevertheless, modern technology has recently brought these restorations back to the fore thanks to the introduction of vitrification processes by surface laser treatments which enabled the fabrication of resin composite veneers with a hard, glossy surface with a texture to fit most dentitions (26).

1.4.1 INDICATIONS FOR DENTAL COMPOSITE VENEERS

The following table enumerates the indications for prefabricated composite veneers (Table 2).

Table 2. Indications for Prefabricated Composite Laminate Veneers.

Dietschi D., Devigus A. (2011) (26)	**a) <u>Single facial restorations</u>** • Large restorations or decays with loss of natural tooth buccal anatomy or color. • Non-vital, discolored teeth. • Traumatized, discolored teeth (without endodontic treatment) • Severe/extended tooth fracture • Extended tooth dysplasia or hypoplasia
	b) <u>Full smile facial rehabilitations</u> • Moderate to severe discolorations (i.e. tetracycline staining and fluorosis). • Generalized enamel hypoplasia/dysplasia (i.e. amelogenesis imperfecta IIIA). • Large serial restorations or decays with loss of natural tooth buccal anatomy or color. • Attrition of incisal edges (after proper occlusal and functional management). • Financial limitations. • Young patients with immature gingival profile.

1.4.2 CLASSIFICATION OF DENTAL COMPOSITE RESINS

Dental composite resins are made up of three major elements: an organic polymer matrix, an inorganic filler and a coupling agent (27). They can be classified according to one of the key determinants of their physical and optical properties, namely the size of their filler particles (28–30). In this sense, the advent of smaller particle fillers (nanohybrids, microfills and nanofills) in the composite matrix has

produced highly polishable composites that will maintain their luster, making them an ideal choice for aesthetic restorations (31).

Macrofilled composites, first introduced in the late 1950s, were obtained through mechanical grinding of larger particles of quartz, ceramic or radiopaque glass into smaller (5-30 μm), splintered, irregular ones that were consequently added to the resin matrix (32). Despite possessing good strength, these composites show significative limitations including insufficient wear resistance, poor polishing ability (due to the loss of filler particles and crack propagation at the matrix/filler interface) as well as early discoloration and staining due to surface roughness (33,34). Therefore, their clinical use is very restricted nowadays (35).

While it makes up 70-80% of the total weight of macrofilled composites, filler content of 35%-50% wt is comprised in microfills (35). The size of the filler particles (commonly referred to as colloidal silica) embedded in the organic matrix averages about 0.04μm (36). These small particles provide excellent natural-looking esthetics as well as a high, easily maintained polish that increases over time and resistance to discoloration (35). For this reason, microfilled composites are ideal in scenarios where the clinician requires an esthetic yet durable material (37). However, on the other hand, the reduced particle size causes a lack of strength (35).

Hybrid composites were introduced to overcome the aforementioned limitations of macrofilled composites on one side and those of microfilled composites on the other (36). They contain a wide range of particle size (typically including a filler with an average of 0.6μm or greater size and another with an average of about 0.05μm or less), leading to a high filler loading (70-80% wt) with resultant high strength along with an acceptable cosmetic result (36,38). The clinical use of this category of composite resins is currently limited (36).

The advances in nanotechnology has led to the development of nanofilled composites, consisting of nanoparticles (measuring approximately 25nm) and nanoaggregates (of approximately 75nm) made up of zirconium/silica or nanosilica

particles which are treated with silane so that they can bind to resin (39). This type of composite, characterized by high filler loading (up to 79.5%), provides several advantages such as better performance in terms of polish and gloss retention, enough mechanical properties to be used in both the anterior and the posterior sector, reduced curing shrinkage, less cusp wall deflection and little presence of micro fissures in the enamel edges (35,39).

1.5 QUALITY OF SURVIVAL OF RESTORATIONS – THE USPHS CRITERIA

US Public Health Service (USPHS) guidelines, developed by Cvar and Ryge, also known as the "Ryge Criteria", are the amongst the most frequently employed parameters for evaluating dental restorative materials (33). Originally, the categories object to evaluation were limited to "color match", "marginal discoloration", "anatomic form", "marginal adaptation" and "caries" (34). However, over the years, this list has been slightly modified according to the type of restoration assessed and started to include criteria such as "surface roughness", "postoperative sensitivity", "wear of restoration", "wear of the antagonist", "fracture of tooth" and "fracture of restoration" for veneers evaluation (34). The following table (Table 3) enumerates the modified USPHS criteria used for the clinical evaluation of the laminate veneers.

Table 3. List of Modified United States Public Health Service (USPHS) criteria used for the clinical evaluations of the laminate veneers.

M.M.M. Gresnigt, M.S. Cune, K. Jansen, S.A.M. van der Made, M. Özcan (2019) (56)	1. Marginal adaptation
	2. Color match
	3. Marginal discoloration
	4. Surface roughness
	5. Fracture of restoration
	6. Fracture of tooth
	7. Wear of restoration
	8. Wear of antagonist
	9. Caries
	10. Postoperative sensitivity

2 JUSTIFICATION, HYPOTESIS AND OBJECTIVES

2.1 JUSTIFICATION

Dental laminate veneers are thin shells of either porcelain or resin composite that are typically bonded to the buccal surface of anterior teeth in order to improve esthetics (42). Due to the steady advances in terms of tooth binding tools as well as ceramic and composite materials that have been taking place over the decades, their field of action has been expanding dramatically, making provision of dental veneers an ordinary practice in dental clinics. In light of the growing popularity of this type of restorations and the new materials available, the present systematic review aims to compare the quality of survival of porcelain and indirect composite veneers according to the modified United States Public Health Service (USPHS) criteria, which are amongst the most frequently employed parameters for evaluating dental restorative materials (33). Specifically, three USPHS categories were chosen for comparing the veneers' clinical performances:

- Marginal Adaptation
- Color Match
- Fracture of Restoration

Marginal adaptation, defined as "the vertical distance between the finish line of the prepared tooth and the margins of the fabricated veneers", is considered to be one of the key factors for success of all fixed dental prostheses, since large marginal discrepancies can result in gingival inflammation, secondary caries, pulpal inflammation, necrosis and, ultimately, failure of the restoration(43,44). Equally crucial criterium is that evaluating potential restoration fractures, as this was reported to be the most common failure type for glass-ceramics laminate veneers (feldspathic, leucite-reinforced and lithium-disilicate based ceramics) (45). On the other hand, USPHS color match assessments provide us significant indications regarding esthetics, referring to whether or not there is chromatic equivalency (also in terms of shade and translucency)

between restoration and adjacent teeth (46). For these reasons, the aforementioned USPHS criteria were selected and analyzed individually in this review.

2.2 HYPOTESIS

The hypothesis is that porcelain laminate veneers provide better esthetics and quality of survival in comparison to indirect resin composite veneers.

2.3 OBJETIVES

The main objective of this systematic review is to compare the clinical outcomes regarding esthetics and quality of survival of porcelain and indirect composite laminate veneers according to the modified USPHS criteria used for the clinical evaluation of laminate veneers.

The specific objectives are the following:

- To compare USPHS marginal adaptation, color match and fracture of restoration of feldspathic porcelain and indirect composite veneers.
- To compare USPHS marginal adaptation, color match and fracture of restoration of leucite-reinforced porcelain and indirect composite veneers.
- To compare USPHS marginal adaptation, color match and fracture of restoration of lithium disilicate-reinforced porcelain and indirect composite veneers.

3 MATERIALS AND METHODS

The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guideline was followed to perform this systematic review (47).

3.1 ELIGIBILITY CRITERIA

Based on the information included in the introduction and justification, a clinical question was written according to the PICO structure to center the systematic review. The eligibility criteria were based on the inclusion and exclusion criteria.

3.1.1 PICO QUESTION

The following clinical question, written according to the PICO structure was constructed: In patients treated with indirect laminate veneers (P), does porcelain (I) or composite (C) provide superior clinical outcomes according to the modified USPHS criteria (O)?

3.1.2 INCLUSION AND EXCLUSION CRITERIA

The inclusion and exclusion criteria established for selecting the studies are enumerated in the following table (Table 4).

Table 4. Inclusion and Exclusion Criteria.

INCLUSION CRITERIA	EXCLUSION CRITERIA
Human studies.	In vitro studies.
Randomized Controlled Trials (RCT).	Case reports.
Studies with at least one year of follow-up.	Systematic reviews.
Patients treated with laminate veneers.	Literature reviews.
Cohort studies.	Studies published in 2010 or before.
Studies that assess the clinical outcomes according to the USPHS criteria.	Studies in languages other than English.

3.2 INFORMATION SOURCES AND SEARCH STRATEGY

A literature search was conducted with MEDLINE Complete and Scopus databases between December 2021 and March 2022, using the following search terms: **((dental veneers) OR (dental laminates) OR (veneers) OR (laminates)) AND (((porcelain laminate veneers) OR (porcelain veneers) OR (ceramic laminate veneers) OR (ceramic veneers)) OR ((indirect composite veneers) OR (prefabricated composite veneers) OR (indirect resin composite veneers) OR (prefabricated resin composite veneers))) AND ((USPHS criteria) OR (modified USPHS criteria) OR (United States public health service criteria) OR (modified United States public health service criteria) OR (public health service criteria) OR (Ryge criteria))**. A restriction to English language was applied in searching.

Table 5. Search Results from Each Search Engine by Using the Search Algorithm.

Databases	*Search algorithm*	*Filters*	*Date*
MEDLINE Complete	((dental veneers) OR (dental laminates) OR (veneers) OR (laminates)) AND (((porcelain laminate veneers) OR (porcelain veneers) OR (ceramic laminate veneers) OR (ceramic veneers)) OR ((indirect composite veneers) OR (prefabricated composite veneers) OR (indirect resin composite veneers) OR (prefabricated resin composite veneers))) AND ((USPHS criteria) OR (modified USPHS criteria) OR (United States public health service criteria) OR (modified United States public health service criteria) OR (public health service criteria) OR (Ryge criteria))	-Year: 2011-2022 - Language: English	February 17th, 2022
Scopus	(("dental veneers" OR "dental laminates" OR "veneers" OR "laminates") AND ("porcelain laminate veneers" OR "porcelain veneers" OR "ceramic laminate veneers" OR "ceramic veneers") OR ("indirect composite veneers" OR "prefabricated composite veneers" OR "indirect resin composite veneers" OR "prefabricated resin composite veneers") AND ("USPHS criteria" OR "modified USPHS criteria" OR "United States public health service criteria" OR "modified United States public health service criteria" OR "public health service criteria" OR "Ryge criteria"))	- Year: 2011-2022 - Language: English	February 17th, 2022

3.3 SELECTION PROCESS

Two impartial reviewers (GD and ES) independently performed the systematic review search. In a first phase, duplicate records were removed, then study titles and abstracts were screened to make sure they were relevant. Subsequently, through full text assessment, the inclusion and exclusion criteria were applied. Finally, the bibliography of each article was reviewed in order to perform a cross-search. Any discrepancy in study eligibility was resolved by mutual consensus of both the reviewers. The level of agreement between the reviewers as calculated using the k-score according to the Landis and Koch criteria (48).

3.4 DATA COLLECTION PROCESS

The following data was collected from each included study: first author's surname, year of publication, country of origin, study design, sample size, follow-up time, mean age of the participants, male/female ratio. The type of restoration under evaluation (porcelain and/or indirect composite veneers) as well as the USPHS criteria used for their assessment along with the recorded scores were also collected.

3.5 STUDY RISK OF BIASED ASSESSMENT

The risk of bias of the selected studies was assessed independently and by the same reviewers who performed the search (GD and ES) according to the Critical Appraisal Skills Program (CASP), in an attempt to confirm and evaluate their quality, validity and relevance. The CASP tool employs a systematic approach based on twelve specific criteria, which are individually assessed for each study with three possible responses: "Yes", "No" or "Cannot tell" (49).

4 RESULTS

4.1 STUDY SELECTION

As illustrated in the PRISMA flowchart (Fig. 1), initially, a total of 54 studies were identified across the following databases via Universidad Europea of Madrid's Ducle Chacón CRAI Library and Elsevier's Scopus: MEDLINE complete (37) and Scopus (17). Amongst all databases, 14 records were duplicated and hence removed, yielding a total of 40 records that underwent the first screening. The first screening consisted of selecting relevant articles based on their title and abstract: 22 out of 40 records were excluded based on the exclusion criteria due to the lack of relevancy to the current topic. Hence, a total of 18 reports were sought for retrieval. Therefore, at the end of the first screening, a total of 18 reports were included and were subsequently assessed in the second screening. The second screening consisted of reading the report in full and excluding those studies that did not meet the inclusion criteria. At this juncture, 2 articles were excluded since they did not report results in a clear and coherent form, while 5 papers were excluded not having assessed the clinical outcomes of the restorations according to the modified USPHS criteria for the evaluation of laminate veneers. As a result, a total of 11 studies were identified via databases. A cross-search was also carried out in order to identify studies via other methods such as websites, organizations and citation searching, although no additional record was obtained. As a result, a total of 11 studies were finally included (44–46,50–57).

