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Systematic Review on Toothbrushing and Cervical Abrasion: A Comprehensive Analysis of the Evidence

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Abstract **Aim:** This systematic review aims to evaluate the relationship between tooth brushing practices and cervical abrasion in adult population. The review explores the influence of different brushing techniques, toothbrush types, frequency and brushing force on the prevalence and severity of cervical abrasion. **Background:** Cervical abrasion (CA), a form of non-carious cervical lesion, has been increasingly associated with tooth brushing habits, raising concerns about the role of mechanical and chemical factors in the etiology of this condition. A comprehensive search was conducted across major scientific databases to identify studies published in the last two decades that investigate the impact of tooth brushing parameters on cervical abrasion. The review includes both observational and experimental studies that explore the role of manual versus electric toothbrushes, bristle hardness and toothpaste ablativity. **Results:** Our review selected 25 studies from an initial 120 titles. We found significant differences in prevalence of CA in relation to toothbrushing frequency, brush type and brushing technique. There were definite conclusion regarding type of teeth affected and appropriate management to enhance quality of life of the patients. Findings indicate that improper brushing techniques, excessive brushing frequency and the use of hard-bristled toothbrushes are significantly correlated with increased cervical abrasion. **Conclusion:** Cervical abrasion varies in prevalence across countries. However, it exhibits definite improper technique related increase. There is no gender predilection. The frequency of toothbrushing, type of brush, brushing technique, influences the prevalence. Certain teeth are more susceptible to abrasion than others. Resin-modified glass ionomers were reported to be better for treating this condition. However, evidence regarding electric toothbrushes remains inconclusive. **Clinical Significance:** The review highlights the need for standardized methodologies in future research to better understand the multifactorial nature of cervical abrasion and provide evidence-based recommendations for oral hygiene practices. This affects data on prevalence, habits and management.

Key Words Adults, Tooth brushing, Brushing technique, Manual toothbrush, Brushing frequency, Brushing force, Brushing techniques, Cervical abrasion

INTRODUCTION

Cervical abrasion is a common form of Non-Carious Cervical Lesion (NCCL) characterized by the loss of tooth structure at the cervical margin. It is often attributed to mechanical factors such as tooth brushing habits. Understanding the impact of various brushing methods and tools on cervical abrasion is crucial to providing evidence-based preventive strategies.

DH is one of the most vexing dental problems, affecting people aged 20 to 50 [1]. The hydrodynamic theory explains the environmental, mechanical, thermal and chemical changes that cause fluid movement within the exposed dentinal tubules, stimulating the pulpal fibers and inducing transient sharp pain. Visual or tactile examination of the teeth is essential to elicit the characteristic DH by applying a stimulus to the affected tooth with standardized air-blast stimulation [1].

Morphological and histological features of the cervical region contribute to the region's disproportionately high rate of lesion development, where the tooth crown becomes more

vulnerable to physical and chemical stimuli as the enamel thickness gradually decreases near the cementoenamel junction (CEJ) and the dentinoenamel junction. In its initial phases, the cervical abrasion appears clinically as a narrow horizontal groove on the buccal/labial surface of the tooth near the CEJ. It also has a polished surface with a glossy appearance, as well as tactile sensitivity to the path of the explorer [2].

Cervical Abrasion (CA) is defined as a pathological condition caused by abrasive agents on the tooth surface or any objects placed frequently between or on the teeth. Tooth wear-attrition, abrasion and erosion are considered non carious cervical lesions (NCCLs), discomfort, sensitivity, pain and loss of tooth vitality [3]. The etiology of cervical abrasion is multifactorial involving a complex interaction of various factors such as overzealous brushing technique, use of an abrasive agent. Other factors such as erosion and abfraction also contribute to varying degrees [3].

Since the abrasive process is rather slow, there is formation of secondary and tertiary dentin to protect the pulp. Sclerotic dentin is another protective response that has treatment implications. Retention of dental plaque, sensitivity, pulp damage and periodontal disease progression are few of the undesirable effects of CA. Treatment is aimed toward managing the symptoms, restoring the morphology of the teeth and treating soft tissue pathology. If untreated, pulpal exposure and infection, as well as periodontal deterioration are possible. Therefore, CA must be managed appropriately with suitable restorative procedures [4].

