

Treatment of tooth wear by restoring the occlusion with direct and indirect restorations

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Background and Objectives. Dental wear is a physiological phenomenon characterised by progressive and irreversible loss of tooth hard tissues. This can lead to poor dental aesthetics and quality of life, impaired occlusal function or even pain in the temporomandibular joint and masticatory muscles. The aim of this study was to perform a systematic review of the scientific literature and to compare the effectiveness of three different types of restorations used to restore the occlusion of worn teeth, in terms of changes in anatomical form and fracture risk.

Methods. This systematic review is based on the PRISMA guidelines. The literature search was conducted until 6 February 2025. PubMed, ScienceDirect, Wiley Online Library. 7 English-language publications evaluating direct and indirect methods of restoring tooth wear were selected for review. The quality of the studies was also assessed.

Results. After applying the selection criteria, 7 articles were chosen, all of which focused on in vivo studies. Based on the Newcastle-Ottawa Scale (NOS), all the articles included were rated as “Good” quality. One subgroup examined the alterations in the anatomical shape of various restorations and found statistically significant results. The findings indicated that indirect ceramic restorations experienced the least change in shape and provided the most effective treatment for tooth wear. Another subgroup of studies evaluated the fracture risk of different restorations, yielding statistically significant results that demonstrated the lowest fracture risk with the use of indirect ceramic restorations for restoring wear.

Conclusion. The analysis of the articles showed that the method of bite restoration chosen for the treatment of tooth wear has an impact on the subsequent anatomical shape changes and fractures of the restorations. In terms of the above criteria, the best clinical results are achieved with indirect ceramic restorations.

Keywords. Worn dentition, tooth wear treatment, indirect restorations, direct restorations, direct treatment, indirect treatment.

Dantų nudilimo gydymas atstatant sąkandį tiesioginėmis bei netiesioginėmis restauracijomis

Santrauka

Įvadas. Dantų dilimas yra natūralus procesas, kuriam būdingas laipsniškas ir nuolatinis kietųjų danties audinių nykimas. Dėl to gali pablogėti dantų estetinis vaizdas, sąkandžio funkcija ir atsirasti smilkininio apatinio žandikaulio sąnario ir kramtymo raumenų skausmai.

Metodika. Ši sisteminė apžvalga atlikta remiantis PRISMA gairėmis. Literatūros paieška atlikta iki 2025 vasario 6 d. Panaudotos elektroninės duomenų bazės: PubMed, ScienceDirect, Wiley Online Library. Apžvalgai atrinktos 7 publikacijos anglų kalba, vertinančios tiesioginį bei netiesioginį dantų nudilimo atstatymo būdus. Taip pat buvo įvertinta tyrimų kokybė.

Rezultatai. Pritaikius atrankos kriterijus, buvo atrinkti 7 straipsniai, kuriuose visi buvo skirti in vivo tyrimams. Viename pogrupyje buvo tiriami įvairių restauracijų anatominės formos pokyčiai ir nustatyti statistiškai reikšmingi rezultatai. Rezultatai parodė, kad netiesioginių keramikinių restauracijų forma pakito mažiausiai ir jos veiksmingiausiai gydė dantų nusidėvėjimą. Kitame tyrimų pogrupyje buvo įvertinta įvairių restauracijų lūžių rizika ir gauti statistiškai reikšmingi rezultatai, kurie parodė, kad mažiausia lūžių rizika yra naudojant netiesiogiškas keramikines restauracijas dantų nusidėvėjimui atkurti.

Išvados. Išanalizavus straipsnius nustatyta, kad dantų nudilimo gydymui pasirinktas sąkandžio atkūrimo būdas turi įtakos tolesniems restauracijų anatominės formos pokyčiams ir lūžiams. Vertinant nurodytus kriterijus, geriausi klinikiniai rezultatai pasiekiami naudojant netiesiogiškas keramikines restauracijas.

Raktažodžiai: dantų nusidėvėjimas, dantų nusidėvėjimo gydymas, netiesiogiškos restauracijos, tiesiogiškos restauracijos, tiesiogiškas gydymas, netiesiogiškas gydymas.