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources

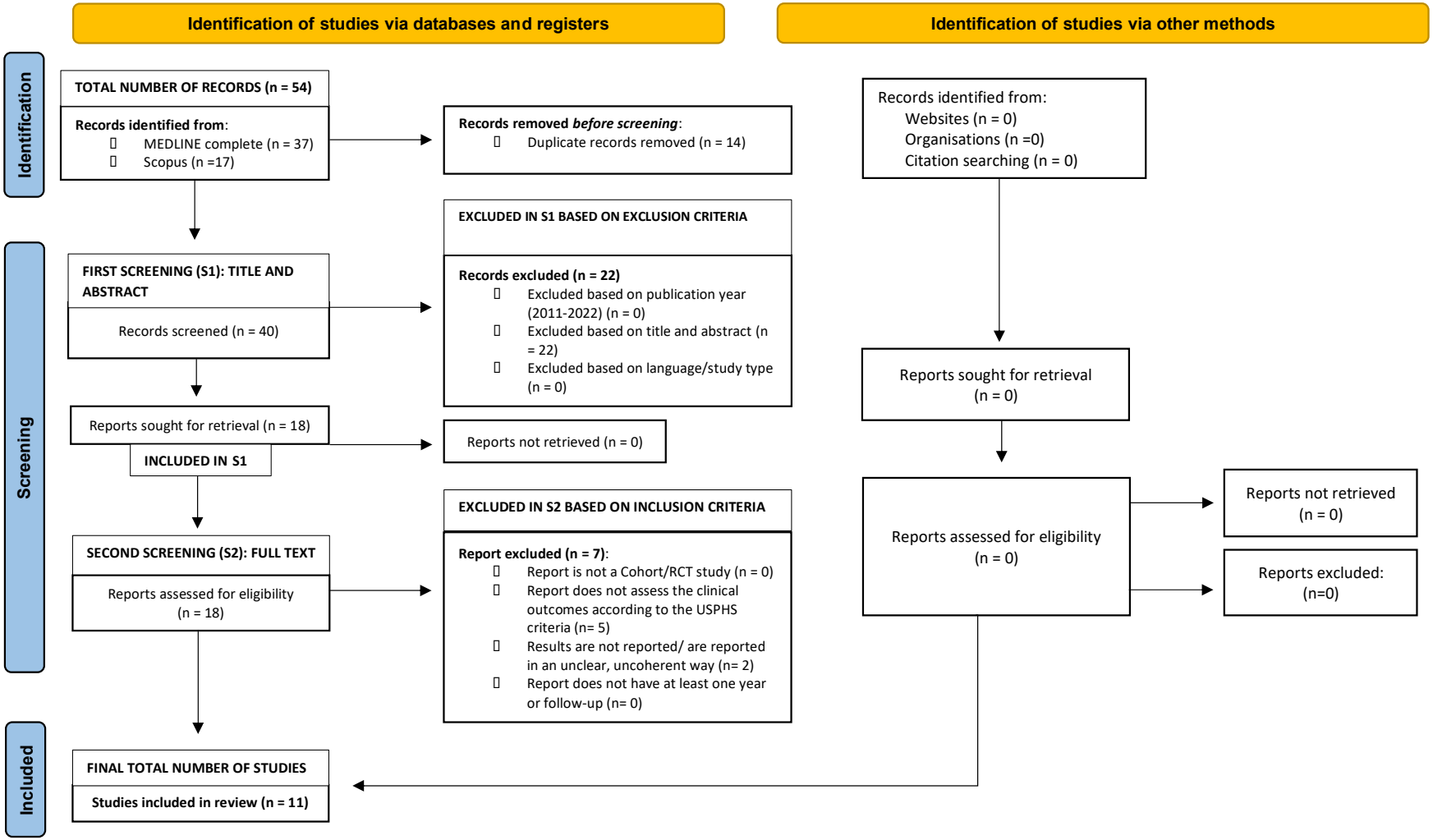

Fig.1: Study identification process and results of the literature search via databases and other methods according to PRISMA 2020 (47).

4.2 STUDY CHARACTERISTICS

Portrayed in Table 6 are the eleven studies that were ultimately included in the present systematic review. Details of the publication's author, year, study design, population sample (including sample size, gender ratio, mean age, number of veneers evaluated), study groups (where applicable), follow-up time, type of restorations under assessment and study variables were all listed. All the included papers consist in either randomized controlled trials or simple longitudinal clinical studies (prospective or retrospective)**.** The sample size of population ranges from 10 to 104 participants, while the number of veneers under assessment from 36 to 384. As regards the male-to-female gender ratio, there was an overall predominance of female participants. The mean age of the participants varies from 19 to 64 years old, while the follow-up period of the studies goes from 1 up to 11 years. Every study selected for the present systematic review focuses on quality of survival of porcelain glass-ceramic veneers (feldspathic, leucite-based or lithium disilicate-reinforced), while only two could be found that examine the clinical outcomes of indirect composite laminate veneers as well (56,57). All eleven studies measure (by means of either a numerical or an Alpha, Bravo, Charlie and Delta score) at least a couple of the three USPHS evaluation categories that were selected for the present systematic review, these being: marginal adaptation, color match and fracture of restoration. All of the studies that employed the Alpha, Bravo, Charlie, Delta rating method recorded the scores at regular intervals across the entire follow-up period, while just two of those recording numerical scores presented a continuous assessment (45,50), with the rest exclusively reporting results at the baseline and at the final recall. Table 7 and Table 8 describe the list of modified USPHS criteria used for the clinical evaluation of the laminate veneers across all studies, along with their respective rating method (numerical or Alpha, Bravo, Charlie, Delta score).

Author/Year	Study Design	Sample			Study groups		Follow-up time (up to, years)	Type of restorations under assessment	Study variables
		Sample size	Gender ratio (M:F)	Mean age (years) / Age range	I	II			
Beata Smielak et al. (2021)	PCS	35 (186)	7:28	45	14 (84)	21 (102)	10	• Feldspathic glass ceramic veneers	• Marginal adaptation • Color match • Fracture of the restoration
Hayat Ibrahim Mahrous El-Banna et al. (2021)	RCT	(36)	N/A	20-30	(18)	(18)	1	• Leucite-based glass ceramic veneers • ZLS veneers	• Marginal adaptation • Fracture of the restoration
Omnia MW El-Mesallamy (2021)	RCT	(36)	N/A	20-30	(18)	(18)	1	• Leucite-based glass ceramic veneers • ZLS veneers	• Marginal adaptation • Fracture of the restoration
M.M.M. Gresnigt et al. (2019)	RCT	11 (48)	3:8	54.5	(24)	(24)	10	• Leucite-based glass ceramic veneers • Indirect composite veneers	• Marginal adaptation • Color match • Fracture of the restoration
M.M.M. Gresnigt et al. (2019)	PCS	104 (384)	80:38	42.1	N/A	N/A	11	• Feldspathic glass ceramic veneers	• Marginal adaptation • Color match Fracture of the restoration

Mert Yuce et al. (2017)	PCS	12 (61)	3:9	19-50	(30)	(31)	2	• Lithium disilicate-based glass ceramic veneers	• Marginal adaptation • Color match • Fracture or the restoration
Elif Özturk et al. (2014)	PCS	28 (125)	5:23 (29:96)	30	N/A	N/A	2	• Lithium disilicate-based glass ceramic veneers	• Marginal adaptation • Fracture of the restoration
Petra C. Guess et al. (2014)	PCS	25 (66)	13:12	19-64	(42)	(24)	7	• Leucite-based glass ceramic veneers	• Marginal adaptation • Color match
M.M.M. Gresnigt et al. (2013)	RCT	10 (46)	3:7	48.6	(23)	(23)	3	• Leucite-based glass ceramic veneers • Indirect composite veneers	• Marginal adaptation • Color match • Fracture of the restoration
M.M.M. Gresnigt et al. (2013)	PCS	20 (92)	5:15	49.7	(26)	(66)	3.3	• Feldspathic glass ceramic veneers	• Marginal adaptation • Color match • Fracture of the restoration
Camillo D'Arcangelo et al. (2011)	RCS	30 (119)	13:17	33	N/A	N/A	7	• Feldspathic glass ceramic veneers	• Marginal adaptation • Color match

Table 6. Included studies and their characteristics.

RCT: Randomized clinical trial; PCS: Prospective clinical study; RCS: Retrospective clinical study; (Number of veneers); N/A: Not applicable/Not available

Table 7. Modified USPHS criteria used for the clinical evaluation of laminate veneers (Numerical score rating method) (56)**.**

Category	*Score*	*Criteria*
Marginal adaptation	*0*	Smooth margin
	1	All margins are closed or possess minor voids or defects (enamel exposed)
	2	Obvious crevice at margin, dentin or base exposed
	3	De-bonded from one end
	4	De-bonded from both ends
Color match	*0*	Very good color match
	1	Good color match
	2	Slight mismatch in color or shade
	3	Obvious mismatch, outside the normal range
	4	Gross mismatch
Fracture of restoration	*0*	No fracture
	1	Minor crack lines over restoration
	2	Minor chippings (1/4)
	3	Moderate chippings (1/2)
	4	Severe chippings (3/4)
	5	Debonding of restoration

Table 8. Modified USPHS criteria used for the clinical evaluation of laminate veneers (Alpha, Bravo, Charlie rating method) (54,55)**.**

Category	*Rating*	*Criteria*
Marginal adaptation	*Alpha*	No visible evidence of crevice along the margin; no catch or penetration of explorer
	Bravo	Visible evidence of crevice and/or catch of the explorer; no penetration of explorer
	Charlie	Visible evidence of crevice; penetration of explorer
Color match	*Alpha*	No mismatch in color, shade or translucency between restoration and adjacent tooth
	Bravo	Mismatch between restoration and tooth structure within the normal range of color, shade and/or translucency (<1 shade off; Vita shade guide)
	Charlie	Mismatch between restoration and tooth structure outside the normal range of color, shade and/or translucency (>1 shade off; Vita shade guide)
Fracture of restoration	*Alpha*	None
	Bravo	Small/acceptable
	Charlie	Moderate/unacceptable
	Delta	Large/unacceptable

4.3 RISK OF BIAS ASSESSMENT

Table 9. CASP checklist for Randomized Controlled Trials (49)**.**

	H.I. Mahrous El-Banna et al. (2021)	Omnia MW El-Mesallamy et al. (2021)	M.M.M. Gresnigt et al. (2019)	M.M.M. Gresnigt et al. (2013)
Did the study address a clearly focused research question?				
Was the assignment of participants to interventions randomized?				
Were all the participants who entered the study accounted for at its conclusion?				
a. Were the participants "blind" to intervention they were given? *b. Were the investigators blind to the intervention they were giving to participants?* *c. Were the people assessing/analyzing outcome/s "blinded"?*				
Were the study groups similar at the start of the RCT?				
Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally?				
Were the effects of intervention reported comprehensively?				
Was precision of the estimate of the intervention or treatment effect reported?				
Do benefits of the experimental intervention outweigh the harms and costs?				
Can the results be applied to your local population/in your contest?				
Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?				

YES **CAN'T TELL** **NO**

Table 10. CASP checklist for Cohort Studies (49)**.**

	B. Smielak et al. (2021)	M.M.M. Gresnigt et al. (2019)	M. Yuce et al. (2017)	E. Özturk et al. (2014)	P.C. Guess et al. (2014)	M.M.M. Gresnigt et al. (2012)	C.D 'Arcangelo et al. (2011)
Did the study address a clearly focused issue?							
Was the cohort recruited in an acceptable way?							
Was the exposure accurately measured to minimize bias?							
a. Have the authors							

identified all important confounding factors? *b. Have they taken account of the confounding factors in the design and/or analysis?*							
a. Was the follow-up of subjects complete enough? *b. Was the follow-up of subjects long enough?*							
Do you believe the results?							
Can the results be applied to the local population?							
Do the results of this study fit with other available evidence?							

YES **CAN'T TELL** **NO**

4.4 RESULTS OF INDIVIDUAL STUDIES

The following tables (Table 11 and 12) outline the results of every study included in the present systematic review in relation to the three USPHS evaluation categories (Marginal adaptation, Color match and Fracture of Restoration) that were analyzed in the present systematic review.

Table 11. USPHS evaluations at baseline and final follow-up. Numerical score rating method.