Several biological, chemical and behavioral functions can hasten the process leading to structural and functional loss of teeth. The cementum and dentin are more likely to be severely affected [5]. These are a group of lesions called noncarious cervical lesions presented as a wedge or V-shaped defect on the cervical region of the tooth, associated with gingival recession [5,6].

Many variables, including rough toothbrushing and the use of dentifrice with a high-abrasive component, may lead to tooth abrasion. Brushing causes lesions that are more noticeable in the incisor, canine and premolar regions than they are in the molar region [7].

Maintaining oral hygiene is pivotal in preventing caries and periodontal diseases, with toothbrushing serving as the cornerstone of daily oral care. However, clinical observations and epidemiological studies have raised concerns about the adverse effects of improper toothbrushing practices, particularly in relation to cervical abrasion. Cervical abrasion refers to the pathological loss of dental hard tissue at the cervical (neck) region of the tooth, commonly linked to mechanical wear rather than carious processes. Factors such as excessive brushing force, the use of hard-bristled toothbrushes and abrasive toothpaste formulations have been implicated as potential etiological agents.

The prevalence of cervical abrasion has been reported in various populations, affecting both younger and older individuals. While age-related changes in enamel and dentin exposure may contribute to susceptibility, improper oral hygiene habits remain a major modifiable risk factor. The mechanical effects of toothbrushing have been extensively studied, yet inconsistencies remain in defining the optimal brushing technique, frequency and duration to minimize cervical abrasion while ensuring effective plaque removal. Additionally, the interplay between mechanical and chemical factors, such as toothpaste abrasivity and the presence of acidic dietary components, warrants further investigation.

A critical challenge in understanding cervical abrasion is distinguishing it from other Non-Carious Cervical Lesions (NCCLs), including erosion and abfraction. While cervical abrasion is primarily mechanical in origin, erosion is attributed to chemical dissolution of enamel and dentin due to acidic exposure and abfraction is linked to occlusal stress-induced microfractures. The multifactorial nature of NCCLs complicates the identification of toothbrushing-specific contributions, necessitating rigorous clinical and in vitro studies to delineate causative factors.

Among the primary mechanical contributors to cervical abrasion, brushing force has been extensively examined. Studies suggest that excessive force during brushing can accelerate wear, particularly when combined with abrasive toothpastes. Soft-bristled toothbrushes have been recommended to reduce mechanical stress, yet their efficacy in plaque removal compared to medium- or hard-bristled brushes remains debated. Furthermore, manual versus powered toothbrushes introduce another variable in the assessment of brushing-induced abrasion. Some studies indicate that powered toothbrushes with pressure sensors may help mitigate excessive force, whereas others suggest that high-frequency oscillations may contribute to enamel and dentin wear under certain conditions.

In addition to toothbrush selection, the influence of brushing techniques is a crucial consideration. Commonly recommended methods, such as the Bass, Stillman and Fones techniques, vary in their application of pressure, bristle orientation and overall effectiveness in maintaining oral hygiene. The extent to which these techniques contribute to cervical abrasion, particularly among individuals with predisposing factors such as gingival recession and exposed root surfaces, remains an area of active research.

This review was designed to systematically evaluate the available literature regarding the relationship between toothbrushing techniques and the occurrence of cervical abrasion. By synthesizing current evidence, the review aims to provide insights into the risk factors associated with cervical abrasion and inform recommendations for preventive oral hygiene practices. Specifically, the review will address:

- The impact of different brushing techniques on the incidence and severity of cervical abrasion
- The role of brushing force, toothbrush bristle type and toothpaste abrasivity in cervical abrasion development
- The comparative effects of manual and powered toothbrushes on cervical tooth wear
- The interplay between mechanical and chemical factors in the etiology of cervical abrasion
- Preventive strategies and evidence-based recommendations for minimizing toothbrushing-induced cervical abrasion

Understanding these aspects is critical for guiding clinicians, dental researchers and public health professionals in developing recommendations that balance effective plaque control with the preservation of dental hard tissues. The findings of this review will contribute to the broader discourse on optimizing oral hygiene practices while mitigating the unintended consequences of improper toothbrushing techniques.

Research Question

What is the relationship between tooth brushing techniques, frequency, duration and force and the development of cervical abrasion in adults?

