(REVIEW ARTICLE)

Evaluating the efficacy of saliva drainage and buccal swab sampling techniques in diagnosing periodontitis: A review

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Abstract

Periodontitis is a periodontal tissue infection that developed from gingivitis to chronic, destructive, and irreversible. Periodontitis can be diagnosed through clinical examination and laboratoris like non-invasive sampling methods using saliva. This review aims to compare the results, advantages, and disadvantages using saliva draining method and buccal swab as a method to diagnosing periodontitis. A comprehensive literature search was conducted using PubMed, NCBI, Scopus, ScienceDirect, ResearchGate, and relevant keywords to identify studies comparing buccal swab and draining saliva methods for periodontitis diagnosis. Buccal swab is a non-invasive method, affordable, scalable, and has a minimum discomfort. The draining method offers enhanced biomarker detection accuracy, thereby serving as a more reliable tool for periodontal disease assessment. The draining saliva method has also been shown to be more effective in diagnosing periodontitis compared to the swab method.

Keywords: Periodontitis; Non-invasive sample; Saliva draining; Buccal swab

1 Introduction

Periodontitis is a periodontal tissue infection that developed from gingivitis to chronic, destructive, and irreversible. Those periodontal tissues include gingiva tissue, alveolar bone, cementum, and periodontal ligament. Periodontal diseases can be caused by a patient's specific risk factors and poor oral hygiene [1].

Periodontitis can be caused by a patient's poor oral hygiene. Poor oral hygiene causes bacteria and plaque buildup on the teeth resulting in gingivitis that can develop to be periodontitis. Anaerobic organisms will colonize the periodontal area and can carry a destructive action. Bacteria that can be found in periodontitis patients are *Aggregatibacter actinomycetemcomitans, Porphyromonas gingivalis, Treponema denticola,* and *Tannerella forsythia* [1].

Periodontitis can be diagnosed through clinical examination and laboratories like non-invasive sampling methods using saliva. On clinical examination, periodontitis patients have some characteristics including loss of tooth attachment to cemento enamel junction, formation of periodontal pockets, gingival margin recession, lost or alveolar bone on radiographs, increasing mobility, tooth migration, and tooth tilt [2].

Non-invasive sampling is a simple method that collects samples from the oral cavity, can be done to any patient's conditions, and produces minimum discomfort. This method can be used to examine a large population. There are a few methods to take a non-invasive oral sample like buccal and tongue swabs, saliva, and oral rinses [3].

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The methods that will be discussed and compared in this literature review are the saliva draining method and the buccal swab. This review aims to compare the results, advantages, and disadvantages of using the saliva draining method and buccal swab as a method for diagnosing periodontitis from various published literature.

2 Methods

2.1 Literature Search and Strategy

A systematic literature search was conducted to identify articles discussing saliva sampling methods for the diagnosis of periodontitis, specifically comparing the draining method and buccal swab. The search strategy utilized a combination of Medical Subject Headings (MeSH) terms and relevant keywords. The primary keywords used included "saliva sampling," "draining method," "buccal swab," "oral fluid collection," "periodontal disease," "diagnosing periodontitis with buccal swab," "buccal swab on periodontitis," and "periodontitis diagnosis."

2.2 Database Selection

The electronic database search was conducted in MEDLINE (via PubMed), NCBI, SCOPUS, ScienceDirect, and ResearchGate.

3 Discussion

A structured comparison of buccal swabs and passive saliva drainage sampling techniques is presented in Table 1, focusing on aspects such as advantages, analytical findings, limitations, and effectiveness of diagnostic implications. The summarized data reflect current evidence regarding each method's relevance in biomarker detection and microbiological assessment for periodontitis diagnosis.