1. Introduction

One of the main oral health problems of our time is excessive tooth wear. Tooth wear is a physiological phenomenon characterised by the progressive and irreversible loss of tooth hard tissues [1]. The process is divided into severe, in which the dentin layer is exposed and a large part ($\geq 1/3$) of the clinical crown is lost, and pathological, which is not specific to the age of the patient. This can lead to impaired dental aesthetics and quality of life, impaired occlusal function, or even pain in the temporomandibular joint and masticatory muscles [1-6, 20, 22]. For this reason, the treatment of dental abrasions should focus on prevention, counselling and monitoring [18-20]. When dental wear causes functional or aesthetic problems, a treatment plan should be selected, discussed with the patient and based on a minimally invasive intervention approach. Direct and indirect treatment approaches using appropriate materials are recommended to restore the occlusion based on this principle [5-11, 21]. Of all the restorative materials available, resin composites and ceramics closely mimic the aesthetics of natural tooth tissue and have a similar solid content. This results in a similar tooth wear process as in natural teeth. Unfortunately, these restorative materials are also not permanent due to their inherent fatigue and wear processes, which can lead to changes in the anatomical shape of the restoration and to cracks or fractures in the restoration [1, 10, 23]. The main method used in the articles to track changes in different restorations was the USPHS criteria scale, which was used to determine the quality and success of treatment. Other auxiliary tracking methods used in the studies, such as the tooth wear index and the Kaplan Meier curve, showed some different and some similar age-related changes in the structures. Therefore, the objective of this systematic review was to compare the effectiveness of two different bite restoration techniques in assessing the risk of anatomical changes and fractures in worn teeth.

2. Materials and methods

2.1. Protocol

This systematic review was conducted and reported following the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).

2.2. Focus question

According to the Participants Intervention Comparison Outcome Study design scheme (PICOS), the study included randomized, prospective, and retrospective controlled non-randomized trials (S) on human patients of any age, ethnicity or sex that focus on patients undergoing dental abrasion treatment (P). The intervention (I) was defined as a restorative treatment data and the comparison (C) was made between results of different restorative methods. The outcome (O) evaluated was changes in anatomical shape and fracture risk between different types of restorations.

The developed focus question was: does the method of bite restoration used in dental abrasion treatment affect the subsequent wear (anatomical changes) and fracture of restorations.

The literature search was conducted using three electronic databases: PubMed, Cochrane Library, and Sciences Direct. Medical Subject Headings (MeSH) terms used were “tooth wear treatment” combined with “direct and indirect restorations” and “USPHS scale”.

Inclusion criteria:

1. Randomized, prospective, and retrospective studies published in English.
2. Access to the full text of the article;
3. Clinical studies in humans (in vivo);
4. Studies involving adult patients.
5. Studies in patients with a diagnosis of dental wear;
6. Studies analysing different treatments for tooth wear;
7. Studies have been carried out to assess the resistance of anatomical anomalies to changes in shape and to fracture of restorations.

2.3.Selection of studies

After removing duplicates, the abstracts of the resulting publications were evaluated for eligibility based on inclusion and exclusion criteria in the initial stage of data selection. Independent reviewer conducted the study selection process. The second reviewer was an experienced senior reviewer who made the final choice. Full-text articles were then screened, and final reports were gathered for all studies that were considered eligible for inclusion in this paper.

Data extraction

The study characteristics, such as design, sample size, observation period and measurements, were extracted independently by the author.

Assessment of methodological quality

The quality of the included study protocols was assessed following study selection by reviewing the full-text articles. The Cochrane Collaboration recommends using the Newcastle-Ottawa Scale (NOS) as a tool for assessing the quality of observational studies. This scale assigns a maximum of nine points (stars) across three domains to indicate the lowest risk of bias: (1) selection of study groups (four points), (2) comparability of groups (two points), and (3) outcome ascertainment (three points).