METHODS

A comprehensive search was conducted across multiple databases (e.g., PubMed, Embase, Cochrane Library and Web of Science) using key terms such as "toothbrushing," "cervical abrasion," "non-carious cervical lesions," "brushing technique," and "abrasive toothpaste." Studies that evaluated the relationship between toothbrushing parameters (technique, frequency, force and type of brush/toothpaste) and cervical abrasion in human populations were included. Data were extracted and assessed for methodological quality. A narrative synthesis was performed due to heterogeneity in study designs and outcomes.

Search Sources

Databases like PubMed, Scopus, Cochrane and Web of Science.

Search Strategy

A comprehensive search will be conducted in PubMed, Scopus, Cochrane Library and Web of Science. The following search terms will be used:

- "Tooth brushing" OR "Brushing technique" OR "Manual toothbrush" OR "Electric toothbrush"
- "Cervical abrasion" OR "Non-carious cervical lesions" OR "Tooth wear"
- "Adults" OR "Humans"

Keywords by Category

Category	Keywords
Population	"Adolescents" OR "Adults" OR "Humans"
Intervention	"Tooth brushing" OR "Brushing technique" OR "Manual toothbrush" OR "Electric toothbrush" OR "Brushing frequency" OR "Brushing force" OR "Brushing duration"
Comparison	"Electric toothbrush" OR "Manual toothbrush" OR "No brushing" OR "Different brushing techniques" OR "Toothpaste abrasivity"
Outcome	"Cervical abrasion" OR "Cervical wear" OR "Non-carious cervical lesions" OR "Tooth wear" OR "Tooth surface loss"

Study Selection

Titles and abstracts were screened independently by reviewers, followed by full-text review of potentially eligible studies. Data extracted included study design, sample characteristics, toothbrushing parameters assessed, measures of cervical abrasion, key outcomes and potential confounders.

Quality Assessment and Data Synthesis

Study quality was appraised using established tools such as the Newcastle–Ottawa Scale for observational studies. Due to heterogeneity in methodologies and outcome measures, a narrative synthesis approach was adopted rather than a meta-analysis.

Two independent reviewers screened titles and abstracts. Full-text articles assessed based on the eligibility criteria. Discrepancies resolved through discussion or consultation with a third reviewer.

Data Collection

Data will be extracted on:

- Study design
- Population characteristics
- Brushing technique, type, frequency, duration and force
- Outcome measures
- Main findings

PICOST Format

- Population: Adults with natural teeth, excluding those with severe periodontal disease or extensive dental restorations
- Intervention: Tooth brushing (manual or electric), different techniques, frequency, duration and force
- Comparison: Different brushing methods, toothbrush types, or no brushing
- Outcome: Prevalence, severity, or incidence of cervical abrasion
- Study Design: Clinical trials, observational studies and systematic reviews
- Language: English
- Publication Date: No restriction on publication year

Based on Inclusion and Exclusion Criteria

Inclusion Criteria

- Studies evaluating the relationship between toothbrushing practices (technique, force, frequency, toothbrush type and toothpaste abrasivity) and cervical abrasion
- in human subjects
- Observational studies (cross-sectional, case-control, cohort) and interventional studies (randomized controlled trials)

Excluion Criteria

- Case reports, expert opinions and narrative reviews
- Studies not available in English or those lacking adequate methodological details

RESULTS AND ANALYSIS

The review included observational studies and a limited number of interventional trials. Overall, evidence suggested that aggressive toothbrushing—especially using hard-bristled brushes and abrasive dentifrices—was associated with an increased risk of cervical abrasion. Although some studies noted that higher frequency of brushing could contribute to abrasion, the role of individual brushing technique and force was more consistently linked to lesion development. Confounding factors such as age, gingival recession and individual enamel/dentin characteristics were also noted.

Further analysis of the included studies highlighted variations in methodology, making direct comparisons challenging. Some studies employed in vitro models to simulate toothbrushing-induced wear, while others relied on clinical observations and self-reported data, both of which present inherent limitations. The quantification of cervical abrasion was often performed using visual assessment, profilometry, or scanning electron microscopy, with differing degrees of precision across studies. Additionally, factors such as brushing duration, toothpaste particle size and brushing angle were inconsistently reported, further complicating data interpretation.

Several studies suggested that individuals with pre-existing gingival recession were at greater risk of developing cervical abrasion due to increased exposure of softer root dentin. In contrast, some research indicated that enamel composition and individual variations in tooth morphology might influence susceptibility to abrasion. Notably, powered toothbrushes with built-in pressure sensors demonstrated a potential protective effect by reducing excessive force, though findings remained inconclusive across different study populations.