Table 1 Comparison of Buccal Swab and Passive Saliva Drainage Methods for Biomarker-Based Detection of Periodontitis

No.	Aspect	Buccal Swab Method	Draining Method
1.	Advantage	Non-invasive method, affordable, scalable, painless, and nonaerosol producing.	Enables collection of unstimulated whole saliva; more representative of the oral microenvironment, including gingival crevicular components relevant to disease.
2.	Findings	Buccal swabs can be used to collect microbiome samples such as *P. gingivalis, F. alocis, F. nucleatum, and T. forsythia*, and can be used as an effective sample source of mtDNA, and patient-oriented detection of biomarkers.	Yields higher concentrations of periodontal biomarkers (e.g., IL-1β, MMP-8, TNF-α); demonstrates stronger correlation with clinical periodontal status.
3.	Limitation	Containing larger proportions of epithelial cells, researchers have to be cautious in interpretation because the ratio can vary greatly between samples, and is time-consuming.	Requires patient cooperation and longer collection time; passive drainage necessitates controlled conditions to avoid sample dilution or contamination.
4.	Effectiveness	Buccal swabs can be used to diagnose periodontitis by identifying the buccal microbiome, however, buccal swabs have some limitations on identifying periodontitis microbiota and may not describe periodontitis stage accurately.	May offer improved diagnostic potential for identifying active periodontal inflammation; appears more consistent for biomarker-based assessment and longitudinal monitoring, though further comparative studies are needed.

3.1 Buccal Swab Method

Buccal mucosa can act as a substitute for teeth in searching for the bacterial composition in the oral cavity [4]. Those microorganisms can spread to periodontitis patients causing an increase in periodontal pathogens in the buccal area. Based on those reasons, a screening and microorganism analysis with a method called buccal swab can be used to take

the non-invasive samples. It is supported by a research result from [5] that states samples from buccal mucosa can be used as a non-invasive method in diagnosing periodontitis.

Swab is an absorbent pad with a shaft that can be used for sample collection such as microorganisms and DNA/RNA [6]. Buccal swabs can be used to collect microbiome samples. The analysis of the buccal microbiome in the periodontitis group showed the abundant presence of *P. gingivalis, F. alocis, F. nucleatum,* and *T. Forsythia* [7]. Periodontal microorganisms not only colonized subgingival pockets but were also detected on the periodontitis patient's mucous membrane. Based on [8] research, in buccal samples and subgingival plaque of periodontitis patients group, found *Veillonella, Treponema, Filifactor, Fretibacterium, Peptostreptococcaceae_[XI][G-6], Peptostreptococcaceae_[XI][G-5], Bacteroidetes_[G-5], Bacteroidetes_[G-3], Peptostreptococcaceae_[XI][G-4],* and *Peptostreptococcaceae_[XI][G-2]* that significantly increases compared to the healthy groups. Microbiomes from the buccal mucosa and subgingival have species-specific colonization patterns based on the researcher's results. It was also found that higher alpha diversity of microbiota from buccal mucous samples and subgingival pockets was associated with periodontal destruction. This can be caused by the formation and accumulation of the dental plaque biofilm. The deepening of the periodontal pocket provided more space and made an ideal environment for dental plaque biofilm. Bacteria have a chance to transfer to other locations in the oral cavity, including buccal mucous [8].

The buccal swab method is one of the promising methods for diagnosing periodontitis. The buccal swabs sampling can be used to collect epithelial cells that show the overview of host immunity response that often changes in periodontitis patients [9]. Buccal swab is a non-invasive method, affordable, scalable, painless, and nonaerosol producing [10] [11]. Buccal swab sampling method is also a non-invasive method that can be used as an effective sample source of mtDNA [12].

Oral swabs have a few disadvantages. Oral swabs are more time-consuming as they have to be extracted before analysis, need an expert, and adequate laboratorium, and especially in children, it is difficult to apply because it is not familiar [13]. The sensitivity of oral samples is better with tongue swabs than buccal swabs [11]. Buccal swabs also have limitations, such as containing larger proportions of epithelial cells compared to leukocytes and the ratio can vary greatly between samples so researchers have to be cautious in interpretation [14] [15].

3.2   Draining method

Saliva collection has become a widely utilized method for diagnosing periodontitis due to its non-invasive nature and practical application. However, the accuracy of biomarker detection can be greatly influenced by the technique used for saliva collection, making the choice of method a critical factor. In recent years, saliva has gained increasing attention as a promising diagnostic fluid because it is readily available, easy to collect without causing discomfort or requiring invasive procedures, and carries a minimal risk of cross-infection. These advantages position saliva as a safe and efficient alternative to other biological samples such as blood or tissue [16].

