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Review

Literature Review on the Clinical Application Effects of Professional Mechanical Tooth Cleaning Technology

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Abstract: In recent decades, the significance of oral hygiene and aesthetic treatments has garnered considerable attention. Professional Mechanical Tooth Cleaning (PMTC) technology has come into being. As an innovative approach, PMTC technology has been extensively adopted in numerous developed nations globally and stands as a pivotal tool in oral healthcare management. This paper, after delineating the definition, underlying principles, foundational operational procedures, and the mechanics of PMTC technology, primarily endeavors to synthesize the advancements in research pertaining to its clinical application effects. Furthermore, this paper undertakes a thorough examination of the limitations.

Keywords: PMTC technology; clinical application effects; plaque removal; oral hygiene

1. Introduction

PMTC technology is a technique defined by the utilization of specialized instruments to meticulously and mechanically eliminate dental plaque from tooth surfaces, often complemented by fluoride application, ultimately aiming to forestall or diminish the incidence of oral diseases [1]. The multifaceted clinical applications of PMTC technology encompass: the prevention of periodontal diseases and the mitigation of the progression of advanced periodontal conditions; the prevention of dental caries; oral care for patients with comorbid conditions and those with disabilities; the enhancement of patients' self-awareness in oral healthcare; the eradication of tooth discoloration; and the comprehensive oral care required during and subsequent to orthodontic treatment, as well as for dental restorations.

The foundational principles of PMTC technology hinge upon the deployment of suitable mechanical interventions to restore tooth surface polish, thereby creating a barrier that discourages bacterial recolonization and encourages the flow of saliva over the tooth surface. Concurrently, chemical adjuncts are incorporated to enhance stain removal and remineralization processes, interfere with or modify the oral microbiota, facilitate ion exchange on the tooth surface, and foster the establishment of a novel bacterial equilibrium [2].

In comparison to conventional ultrasonic scaling techniques and air-polish scaling techniques, PMTC technology distinguishes itself through the employment of more specialized cleaning instruments and the adoption of a gentler cleaning force, ultimately resulting in more effective oral hygiene outcomes [3]. Furthermore, PMTC technology stands as a professional oral preventive technique primarily designed to eliminate dental plaque and bacteria, thereby exerting a potent preventive effect against oral diseases.

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2. Operational Basics and Procedures

2.1. Operational Basics

2.1.1. Instruments

PMTC technology typically incorporates the use of oral slow-speed handpieces, which are seamlessly connected to specialized PMTC abrasive tips tailored to specific applications. These abrasive tips are categorized into distinct models based on their intended site of use and functional requirements. The abrasive surfaces of these tips are meticulously engineered with various textures, aimed at optimizing grinding efficiency while mitigating mechanical trauma during the procedure. The material composition of these abrasive tips predominantly consists of high-quality medical-grade rubber, renowned for its exceptional elasticity and wear resistance properties [4]. Furthermore, PMTC treatments may necessitate the utilization of specially formulated abrasive tips, such as flat or V-shaped four-wing configurations, to effectively clean interdental plaque.

2.1.2. Plaque Stain

Plaque stain serves as an instrumental tool in visualizing dental plaque and tartar, enabling the precise localization of these deposits on the teeth of concern and informing subsequent PMTC technology. Moreover, the application of plaque stain facilitates an accurate evaluation of the therapeutic outcomes achieved through PMTC treatment.

2.1.3. Polishing Agent

The integration of polishing agents with specialized PMTC abrasive tips constitutes a pivotal step in the eradication of dental plaque and tartar. A multitude of PMTC polishing agents are routinely employed in clinical settings, primarily differentiated by their abrasive particle attributes, fluid dynamics, viscosity profiles, and olfactory characteristics. Certain studies have posited that the selection of a polishing agent does not exert a substantial influence on the therapeutic outcome of PMTC procedures, thereby affording clinicians the latitude to tailor their choice based on patient-specific factors, including the degree of tartar discoloration, age, and individual preferences [5].

Conversely, other scholarly endeavors have contended that distinct polishing materials can exert a marked impact on treatment efficacy. Sato et al. conducted a comparative analysis of white alumina (WA), calcium carbonate (CaCO3), and agar particle polishing agents [6]. Their findings revealed that while simulated stains were nearly eradicated following abrasive blasting with WA particles and CaCO3 polishing agent, this was accompanied by an augmentation in the surface roughness of the simulated samples. Alternatively, the utilization of glycine particles and agar particles for abrasive blasting resulted in a diminished increase in surface roughness, albeit with the removal of a substantial portion of stains on the simulated samples. Similarly, Amari et al. examined the impact of various PMTC polishing agents on the surface roughness and morphological attributes of dental substrate and restoration surfaces [7]. Their research underscored significant disparities among different polishing agents, further highlighting the nuanced considerations involved in selecting an appropriate polishing agent for PMTC procedures.

2.1.4. Oral Rinse Solutions

Upon the conclusion of the abrasive phase of PMTC, an oral rinse solution is indispensable for the thorough removal of any residual abrasive agent, concurrently facilitating oral cavity cleansing. The primary constituent of the rinse solution employed in PMTC is hypochlorous acid, which is characterized by its minimal irritancy to oral mucosa and skin, as well as its low toxicity profile.

2.1.5. Fluoride

Subsequent to the oral rinse, the application of fluoride is essential across all dental surfaces within the oral cavity. Typically, toothpaste or liquid formulations containing 0.4% fluoride are utilized for this purpose. For patients reporting heightened sensitivity, toothpaste or liquid preparations containing 2% fluoride may be considered as an alternative option.

3. Clinical Application Effects

Existing research on the clinical application effects of PMTC technology primarily centers on several aspects, including the enhancement of oral health status, the prevention of dental caries and gingivitis, and the prevention and management of periodontitis.