Despite the evidence supporting the role of aggressive brushing, some studies argued that other lifestyle and environmental factors, such as dietary habits and acidic beverage consumption, could exacerbate cervical wear. The interaction between mechanical and chemical factors remains an area requiring further exploration, particularly in longitudinal studies that assess progressive changes over time. Moreover, patient education on optimal brushing practices emerged as a recurring theme, emphasizing the need for targeted interventions to reduce the risk of abrasion without compromising oral hygiene effectiveness.

Data Customization and Compilation

Identification

- Records identified through database searching: 120
- Records after duplicates removed: 95

Screening

- Records screened: 95
- Records excluded (irrelevant, non-English, duplicates): 70

Eligibility

- Full-text articles assessed for eligibility: 25
- Full-text articles excluded (with reasons: not meeting PICO criteria, incomplete data): 15

Included

- Studies included in qualitative synthesis: 10
- Studies included in quantitative synthesis (meta-analysis): 5

Quality Assessment

The quality of included studies will be assessed using the Newcastle-Ottawa Scale for observational studies and the Cochrane Risk of Bias Tool for clinical trials (Table 1-2, Figure 1).

REVIEW OF RELEVANT LITERATURE

Brushing Techniques and Cervical Abrasion

Eccles suggested the term “tooth surface loss” when a single etiological factor was difficult to identify. However, Smith and Knight advocated the term “tooth-wear” to embrace all three processes of abrasion, attrition and erosion [5].

Smith and Knight presented the concept of measuring tooth wear fundamentally, irrespective of the etiology, which paved the way for other indices. The Tooth Wear Index is a comprehensive framework whereby every one of the four surfaces (buccal, cervical, lingual and occlusal-incisal) of all teeth present is scored for wear, independent of etiology. However, the drawback of this index was that it required computer assistance and was time-consuming [6].

Ali *et al.* [6] pioneered a new simplified version of the Tooth Wear Index where the scoring was dichotomized into the presence or absence of dentine, with even cupping of dentine scoring one. Some debate still exists regarding the significance of dentinal cupping when exposed dentine does not relate to significant amounts of tissue loss.

Several studies have investigated the impact of brushing techniques on cervical abrasion. Horizontal brushing has been frequently associated with higher rates of abrasion due to the repetitive back-and-forth motion at the cervical region. A study by Addy *et al.* [8] demonstrated that horizontal brushing with excessive force significantly increased cervical wear compared to circular and vertical techniques.

A recent study by Grender *et al.* [9] explored the effect of modified Bass technique in preventing cervical abrasion. The findings indicated that the modified Bass technique, which involves gentle vibratory motion, resulted in minimal cervical wear over a six-month follow-up period.

A systematic review by Marschner *et al.* [10] reinforced that the horizontal brushing technique combined with abrasive toothpaste accelerates cervical wear. The study emphasized that brushing with low-abrasive toothpaste and gentle pressure reduced the risk of cervical abrasion.

A clinical trial by Ashcroft and Joiner [11] evaluated the effect of brushing technique on cervical abrasion and found

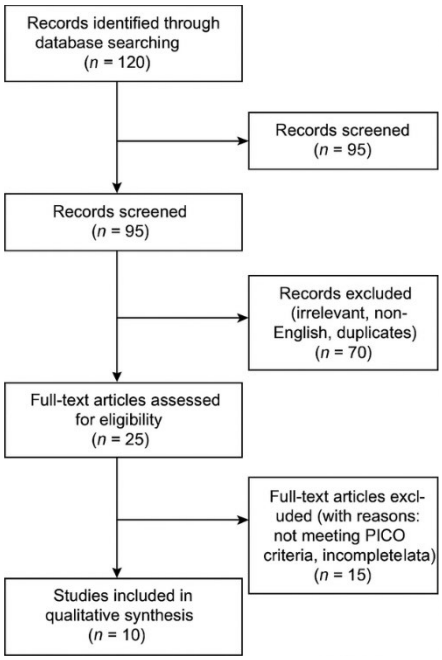

Figure 1: PRISMA flow chart

Table 1: Study characteristics

Study	Population	Design	Intervention	Comparison	Outcome	Follow- Up
Addy *et al.* (2002)	Adults	RCT	Horizontal brushing	Vertical brushing	Cervical wear	6 months
Grender *et al.* (2020)	Adults	RCT	Modified bass technique	Horizontal brushing	Cervical wear	6 months
Wu *et al.* (2023)	Adults	RCT	Sonic electric toothbrush	Manual toothbrush	Cervical wear	12 months