3. Results

3.1.Study selection

A search of Pubmed, Willey Online Library and Science Direct for the keywords used and the filters activated identified a total of 8482 articles. Literature reviews, meta-analyses, topic and articles that did not meet the aim of the paper were then excluded. This screening left 646 articles, which were rejected for inappropriate abstracts and incomplete text. After applying the selection

criteria, 7 scientific publications were selected for final analysis. The study selection process is illustrated in a flowchart in Fig 1.

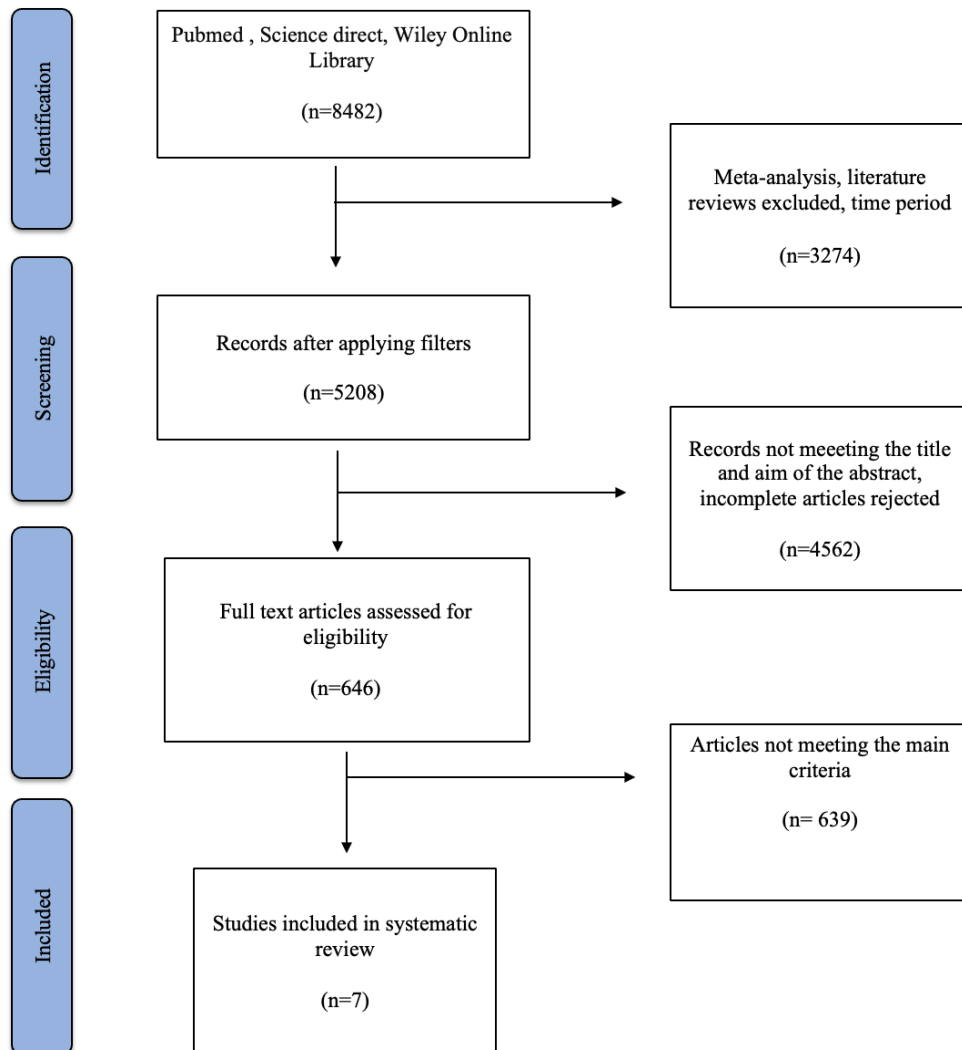


Figure 1. Flowchart

3.2. Study characteristics

A total of 202 patients with a diagnosis of tooth wear were enrolled in the in vivo studies reviewed. A total of 2538 restorations of two different types were applied to the patients: 1363 direct restorations and 1175 indirect restorations. The restorations were evaluated using a Canon EOS 300D Digital SLR camera, t-tests, various analysis systems and a 3D computer model. The USPHS scale was used to assess the quality of the restorations in almost all studies. The following criteria were used for the study participants: subjects had to be over 18 years of age with full dental arches, have a diagnosis of moderate or severe generalised tooth wear requiring treatment, and an assessed need for an increase in the vertical dimension of the occlusion (<3mm

in the molar area). People with diagnosed bruxism and gastro-oesophageal reflux disease were also included in the tooth wear restoration studies. Patients with the following clinical features were excluded: limited mouth opening, temporomandibular dysfunction, advanced periodontitis, deep caries lesions or multiple large restorations, including teeth with endodontic problems, and patients with local or systemic diseases. The subjects also had no harmful habits and did not smoke.