Author/ Year	Subject	Follow-up (up to, years)	Variables	Score	Baseline		Final evaluation	
B. Smielak et al. (2021)	Feldspathic ceramic: conventional vs no prep	10	Marginal adaptation		Conventional (n=84)	No prep (n=102)	Conventional (n=74)	No prep (n=102)
				0	84	102	74	102
				1				
				2				
				3				
				4				
			Color match	*0*	84	102	74	102
				1				
				2				
				3				
				4				
			Fracture of restoration	*0*	84	102	71	100
				1				
				2				
				3			3	2
				4				
				5				
H.I. Mahrous El-Banna et al. (2021)	IPS Empress CAD vs CELTRA DUO (leucite-based glass ceramic vs ZLS ceramic)	1	Marginal adaptation		Empress (n=18)	Celtra (n=18)	Empress (n=18)	Celtra (n=18)
				0	18	18	18	18
				1				
				2				
				3				
				4				
			Fracture of restoration	*0*	18	18	18	18
				1				
				2				
				3				
				4				
				5				
O.MW. El-Mesallamy et al. (2021)	IPS Empress CAD vs VITA SUPRINITY (leucite-based glass ceramic vs ZLS ceramic)	1	Fracture of restoration		Empress (n=18)	Suprinity (n=18)	Empress (n=18)	Suprinity (n=18)
				0	18	18	18	18
				1				
				2				
				3				
				4				
				5				
M.M.M. Gresnigt et al.	Estenia vs IPS Esthetic (composite vs leucite-	10	Marginal adaptation		Estenia (n=24)	IPS Esthetic (n=24)	Estenia (n=18)	IPS Esthetic (n=24)
				0	17	20	4	14
				1	6	4	10	10
				2	1		4	
				3				
				4				
				0	9	10	10	24

(2019)	based glass ceramic)		Color match	*1*	15	14	3	
				2			5	
				3				
				4				
			Fracture of restoration	*0*	24	24	12	23
				1			3	1
				2			3	
				3				
				4				
				5				
M.M.M. Gresnigt (2019)	Leucite-based glass ceramic with use of IDS	11	Marginal adaptation		N/A (n=444)		N/A (n=384)	
				0	444		341	
				1			42	
				2			1	
				3				
				4				
			Color match	*0*	444		385	
				1			25	
				2			1	
				3				
				4				
			Fracture of restoration	*0*	444		367	
				1			14	
				2			2	
				3			1	
				4				
				5				
M.M.M. Gresnigt et al. (2013)	Estenia vs IPS Esthetic (composite vs leucite-based glass ceramic veneers)	3	Marginal adaptation		Estenia (n=23)	IPS Esthetic (n=23)	Estenia (n=20)	IPS Esthetic (n=23)
				0	18	23	14	20
				1	6		6	3
				2	1			
				3				
				4				
			Color match	*0*	10	7	20	19
				1	13	16		4
				2				
				3				
				4				
			Fracture of restoration	*0*	23	23	20	23
				1				
				2				
				3				
				4				
				5				
M.M.M. Gresnigt et al. (2012)	Shofu Vintage AL (feldspathic ceramic): bonded to teeth with and without existing composite restorations	3.3	Marginal adaptation		Without obt. (n=26)	With obt. (n=66)	Without obt. (n=25)	With obt. (n=62)
				0	26	66	23	48
				1			2	14
				2				
				3				
				4				
			Color match	*0*	26	66	25	61
				1				1
				2				
				3				
				4				
				0	26	66	24	59

			Fracture of restoration	*1*				
				2				
				3				
				4				
				5				

Table 12. **USPHS evaluations at baseline and final follow-up. Alpha, Bravo, Charlie rating method.**

Author/Year	Subject	Variables	Rating	Baseline		12 months	
				HP (n=30)	C (n=31)	HP (n=30)	C (n=31)
M. Yuce et al. (2017)	Heat pressed vs CAD/CAM (lithium silicate-based glass ceramic veneers)	Marginal adaptation	Alpha	30	31	30	31
			Bravo				
			Charlie				
		Color match	Alpha	30	31	30	31
			Bravo				
			Charlie				
		Fracture of restoration	Alpha	30	31	30	31
			Bravo				
			Charlie				
			Delta				
E. Öztürk (2014)	Different degrees of Dentin Exposure (lithium silicate-based glass ceramic veneers)	Marginal adaptation	Alpha	N/A (n=125)		N/A (n=124)	
			Bravo	125		124	
			Charlie				
		Fracture of restoration	Alpha	125		122	
			Bravo			1	
			Charlie				
			Delta			1	
	Leucite-based glass ceramic veneers	Marginal adaptation	Alpha	OV (n=42)	FV (n=24)	OV (n=30)	FV (n=22)
			Bravo	100%	100%	93%	90%
			Charlie			7%	10%
		Color match	Alpha	100%	100%	97%	100%
			Bravo				

P. C. Guess et al. **(2014)**	(OV vs FV prep)		Charlie			3%	
		Fracture of restoration	Alpha	100%	100%		
			Bravo				
			Charlie				
			Delta				
C.D'Arcangelo et al. **(2012)**	Feldspathic glass ceramic veneers (bonded with light-cured composite)	Marginal adaptation		N/A (n=119)		N/A (n=119)	
			Alpha	119		119	
			Bravo				
			Charlie				
		Color match	Alpha	119		119	
			Bravo				
			Charlie				
		Fracture of restoration	Alpha	119		119	
			Bravo				
			Charlie				
			Delta				

4.4.1 FELDSPATHIC vs INDIRECT COMPOSITE LAMINATE VENEERS

Four out of the eleven included studies focus on the clinical outcomes of feldspathic porcelain veneers (44,51,52,55). They are all longitudinal studies and rate the restorations by means of both the numerical score and the Alpha, Bravo, Charlie, Delta rating methods. However, the only C. D'Angelo et al.'s study reports a continuous evaluation of the laminate veneers across the entire follow-up period (at 36, 48, 60 and 72 months) (55). As concerns indirect composite veneers, their quality of survival is observed in two papers (56,57), where all the categories are evaluated according to the numerical score system, at the baseline and at a final recall, taking place after ten and three years, respectively.

4.4.1.1 Marginal adaptation

The following tables (Table 13 and Table 14) outline the USPHS ratings in terms of marginal adaptation of feldspathic and indirect composite veneers over a follow-up period of 10 and 3 years, respectively.

Table 13. USPHS Marginal Adaptation evaluations over a follow-up period of up to 10 years.

	Number of restorations		**Score/Baseline**		**Score/10+ years**	
Feldspathic porcelain laminate veneers **B. Smielak et al.** **(2021)** (51)	Baseline	10 years	0	100%	0	100%
			1	-	1	-
	186	176	2	-	2	-
			3	-	3	-
			4	-	4	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (56)	Baseline	10 years	0	71%	0	22%
			1	25%	1	56%
	24	18	2	4%	2	22%
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (52)	Baseline	11 years	0	100%	0	89%
			1	-	1	11%
	444	384	2	-	2	-
			3	-	3	-
			4	-	4	-

Table 14. USPHS Marginal Adaptation evaluations over a follow-up period of up to 3 years.

	Number of restorations		**Score/Baseline**		**Score/3 years**	
Feldspathic porcelain laminate veneers **C.D'Arcangelo et al.** **(2012)** (55)	Baseline	3 years	Alpha	100%	Alpha	100%
			Bravo	-	Bravo	-
	119	119	Charlie	-	Charlie	-

Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (57)	Baseline	3 years	0	70%	0	70%
			1	26%	1	30%
	23	20	2	4%	2	-
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (44)	Baseline	3 years	0	100%	0	82%
			1	-	1	18%
	92	87	2	-	2	-
			3	-	3	-
			4	-	4	-

4.4.1.2 Color match

The following tables (Table 15 and Table 16) outline the USPHS ratings in terms of color match of feldspathic and indirect composite veneers over a follow-up period of ten and three years, respectively.

Table 15. USPHS Color Match evaluations after a follow-up period of up to 10 years.

	Number of restorations		**Score/Baseline**		**Score/10 years**	
Feldspathic porcelain laminate veneers **B. Smielak et al.** (51) **(2021)**	Baseline	10 years	0	100%	0	100%
			1	-	1	-
	186	176	2	-	2	-
			3	-	3	-
			4	-	4	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (56)	Baseline	10 years	0	38%	0	55%
			1	62%	1	17%
	24	18	2	-	2	28%
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (52)	Baseline	11 years	0	100%	0	93%
			1	-	1	7%
	444	384	2	-	2	-
			3	-	3	-

			4	-	4	-

Table 16. USPHS Color Match evaluations over a follow-up period of up to 3 years.

	Number of restorations		Score/Baseline		Score/3 years	
Feldspathic porcelain laminate veneers **C.D'Arcangelo et al.** **(2012)** (55)	Baseline	3 years	Alpha	100%	Alpha	100%
			Bravo	-	Bravo	-
	119	119	Charlie	-	Charlie	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (57)	Baseline	3 years	0	43%	0	100%
			1	57%	1	-
	23	20	2	-	2	-
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (44)	Baseline	3 years	0	100%	0	99%
			1	-	1	1%
	92	87	2	-	2	-
			3	-	3	-
			4	-	4	-

4.4.1.3 Fracture of restoration

The following tables (Table 17 and Table 18) outline the USPHS ratings in terms of fracture of restoration of feldspathic and indirect composite veneers over a follow-up period of ten and three years, respectively.

Table 17. USPHS Fracture of Restoration evaluations over a follow-up period of up to 10 years.

	Number of restorations		Score/Baseline		Score/10 years	
Feldspathic porcelain laminate veneers **B. Smielak et al.**	Baseline	10 years	0	100%	0	98%
			1	-	1	-
			2	-	2	2%

(2021) (51)	186	176	3	-	3	-
			4	-	4	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (56)	Baseline	10 years	0	100%	0	66%
			1	-	1	17%
	24	18	2	-	2	17%
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (52)	Baseline	11 years	0	100%	0	96%
			1	-	1	4%
	444	384	2	-	2	-
			3	-	3	-
			4	-	4	-

Table 18. USPHS Fracture of Restoration evaluations over a follow-up period of up to 3 years.

	Number of restorations		**Score/Baseline**		**Score/3 years**	
Feldspathic porcelain laminate veneers **C.D'Arcangelo et al.** **(2012)** (55)	Baseline	3 years	Alpha	100%	Alpha	100%
			Bravo	-	Bravo	-
	119	119	Charlie	-	Charlie	-
			Delta	-	Delta	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (57)	Baseline	3 years	0	100%	0	100%
			1	-	1	-
	23	20	2	-	2	-
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (44)	Baseline	3 years	0	100%	0	95%
			1	-	1	-
	92	87	2	-	2	-
			3	-	3	-
			4	-	4	-

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4.4.2 LEUCITE-REINFORCED vs INDIRECT COMPOSITE LAMINATE VENEERS

Five of the eleven included studies assess the clinical outcomes of leucite-reinforced porcelain veneers (45,50,53,56,57). They are all RCTs (except from the P.C. Guess et cols study) and rate the restorations by means of both the numerical score and the Alpha, Bravo, Charlie, Delta rating methods. Three of these five papers report a continuous evaluation of the laminate veneers across the entire follow-up period (45,46,50). In regard to indirect composite veneers, their quality of survival is observed in two studies (56,57), where all USPHS categories are evaluated through numerical scores, at the baseline and at a final recall (taking place after ten and three years, respectively). The aforementioned articles directly compare clinical outcomes of leucite-reinforced porcelain laminate veneers and indirect composite laminate veneers and their results are outlined in the following tables (Table 19 and Table 20).

Table 19. Indirect Resin Composite vs Leucite-based ceramic veneers: Up to 10-year follow-up. USPHS evaluation at baseline and final follow-up.

	Criteria	**Score**	**Baseline**		**Final evaluation**	
			ICV (n=24)	LBCV (n=24)	ICV (n=18)	LBCV (n=24)
M.M.M. Gresnigt et al. (2019) (56)	Marginal Adaptation	0 1 2 3 4	71% 25% 4% - -	83% 17% - - -	22% 56% 22% - -	58% 42% - - -
	Color Match	0 1 2 3 4	37.5% 62.5% - - -	42% 58% - - -	55% 17% 28% - -	100% - - - -
	Fracture of Restoration	0 1 2 3 4 5	100% - - - - -	100% - - - - -	66% 17% 17% - - -	96% 4% - - - -

ICV: Indirect Composite Veneers; LBCV: Leucite-Based Ceramic Veneers.

Table 20. Indirect Resin Composite vs Leucite-based ceramic veneers: Up to 3-year follow-up. USPHS evaluations at baseline and final recall.

			Baseline		**Final evaluation**	
			ICV	LBCV	ICV	LBCV

	Criteria	Score	(n=23)	(n=23)	(n=20)	(n=23)
M.M.M. Gresnigt et al. **(2013)** (57)	Marginal Adaptation	0 1 2 3 4	70% 26% 4% - -	100% - - - -	70% 30% - - -	87% 13% - - -
	Color Match	0 1 2 3 4	43% 57% - - -	30% 70% - - -	100% - - - -	83% 7% - - -
	Fracture of Restoration	0 1 2 3 4 5	100% - - - - -	100% - - - - -	100% - - - - -	100% - - - - -

ICV: Indirect Composite Veneers; LBCV: Leucite-Based Ceramic Veneers.

Vice versa, the rest of the clinical studies report continuous evaluation of the restorations throughout the whole follow-up period and provide us data concerning solely leucite-reinforced porcelain laminate veneers. All three studies include fracture of restoration USPHS assessments (Table 21), while only two focus on marginal adaptation (Table 22) and just one of them presents color match evaluations as well (46). Indeed, P.C. Guess and cols examined all three USPHS categories, in a comparison of clinical outcomes of leucite-based ceramic veneers with two distinct types of dental preparation; over an observation spell of one year, very modest changes as of color match were detected, with 100% of the restorations rated with a USPHS score Alpha at the baseline and 98% of the veneers still available for assessment maintaining the same score at the twelve-months-evaluation and only a 2% ending up rated with a score Bravo (46).

Table 21. Leucite-based ceramic veneers: one-year follow-up. USPHS Fracture of Restoration evaluations at baseline and final recall.