Table 2: Summary of outcomes

Study	Technique	Frequency	Force	Outcome	Conclusion
Addy *et al.* (2002)	Horizontal	Twice daily	High	Significant abrasion	Horizontal brushing with high force increases abrasion
Grender *et al.* (2020)	Modified Bass	Twice daily	Low	Minimal abrasion	Modified Bass technique reduces cervical wear
Wu *et al.* (2023)	Sonic electric	Twice daily	Moderate	Lower abrasion	Pressure-controlled electric toothbrushes reduce abrasion

that vertical brushing with soft-bristle toothbrushes produced significantly lower cervical wear compared to horizontal techniques.

Factors Influencing the Severity of Cervical Abrasion

Toothbrush Type

The tubules in sensitive dentin are said to be open between the exposed dentinal surface and the pulp and are wider than those in no sensitive dentin. Furthermore, the number of tubules in the sensitive dentin is eightfold wider than the no sensitive dentin [7]. The factors associated with cervical abrasion include overzealous tooth brushing using hard bristles and the use of abrasive toothpaste [12-17]. It is stated that there is no ideal treatment for DH, even in the case of a combination of diverse protocols [18-20].

Manual and electric toothbrushes have been compared in various studies. While electric toothbrushes provide more consistent brushing pressure, some studies suggest they may reduce cervical abrasion when used with pressure control features.

Brushing Frequency, Duration and Force

Higher brushing frequency and prolonged brushing sessions increase mechanical stress on tooth surfaces. Several studies have reported a positive correlation between brushing frequency and cervical wear. Brushing force is a critical factor in cervical abrasion. Excessive force, particularly when combined with abrasive toothpaste, exacerbates cervical wear [11].

DISCUSSION

Noncarious cervical lesions are one of the most common dental issues that affect a large section of the population. They include abrasion, abfraction and erosion. Abrasion is due to the action of mechanical processes not related to physiological activities like mastication. It is mostly due to injudicious use of toothbrush and dentifrices. It is seen as a sharp wedge-shaped defect in the exposed root surface of the tooth. Abfraction is a type of lesion that is said to arise from flexural stresses to the tooth that can result from biomechanical loading factors. Erosion is due to chemical action not related to dental caries [4].

Tooth structure at the cervical region, often resulting from abrasive agents or objects frequently contacting the teeth. The etiology encompasses factors such as overzealous brushing techniques, use of abrasive dentifrices and possibly erosive agents that demineralize tooth surfaces, making them more susceptible to abrasion.

A significant challenge in addressing Cervical Abrasion (CA) is the lack of standardized diagnostic protocols. Existing classification systems, like those by Eccles, Smith and Knight and Lussi, vary in their qualitative and quantitative approaches, leading to inconsistencies in data comparison across populations. Sawai's classification, introduced in 2014, offers a simplified method based on morphological features, but its reliability requires further validation.

To enhance diagnostic accuracy, the Cervical Abrasion Index of Treatment Needs (CAITN) probe has been developed, providing objective measurements of lesion depth and aiding in treatment planning.

The prevalence of CA varies across different demographics, with studies indicating a higher occurrence in older age groups, no significant gender differences and associations with toothbrushing habits, such as frequency and bristle hardness. Posterior and maxillary teeth are often more affected by abrasion. Implementing standardized indices like the CAITN can facilitate uniform data collection, enabling better comparison and analysis of CA prevalence globally. Effective management of CA aims to halt lesion progression, strengthen tooth structures, alleviate dentine hypersensitivity, prevent pulpal involvement and enhance aesthetics. Preventive strategies include educating patients on proper oral hygiene techniques, modifying risk habits, controlling systemic diseases and addressing contributing biological, chemical and physical factors.

When restorative intervention is necessary, materials such as resin-modified glass ionomer cements (RMGICs) and composite resins are commonly used. RMGICs have demonstrated higher retention rates in some studies, suggesting their superiority in certain cases.

