

# Chewing performance of patients with worn dentition before and after restorations: A scoping review

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## Abstract

**Background:** Tooth wear is a multifactorial complex process related to the loss of dental tissue, due to chemical or mechanical processes, by abrasion, attrition, erosion. Restorative treatment represents an attempt to rebuild and recreate the lost structure.

**Objective:** This scoping review aims to investigate whether restorative treatment of worn dentition (either with direct or indirect adhesive composite adhesive procedures or with prosthetic techniques) can have an impact on the masticatory performance parameters.

**Methods:** A scoping review was conducted on multiple databases (Pubmed, Medline CENTRAL, ICTRP), following the PRISMA guidelines. Abstracts of research papers were screened for suitability, and full-text articles were obtained for those who satisfied the inclusion and exclusion criteria.

**Results:** Only one article meet the inclusion criteria of the review. Restorative treatment of worn dentition although have a positive impact on the self-report ability to chew, has no effect on the masticatory performance test.

**Conclusion:** At the moment, not enough evidence to comment on the actual therapeutic role of restorative treatment on tooth wear is available. Clinicians, before taking any clinical decision, should carefully discuss with patients the needs and expectations of the treatment plan.

## KEYWORDS

mastication, oral health, oral prostheses, oral rehabilitation, restorative dentistry, tooth wear

## 1 | INTRODUCTION

According to the ninth edition of the Glossary of Prosthodontic Terms,<sup>1</sup> Mastication is the 'process of chewing food for swallowing and digestion'. and masticatory performance is 'a measure of the comminution of food attainable under standardized testing conditions'. Extensive tooth loss frequently impairs masticatory and gastrointestinal functions, nutritional status, oral health-related quality

of life.<sup>2,3</sup> Impaired masticatory function may cause difficulties in food intake and increase the risk of undernutrition, which is associated with an increased risk of all-cause mortality, especially among frail older adults.<sup>4,5</sup> There is also evidence of a direct connection between mastication and systemic and cognitive functions.<sup>6,7</sup>

From a functional viewpoint (i.e. 'masticatory function'), masticatory performance can be defined as an objective assessment of mastication with various comminution or chewing tests, whilst

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masticatory ability is a subjective assessment based on individual's self-evaluation.<sup>8</sup> Objective measures of mastication have been considered more valid than the patients' perceptions, even if patient-based ratings of these dimensions should have relevance as well, since the aim of any prosthodontics treatment is to improve the oral health of the patient, also encompassing feelings, comfort and aesthetics.<sup>1,9</sup>

Whilst a scientifically accepted method for assessing mastication is still lacking, a wide variety of methods has been used to analyse chewing performance, such as: measuring colour change in chewing gum,<sup>10-12</sup> sugar loss from chewing gum,<sup>13</sup> dye colorimetric method,<sup>14</sup> photometric methods<sup>15-17</sup> and optical scanning of chewed particles.<sup>18,19</sup>

Studies show that implant-supported prostheses improve the masticatory function and satisfaction in edentulous patients,<sup>20-24</sup> while masticatory performance is reduced both in people who have lost post-canine teeth and in removable dentures patients.<sup>8</sup> However, there is still paucity of available data about the possible influence of a worn dentition on masticatory performance.

In recent years, there has been a growing interest on the causes and management of the worn dentition. Tooth wear is physiological when 29 microns/year (0,29mm/10years), 15 microns/year (0,1mm/10years), 16 microns/year (0,16mm/10years) and 24 microns/year (0,24mm/10years) of occlusal/incisal tooth substance is lost respectively for molars, premolars, upper incisors and lower incisors.<sup>25,26</sup> Pathological tooth wear is defined as 'tooth wear which is atypical for the age of the patient, causing pain or discomfort, functional problems, or deterioration of aesthetic appearance, which, if it progresses, may give rise to undesirable complications of increasing complexity'.<sup>27</sup>

Tooth wear is a multifactorial condition, leading to the loss of dental hard tissue (enamel and dentin) and it can be divided into chemical wear (erosion) and mechanical wear (attrition and abrasion).<sup>28,29</sup> In 2016, an investigation on 1125 subjects in the Netherlands reported higher degrees of tooth wear in older than in younger age groups (for all types of teeth). In addition to that, men showed more tooth wear than women, and participants with a low socio economical status showed higher tooth wear scores than individuals belonging to high social layers.<sup>30</sup> Mild and moderate tooth wear turned out to be common conditions, with prevalence of 13% and 80%, respectively, while severe tooth wear (with a prevalence of 6%) was rare.