	Number of restorations		Score/Baseline		Score/1 year	
H.I. Mahrous El-Banna et al. **(2021)** (45)	Baseline	1 year	0	100%	0	100%
			1	-	1	-
			2	-	2	-
			3	-	3	-

	18	18	4	-	4	-
O.MW. El-Mesallamy et al. **(2021)** (50)	Baseline	1 year	0	100%	0	100%
			1	-	1	-
	18	18	2	-	2	-
			3	-	3	-
			4	-	4	-
P. C. Guess et al. **(2014)** (46)	Baseline	1 year	Alpha	100%	0	100%
			Bravo	-	1	-
	66	52	Charlie	-	2	-
			Delta	-	3	-

Table 22. Leucite-based ceramic veneers: one-year follow-up. USPHS Marginal Adaptation evaluations at baseline and final recall.

	Number of restorations		**Score/Baseline**		**Score/1 year**	
H.I. Mahrous El-Banna et al. **(2021)** (45)	Baseline	1 year	0	100%	0	100%
			1	-	1	-
	18	18	2	-	2	-
			3	-	3	-
			4	-	4	-
P. C. Guess et al. **(2014)** (46)	Baseline	1 year	Alpha	100%	Alpha	92%
			Bravo	-	Bravo	8%
	66	52	Charlie	-	Charlie	-

4.4.3 LITHIUM DISILICATE-REINFORCED vs INDIRECT COMPOSITE LAMINATE VENEERS

Two out of the eleven included studies focus on the clinical outcomes of lithium-disilicate-reinforced porcelain veneers (53,54). They are both longitudinal prospective studies, rate the restorations by means of the Alpha, Bravo, Charlie, Delta rating method and report a continuous evaluation of the laminate veneers across the entire follow-up period of two years. The Özturk et cols' paper includes assessment of two out of three USPHS criteria of interest (these being marginal adaptation and fracture of restoration),

while the Yuce et cols study presents evaluation of all three categories (53,54). The following table (Table 23) outlines the results of both articles at baseline, after 12 and 24-months-assessments. Unfortunately, no clinical study analyzing clinical outcomes of indirect composite veneers over a comparable observation spell was found in the search.

Table 23. USPHS evaluations over a follow-up period of 2 years.

	Number of restorations			Criteria	Rating	Baseline	1 year(s)	2 year(s)
M. Yuce et al. **(2017)** (53)	**Baseline**	**1 year(s)**	**2 year(s)**	**Marginal adaptation**	Alpha	100%	100%	97%
					Bravo	-	-	3%
					Charlie	-	-	-
	61	61	61	**Color match**	Alpha	100%	100%	100%
					Bravo	-	-	-
					Charlie	-	-	-
				Fracture of the restoration	Alpha	100%	100%	100%
					Bravo	-	-	-
					Charlie	-	-	-
					Delta	-	-	-
E. Öztürk **(2014)** (54)	**Baseline**	**1 year (s)**	**2 year(s)**	**Marginal adaptation**	Alpha	100%	100%	100%
					Bravo	-	-	-
					Charlie	-	-	-
	125	124	124	**Fracture of the restoration**	Alpha	100%	98%	100%
					Bravo	-	1%	-
					Charlie	-	-	-
					Delta	-	1%	-

5 DISCUSSION

The clinical performance of minimally invasive restorations such as laminate veneers relies on a multitude of factors including dental preparation design, patient-related aspects (like tooth vitality, parafunctional habits and oral hygiene), experience level of the clinicians and technicians involved, adhesive system used and, last but not least, veneering material of choice. Laminate veneers are typically fabricated from either particulate filled composites or glass-based ceramics, both materials with proven adequacy for aesthetic rehabilitation of the anterior sector (26,57). Glass-based ceramics can be classified into three groups: feldspathic, leucite-reinforced and lithium disilicate-reinforced porcelains (45). Feldspathic porcelain is known for providing considerable aesthetic value and high translucency while other types of glass ceramic, due to the presence of crystalline fillers within their composition, may not possess such advanced optical properties but offer improved resistance to mechanical fracture, thermal shock and corrosion (58). Indirect composite restorations, on the other hand, generally have lower elastic modulus, are easy to lute and repair, cost-effective, less abrasive to the antagonistic teeth and may allow for better absorption of the polymerization stresses occurring during cementation procedures (31,56). Contemporary laboratory-made composites (Estenia, Kuraray Co., Tokyo, Japan) present higher filler content which increases both strength and optical properties, but also makes the material more brittle (57). In an in vitro study, Dederichs et al. reported that prefabricated composite veneers (Visalys Veneer Chairside and Componeer Veneer System) demonstrate more wear after abrasion and erosion tests compared to lithium disilicate veneers (e.max CAD) (59). However, Fradeani et al. stated that in vitro and in vivo studies regarding clinical performance of laminate veneers do not have the same value (60). Although the current in vivo literature analyzing survival quality of composite laminate veneers is rather limited, some reviews suggested that, while composite veneers provide acceptable aesthetic outcome and patient satisfaction, they tend to fail faster than porcelain veneers and have a higher risk of fracture than the latter (61–63). Within its limitations, the present systematic review aims to compare the clinical performances of glass ceramic and indirect composite laminate veneers.

5.1 FELDSPATHIC vs INDIRECT COMPOSITE LAMINATE VENEERS

Given the discrepancy in clinical performance over follow-up periods of up to 10 years shown by feldspathic and indirect composite veneers, the hypothesis could be accepted. However, across shorter observation spells of up to 3 years, differences regarding quality of survival were less noticeable. Smielak et al. assessed the clinical performance of feldspathic laminate veneers (Sakura Interaction) with conventional and no-prep/minimally invasive dental preparations; over a follow-up period of up to 10 years, no changes were noted in terms of marginal adaptation and color match, with 100% of the veneers rated with a USPHS 0 score at both baseline and final recall, regardless of the type of preparation that had been carried out (51). Meanwhile, slight fractures of the restorations were detected on five (2%) of the 176 feldspathic veneers 85 to 101 months after cementation (USPHS criteria, fracture of restoration-Score 2); of these five fractures, three occurred on conventional (4%), while two on no-prep/minimally invasive veneers (2%) (51) . Over an observation spell of up to 11 years, Gresnigt et al. conducted a prospective clinical trial analyzing quality of survival of feldspathic laminate veneers (Creation Zi CT) with special interest on existing restorations, immediate dentin sealing (IDS) and endodontically treated teeth; while 100% of the restorations had been given a marginal adaptation and color match USPHS score 0 at the baseline, by the final evaluation, 11% presented slight marginal defects (USPHS criteria, marginal adaptation-score 1) and 7% changes in terms of color match (USPHS criteria, color match-score 1), with laminate veneers bonded to endodontically treated teeth performing significantly worse than those bonded to vital teeth in regard to the latter aspect (52). As concerns indirect composite veneers (Estenia C&B), Gresnigt et al. evaluated their performance in a randomized split-mouth clinical trial over a comparable follow-up time (up to 10 years) and minor voids, marginal discrepancies and defects were observed in 78% of the restorations by the final evaluation (USPHS criteria, marginal adaptation-scores 1-2). Regarding USPHS color match evaluations, by the final recall, 45% of the composite veneers did not match the surrounding teeth (USPHS criteria, color match-scores 1-2). Fractures were seen in 34% of the restorations by the final evaluation (USPHS criteria, fracture of restoration-Scores 1-2) (56). D'Arcangelo et al. assessed the clinical performance of feldspathic laminate veneers (Omega 900, VITA)

bonded with light-cured composite over a follow-up period of up to 7 years (at baseline and after 36, 48, 60, 72 and 84 months) (55). At the 36-months-evaluation, no changes were detected in terms of marginal adaptation, color match or fracture of restorations, with all veneers rated with an USPHS Alpha score, just like at the baseline (55). Over an observation spell of up to 40 months, Gresnigt at al. analyzed quality of survival of feldspathic laminate veneers (Shofu Vintage AL) bonded to teeth with and without existing composite restorations; slight marginal defects were noted in 18% of the veneers and they were more common on existing composite restorations than intact teeth (44). As concerns indirect composite veneers (Estenia C&B), Gresnigt et al. evaluated their performance in a randomized split-mouth clinical trial over a comparable follow-up time (up to 3 years) and minor voids, marginal discrepancies and defects were observed in 30% of the restorations (USPHS criteria, marginal adaptation-score 1) (57).

5.2 LEUCITE-REINFORCED vs INDIRECT COMPOSITE LAMINATE VENEERS

Given the discrepancy in clinical performance over follow-up periods of up to 10 years shown by leucite-based and indirect composite veneers, the hypothesis could be accepted. However, across shorter observation spells of up to 3 years, differences regarding quality of survival were less noticeable. Gresnigt et al. compared the clinical performances of leucite-reinforced (IPS Empress Esthetic) and indirect composite veneers (Estenia C&B) in a randomized split-mouth clinical trial over an observation spell of up to 10 years (56). For all the variables (USPHS marginal adaptation, color match and fracture of restoration), the ceramic restorations were rated better (56). On the other hand, in a randomized split-mouth clinical trial with a follow-up period of up to 3 years, resin composite performed slightly worse than leucite-based porcelain in terms of marginal adaptation but did surprisingly better when it comes to color match; moreover, a total of two fractures occurred in the incisal area of the indirect composite veneers (57). El Banna et al. and El-Mesallamy et al. evaluated quality of survival of leucite-reinforced ceramic veneers (IPS-Empress CAD) throughout 12 months and only zero scores were recorded for all USPHS categories of interest across all the follow-up sessions (45,50). On the other hand, Guess et al. reported a quite significant decrease in

marginal adaptation ratings already at the one-year-evaluation for both types of dental preparation under assessment (incisal/palatal butt-joint margin and palatal rounded shoulder margin) (46).

5.3 LITHIUM DISILICATE-REINFORCED vs INDIRECT COMPOSITE LAMINATE VENEERS

Only two studies evaluating clinical performance of lithium silicate laminate veneers (IPS e.max CAD and IPS e.max pressed) could be retrieved, both presenting a follow-up period of up to 2 years (53,54). Unfortunately, due to the discrepancy in terms of observation spells, no direct comparison could be made between quality of survival of this type of restoration and that of indirect composite veneers, hence further clinical investigation on the matter is required. All lithium silicate-reinforced veneers performed within clinically acceptable ranges over a follow-up period of two years.

5.4 LIMITATIONS OF THE REVIEW

For clinically successful dental restorations, four basic requirements must be fulfilled: marginal adaptation, biocompatibility, esthetics and mechanical strength (64). Aim of the present systematic review was to examine to what degree these properties are present in ceramic and indirect composite veneers for subsequently comparing the two; in this pursuit, common criteria had to be established for collating the materials' clinical outcomes and, for this reason, three USPHS evaluation criteria were taken into consideration: marginal adaptation, color match and fracture of restoration. As previously brought up in the result section, while all included studies assessed at least a couple of the aforementioned USPHS criteria, not every paper employed the exact same evaluation method, with four of them rating the laminate veneers by means of Alpha, Bravo, Charlie, Delta as opposed of numerical scores. This discrepancy in terms of ratings constituted a somewhat of a limitation since, as highlighted in Tables 7 and 8, there are slight differences between the two methods.

Furthermore, due to a lack of available literature, not the totality of the included studies could present mutual clinical settings such as: same dental preparation technique, clinicians and technicians with identical levels of experience, same processing technique employed for fabricating the restorations. This is mainly because many of the selected papers are themselves analyzing or comparing survival quality of laminate veneers using particular clinical approaches, under specific clinical settings or employing distinct processing techniques. Regarding their participants, all the studies included patients requiring esthetic improvement of anterior teeth, with good oral hygiene habits, having no caries to be treated, active periodontal or pulpal diseases, able to tolerate conventional restoration procedures, not allergic to resin-based materials and willing to return for follow-up examinations. Existing composite fillings were generally judged based on extension and location on teeth and subjects with restorations of good quality, presenting no caries, ditching or marginal staining were not excluded from the trials. However, two studies are restricted to non-carious, unrestored teeth (45,50). It was reported that veneer restorations are a good choice for endodontically treated teeth as well (65), although they were excluded in four of the present studies (45,46,50,53). As concerns parafunctional habits, despite the lack of available in vivo studies on the matter, it has been proven that the likelihood of fracture and debonding of porcelain laminate veneers increases considerably in patients suffering from bruxism, even though the use of occlusal splints reduces the probability of fracture by eight times (66). For this reason, six of the eleven present studies did not exclude patients with bruxism but informed them of the risks associated with the procedure and that they would need to use a night guard following the treatment (44,51,52,55–57).

All the eleven included studies analyze the clinical performance of glass-ceramics laminate veneers (feldspathic, leucite-reinforced and lithium-disilicate based ceramics), while just two of them report evaluations of indirect composite veneers. Four papers focus on the survival quality of feldspathic ceramic laminate veneers (Sakura Interaction, Creation Zi CT, Shofu Vintage AL, Omega 900 VITA), all fabricated by means of the traditional layering technique with the use of refractory dies (44,51,52,55). On the other hand, of the five studies examining clinical outcomes of leucite-reinforced ceramic

laminate veneers (IPS Empress), three employed heat-pressed restorations, processed through the lost-wax technique (46,56,57), while the rest used CAD/CAM-fabricated restorations (45,50). Lithium-disilicate reinforced veneers (IPS e.max), both heat-pressed and CAD/CAM-manufactured, were assessed in two studies (53,54). Lastly, as concerns indirect composite veneers, Estenia C&B restorations fabricated using the layering technique were evaluated in both studies (56,57).