3.1. Enhancement of Oral Health Status

Extensive research has demonstrated the efficacy of PMTC (Professional Mechanical Tooth Cleaning) technology in managing dental plaque and sustaining optimal oral hygiene status [8,9]. Studies by Tamaki et al. and Jones and Hoyle have conclusively shown that the integration of PMTC technology with oral antibacterial agents, such as azithromycin, results in a substantial reduction in the levels of bacteria, including Streptococcus mutans and Actinobacillus actinomycetemcomitans, in oral saliva [10,11]. Trombelli et al. conducted a comparative analysis between PMTC and chemical plaque control methods, revealing that chemical adjuvants do not offer supplementary advantages over PMTC [12]. Additionally, research indicates that the enhancement of oral hygiene through PMTC is contingent upon the treatment frequency, with peak effectiveness observed at intervals of 1, 3, and 6 months [13,14]. In studies involving specific demographics, Zenthöfer et al. explored the therapeutic impact of PMTC on dental and prosthodontic hygiene among the elderly, finding that participation in PMTC treatment leads to a significant reduction in plaque accumulation and gingival bleeding [15]. Furthermore, Migliorati et al. employed a meta-analysis to evaluate the effectiveness of PMTC in controlling dental plaque among patients undergoing fixed orthodontic treatment, concluding that regular PMTC and associated dental cleaning interventions are instrumental in maintaining optimal oral hygiene during the orthodontic process [16].

3.2. Prevention of Dental Caries and Gingivitis

In examining the efficacy of PMTC technology in the prevention of dental caries and gingivitis, several studies have reported that regular and repetitive PMTC interventions can diminish the predisposition to dental caries [17], mitigate the incidence of gingivitis, and exhibit a favorable impact on the prevention of various caries forms, including maxillofacial and interproximal caries. The research robustly substantiated that PMTC is capable of markedly alleviating gingival sulcus bleeding, managing oral plaque accumulation, and ameliorating gingival symptoms in patients with adolescent gingivitis, thereby exhibiting substantial preventive and therapeutic benefits for this condition [18]. Conversely, some scholarly works have observed that while PMTC technology can indeed enhance oral hygiene status in pediatric populations, effectively mitigating the clinical manifestations of gingivitis and dental caries, it falls short of providing a definitive preventive effect against dental caries [19]. Furthermore, Birt et al. conducted an assessment comparing the preventive capabilities of routine dental prophylaxis (scaling) and PMTC treatment in relation to gingivitis and periodontitis, ultimately concluding that PMTC technology does not demonstrate a significant preventive effect against gingivitis [20].

3.3. Prevention and Management of Periodontitis

With respect to the efficacy of PMTC (Professional Mechanical Tooth Cleaning) technology in the prevention and management of periodontitis, a series of studies have demonstrated its capacity to effectively curb the proliferation of oral pathogenic bacteria,

thereby mitigating the progression of periodontitis and lowering its incidence rates [21]. During the therapeutic phase of periodontitis, evidence suggests that PMTC interventions contribute to maintaining oral hygiene, enhancing the efficacy of periodontitis treatment, and augmenting the success rates of periodontal surgeries [22]. Additionally, select studies have highlighted the potential of PMTC in preventing the transition from localized to aggressive periodontitis, thereby retarding the deterioration of periodontal conditions.

In terms of mitigating the adverse consequences of periodontitis, investigations by Costa et al., Trombelli et al., and Al-Harthi et al. have collectively indicated that PMTC can significantly decrease the prevalence of tooth loss among periodontitis patients and postpone the onset of tooth exfoliation [23-25]. Furthermore, Deutscher et al. evaluated the impact of PMTC on oral malodor among periodontal disease patients, revealing that PMTC can effectively diminish volatile sulfur compounds in the oral cavity, thereby alleviating halitosis [26].

Conversely, some research has questioned the positive role of PMTC in periodontitis prevention and treatment. Jentsch et al. conducted a study involving 52 patients with chronic periodontitis to assess the influence of PMTC on the outcomes of non-surgical periodontal therapy [27]. While both the experimental and control groups exhibited significant improvements in probing depth, attachment level, probing bleeding, and interproximal plaque index at 3 and 6 months postoperatively, and a notable reduction in Tannerella forsythia in both groups, with Porphyromonas gingivalis decreasing only in the experimental group, no statistically significant differences were observed between the two groups in any clinical or non-clinical variables.

4. Conclusion

PMTC technology represents a method that employs specialized instruments in conjunction with fluoride applications to cleanse the dental surface and periodontal tissues of patients, effectively eliminating dental plaque. The persistent accumulation of dental plaque on the tooth surface and in interdental spaces fosters the survival of oral pathogenic bacteria. Prolonged neglect of oral hygiene can ultimately lead to the development of dental caries and periodontal diseases. Consequently, regular oral cleansing plays a pivotal role in mitigating bacterial proliferation between and around teeth, thereby preventing the onset of oral diseases.

Extensive research has been conducted to investigate the clinical application effects of PMTC. However, the majority of these studies have primarily centered on the impact of PMTC on oral hygiene status and the prevention of oral diseases. Relatively little attention has been paid to the application effects of PMTC technology in children's oral health care, and there is an even greater dearth of research exploring the influence of PMTC technology on children's attitudes and behaviors toward oral health. Furthermore, existing research has failed to reach a consensus on the clinical application effects of PMTC. This may be attributed to the fact that the clinical application effects of PMTC technology and individual oral health care are influenced by factors such as oral health attitudes and behaviors, which have not been adequately controlled in existing research when assessing the clinical application effects of PMTC technology. In the future, it is imperative to further explore the clinical application effects of PMTC while controlling these factors, in order to provide definitive evidence for the clinical practice of PMTC.

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