Numerous attempts have been made to develop wear indices and classification systems.<sup>29,31,32</sup> While a universally accepted classification system is missing, patients with worn dentition present different challenging clinical scenarios for the dentist who wishes to restore the physiological anatomy of the dentition, if indicated or requested by the patient, usually for aesthetic issues. For decades, prosthodontists have restored these patients with classical crown and bridge treatments, sacrificing a large amount of dental tissue in order to obtain the space needed for prosthetic materials. Increasing the vertical dimension of occlusion (VDO), besides providing aesthetic advantages, was a way to minimise more invasive dental procedures, such as preventive endodontic treatment and/or surgical crown lengthening.

The relatively recent cultural wave of minimally invasive and adhesive dentistry led to a paradigm shift in treatment plans that are

proposed for managing worn dentition: minimising hard tissues sacrifice, using bondable restoration materials, previsualizing final outcomes thanks to digital tools and mockups.<sup>33</sup> Therefore, a common belief grew up within some dental communities that restoring worn dentition is a medically needed procedure, but despite the impact of restoration procedures on aesthetics and patients' satisfaction,<sup>27</sup> the literature has repeatedly shown that tooth wear is not associated with clinical symptoms of musculoskeletal dysfunction.<sup>34,35</sup> The effects of tooth wear restorative procedures on masticatory performance has never been reviewed.

Within these premises, the aim of this paper is to perform a systematic review of the literature on the assessment of masticatory performance of patients with tooth wear before and after dental management. The secondary goal is to prepare a scoping review that serves as a standpoint for the design of future researches, with an insight on the differences between medical vs technical needs.

## 2 | MATERIALS AND METHODS

### 2.1 | Review protocol

The Cochrane Handbook Method Guidelines<sup>36</sup> and Centre for Reviews and Dissemination (CRD) guidelines<sup>37</sup> were consulted to prepare this study. The protocol was written according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and checklist.<sup>38</sup> According to the population, intervention, comparison and outcome (PICO) approach,<sup>37,39</sup> the guiding question of this review was: 'Which is the masticatory performance before and after oral rehabilitation in patients with worn dentition?'

### 2.2 | Search strategy

A digital systematic literature search in PubMed/MEDLINE and Cochrane Central Register of Controlled Trials (CENTRAL) was conducted on October 21, 2022. The US National Institutes of Health Ongoing Trials Register ([clinicaltrials.gov](https://clinicaltrials.gov)) and World Health Organisation International Clinical Trials Registry Platform ([apps.who.int/trialsearch](https://apps.who.int/trialsearch)) were searched on the same date for ongoing studies.

The search query was implemented using the following combinations of keywords: 'tooth wear' OR 'worn dentition'; AND 'treatment'; AND 'chewing ability' OR 'masticatory performance'. No limits were applied to the year of study, whilst only articles published in English were searched. The digital search was implemented by manually searching the reference lists from full-text articles and related reviews.

### 2.3 | Inclusion criteria

The PICO criteria related to research question are detailed below:

1. Population: Patients with Tooth wear who had a clear request for rehabilitative intervention due to problems such as difficulties

with chewing, discomfort or aesthetics. 2. Intervention: Full oral rehabilitation of the existing teeth, implying an increasing in VDO, either with direct or indirect restorations. 3. Comparison: Patients at baseline and/or one or more other therapies (e.g. monitoring with non-intervention and extraction of severe worn teeth with implant replacement when could be indicated). 4. Outcome: 4.1. Primary: Masticatory performance. 4.2. Secondary: Self-reported masticatory function; Clinical methods (e.g. scales) for assessment of masticatory performance were listed to create a dataset of efficacy criteria prevalence in published studies related to this topic.