A further limitation of the present review is the existing discrepancy of follow-up periods amongst the available studies, with observation spells going from a minimum of one (45,50) to a maximum of eleven years (52). For this reason, not all types of ceramic veneers could be compared with the composite counterparts over mutual follow-up terms. Moreover, not all studies presented continuous evaluations at regular intervals across the entire length of the trial but some reported results at the baseline and at the final recall only. Within its limitations, the present systematic review aims to compare the clinical performances of glass ceramic and indirect composite laminate veneers.

6 CONCLUSIONS

Ceramic veneers generally perform better in terms of marginal adaptation, color match and fracture of restoration compared to indirect composite laminate veneers over large follow-up periods (up to 10 years), while across shorter observation spells (up to 3 years), differences regarding quality of survival are less noticeable.

Feldspathic porcelain veneers perform better in terms of marginal adaptation, color match and fracture of restoration compared to indirect composite veneers over large follow-up periods (up to 10 years), while across shorter observation spells of up to 3 years, differences regarding quality of survival are less noticeable.

Leucite-reinforced porcelain veneers perform better in terms of marginal adaptation, color match and fracture of restoration compared to indirect composite veneers over large follow-up periods (up to 10 years), while across shorter observation spells of up to 3 years, differences regarding quality of survival are less noticeable.

Due to the discrepancy in follow-up times, clinical performance of lithium disilicate-reinforced and indirect composite veneers could not be compared directly. Further in vivo clinical studies investigating survival quality of indirect composite veneers over comparable observation spells are required.

BIBLIOGRAPHY

1. Eli I, Bar-Tal Y, Kostovetzki I. At first glance: social meanings of dental appearance. J Public Health Dent. 2001;61(3):150-4.
2. Henson ST, Lindauer SJ, Gardner WG, Shroff B, Tufekci E, Best AM. Influence of dental esthetics on social perceptions of adolescents judged by peers. Am J Orthod Dentofacial Orthop. 2011 Sep;140(3):389-95.
3. Pithon MM, Nascimento CC, Barbosa GC, Coqueiro Rda S. Do dental esthetics have any influence on finding a job? Am J Orthod Dentofacial Orthop. 2014 Oct;146(4):423-9.
4. Salim NA, Jubair F, Hassona YM, Izriqi S, Al-Fuqaha'a D. Esthetic Dentistry on Twitter: Benefits and Dangers. Int J Dent. 2021 Dec 8; 1-11.
5. Sampson A, Jeremiah HG, Andiappan M, Newton JT. The effect of viewing idealised smile images versus nature images via social media on immediate facial satisfaction in young adults: A randomised controlled trial. J Orthod. 2020 Mar;47(1):55-64.
6. Layton D, Walton T. An up to 16-year prospective study of 304 porcelain veneers. Int J Prosthodont. 2007 Jul-Aug;20(4):389-96.
7. Fons-Font A, Solá-Ruíz MF, Granell-Ruíz M, Labaig-Rueda C, Martínez-González A. Choice of ceramic for use in treatments with porcelain laminate veneers. Med Oral Patol Oral Cir Bucal. 2006 May 1;11(3):E297-302.
8. Carrillo SC. Michael G. Buonocore, padre de la odontología adhesiva moderna, 63 años del desarrollo de la técnica del grabado del esmalte (1955-2018). Rev ADM. 2018;75(3):135-142. Available from: www.medigraphic.com/adm.
9. Perdigão J, Araujo E, Ramos RQ, Gomes G, Pizzolotto L. Adhesive dentistry: Current concepts and clinical considerations. J Esthet Restor Dent. 2021 Jan;33(1):51-68.
10. El-Mowafy O, El-Aawar N, El-Mowafy N. Porcelain veneers: An update. Dent Med Probl. 2018 Apr-Jun;55(2):207-11.

11. Burke FJ. Survival rates for porcelain laminate veneers with special reference to the effect of preparation in dentin: a literature review. J Esthet Restor Dent. 2012 Aug;24(4):257-65.
12. Nakabayashi N, Nakamura M, Yasuda N. Hybrid layer as a dentin-bonding mechanism. J Esthet Dent.1991Jul-Aug;3(4):133-8.
13. Magne P. Immediate dentin sealing: a fundamental procedure for indirect bonded restorations. J Esthet Restor Dent. 2005;17(3):144-54.
14. Samartzi TK, Papalexopoulos D, Sarafianou A, Kourtis S. Immediate Dentin Sealing: A Literature Review. Clin Cosmet Investig Dent. 2021 Jun 21;(13):233-56.
15. Packham D. Handbook of Adhesion. Chichester, UK: John Wiley & Sons, Ltd; 2005.
16. Eick JD, Cobb CM, Chappell RP, Spencer P, Robinson SJ. The dentinal surface: its influence on dentinal adhesion. Part I. Quintessence Int. 1991 Dec;22(12):967-77.
17. Sezinando A. Looking for the ideal adhesive-A review., Rev Port Estomatol, Med Dent Cir Maxilofac. 2014;55(4): 194-206.
18. Beniash E, Stifler CA, Sun CY, Jung GS, Qin Z, Buehler MJ, Gilbert PUPA. The hidden structure of human enamel. Nat Commun. 2019 Sep 26; 10(1):4383.
19. Perdigão J, Sezinando A. Enamel and dentin bonding for adhesive restorations. In: Non-Metallic Biomaterials for Tooth Repair and Replacement. Elsevier; 2013. 45–89.
20. Usha C, Ramarao S, John BM, Rajesh P, Swatha S. Evaluation of the Shear Bond Strength of Composite Resin to Wet and Dry Enamel Using Dentin Bonding Agents Containing Various Solvents. J Clin Diagn Res. 2017 Jan;11(1): 41-4.
21. Perdigão J. Current perspectives on dental adhesion: Dentin adhesion - not there yet. Jpn Dent Sci Rev. 2020 Nov;56(1):190-207.
22. Magne P, Urs Belser. Bonded Porcelain Restorations in the Anterior Dentition-a Biomimetic Approach. Chicago, USA: Quintessence Pub. Co; 2002.
23. Edward A. McLaren, Phong Tran Cao. Ceramics-in-Dentistry. In Dent. 2009 Nov;94–104.

24. Giordano R, McLaren EA. Ceramics overview: classification by microstructure and processing methods. Compend Contin Educ Dent. 2010 Nov-Dec;31(9):682-8.
25. Vafiadis D, Goldstein G. Single visit fabrication of a porcelain laminate veneer with CAD/CAM technology: a clinical report. J Prosthet Dent. 2011 Aug;106(2):71-3.
26. Dietschi D, Devigus A. Prefabricated composite veneers: historical perspectives, indications and clinical application. Eur J Esthet Dent. 2011;6(2):178-87.
27. Zimmerli B, Strub M, Jeger F, Stadler O, Lussi A. Composite materials: composition, properties and clinical applications. A literature review. Schweiz Monatsschr Zahnmed. 2010;120(11):972-86.
28. Nahsan FP, Mondelli RF, Franco EB, Naufel FS, Ueda JK, Schmitt VL, Baseggio W. Clinical strategies for esthetic excellence in anterior tooth restorations: understanding color and composite resin selection. J Appl Oral Sci. 2012 Mar-Apr;20(2):151-6.
29. Patodiya A, Hegde MN. Dental composites: past, present and future. Natl. J Community med. 2012; (3): 754-756. Available from: www.njcmindia.org.
30. Alrahlah A. Physical, Mechanical and Surface Properties of Dental Resin-composites. The University of Manchester (United Kingdom); 2013.
31. Gomes G, Perdigão J. Prefabricated composite resin veneers-a clinical review. J Esthet Restor Dent. 2014 Sep-Oct;26(5):302-13.
32. Klapdohr S, Moszner N. New Inorganic Components for Dental Filling Composites. Monatshefte für Chemie - Chemical Monthly. 2005 Jan 30;136(1):21–45.
33. Heuer GA, Garman TA, Sherrer JD, Williams HA. A clinical comparison of a quartz- and glass-filled composite with a glass-filled composite. J Am Dent Assoc. 1982 Aug;105(2):246-7.
34. Phillips RW, Avery DR, Mehra R, Swartz ML, McCune RJ. Observations on a composite resin for class II restorations: two-year report. J Prosthet Dent. 1972 Aug;28(2):164-9.
35. Luis Guilherme Sensi, Howard E. Strassler and William Webley. Direct Composite Resins. Inside Dentistry. 2007 Aug;3(7).

36. Gary M. Radz, Karl F. Leinfelder. The Current State of Composite Resins. Inside Dentistry. 2008 Nov;4(10).
37. Ferracane JL. Resin composite--state of the art. Dent Mater. 2011 Jan;27(1):29-38.
38. Sideridou ID, Karabela MM, Micheliou CN, Karagiannidis PG, Logothetidis S. Physical properties of a hybrid and a nanohybrid dental light-cured resin composite. J Biomater Sci Polym Ed. 2009;20(13):1831-44.
39. Hervás-García A, Martínez-Lozano MA, Cabanes-Vila J, Barjau-Escribano A, Fos-Galve P. Composite resins. A review of the materials and clinical indications. Med Oral Patol Oral Cir Bucal. 2006 Mar 1;11(2):E215-E220.
40. Cvar JF, Ryge G. Reprint of criteria for the clinical evaluation of dental restorative materials. Clin Oral Investig. 2005 Dec;9(4):215-32.
41. Bayne SC, Schmalz G. Reprinting the classic article on USPHS evaluation methods for measuring the clinical research performance of restorative materials. Clin Oral Investig. 2005 Dec;9(4):209-14.
42. Peumans M, Van Meerbeek B, Lambrechts P, Vanherle G. Porcelain veneers: a review of the literature. J Dent. 2000 Mar;28(3):163-77.
43. Hamza TA, Sherif RM. In vitro evaluation of marginal discrepancy of monolithic zirconia restorations fabricated with different CAD-CAM systems. J Prosthet Dent. 2017 Jun;117(6):762-6.
44. Gresnigt MM, Kalk W, Özcan M. Clinical longevity of ceramic laminate veneers bonded to teeth with and without existing composite restorations up to 40 months. Clin Oral Investig. 2013 Apr;17(3):823-32.
45. El-Banna HIM; Zamzam ML; Fouad EJ; Soliman IA. One-year clinical evaluation of IPS Empress CAD versus polished Celtra Duo ceramic laminate veneers (randomized controlled trial). Braz. Dent. Sci. 2021 Jul; 24(3):1-14
46. Guess PC, Selz CF, Voulgarakis A, Stampf S, Stappert CF. Prospective clinical study of press-ceramic overlap and full veneer restorations: 7-year results. Int J Prosthodont. 2014 Jul-Aug;27(4):355-8.
47. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021 Mar 29;372:n71.

48. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977 Mar;33(1):159-74.
49. Cabello López, J.B. Plantilla para ayudarte a entender una Revisión Sistemática. En: CASPe. Guías CASPe de Lectura Crítica de la Literatura Médica. Alicante: CASPe. Elsevier; 2005. 13-7.
50. El-Mesallamy OMW, EL-Banna HIM, Zamzam ML, *et al.* Patient Satisfaction and Clinical Evaluation of IPS Empress CAD versus ZLS Ceramic Laminate Veneers: A Randomized Controlled Clinical Trial. World J Dent 2021;12(3):183–8.
51. Smielak B, Armata O, Bojar W. A prospective comparative analysis of the survival rates of conventional vs no-prep/minimally invasive veneers over a mean period of 9 years. Clin Oral Investig. 2022 Mar;26(3):3049-59.
52. Gresnigt MMM, Cune MS, Schuitemaker J, van der Made SAM, Meisberger EW, Magne P, Özcan M. Performance of ceramic laminate veneers with immediate dentine sealing: An 11 year prospective clinical trial. Dent Mater. 2019 Jul;35(7):1042-52.
53. Yuce M, Ulusoy M, Turk AG. Comparison of Marginal and Internal Adaptation of Heat-Pressed and CAD/CAM Porcelain Laminate Veneers and a 2-Year Follow-Up. J Prosthodont. 2019 Jun;28(5):504-10.
54. Oztürk E, Bolay S. Survival of porcelain laminate veneers with different degrees of dentin exposure: 2-year clinical results. J Adhes Dent. 2014 Oct;16(5):481-9.
55. D'Arcangelo C, De Angelis F, Vadini M, D'Amario M. Clinical evaluation on porcelain laminate veneers bonded with light-cured composite: results up to 7 years. Clin Oral Investig. 2012 Aug;16(4):1071-9.
56. Gresnigt MMM, Cune MS, Jansen K, van der Made SAM, Özcan M. Randomized clinical trial on indirect resin composite and ceramic laminate veneers: Up to 10-year findings. J Dent. 2019 Jul;86:102-9.
57. Gresnigt MM, Kalk W, Ozcan M. Randomized clinical trial of indirect resin composite and ceramic veneers: up to 3-year follow-up. J Adhes Dent. 2013 Apr;15(2):181-90.
58. Sadaqah N. Ceramic Laminate Veneers: Material Advances and Selection. OJS. 2014 May; (4):268-79.

