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Guided Biofilm Therapy: A new horizon in periodontal care

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Abstract
Guided Biofilm Therapy (GPT) presents a novel approach for mechanical plaque control in periodontal therapy, which involves in detection of plaque by plaque detector agent, removal of supra-gingival and sub-gingival biofilm and stain by air abrasion, and finally (if required) scaling with a specially designed tip. The air polishing device removes plaque by directing a controlled jet of abrasive powder particle, compressed air and water onto tooth surface through a nozzle. This article aims to discuss the working principal, protocol, benefits, limitation and future scope of the technique in brief.

Keywords: Guided Biofilm Therapy (GBT), periodontal disease, air polishing

1. Introduction
Biofilm is a community of microorganism, which is attached to a substrate surface, and submerged into an extra-cellular slimy matrix [1]. It represents the predominant mode of existence of bacteria. It has been the major concern for chronic infectious diseases in human; as the microbial count, as well as composition, and the ecology in the biofilm determines the dynamics of health and disease [2].
Clinically, plaque presents as ‘a structured, resilient, yellow-greyish substance that tenaciously adheres to the intra-oral hard surface’ [3]. Plaque is composed of microbial micro-colonies, non-randomly distributed in a shaped matrix or glycocalyx. Hence, the dental plaque is an example of biofilm [4], which is widely found over both supra-gingival and sub-gingival tooth surface; and periodontal infection can be viewed as biofilm infection.
The current periodontal treatment plan begins with removing/reducing biofilm mechanically, which is achieved with manual, as well as ultra-sonic debridement, i.e. SRP (Scaling and Root Planning), referred to as ‘mechanical plaque control’ under ‘phase 1 therapy/Non-surgical periodontal therapy (NSPT)’.
Although SRP presents an economical, effective and universally practiced tool for plaque removal in periodontal therapy; pain, complications like sensitivity, compliance etc. have been the issues till date with SRP. In such context, Guided Biofilm Therapy (GBT), as single therapy, or adjunct to SRP, brings a novel approach in biofilm control, which largely overcomes the problems of conventional SRP.

2. Working Principle
Guided Biofilm Therapy (GPT) presents a novel approach for mechanical plaque control in periodontal therapy, which involves in detection of plaque by plaque detector agent, removal of supra-gingival and sub-gingival biofilm and stain by air abrasion, and finally (if required) scaling with a specially designed tip [5]. Figure 1 shows a GBT unit manufactured by EMS.
The steps of the protocol are explained here:
1. Application of plaque detector to make the plaque visible
2. Removal of supra-gingival biofilm and stain from teeth and implants using standard nozzle
3. Removal of sub-gingival plaque biofilm from deeper periodontal pockets around teeth and implants using sub-gingival nozzle

4. Minimally invasive scaling with specially designed tip for removal of calculus, if required
5. Reassessment, re-disclosing of plaque biofilm, and re-treatment, if required.

2.1 Polishing Device
Air polishing device removes plaque biofilm, soft deposits, extrinsic stains or tooth material effectively. Presently it is used for biofilm removal widely, though it was first designed for cavity preparation in 1945 [6]. The device performs by directing a controlled jet of abrasive powder particle, compressed air and water onto tooth surface through a nozzle.
Presently air polishers employ any one of the two working principle:

- **Venturi Chamber principle:** Where the mixture of air and abrasive powder is produced by a carburetor like machine, combined with a swirling action; and the mixture exits through the bottom of the chamber [7]. The amount of powder released through the hjchamber depends on the position of a slopping deflector cap that maintains a consistent flow of the powder.
- **Pressurized chamber:** Where compressed air is forced into the powder chamber, and the slurry exists though the chamber by swirling action [8]. The quantity of powder released through the chamber depends on the screw settings; and the flow of the powder is somehow inconsistent.

Currently air polishers have two sets of nozzles, which are separately designed for supra-gingival and sub-gingival use.

- **Supra-gingival nozzle:** These represent the standard nozzles, used for removal of plaque and stain from supra-gingival tooth surface and also sub-gingivally up to 4mm, angulated 120^0 for premolars and molars, and 90^0 for incisor and canines [9, 10]. Figure 3 shows *Airflow* used for supra-gingival area and up to 4mm sub-gingivally.
- **Sub-gingival nozzles:** These are specially designed for removal of sub-gingival plaque, as in management for deeper periodontal pockets and peri-implant-disease. For example, EMS Perioflow system features three outlets: two lateral and one terminal. The laterals release the abrasive powder, while terminal releases water. Other systems, as ACETON, uses two-outlet configuration [9, 10]. Figure 4 shows *Perioflow* used for sub-gingival area up to 9mm for teeth, and up to 3 mm for implant.

The design of the nozzle, like tube length, diameter, curvature and angulation, determines the clinical effectiveness of the polisher [11]. In addition, clinical factors like angulation, as well as distance between tooth surface and nozzle play important role here. The guidelines for application should be followed, because incorrect position of nozzle not only reduce clinical efficiency, but also harms soft tissues [12].