Saliva can be obtained in various forms, including: (a) resting or unstimulated whole saliva, (b) stimulated whole saliva, (c) glandular saliva, primarily from the parotid gland, either with or without stimulation, as well as submandibular and sublingual saliva [16]. In salivary diagnostics, unstimulated saliva is generally favored over stimulated whole saliva, as the latter tends to have a lower concentration of biomarkers due to dilution, making detection more challenging. However, factors such as hydration levels, body posture, head position during collection, light exposure, medication use, and circadian rhythm can influence the composition of unstimulated saliva [17].

Whole saliva or unstimulated saliva refers to the combined fluid present in the oral cavity, consisting not only of secretions from various salivary glands but also including additional components such as nasal and bronchial secretions, remnants of food, tears, microorganisms, and gingival crevicular fluid [18]. One of the collection methods for whole saliva is the draining method, also known as passive drooling. This technique involves allowing saliva to flow naturally into a collection container without stimulation, ensuring a more representative sample of the oral environment. It is widely used in research and clinical diagnostics due to its ability to provide a larger sample volume with minimal contamination, preserving the integrity of salivary biomarkers. The subject is made to sit quietly with the head bent down and the mouth open to allow the saliva to drip passively from the lower lip into the graduated sterile tubes. Saliva collected by draining is without any stimulation and is more reliable [16].

Earlier research has shown that microbial factors have the potential to differentiate individuals with periodontitis from those without the condition. An imbalance in the oral microbiome, known as dysbiosis, can trigger the host's immune response, leading to the production of several inflammatory mediators such as matrix metalloproteinase-8 (MMP-8), C-reactive protein (CRP), and secretory immunoglobulin A (sIgA) which contribute to inflammation and periodontal tissue

degradation [19]. Additionally, other biomarkers like interleukin-1β (IL-1β), pyridinoline cross-linked carboxyterminal telopeptide of type I collagen (ICTP), and *Porphyromonas gingivalis* (Pg) are highly prevalent in individuals with periodontitis and strongly linked to disease progression. With its high sensitivity, the draining method enables more accurate detection of these biomarkers, making it a reliable diagnostic tool for assessing periodontal status [20].

A study conducted by [21] stated that unstimulated saliva can serve as a valuable diagnostic fluid due to its sensitivity in detecting periodontal-related biomarkers. Building on this, unstimulated whole saliva demonstrates notable diagnostic potential for periodontitis detection. Several biomarkers—including alkaline phosphatase, osmolarity, lactoferrin, hemoglobin, and leukocytes—were found to be significantly elevated in periodontitis patients compared to healthy individuals. These findings suggest that unstimulated saliva, despite its lower volume compared to stimulated saliva, provides a more reliable reflection of inflammatory and biochemical changes associated with periodontal disease. Therefore, the collection of unstimulated saliva with the draining method may serve as an effective, non-invasive diagnostic approach for identifying periodontitis.

One of the main challenges in saliva-based diagnosis is the difficulty in detecting early-stage periodontitis (Stage I). This study, along with others, has demonstrated that biomarker-based screening methods cannot accurately distinguish between gingivitis and early-stage periodontitis. This is due to the characteristics of Stage I periodontitis, which exists in a transitional state between gingivitis and periodontitis, leading to lower biomarker levels compared to more severe stages [20].

A larger sample is collected, allowing for the detection of multiple biomarkers. The draining method has been proven to have high accuracy in detecting various salivary biomarkers, including interleukin-1 beta (IL-1β), matrix metalloproteinase-8 (MMP-8), pyridinoline cross-linked carboxyterminal telopeptide of type I collagen (ICTP), and *Porphyromonas gingivalis* (Pg) [20]. These biomarkers play a crucial role in distinguishing healthy individuals from those with periodontitis, as they reflect key pathological processes such as bacterial invasion, the body's inflammatory response, connective tissue degradation, and bone resorption. The ability of the draining method to effectively capture these biomarkers highlights its reliability as a non-invasive approach for diagnosing and monitoring periodontal disease.

The draining saliva method has also been shown to be more effective in detecting *Aggregatibacter actinomycetemcomitans* (one of the bacteria responsible for periodontitis) compared to the swab method. This is because the bacterium is detected simultaneously in multiple locations more commonly than in a single site alone [22].

4   Conclusion

Each method has its own advantages, disadvantages, and various results. The draining saliva method is more effective and accurate in diagnosing periodontitis compared to the buccal swab method.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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