59. Dederichs M, Fahmy MD, An H, Guentsch A, Viebranz S, Kuepper H. Comparison of Wear Resistance of Prefabricated Composite Veneers Versus Ceramic and Enamel. J Prosthodont. 2021 Oct;30(8):711-9.
60. Fradeani M, Redemagni M, Corrado M. Porcelain laminate veneers: 6- to 12-year clinical evaluation--a retrospective study. Int J Periodontics Restorative Dent. 2005 Feb;25(1):9-17.
61. Alothman Y, Bamasoud MS. The Success of Dental Veneers According To Preparation Design and Material Type. Open Access Maced J Med Sci. 2018 Dec 14;6(12):2402-8.
62. Liu M, Gai K, Chen J, Jiang L. Comparison of Failure and Complication Risks of Porcelain Laminate and Indirect Resin Veneer Restorations: A Meta-Analysis. Int J Prosthodont. 2019 Jan/Feb;32(1):59-65.
63. Sailo JL, Bathla N, Thakur P, Nagpal A, Gupta R, Duvedi K. Porcelain Veneers vs Composite Resin Veneers: A Review. J Adv Med. Advances in Medicine and Medical Research. 2020 Dec;32(24):316–26.
64. Arif R, Dennison JB, Garcia D, Yaman P. Retrospective evaluation of the clinical performance and longevity of porcelain laminate veneers 7 to 14 years after cementation. J Prosthet Dent. 2019 Jul;122(1):31-7.
65. D'Arcangelo C, De Angelis F, Vadini M, D'Amario M, Caputi S. Fracture resistance and deflection of pulpless anterior teeth restored with composite or porcelain veneers. J Endod. 2010 Jan;36(1):153-6.
66. Granell-Ruíz M, Agustín-Panadero R, Fons-Font A, Román-Rodríguez JL, Solá-Ruíz MF. Influence of bruxism on survival of porcelain laminate veneers. Med Oral Patol Oral Cir Bucal. 2014 Sep 1;19(5):e426-32.

ANNEX 1: MANUSCRIPT

TITLE: "Clinical Outcomes of Porcelain versus Indirect Composite Laminate Veneers: A Systematic Review"

RUNNING TITLE: Porcelain vs Indirect Composite Laminate Veneers

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ABSTRACT

Objective: Given the increase in popularity of this type of restoration over the last four decades and the advances that have taken place in terms of biomaterials, the present study aims to systematically review and compare the clinical performances of glass-ceramic (feldspathic, leucite-reinforced, lithium disilicate-reinforced) and indirect composite veneers according to the modified USPHS criteria used for the clinical evaluation of laminate veneers.

Material and methods: Following the recommended methods for systematic reviews and meta-analyses (PRISMA), an electronic search was performed in the MEDLINE Complete and Scopus databases to identify all relevant articles published until March 2022. The risk of bias of the selected studies was assessed according to the Critical Appraisal Skills Program (CASP), in an attempt to confirm and evaluate their quality, validity and relevance.

Results: Eleven papers assessing the clinical performance of indirect composite and glass-ceramic veneers complied with the inclusion criteria. Results of studies with matching follow-up periods were compared for each USPHS criterium (marginal adaptation, color match and fracture of restoration). Ceramic veneers seem to show better quality of survival compared to indirect composite laminate veneers in relation to the aforementioned clinical parameters.

Conclusion: Feldspathic and leucite-reinforced ceramic veneers perform significantly better in terms of marginal adaptation, color match and fracture of restoration compared to indirect composite veneers over large follow-up periods (up to 10 years), while across shorter observation spells of up to 3 years, differences regarding quality of survival are less noticeable. Due to the discrepancy in follow-up times, clinical performance of lithium disilicate-reinforced and indirect composite veneers could not be compared directly. Further in vivo clinical studies investigating survival quality of indirect composite veneers over comparable observation spells are required.

***Keywords**: "Porcelain Laminate Veneers", "Indirect Composite Veneers", "USPHS criteria", "Marginal Adaptation", "Color Match" and "Fracture of Restoration"*

1. INTRODUCTION

Ceramic laminate veneers typically consist of thin shells of porcelain, the fitted surface of which has been etched with hydrofluoric acid and coated with a silane coupling agent before being bonded to the acid-etched enamel using a resin-based cement (1). Dental ceramics can exist in a glass form without crystalline phase, in a glass form with varying amount and types of crystalline phase, as a mostly crystalline material with small amounts of glass or in the form of a polycrystalline solid (a glass-free material) (2).

Glass-based systems, also known as feldspars, contain silica dioxide (or quartz) as their basic component as well as alumina (3). Traditionally, veneers were mostly made out of conventional feldspathic porcelain (without crystalline phase), a material which has proven to offer very good esthetic effect but low fracture resistance (3). In order to improve the latter aspect, over the decades new materials have been developed by growing into the matrix of glass-based ceramics varying amounts of crystalline fillers, typically leucite or lithium disilicate (4). It is key to stress glass-based systems are etchable, thus easily bondable and for this reason very much suitable for porcelain laminate veneers fabrication (2). While the porcelain veneering technique has been growing in popularity over the decades, the concept of indirect composite veneers was first introduced in dentistry over 30 years ago but then temporarily abandoned due to former technological limitations. Nevertheless, modern technology has recently brought these restorations back to the fore thanks to the introduction of vitrification processes by surface laser treatments (5).

Dental composite resins are made up of three major elements: an organic polymer matrix, an inorganic filler and a coupling agent (6). They can be classified according to the size of their filler particles (7–9). In this sense, the advent of smaller particle fillers in the composite matrix has produced highly polishable composites that will maintain their luster, making them an ideal choice for aesthetic restorations (10).

US Public Health Service (USPHS) guidelines are the amongst the most frequently employed parameters for evaluating dental restorative materials (11). Specifically, three USPHS categories were chosen for comparing the veneers' clinical performances in the present systematic review. Marginal adaptation, defined as "the vertical distance between the finish line of the prepared tooth and the margins of the fabricated

veneers", is considered to be one of the key factors for success of all fixed dental prostheses, since large marginal discrepancies can result in gingival inflammation, secondary caries, pulpal inflammation, necrosis and, ultimately, failure of the restoration (12,13). Equally crucial criterium is that evaluating potential restoration fractures, as this was reported to be the most common failure type for glass-ceramics veneers (14). On the other hand, USPHS color match assessments provide us significant indications regarding esthetics, referring to whether or not there is chromatic equivalency between restoration and adjacent teeth (15).

2. MATERIAL AND METHOD

2.1 Protocol and focused question

The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guideline was followed to perform this systematic review (16). The following clinical question, written according to the PICO structure was constructed: In patients treated with indirect laminate veneers (P), does porcelain (I) or composite (C) provide superior clinical outcomes according to the modified USPHS criteria (O)?

2.2 Selection criteria

Studies were excluded based on the following exclusion criteria 1) In vitro studies; 2) Case reports; 3) Systematic reviews; 4) Literature reviews; 5) Studies published in 2010 or before; 6) Studies in languages other than English. Studies were included based on the following inclusion criteria 1) Human studies; 2) Randomized Controlled Trials; 3) Studies with at least a year of follow-up; 4) Patients treated with laminate veneers; 5) Cohort studies; 6) Studies that assess clinical outcomes according to the USPHS criteria.

2.3. Search strategy

A literature search was conducted with MEDLINE Complete and Scopus databases between December 2021 and March 2022, using the following search terms: ((dental veneers) OR (dental laminates) OR (veneers) OR (laminates)) AND (((porcelain laminate veneers) OR (porcelain veneers) OR (ceramic laminate veneers) OR (ceramic veneers)) OR ((indirect composite veneers) OR (prefabricated composite veneers) OR (indirect

resin composite veneers) OR (prefabricated resin composite veneers))) AND ((USPHS criteria) OR (modified USPHS criteria) OR (United States public health service criteria) OR (modified United States public health service criteria) OR (public health service criteria) OR (Ryge criteria)).

2.4. Selection process

Two impartial reviewers (GD and ES) independently performed the systematic review search. In a first phase, duplicate records were removed, then study titles and abstracts were screened to make sure they were relevant. Subsequently, through full text assessment, the inclusion and exclusion criteria were then applied. Finally, the bibliography of each article was reviewed in order to perform a cross-search. Any discrepancy in study eligibility was resolved by mutual consensus of both the reviewers. The level of agreement between the reviewers as calculated using the k-score according to the Landis and Koch criteria (17).

2.5. Risk of bias assessment

The risk of bias of the selected studies was assessed independently and by the same reviewers who performed the search (GD and ES) according to the Critical Appraisal Skills Program (CASP), in an attempt to confirm and evaluate their quality, validity and relevance. The CASP tool employs a systematic approach based on specific criteria, which are individually assessed for each study with three possible responses: “Yes”, “No” or “Cannot tell” (18).

3. RESULTS

3.1 Study selection

As illustrated in the PRISMA flowchart (Fig. 1), initially, a total of 54 studies were identified across MEDLINE complete and Scopus and a total of 11 studies were finally included in the present systematic review (13-15,19–26).

3.2 Characteristics of the included studies

Portrayed in Figure 4 are the characteristics of the included studies. Details of the publication's author, year, study design, population sample (including sample size, gender ratio, mean age, number of veneers evaluated), study groups (where applicable), follow-up time, type of restorations under assessment and study variables were all listed.

3.4 Risk of bias assessment

Portrayed in Fig. 2, the CASP checklists for Randomized Controlled Trials (RCTs) and Cohort Studies (18).

3.5 Results of individual studies

I. Feldspathic vs Indirect Composite Laminate Veneers

Table 1 outlines the USPHS ratings in terms of marginal adaptation of feldspathic and indirect composite veneers over a follow-up period of 10 and 3 years, respectively. Table 2 outlines the USPHS ratings in terms of color match of feldspathic and indirect composite veneers over a follow-up period of 10 and 3 years, respectively.

Table 3 outlines the USPHS ratings in terms of restoration fracture for feldspathic and indirect composite veneers over a follow-up period of 10 and 3 years, respectively.

II. Leucite-Reinforced vs Indirect Composite Laminate Veneers

Table 4 outlines the USPHS ratings for leucite-reinforced and indirect composite veneers over a follow-up period of 10 and 3 years, respectively.

III. Lithium Disilicate-Reinforced vs Indirect Composite Laminate Veneers

Two out of the eleven included studies focus on the clinical outcomes of lithium-disilicate-based porcelain veneers (22,23). They are both longitudinal prospective studies, rate the restorations by means of the Alpha, Bravo, Charlie, Delta rating method and report a continuous evaluation of the laminate veneers across the entire follow-up period of two years. Unfortunately, no clinical study analyzing clinical outcomes of indirect composite veneers over a comparable observation spell was found in the search.

4. DISCUSSION

In an in vitro study, Dederichs et al. reported that prefabricated composite veneers demonstrate more wear after abrasion and erosion tests compared to lithium disilicate veneers (27). However, Fradeani et al. stated that in vitro and in vivo studies regarding clinical performance of laminate veneers do not have the same value (28). Although the current in vivo literature analyzing survival quality of composite laminate veneers is rather limited, some reviews suggested that, while composite veneers provide acceptable aesthetic outcome and patient satisfaction, they tend to fail faster than porcelain veneers and have a higher risk of fracture than the latter (29-31). Within its limitations, the present systematic review aims to compare the clinical performances of glass ceramic and indirect composite laminate veneers.

4.1 Feldspathic vs Indirect Composite Laminate Veneers

Given the discrepancy in clinical performance over follow-up periods of up to 10 years shown by feldspathic and indirect composite veneers, the former seem to show better quality of survival compared to the latter. However, across shorter observation spells of up to 3 years, differences regarding quality of survival were less noticeable. Smielak et al. assessed the clinical performance of feldspathic laminate veneers with conventional and no-prep/minimally invasive dental preparations; over a follow-up period of up to 10 years, slight fractures of the restorations were detected on five (2%) of the 176 feldspathic veneers 85 to 101 months after cementation (20). Over an observation spell of up to 11 years, Gresnigt et al. conducted a prospective clinical trial analyzing quality of survival of feldspathic laminate veneers with special interest on existing restorations, immediate dentin sealing (IDS) and endodontically treated teeth; by the final evaluation, 11% presented slight marginal defects and 7% changes in terms of color match, with laminate veneers bonded to endodontically treated teeth performing significantly worse than vital teeth in regard to the latter aspect (21). As concerns indirect composite veneers, Gresnigt et al. evaluated their performance in a randomized split-mouth clinical trial over a comparable follow-up time (up to 10 years) and minor voids, marginal discrepancies and defects were observed in 78% of the restorations by the final evaluation. Regarding USPHS color match evaluations, by the final recall, 45% of the composite veneers did not match the surrounding teeth. Fractures were seen in 34% of

the restorations by the final evaluation (25). Over an observation spell of up to 40 months, Gresnigt at al. analyzed quality of survival of feldspathic laminate veneers bonded to teeth with and without existing composite restorations; slight marginal defects were noted in 18% of the veneers and they were more common on existing composite restorations than on those bonded to intact teeth (13). As concerns indirect composite veneers, Gresnigt et al. evaluated their performance in a randomized split-mouth clinical trial over a comparable follow-up time (up to 3 years) and minor voids, marginal discrepancies and defects were observed in 30% of the restorations (26).

4.2 Leucite-Reinforced vs Indirect Composite Laminate Veneers

Given the discrepancy in clinical performance over follow-up periods of up to 10 years shown by leucite-reinforced and indirect composite veneers, the former seem to show better quality of survival compared to the latter. However, across shorter observation spells of up to 3 years, differences regarding quality of survival were less noticeable. Gresnigt et al. compared the clinical performances of leucite-reinforced and indirect composite veneers in a randomized split-mouth clinical trial over an observation spell of up to 10 years (25). For all the variables, the ceramic restorations were rated better (25). On the other hand, in a randomized split-mouth clinical trial with a follow-up period of up to 3 years, resin composite performed slightly worse than leucite-based porcelain in terms of marginal adaptation but did surprisingly better when it comes to color match; moreover, a total of two fractures occurred in the incisal area of the indirect composite veneers (26).