3.3. Restorations anatomical changes

Several studies examined changes in anatomical parameters using direct restorations [11,13,15,16]. The USPHS criteria scale was used for treatment quality and analysis, describing changes in anatomical shape. In a study by Wedad Hammoudi and co-authors [16], comparing two different and the most durable materials for anatomical shape changes in indirect restorations, better clinical results were observed in the group of clear zirconia restorations. After 6 years of follow-up, not only was the treatment itself more successful (99.1% of cases compared with 98.6% for lithium disilicate restorations), but all zirconia restorations were also rated with alpha value. The other material used in the study, lithium disilicate ceramics, also showed excellent clinical results, with 83.6% of the restorations retaining an ideal or almost unchanged anatomical shape. According to the authors, the colour, margin and anatomical shape of the ceramic restorations remained stable over a 10-year period. Effective treatment of tooth wear was found in up to 90.1% of cases, which was influenced by the increased vertical dimension of the occlusion, in addition to the type of restorative material. The study by Al-Khayatt and co-authors [13] also showed excellent clinical results with the use of a microhybrid composite for the direct treatment of tooth wear. The vertical dimension of the occlusion was increased from 0.5 to 5 mm. The majority of these, 63 (88%) patient restorations, had lost less than 50% of the restorative material and only 3 (4%) had deteriorated and lost more than 50% of the microhybrid composite. These findings are complemented by K. Ning and co-authors in their study [11], where direct restorations reduced the bite height after one year to 0.5 mm in all tooth groups, but the highest wear was recorded in the molar region, irrespective of the composite chosen.

3.4. Restorations fracture risk

The lowest risk of fracture was observed with indirect ceramic restorations in the remaining articles [12,16,17]. This is supported by a study by Wedad Hammoudi and co-authors [16], which reported only one restoration (0.9% of the total sample) that cracked at the cemento-enamel junction. In this analysis, the authors investigated an important criteria for the prevention of fracture in ceramic restorations: the thickness of the restoration, which should be at least 1 mm. In this way, the indirect restoration consisted of a thicker layer of solid material, which resulted in a higher resistance to cracking and fracture. Indirect composite restorations had a higher risk of fracture. This is supported by the article by L.A.M.J. Crins and co-authors [17], who concluded that more fractures occurred in anterior teeth with indirect composite restorations (5.6%) than with direct restorations (3.96%). Significant differences were found in the first molars, where indirect composite restorations caused as many as 27.36% of fractures, whereas direct restorations caused only 7.04%. Similarly, the results of the study by B.A.C. Loomans and co-

authors [12] showed a low risk of cracks and fractures (3.42%) with direct composite restorations in both anterior and posterior teeth. This direct restoration method with composite materials was favourable in 94.8% of cases.

Quality assessment

The articles reviewed in our study were evaluated using the Newcastle-Ottawa Scale and were classified as "Good" quality. The ratings for the chosen studies ranged from 7 to 8 out of a possible 9 points on the scale.