## 2.4 | Exclusion criteria

Studies presenting at least one of the following characteristics were excluded from this review: 1. Population: Systemic or local conditions that would contra-indicate dental procedures. 2. Intervention: Oral rehabilitation that not implied an increasing in VDO; Full oral rehabilitation based on implantology. 3. Comparison: None. 4. Outcome: Masticatory performance evaluated with non-validated methods.

## 2.5 | Selection process

Two reviewers (M.L., M.R.) independently screened the above-mentioned databases to select studies that met the inclusion criteria. In order to do this, these authors independently assessed each study found in the review process by grading it as 'eligible', 'not eligible' or 'might be eligible'.<sup>40</sup> A study was included if both reviewers independently assessed it to be satisfying the inclusion criteria based on the full-text article. Studies' authors were contacted, if necessary, to request clarifications, raw data, or additional data to those already reported. In case of disagreement, the full text was analysed and discussed by all the reviewers to find a consensus.

## 2.6 | Data extraction

A data extraction form was created using Excel software (version 16.46, Microsoft, Redmond) to collect information of interest from articles and facilitate comparison between studies. The two reviewers responsible for screening databases independently used this tool to record all the studies found in the review process. Therefore, data from each study were collected in duplicate and compared at the end of the process. A third reviewer (O.S.) checked the collected data for consistency and clarity.

## 2.7 | Measurement of treatment effect

Masticatory performance was evaluated according to the criteria specified in the individual studies. As various assessment methods

exist for evaluating masticatory performance, the clinical methods that were used were listed to create a dataset of efficacy criteria.

## 2.8 | Unit of analysis

The statistical unit was the patient undergoing oral rehabilitative intervention aimed at treating worn dentition.

## 2.9 | Synthesis of results

The study protocol dictated that, if possible, multiple outcomes were combined and calculated using statistical R software (version 4.0.1, FOAS) for meta-analysis and scientifically validated methods.<sup>36</sup> If not, only a descriptive report of the results would have been produced.

# 3 | RESULTS

## 3.1 | Search results

The search query led to 2850 results. Duplicate records from different registers or databases were excluded from the review, resulting in 2779 studies. In the first instance, the authors excluded the majority of the articles by reading the titles. Subsequently, the abstracts of the remnant studies classified as 'might be eligible' were reviewed, selecting 21 studies for full-text analysis. Manual search of the bibliographies identified four additional articles. After full-text evaluation, only one article<sup>41</sup> fully met the inclusion criteria of the review. The flow diagram summarises the whole selection process, following PRISMA guidelines (Figure 1).