4.3 Lithium disilicate-Reinforced vs Indirect Composite Laminate Veneers

Only two studies evaluating clinical performance of lithium silicate laminate veneers could be retrieved, both presenting a follow-up period of up to 2 years (22,23). Unfortunately, due to the discrepancy in terms of observation spells, no direct comparison could be made between quality of survival of this type of restoration and that of indirect composite laminate veneers, hence further clinical investigation on the matter is required. All lithium disilicate-reinforced veneers performed within clinically acceptable ranges over a follow-up period of two years.

4.4 Limitations of the studies

As previously brought up in the result section, while all included studies assessed at least a couple of the aforementioned USPHS criteria, not every paper employed the exact same evaluation method, with four of them rating the laminate veneers by means of Alpha, Bravo, Charlie, Delta as opposed of numerical scores. This discrepancy in terms of ratings constituted a somewhat of a limitation since, as highlighted in Fig. 2 and 3, there are slight differences between the two methods. Furthermore, due to a lack of available literature, not the totality of the included studies could present mutual clinical settings. Regarding their participants, all the studies included patients requiring esthetic improvement of anterior teeth, with good oral hygiene habits, having no caries to be treated, no active periodontal or pulpal diseases, able to tolerate conventional restoration procedures, not allergic to resin-based materials and willing to return for follow-up examinations. Existing composite fillings were generally judged based on extension and location on teeth and subjects with restorations of good quality, presenting no caries, ditching or marginal staining were not excluded from the trials. However, two studies are restricted to non-carious, unrestored teeth (14,19). It was reported that veneer restorations are a good choice for endodontically treated teeth as well (65), although they were excluded in four of the present studies (14,15,18,21). As concerns parafunctional habits, six of the eleven present studies did not exclude patients with bruxism but informed them of the risks associated with the procedure and that they would need to use a night guard following the treatment (13,20,21,24–26). All the eleven included studies analyze the clinical performance of glass-ceramics laminate veneers, while just two of them report evaluations of indirect composite veneers. Four papers focus on the survival quality of feldspathic ceramic laminate veneers, all fabricated by means of the traditional layering technique with the use of refractory dies (13,20,21,24). On the other hand, of the five studies examining clinical outcomes of leucite-based ceramic laminate veneers, three employed heat-pressed restorations, processed through the lost-wax technique (15,25,26), while the rest used CAD/CAM-fabricated restorations (18,19). Lithium-disilicate based ceramics laminate veneers, both heat-pressed and CAD/CAM-manufactured, were assessed in two studies (22,23). Lastly, as concerns indirect composite veneers, restorations fabricated using the layering technique were evaluated in both studies (24,25).

A further limitation of the present review is the existing discrepancy of follow-up periods amongst the available studies, with observation spells going from a minimum of one (14,19) to a maximum of eleven years (21). For this reason, not all types of ceramic veneers could be compared with the composite counterparts over mutual follow-up terms. Moreover, not all studies presented continuous evaluations at regular intervals across the entire length of the trial but reported results at the baseline and at the final recall only.

4.5 Conclusions

Ceramic veneers generally perform better in terms of marginal adaptation, color match and fracture of restoration compared to indirect composite laminate veneers over large follow-up periods, while across shorter observation spells, differences regarding quality of survival are less noticeable. Feldspathic and leucite-reinforced ceramic veneers perform better in terms of marginal adaptation, color match and fracture of restoration compared to indirect composite laminate veneers over large follow-up periods (up to 10 years), while across shorter observation spells (up to 3 years), differences regarding quality of survival are less noticeable. Due to the discrepancy in follow-up times, clinical performance of lithium disilicate-reinforced and indirect composite veneers could not be compared directly. Further in vivo clinical studies investigating survival quality of indirect composite veneers over comparable observation spells are required.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest in this study.

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REFERENCES

1. El-Mowafy O, El-Aawar N, El-Mowafy N. Porcelain veneers: An update. Dent Med Probl. 2018 Apr-Jun;55(2):207-11.
2. Edward A. McLaren, Phong Tran Cao. Ceramics-in-Dentistry. In Dent. 2009 Nov;94–104.
3. Fons-Font A, Solá-Ruíz MF, Granell-Ruíz M, Labaig-Rueda C, Martínez-González A. Choice of ceramic for use in treatments with porcelain laminate veneers. Med Oral Patol Oral Cir Bucal. 2006 May 1;11(3):E297-302.
4. Giordano R, McLaren EA. Ceramics overview: classification by microstructure and processing methods. Compend Contin Educ Dent. 2010 Nov-Dec;31(9):682-8.
5. Dietschi D, Devigus A. Prefabricated composite veneers: historical perspectives, indications and clinical application. Eur J Esthet Dent. 2011;6(2):178-87.
6. Zimmerli B, Strub M, Jeger F, Stadler O, Lussi A. Composite materials: composition, properties and clinical applications. A literature review. Schweiz Monatsschr Zahnmed. 2010;120(11):972-86.
7. Nahsan FP, Mondelli RF, Franco EB, Naufel FS, Ueda JK, Schmitt VL, Baseggio W. Clinical strategies for esthetic excellence in anterior tooth restorations: understanding color and composite resin selection. J Appl Oral Sci. 2012 Mar-Apr;20(2):151-6.
8. Patodiya A, Hegde MN. Dental composites: past, present and future. Natl. J Community med. 2012; (3): 754-6. Available from: www.njcmindia.org.
9. Alrahlah A. Physical, Mechanical and Surface Properties of Dental Resin-composites. The University of Manchester (United Kingdom); 2013.
10. Gomes G, Perdigão J. Prefabricated composite resin veneers-a clinical review. J Esthet Restor Dent. 2014 Sep-Oct;26(5):302-13.
11. Heuer GA, Garman TA, Sherrer JD, Williams HA. A clinical comparison of a quartz- and glass-filled composite with a glass-filled composite. J Am Dent Assoc. 1982 Aug;105(2):246-7
12. Hamza TA, Sherif RM. In vitro evaluation of marginal discrepancy of monolithic zirconia restorations fabricated with different CAD-CAM systems. J Prosthet Dent. 2017 Jun;117(6):762-6.
13. Gresnigt MM, Kalk W, Özcan M. Clinical longevity of ceramic laminate veneers bonded to teeth with and without existing composite restorations up to 40 months. Clin Oral Investig. 2013 Apr;17(3):823-32.
14. El-Banna HIM; Zamzam ML; Fouad EJ; Soliman IA. One-year clinical evaluation of IPS Empress CAD versus polished Celtra Duo ceramic laminate veneers (randomized controlled trial). Braz. Dent. Sci. 2021 Jul; 24(3):1-14.

15. Guess PC, Selz CF, Voulgarakis A, Stampf S, Stappert CF. Prospective clinical study of press-ceramic overlap and full veneer restorations: 7-year results. Int J Prosthodont. 2014 Jul-Aug;27(4):355-8.
16. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021 Mar 29;372:n71.
17. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977 Mar;33(1):159-74.
18. Cabello López, J.B. Plantilla para ayudarte a entender una Revisión Sistemática. En CASPe. Elsevier; 2005. 13-7.
19. El-Mesallamy OMW, EL-Banna HIM, Zamzam ML, et al. Patient Satisfaction and Clinical Evaluation of IPS Empress CAD versus ZLS Ceramic Laminate Veneers: A Randomized Controlled Clinical Trial. World J Dent 2021;12(3):183–8.
20. Smielak B, Armata O, Bojar W. A prospective comparative analysis of the survival rates of conventional vs no-prep/minimally invasive veneers over a mean period of 9 years. Clin Oral Investig. 2022 Mar;26(3):3049-3059.
21. Gresnigt MMM, Cune MS, Schuitemaker J, van der Made SAM, Meisberger EW, Magne P, Özcan M. Performance of ceramic laminate veneers with immediate dentine sealing: An 11 year prospective clinical trial. Dent Mater. 2019 Jul;35(7):1042-52.
22. Yuce M, Ulusoy M, Turk AG. Comparison of Marginal and Internal Adaptation of Heat-Pressed and CAD/CAM Porcelain Laminate Veneers and a 2-Year Follow-Up. J Prosthodont. 2019 Jun;28(5):504-10.
23. Oztürk E, Bolay S. Survival of porcelain laminate veneers with different degrees of dentin exposure: 2-year clinical results. J Adhes Dent. 2014 Oct;16(5):481-9.
24. D'Arcangelo C, De Angelis F, Vadini M, D'Amario M. Clinical evaluation on porcelain laminate veneers bonded with light-cured composite: results up to 7 years. Clin Oral Investig. 2012 Aug;16(4):1071-9.
25. Gresnigt MMM, Cune MS, Jansen K, van der Made SAM, Özcan M. Randomized clinical trial on indirect resin composite and ceramic laminate veneers: Up to 10-year findings. J Dent. 2019 Jul;86:102-9.
26. Gresnigt MM, Kalk W, Ozcan M. Randomized clinical trial of indirect resin composite and ceramic veneers: up to 3-year follow-up. J Adhes Dent. 2013 Apr;15(2):181-90.
27. Dederichs M, Fahmy MD, An H, Guentsch A, Viebranz S, Kuepper H. Comparison of Wear Resistance of Prefabricated Composite Veneers Versus Ceramic and Enamel. J Prosthodont. 2021 Oct;30(8):711-9.

28. Fradeani M, Redemagni M, Corrado M. Porcelain laminate veneers: 6- to 12-year clinical evaluation--a retrospective study. Int J Periodontics Restorative Dent. 2005 Feb;25(1):9-17.
29. Alothman Y, Bamasoud MS. The Success of Dental Veneers According To Preparation Design and Material Type. Open Access Maced J Med Sci. 2018 Dec 14;6(12):2402-8.
30. Liu M, Gai K, Chen J, Jiang L. Comparison of Failure and Complication Risks of Porcelain Laminate and Indirect Resin Veneer Restorations: A Meta-Analysis. Int J Prosthodont. 2019 Jan/Feb;32(1):59-65.
31. Sailo JL, Bathla N, Thakur P, Nagpal A, Gupta R, Duvedi K. Porcelain Veneers vs Composite Resin Veneers: A Review. J Adv Med. Advances in Medicine and Medical Research. 2020 Dec;32(24):316–26.
32. D'Arcangelo C, De Angelis F, Vadini M, D'Amario M, Caputi S. Fracture resistance and deflection of pulpless anterior teeth restored with composite or porcelain veneers. J Endod. 2010 Jan;36(1):153-6.

TABLES AND FIGURES

Table 1.Feldspathic vs Indirect Composite Veneers. USPHS Marginal Adaptation evaluations.

	Number of restorations		**Score/Baseline**		**Score/10+ years**	
Feldspathic porcelain laminate veneers **B. Smielak et al.** **(2021)** (20)	Baseline	10 years	0	100%	0	100%
			1	-	1	-
	186	176	2	-	2	-
			3	-	3	-
			4	-	4	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (25)	Baseline	10 years	0	71%	0	22%
			1	25%	1	56%
	24	18	2	4%	2	22%
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (21)	Baseline	11 years	0	100%	0	89%
			1	-	1	11%
	444	384	2	-	2	-
			3	-	3	-
			4	-	4	-
	Number of restorations		**Score/Baseline**		**Score/3 years**	

Feldspathic porcelain laminate veneers **C.D'Arcangelo et al.** **(2012)** (24)	Baseline	3 years	Alpha	100%	Alpha	100%
			Bravo	-	Bravo	-
	119	119	Charlie	-	Charlie	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (26)	Baseline	3 years	0	70%	0	70%
			1	26%	1	30%
	23	20	2	4%	2	-
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (13)	Baseline	3 years	0	100%	0	82%
			1	-	1	18%
	92	87	2	-	2	-
			3	-	3	-
			4	-	4	-

Table 2.Feldspathic vs Indirect Composite Veneers. USPHS Color Match evaluations.

	Number of restorations		**Score/Baseline**		**Score/10 years**	
Feldspathic porcelain laminate veneers **B. Smielak et al.** **(2021)** (20)	Baseline	10 years	0	100%	0	100%
			1	-	1	-
	186	176	2	-	2	-
			3	-	3	-
			4	-	4	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (25)	Baseline	10 years	0	38%	0	55%
			1	62%	1	17%
	24	18	2	-	2	28%
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers	Baseline	11 years	0	100%	0	93%
			1	-	1	7%
			2	-	2	-

M.M.M. Gresnigt et al. **(2019)** (21)	444	384	3	-	3	-
			4	-	4	-
	Number of restorations		**Score/Baseline**		**Score/3 years**	
Feldspathic porcelain laminate veneers **C.D'Arcangelo et al.** **(2012)** (24)	Baseline	3 years	Alpha	100%	Alpha	100%
			Bravo	-	Bravo	-
	119	119	Charlie	-	Charlie	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (26)	Baseline	3 years	0	43%	0	100%
			1	57%	1	-
	23	20	2	-	2	-
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (13)	Baseline	3 years	0	100%	0	99%
			1	-	1	1%
	92	87	2	-	2	-
			3	-	3	-
			4	-	4	-

Table 3. Feldspathic vs Indirect Composite Veneers. USPHS Fracture of Restoration evaluations.