2.2 Polishing Powder
The abrasive powder is the core of air-polishing system. The finely grounded powder particle, propelled by a jet of compressed air and water, from the polishing device onto the tooth or implant surface, mechanically disrupt the biofilm, stain or soft deposits. Since 1970's, different abrasive powders have been used, including Sodium Bicarbonate ($NaHCO_3$), Erythritol, Glycine, Bio-active glass etc [13].
The cleaning effect of the abrasive depends upon factors like size of the particle, mass hardness and angularity of delivery [6 48]. Larger and harder and more angular crystal pattern, more effective is the powder. In addition, higher air pressure increases the effectiveness. The role of water in the effectiveness is debated, as some evidences suggest that water enhances the biofilm removal by flushing away embedded particles, while other argue that water reduces powder's impact by fragmenting the particle into smaller one.
Beyond their physical properties and clinical effectiveness, the chemical composition and safety profile of the abrasive agents are also a matter of concern. The most used agents are mentioned below:

2.3 Sodium Bicarbonate
This has large, angular crystal with higher abrasive quality [13]. Even it is effective on titanium surface [14, 15]. Water solubility makes it possible to use as slurry. As it is seen to alter tooth and even corrosive to restorative material surface [16], it is gradually replaced by other less abrasive alternatives.

2.4 Glycine
This has the shape similar to Sodium Bicarbonate, with particle size 45-60 µm, but the particles are smoother and almost 80% less abrasive than Sodium Bicarbonate, with poor water solubility. It is seen to result zero or minimal soft tissue as well as cementum trauma. Rarely untoward effects like air emphysema has been reported [17].

2.5 Erythritol
This is water soluble polyol (widely used as food additive) having known anti-microbial action [18]. It has smaller particle size (14-31 µm), offering low abrasiveness. Hence it produces a smoother dentine surface (Figure 5). It effectively disrupt plaque with no impact on soft tissues [19, 20].

2.6 Bio-active glass
This is silica-based bio-active particle with size 1-10µm. the uniformly shaped powder particles offers minimum abrasiveness with potent plaque removal effect. In addition, it is seen to release calcium, phosphate and silica ions, promoting re-mineralization [21]. Hence, it is well tolerated by sensitive patients.

3. Review of Literature
GBT, as an adjunct to scaling and planning, or as a single therapy, not only removes plaque biofilm, but also alters sub-gingival microbial flora. In 2012, Flemming *et al*. first showed that supra-gingival glycine powder air polishing significantly reduced total viable bacterial count in 30 patients with deep periodontal pockets, compared to SRP [22]. After that, Muller *et al*. (2014) reported significant reduction in f A. actinomycetemcomitas count in 50 patients after sub-gingival air polishing compared to ultra-sonic debridement [23]. Park *et al*. (2018) found significant reduction of P. gingivalis in patients treated with erythritol powder air-polishing as an adjunct to SRP, compared to SRP alone [24]. Reinhardt *et al*. (2019) and Jentsch *et al*. (2020) also found significant reduction of Red Complex microbiota with air polishing as adjunctive to NSPT [25, 26]. In addition, Reinhardt reported a marked decrease of MMP-8 also in test group, suggesting that GBT successfully limits the underlying disease process also.
Not only microbial count, but most of the research work reported significant improvement of clinical indices also with GBT. Hagi *et al*. (2015) observed reduction of PPD and BOP and increase in CAL with sub-gingival erythritol powder air polishing, compared to SRP [27]. Caygur *et al*. (2017) found similar results with glycine slurry also [28].

Significantly lesser pain and discomfort, and hence better patients' acceptability, are reported with GBT in different studies. Wennstrom *et al*. (2011) observed less 'perceived patient discomfort' with air polishing that ultrasonic debridement [29 11]. Again, Haggi *et al*. (2013) got similar result using Visual Analogue Scale [27 3].

GBT is reportedly being used in the management of peri-implant disease. Sahm *et al*. (2011) and John *et al*. (2015) showed significant improvement of bleeding in 30 and 25 peri-implant disease patients respectively using amino acid glycine powder air polishing over manual debridement using carbon curettes [30, 31]. Siene *et al*. (2015) reported significant improvement in probing depth in 30 patients. Lupi *et al*. (2017) observed similar results in 46 patients with 88 implants [32, 33]. Though studies by Al Ghazal (2017) and Ji. Y. J (2021) reported no significant difference between two modalities [34, 35].

Fig 1: The EMS-GBT System

Fig 2: EMS MAX PLUS Air Polishing Powder

Fig 3: EMS AIRFLOW for sub-gingival use

Fig 4: EMS *PERIOFLOW* for supra-gingival use

Fig 5: EMS PIEZON for residual scaling

4. Conclusion

As plaque represents the primary etiologic cause of periodontal infection, mechanical plaque control remains central to the non-surgical periodontal therapy, as well as in maintenance phase. As discussed, GBT presents a minimally invasive novel approach to professional plaque control using a jet of abrasive powder mixed with water, propelled by compressed air. Evidences show, both as an adjunct to SRP, or as a single therapy, GBT offers an effective biofilm removal solution with many befits over traditional ultra-sonic debridement; including minimal trauma, hence minimal pain and sensitivity, and excellent compliance; but the high-cost device still limits the use of the technology universally. In addition, its efficacy in treatment of peri-implant disease yet demands improvement. Furthermore, systemic impact of the abrasive powder isn't well studied.

Considering all existing evidences, this can be concluded that GBT opens a promising, yet unexplored avenue in the field of periodontal care, which till requires further research and development.

Conflict of Interest
Not available

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Not available

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