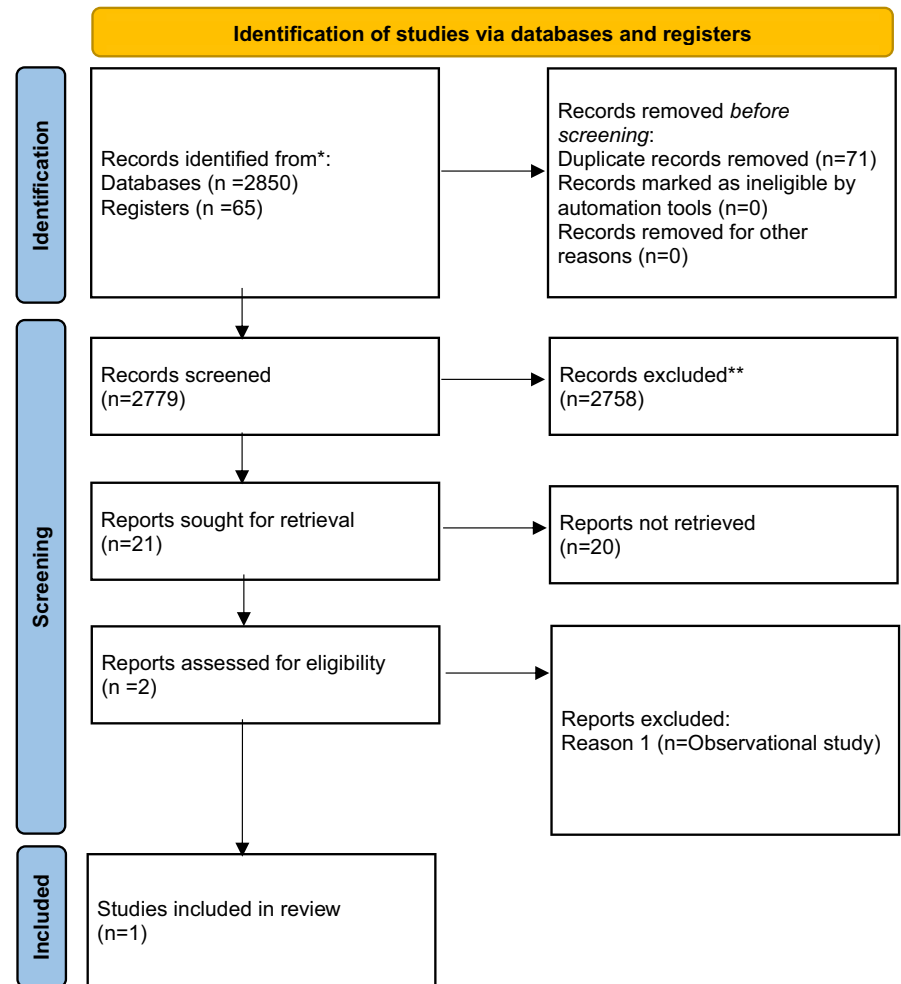
## 3.2 | Included studies

The characteristics of the included study are described in Table 1. A total of 23 fully dentate adults (17 male, six female, age  $41.7 \pm 8.3$  years) took part in it. Participants presented generalised tooth wear TWI-score of  $2.2 \pm 0.5$  and an average number of occlusal units of  $11.6 \pm 0.9$  without limited mouth opening, periodontitis, deep carious lesions or endodontic problems, nor local or systemic conditions that could affect the dental procedures.

## 3.3 | Measures (assessment of masticatory performance)

Researchers used comminution of artificial food test for the assessment of the masticatory performance. Patients performed 20 masticatory cycles on 17 cubes of silicon with an edge size of 5.6 mm ( $3\text{cm}^3$ ), and the median particle size (X50) resulted was measured with a series of sieves. Furthermore, patients filled Oral Health

FIGURE 1 Identification of studies via databases and registers.



Impact Profile (OHIP-49) questionnaire at baseline and after the intervention. Researchers recorded also other variables, as maximum voluntary bite force (bite force transducer) and 3-dimensional scans before and after treatment for the evaluation of the increase in VDO (software Meshlab).

### 3.4 | Effect of the intervention

The results are summarised in Table 1. All the 23 patients completed the study. At baseline, the median particle size X50 was  $4.19 \pm 0.97$ . At the recall 1 month after treatment, this variable was  $4.03 \pm 0.76$ , with a statistically non-significant difference ( $p = .327$ ) compared to baseline. Conversely, bite force decreased significantly from 388.52 N to 323.16 N after treatment ( $p = .028$ ), and the OHIP-49 questionnaire showed a significant improvements in all categories ( $p = .053$ – $p = .072$ ). The VDO increase after treatment was  $2.0 \pm 0.99$  mm.

## 4 | DISCUSSION

The majority of the literature studying the masticatory performances was published in the last 15 years. Despite not having an

international consensus that set the specific criteria on the applicability of a masticatory performance test in a specific clinical scenario, the focus on the topic is rising. In particular, a recent consensus paper represents a first attempt to define a framework to facilitate the choice of the evaluation test, with the aim of reaching a standardisation among authors and ease the comparison of different studies.<sup>42</sup> It shed light on the topic of masticatory performances tests, making a clear distinction between the types of tests available, without however indicating strict criteria for the choice of a particular study design in a specific clinical situation.<sup>42</sup> The test food used by the authors (Optosil Comfort®), being solid, has the great advantage of simulating very closely the real food, and the one that is more challenging for the patient to chew. We can speculate that if a patient can masticate something that has a certain stiffness and hardness, will also be able to chew every other type of food that is softer. To support the type of test adopted by the researchers and considering that the population involved was fully dentated, affected only by tooth worn without any other pathology affecting the masticatory system, the test material used was not inadequate, as it would have been in a population of edentulous patients or children, with obvious limitations of masticatory function.