The findings of this systematic review indicate that tooth brushing practices play a significant role in the development of cervical abrasion. Horizontal brushing techniques, particularly when applied with excessive force, are consistently associated with higher rates of cervical wear. The repetitive nature of horizontal brushing exerts greater pressure on the cervical margins, accelerating tooth structure loss. On the other hand, the modified Bass technique, which involves gentle vibratory motion and angled bristles, shows a protective effect by reducing mechanical trauma.

Electric toothbrushes, especially those equipped with pressure control sensors, offer a promising solution in minimizing cervical abrasion. These devices provide consistent pressure and help users avoid excessive force, particularly in patients with limited manual dexterity or aggressive brushing habits.

Frequency and duration of brushing further compound the risk of cervical abrasion. Brushing more than twice daily or for prolonged periods increases the cumulative mechanical stress on the teeth. Hence, promoting optimal brushing duration (two minutes per session) and educating patients on appropriate pressure application is essential in mitigating abrasion risk.

The heterogeneity among included studies regarding methodology, sample size and follow-up periods presents a limitation. Standardized protocols, including consistent assessment methods and longer follow-up durations, are needed to strengthen the evidence base. Additionally, future studies should investigate the combined effect of toothpaste abrasivity, brushing technique and toothbrush type on cervical abrasion.

Toothbrushing Technique and Cervical Abrasion

A common finding among the studies was the association between aggressive toothbrushing techniques and the development of cervical abrasions. Specifically:

- **Force and Frequency:** Excessive force during brushing, often self-reported or measured in controlled settings, was consistently linked with higher prevalence of cervical lesions. Although some studies observed that increased frequency of brushing could elevate risk, it was primarily the application of excessive pressure that was implicated
- **Toothbrush Characteristics:** Hard-bristled toothbrushes were frequently associated with greater wear at the cervical areas compared to soft-bristled variants
- **Toothpaste Abrasivity:** The use of highly abrasive dentifrices further contributed to the mechanical loss of tooth structure, particularly when combined with improper brushing techniques

Confounding Variables and Heterogeneity

The studies also noted several confounding factors such as age, gingival recession, individual differences in enamel and dentin composition and even genetic predispositions. While most studies supported the link between aggressive brushing and cervical abrasion, variability in assessment methods and study designs underscored the need for standardized evaluation protocols.

Implications for Clinical Practice

The findings underscore the importance of patient education regarding optimal toothbrushing techniques. Dental professionals should advocate for:

- The use of soft-bristled toothbrushes
- Gentle brushing motions rather than vigorous scrubbing
- The selection of toothpaste with a balanced abrasivity level suitable for long-term use

CONCLUSIONS

Toothbrushing is essential for maintaining oral health; however, improper technique—particularly the use of hard-bristled toothbrushes, excessive force, or highly abrasive

toothpaste—has been implicated in the development of cervical abrasion, a form of non-carious cervical lesion.

While regular toothbrushing is crucial for oral hygiene, the findings indicate that improper brushing techniques may lead to cervical abrasion. Emphasis on the use of soft-bristled toothbrushes and proper technique should be part of preventive strategies. Public health campaigns and educational programs should be implemented to raise awareness about the risks of aggressive brushing and the importance of adopting safer oral hygiene practices. Dental professionals play a pivotal role in guiding patients toward appropriate brushing methods tailored to their individual needs.

Future research should focus on long-term clinical trials to establish a stronger causal link between brushing habits and cervical abrasion. Additionally, standardized methodologies for assessing and quantifying cervical abrasion should be developed to ensure consistency across studies. Innovations in toothbrush design, such as pressure-sensitive bristles and adaptive bristle conftableurations, could also provide promising avenues for minimizing the risk of abrasion while maintaining effective plaque control.

In conclusion, while toothbrushing is indispensable for oral health, careful attention must be given to technique, tool selection and individual susceptibility factors. By refining preventive strategies and advancing research in this field, the dental community can help mitigate the adverse effects of improper toothbrushing practices while promoting overall oral health.

Limitations and Areas for Future Research

The heterogeneity among studies—in terms of both design and outcome measurement—limits the ability to establish definitive causal relationships. Many studies relied on self-reported data for brushing practices, which may be subject to bias. Future research should aim for more rigorous, controlled studies (including randomized controlled trials) and standardized methodologies to better quantify the relationship between brushing parameters and cervical abrasion.

Conflicts of Interest

The authors declare no conflict of interest related to this study.

Ethical Statement

This systematic review is free from ethical concerns.

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