	Number of restorations		**Score/Baseline**		**Score/10 years**	
Feldspathic porcelain laminate veneers **B. Smielak et al.** **(2021)** (20)	Baseline	10 years	0	100%	0	98%
			1	-	1	-
	186	176	2	-	2	2%
			3	-	3	-
			4	-	4	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (25)	Baseline	10 years	0	100%	0	66%
			1	-	1	17%
	24	18	2	-	2	17%
			3	-	3	-
			4	-	4	-

Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2019)** (21)	Baseline	11 years	0	100%	0	96%
			1	-	1	4%
	444	384	2	-	2	-
			3	-	3	-
			4	-	4	-
	Number of restorations		**Score/Baseline**		**Score/3 years**	
Feldspathic porcelain laminate veneers **C.D'Arcangelo et al.** **(2012)** (24)	Baseline	3 years	Alpha	100%	Alpha	100%
			Bravo	-	Bravo	-
	119	119	Charlie	-	Charlie	-
			Delta	-	Delta	-
Indirect composite laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (26)	Baseline	3 years	0	100%	0	100%
			1	-	1	-
	23	20	2	-	2	-
			3	-	3	-
			4	-	4	-
Feldspathic porcelain laminate veneers **M.M.M. Gresnigt et al.** **(2013)** (13)	Baseline	3 years	0	100%	0	95%
			1	-	1	-
	92	87	2	-	2	-
			3	-	3	-
			4	-	4	-

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Table 4. Leucite-reinforced vs Indirect Composite Veneers. USPHS evaluations over follow-up periods of up to 10 and 3 years.

	Criteria	**Score**	**Baseline**		**Final evaluation**	
			ICV (n=24)	LBCV (n=24)	ICV (n=18)	LBCV (n=24)
M.M.M. Gresnigt et al.	Marginal Adaptation	0 1 2 3 4	71% 25% 4% - -	83% 17% - - -	22% 56% 22% - -	58% 42% - - -
	Color Match	0 1 2 3 4	37.5% 62.5% - - -	42% 58% - - -	55% 17% 28% - -	100% - - - -

(2019) (25)	Fracture of Restoration	0 1 2 3 4 5	100% - - - - -	100% - - - - -	66% 17% 17% - - -	96% 4% - - - -
	Criteria	**Score**	**Baseline**		**Final evaluation**	
			ICV (n=23)	LBCV (n=23)	ICV (n=20)	LBCV (n=23)
M.M.M. Gresnigt et al. **(2013)** ()	Marginal Adaptation	0 1 2 3 4	70% 26% 4% - -	100% - - - -	70% 30% - - -	87% 13% - - -
	Color Match	0 1 2 3 4	43% 57% - - -	30% 70% - - -	100% - - - -	83% 7% - - -
	Fracture of Restoration	0 1 2 3 4 5	100% - - - - -	100% - - - - -	100% - - - - -	100% - - - - -

ICV: Indirect Composite Veneers; LBCV: Leucite-Based Ceramic Veneers.

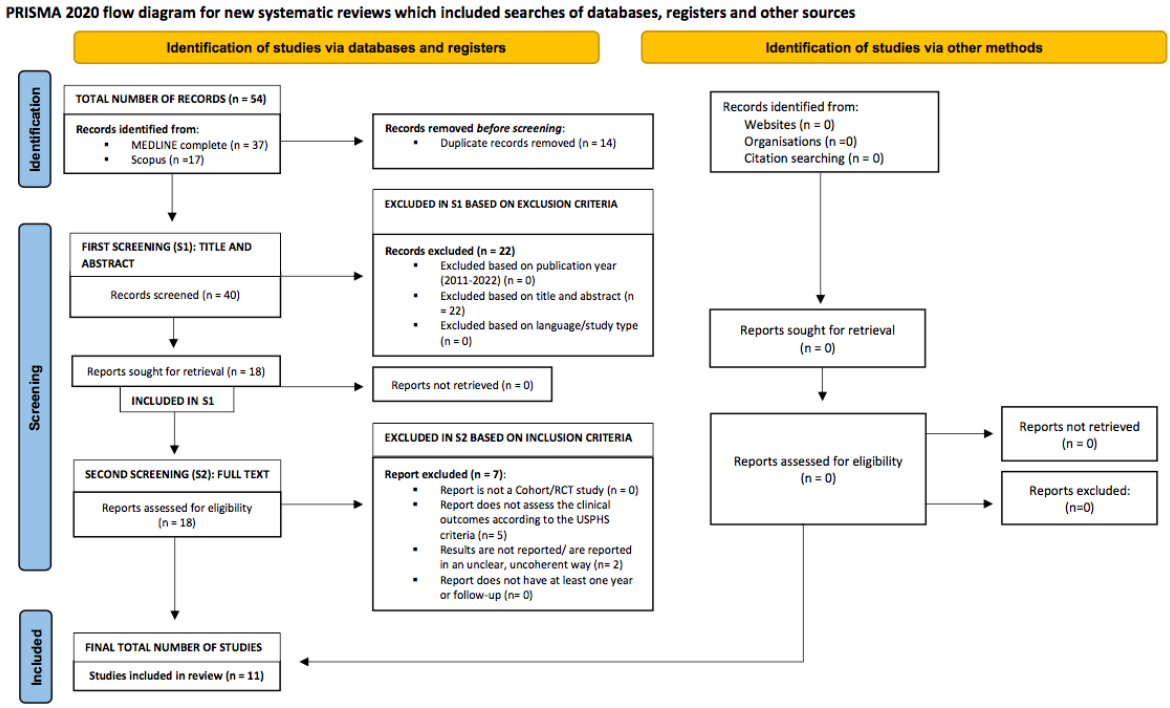

Figure 1. Study identification process and results of the literature search via databases and other methods according to PRISMA 2020. (16)

	H.I. Mahrous El-Banna et al. (2021)	Omnia MW El-Mesallamy et al. (2021)	M.M.M. Gresnigt et al. (2019)	M.M.M. Gresnigt et al. (2013)
Did the study address a clearly focused research question?				
Was the assignment of participants to interventions randomized?				
Were all the participants who entered the study accounted for at its conclusion?				
a. Were the participants "blind" to intervention they were given? *b. Were the investigators blind to the intervention they were giving to participants?* *c. Were the people assessing/analyzing outcome/s "blinded"?*				
Were the study groups similar at the start of the RCT?				
Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally?				
Were the effects of intervention reported comprehensively?				
Was precision of the estimate of the intervention or treatment effect reported?				
Do benefits of the experimental intervention outweigh the harms and costs?				
Can the results be applied to your local population/in your contest?				
Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?				

B)

	B. Smielak et al. (2021)	M.M.M. Gresnigt et al. (2019)	M. Yuce et al. (2017)	E. Özturk et al. (2014)	P.C. Guess et al. (2014)	M.M.M. Gresnigt et al. (2012)	C.D 'Arcangelo et al. (2011)
Did the study address a clearly focused issue?							
Was the cohort recruited in an acceptable way?							
Was the exposure accurately measured to minimize bias?							
c. Have the authors identified all important confounding factors? *d. Have they taken account of the confounding*							

factors in the design and/or analysis?							
c. Was the follow-up of subjects complete enough? *d. Was the follow-up of subjects long enough?*							
Do you believe the results?							
Can the results be applied to the local population?							
Do the results of this study fit with other available evidence?							

Figure 2. A) CASP checklist for Randomized Controlled Trials B) CASP checklist for Cohort Studies. (18)

Category	Score	Criteria
Marginal adaptation	0	Smooth margin
	1	All margins are closed or possess minor voids or defects (enamel exposed)
	2	Obvious crevice at margin, dentin or base exposed
	3	De-bonded from one end
	4	De-bonded from both ends
Color match	0	Very good color match
	1	Good color match
	2	Slight mismatch in color or shade
	3	Obvious mismatch, outside the normal range
	4	Gross mismatch
Fracture of restoration	0	No fracture
	1	Minor crack lines over restoration
	2	Minor chippings (1/4)
	3	Moderate chippings (1/2)
	4	Severe chippings (3/4)
	5	Debonding of restoration

Category	Rating	Criteria
Marginal adaptation	Alpha	No visible evidence of crevice along the margin; no catch or penetration of explorer
	Bravo	Visible evidence of crevice and/or catch of the explorer; no penetration of explorer
	Charlie	Visible evidence of crevice; penetration of explorer
Color match	Alpha	No mismatch in color, shade or translucency between restoration and adjacent tooth
	Bravo	Mismatch between restoration and tooth structure within the normal range of color, shade and/or translucency (<1 shade off; Vita shade guide)
	Charlie	Mismatch between restoration and tooth structure outside the normal range of color, shade and/or translucency (>1 shade off; Vita shade guide)
Fracture of restoration	Alpha	None
	Bravo	Small/acceptable
	Charlie	Moderate/unacceptable
	Delta	Large/unacceptable

Figure 3. Modified USPHS criteria used for the clinical evaluation of laminate veneers (23-25)

Author/Year	Study Design	Sample			Study groups		Follow-up time (up to, years)	Type of restorations under assessment	Study variables
		Sample size	Gender ratio (M:F)	Mean age (years) / Age range	I	II			
Beata Smielak et al. (2021)	PCS	35 (186)	7:28	45	14 (84)	21 (102)	10	• Feldspathic glass ceramic veneers	• Marginal adaptation • Color match • Fracture of the restoration
Hayat Ibrahim Mahrous El-Banna et al. (2021)	RCT	(36)	N/A	20-30	(18)	(18)	1	• Leucite-based glass ceramic veneers • ZLS veneers	• Marginal adaptation • Fracture of the restoration
Omnia MW El-Mesallamy (2021)	RCT	(36)	N/A	20-30	(18)	(18)	1	• Leucite-based glass ceramic veneers • ZLS veneers	• Marginal adaptation • Fracture of the restoration
M.M.M. Gresnigt et al. (2019)	RCT	11 (48)	3:8	54.5	(24)	(24)	10	• Leucite-based glass ceramic veneers • Indirect composite veneers	• Marginal adaptation • Color match • Fracture of the restoration
M.M.M. Gresnigt et al. (2019)	PCS	104 (384)	80:38	42.1	N/A	N/A	11	• Feldspathic glass ceramic veneers	• Marginal adaptation • Color match Fracture of the restoration
Mert Yuce et al. (2017)	PCS	12 (61)	3:9	19-50	(30)	(31)	2	• Lithium disilicate-based glass ceramic veneers	• Marginal adaptation • Color match • Fracture or the restoration
Elif Özturk et al. (2014)	PCS	28 (125)	5:23 (29:96)	30	N/A	N/A	2	• Lithium disilicate-based glass ceramic veneers	• Marginal adaptation • Fracture of the restoration
Petra C. Guess et al. (2014)	PCS	25 (66)	13:12	19-64	(42)	(24)	7	• Leucite-based glass ceramic veneers	• Marginal adaptation • Color match
M.M.M. Gresnigt et al. (2013)	RCT	10 (46)	3:7	48.6	(23)	(23)	3	• Leucite-based glass ceramic veneers • Indirect composite veneers	• Marginal adaptation • Color match • Fracture of the restoration
M.M.M. Gresnigt et al. (2013)	PCS	20 (92)	5:15	49.7	(26)	(66)	3.3	• Feldspathic glass ceramic veneers	• Marginal adaptation • Color match • Fracture of the restoration
Camillo D'Arcangelo et al. (2011)	PCS	30 (119)	13:17	33	N/A	N/A	7	• Feldspathic glass ceramic veneers	• Marginal adaptation • Color match

Figure 4: Included studies and their characteristics.

RCT: Randomized clinical trial; PCS: Prospective clinical study; RCS: Retrospective clinical study; (Number of veneers); N/A: Not applicable/Not available

ANNEX 2: PRISMA CHECKLIST

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Cover page
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	5
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	5
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	17
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	18
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	18
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	19
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	19
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	19
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	19
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	19
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	-
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	-
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	-
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	-
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	-
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	-
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	-
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	-
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	-

Section and Topic	Item #	Checklist item	Location where item is reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	20-21
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	20
Study characteristics	17	Cite each included study and present its characteristics.	21-22
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	25-26
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	27-30
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	-
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	-
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	-
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	-
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	-
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	-
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	39
	23b	Discuss any limitations of the evidence included in the review.	42-44
	23c	Discuss any limitations of the review processes used.	42-44
	23d	Discuss implications of the results for practice, policy, and future research.	40-44
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	-
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	-
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	-
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	-
Competing interests	26	Declare any competing interests of review authors.	-
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	-

Section and Topic	Item #	Checklist item	Reported (Yes/No)
TITLE			
Title	1	Identify the report as a systematic review.	**YES**
BACKGROUND			
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.	**YES**
METHODS			
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	**YES**
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	**YES**
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	**YES**
Synthesis of results	6	Specify the methods used to present and synthesise results.	-
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	**YES**
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	**YES**
DISCUSSION			
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	**YES**
Interpretation	10	Provide a general interpretation of the results and important implications.	**YES**
OTHER			
Funding	11	Specify the primary source of funding for the review.	-
Registration	12	Provide the register name and registration number.	-

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71