4. Discussion

When comparing the changes in the anatomical shape of the different types of restorations, it was found that the least altered shape and the most effective result in the treatment of tooth wear was achieved with indirect ceramic restorations. Another important feature of the success of the treatment of tooth wear is the presence of cracks and fractures in direct and indirect restorations [12, 14, 16, 17]. The best results also showed direct zirconia restorations. As the lowest wear of this restorative material was observed compared with direct restorations [11, 13, 15, 16]. Less wear and anatomical shape changes are observed in the nanocomposite group compared to the microhybrid composite. The reduction in restoration height in mandibular teeth varied from 0.25 to 0.5 mm. The results of this treatment modality were favourable in 95% of cases. Direct restorations showed a 94.8% treatment success rate and a 99.3% restoration durability at 3.5 years after application. Only 3.42% of fractures were observed with direct restorations. [11,12]. Direct restoration with composite materials had favourable results in 94.8% of cases while the success rate for Lithium disilicate ceramics was 98.6% and for Translucent zirconia restorations 99.1%. The risk of fracture in indirect restorations was estimated at only 0.9%. All zirconia restorations were assessed with alpha value. Lithium disilicate ceramics also showed excellent clinical results, with 83.6% of restorations having an ideal or almost unchanged anatomical shape [16,17].

5. Conclusion

The method of bite restoration used in the treatment of tooth wear has been shown to influence the subsequent anatomical shape changes and fractures of restorations. Indirect ceramic restorations were the most effective in assessing changes in anatomical shape and fracture risk. Of the composite materials, nanocomposite was the most resistant to fracture and anatomical shape changes, and clear zirconia ceramic was the most resistant to fracture and anatomical shape changes.

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Table 1. Results of individual studies.

R	Author, year	Study design	Study length	Study sample	Tested substance	Conclusions
Direct restorations	K Ning et al., [11], 2021	In vivo	5 years	16 persons, 2964 scans	Micro-hybrid composite - Clearfil, APX (Kuraray), nanocomposite - Filtek Supreme XTE, 3M	Better results with nanocomposite. The reduction in restoration height varied from 0.25 to 0.5 mm. The results of this treatment modality were favourable in 95% of cases.
	B.A.C. Loomans et al., [12], 2018	In vivo	3,5 years	34 persons, 1256 restorations	Flowable composite - Clearfil Majesty Flow (Kuraray), resin composites - Clearfil AP-X (Kuraray), IPS Empress Direct (Ivoclar Vivadent)	Direct restorations showed a 94.8% treatment success rate and a 99.3% restoration durability at 3.5 years after application. Fractures of direct restorations were recorded in 3.42% of all cases.
	Al-Khayatt et al., [13], 2013	In vivo	7 years	15 persons, 107 restorations	Herculite XRV microhybrid composite (Kerr)	In the mandibular anterior teeth, the vertical occlusal height was increased by 0.5 - 5 mm. 85% of the restorations were successfully retained within 7 years.
Indirect restorations	Daniel Edelhoff et al., [14], 2022	In vivo	13 years	21 persons, 436 restorations	Pressable LD- IPS e.max-Press (Ivoclar), CAD/CAM resin composite (Ivoclar)	Better clinical results were found with the indirect treatment with lithium disilicate ceramics. The risk of cracks and fractures in these restorations was 2.92%, while the risk of fractures in composite restorations was 6.17%. All of them were evaluated with bravo value.

	Tauböck T. et al., [15], 2021	In vivo	11 years	13 persons, 164 restorations	Micro-hybrid composite - Tetric (Ivoclar Vivadent), nanocomposite - Filtek Supreme (3M)	Minimal changes in anatomical shape were found in 38% of restorations. Nanocomposite showed better results. 70.4 % restorations remained almost unchanged.
	Wedad Hammoudi et al., [16], 2020	In vivo	6 years	62 persons, 713 restorations	LD - IPS e.max- Press (Ivoclar Vivadent), TZ - BruxZir Solid Zirconia (3Y-TZP)	The success rate for LD was 98.6% and for TZ restoration 99.1%. The risk of fracture in restoration was estimated at only 0.9%. All zirconia restorations were assessed with alpha value. 83.6% of LD restorations having an ideal or almost unchanged anatomical shape.
	L.A.M.J. Crins et al., [17], 2021	In vivo	3 years	41 persons, 408 composite restorations	Mikrohibridinis - Clearfil AP-X, Clearfil Estenia C&B („Kuraray“), nanohibridinis - IPS Empress Direct	Direct composite restorations have better results than indirect restorations. Only 3.42% of fractures were observed with direct restorations. This direct restoration with composite materials had favourable results in 94.8% of cases.