Another difficulty that emerges from the research setting is the potentially poor correlation between the objective evaluation of

TABLE 1 Characteristics of the included study.

| Population   | Intervention   | Comparison | Outcome  | Baseline                              | After Intervention                   | p Value                   |
|--|--|------------|--|---------------------------------------|--------------------------------------|---------------------------|
| 23 fully dentate adults (17M, 6F; 41.7 ± 8.3 years), generalised tooth wear (TWI score: 2.2 ± 0.5) | Direct composite restorations of worn teeth with increase of VDO | Baseline   | <ul style="list-style-type: none"> <li>-Comminution of artificial food test, median particle size (X50)</li> <li>Oral health impact profile (OHIP-49) questionnaire</li> <li>-Maximum voluntary bite force (transducer)</li> </ul> | 4.19 ± 0.97<br>10.6 ± 4.8<br>388.52 N | 4.03 ± 0.76<br>6.6 ± 2.5<br>323.16 N | .327<br>.028<br>.053–.072 |

masticatory performances and the patient's self-perception through the questionnaire.<sup>43–45</sup> Based on that, it cannot be excluded that part of the patient's satisfaction related to the treatment might also come from a placebo effect.<sup>46,47</sup>

Conversely, much attention has recently been given to the study of tooth wear.<sup>48</sup> For years, tooth wear has been considered by most professionals as the result of severe bruxism, but recent developments on bruxism knowledge have shown the absence of a linear relationship between the two conditions.<sup>49–52</sup> The aetiology of tooth wear is multifactorial, being the result of multiple causes and phenomena of abrasion, attrition, and erosion, ultimately leading to loss of hard dental structures.<sup>53,54</sup> Didactically, the nature of tooth wear can be divided into mechanical (abrasion, attrition) and chemical (erosion) type, but the complex interplay of these two causes is not negligible at the clinical level.<sup>28,53,55</sup> In addition to this we have to consider the impact on tooth wear of the growing consumption of acidic beverages and food, and of the increase in both prevalence and incidence of the gastroesophageal reflux disease (GERD).<sup>56–59</sup> The latter was found to have a combined effect on tooth wear together with bruxism.<sup>60–63</sup>

Several indexes have been proposed to accurately evaluate tooth wear,<sup>64–66</sup> with the recent tooth wear evaluation system (TWES) and its update<sup>67</sup> being a nice attempt to recap the potential quantitative and qualitative assessment strategies.<sup>29,65,66</sup> The discrimination between physiological and pathological tooth wear implies a comprehension of the phenomenon of ageing and natural evolution of tooth wear.<sup>68</sup> Several studies reported a quantitative measure of what should be considered a physiological loss of hard dental structure, ranging from a maximum of 1.7 mm to a minimum of 0.9 mm over a span of 60 years.<sup>26</sup> Pathological tooth wear is a condition of unacceptable levels of tooth wear, leading to sensitivity and worsened aesthetic aspect.<sup>69</sup>

The above considerations are important to define treatment indications of tooth wear. Loomans et al. in an expert consensus document recently defined severe tooth wear as 'Tooth wear with substantial loss of tooth structure, with dentin exposure and significant loss ( $\geq 1/3$ ) of the clinical crown' and pathological tooth wear as 'Tooth wear which is atypical for the age of the patient, causing pain or discomfort, functional problems, or deterioration of esthetic appearance, which, if it progresses, may give rise to undesirable complications of increasing complexity'. A clinical guide for dentists to decide whether a patient with tooth wear is a possible candidate for a restorative treatment program has been provided.<sup>27</sup>

Within these premises, the present review was performed to summarise findings on the impact of tooth wear restoration procedures on masticatory performance.

Only one article met the inclusion criteria. The authors recruited a group of individuals with tooth wear who underwent restorative treatment with full mouth composite restorations and conducted a before-after study of masticatory performance.<sup>70</sup> Both an objective and a subjective method to evaluate the improvement in masticatory performance were adopted. The objective test consisted in evaluating the capability of patients to comminute an artificial food,

made of dental impression material. The study findings suggest an absence of any statistically significant difference in masticatory performance before and after the intervention. The subjective method was a self-reported five-item questionnaire (OHIP-item related to chewing and eating). It showed that patients had a statistically significant perception of masticatory ability improvement after receiving the restoration. The inconsistency of findings between the comminution test and the subjective perception may suggest that psychological factors associated with the new aesthetics may be responsible for the patients' satisfaction. Interestingly, these finding may also be at the basis of the purported improvement in musculoskeletal pain after dental procedures, which are otherwise unsupported by the literature.<sup>71-73</sup> Another reason for the difference between the subjective and objective outcomes could be related to the reduction in teeth hypersensitivity after restorations. Despite there are no studies on the topic, it can be speculated that covering the exposed dentin with restorative composite material might have contributed to the reduction of potential hypersensitivity, thus enhancing masticatory ability.

In the study included in this review, the authors chose to perform the restoration with conventional composite with the DSO technique. Other options might have been considered for the restoration of worn dentition, such as resin composite with a direct or indirect application<sup>27</sup> or prosthodontic rehabilitations.<sup>74</sup> Few longitudinal studies tried to compare the long-term effectiveness of direct vs indirect restorations.<sup>75</sup>

The strength of evidence that can derive from this review is limited, since it highlighted a general lack of investigations on the topic of masticatory performance in patients with worn dentition. On one hand, this suggests the need for a more standardised research protocol for the evaluation of the masticatory performance, for an investigation of the complex interplay of factors that lead to severe tooth wear, as well as from longitudinal studies assessing which could be the ideal material for performing restorative procedures. On the other hand, the paucity of literature and the findings of the only article that has been included in the review suggest the existence of a gap between common claims about the medical necessity of certain dental procedures and the absence of a proven efficacy to actually treat dysfunction. This concept has been repeatedly addressed in the literature on temporomandibular joint disorders.<sup>76,77</sup>

Since the effects of tooth wear restorative procedures concerns mainly the aesthetics sphere and the diminution of sensitivity due to dentin exposure sensitivity, dental communities should embrace an ethically driven approach to patients' information, in line with what has been suggested for other occlusal therapies.<sup>78,79</sup> Such an approach should be based, for instance, on literature evidence about the non-existent association between musculoskeletal disorders and tooth wear.<sup>34,80</sup> On the other hand, we should not forget that the restorative treatment of generalised tooth wear using direct resin bonded composite improves significantly the masticatory ability (subjectively evaluated), which is an important treatment goal within the context of an appropriate doctor-to-patient relationship.

## 5 | CONCLUSIONS

Within the limitations of this scoping review, it can be concluded that there is not enough evidence to comment on the actual therapeutic role of tooth wear restoration on masticatory function, given that only one investigation on the topic was performed. It is likely that restorative treatments of the worn dentition lead to a subjective improvement of masticatory ability, but this is not necessarily associated with an improvement in objective masticatory performance. Based on that, along with the need for further studies, it is recommended that clinicians carefully discuss the patient's needs and expectations on an individual basis, without giving for granted that a functional rehabilitation is consequential to the aesthetic restoration.

### AUTHOR CONTRIBUTIONS

MR contributed to data acquisition and paper extraction. OIS and ML contributed to data interpretation, tables, figures and drafting of the article. MF, FC, DM contributed to the conception of the manuscript, design, editing, and approval of the final version for submission.

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### CONFLICT OF INTEREST STATEMENT

No conflict of interest declared.

### PEER REVIEW

The peer review history for this article is available at <https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/joor.13549>.

### DATA AVAILABILITY STATEMENT

Data sharing not applicable – no new data generated.

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