ORIGINAL RESEARCH PAPER

Volume - 9 | Issue - 6 | June - 2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

A NOVEL CHEMICO-MECHANICAL TECHNIQUE OF HAND SCALING – A CLINICAL AND SCANNING ELECTRON MICROSCOPIC (SEM) EVALUATION

Periodontology

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ABSTRACT

Background— Hand Scaling is cumbersome for both patient and operator. To make this process comfortable and effortless, the use of a calculus softening agent (CSA) prior to hand scaling has been advocated.

Methods— The CSA was applied onto the calculus on the lingual surfaces of mandibular anterior teeth-Group A: (41 to 43) & Group B (31 to 33). A Visual Analogue Scale (VAS) recorded the response from patient and operator. A SEM scan of the calculus surface and cut surface was performed.

Results— Statistically significant operator effort reduction and patient comfort (p=0) in CSA areas. SEM scans demonstrate surface pores and penetration of CSA through the calculus mass, weakening its attachment.

Conclusion— CSA combines the advantages of plaque removal, softening calculus and hand scaling with comfort to the patient and operator.

KEYWORDS

Scaling and root planing, Calculus, SEM Imaging, Non-surgical

Introduction

Dental calculus provides a rough surface for plaque retention contributing to chronic inflammatory periodontal disease.[1] Removal of calculus by hand/ power driven scaling and root planing (SRP) is an essential component of periodontal therapy.[4]

Although considered gold standard, the use of hand instruments can prove to be fatiguing, time-consuming and often uncomfortable for both patients and clinicians. Uncontrolled forces may lead to unintentional sequelae such as roughness, gouges, uneven tooth surfaces and unwarranted haemorrhage.[5,6]

Hand-scaling results in smooth root surfaces thus reducing plaque retention when compared with ultrasonic scaling.[10]

As the world faces COVID-19 challenge, dentists need to minimize the generation of aerosols in operatory. Efforts to address this issue include use of hand instruments for common procedures like SRP that significantly reduces aerosol production[7,8]

The use of a novel CSA(Phoenix Dental Inc. Fenton MI. 48430, USA), which claims to soften calculus, increase our instrumentation efficacy and patient acceptance and lessen operator hand fatigue was tested clinically and Scanning Electron Microscopy (SEM) scan.

Materials and Methods

The study design was a split mouth, single blind (investigator blinded) randomised study with 40-subjects (22 males,18-females). Participants were excluded if they had any systemic disorder, had any missing teeth among the 6-mandibular anterior teeth or had received oral prophylaxis within the previous 6-months.

The novel CSA contains an organic carboxylic acid with pH of 1.7 in an aqueous base with ferric chloride for astringent properties. The CSA can be dispensed in a plastic/ glass container and applied with applicator tips.

After visual examination an informed consent was recorded from the patient. The same operator, investigator and assistant (post graduate students) conducted the study. Patients were randomised into Group A (CSA was applied on the calculus deposits of lingual surfaces of 31, 32, 33) and Group B (CSA was applied on the calculus deposits of lingual surfaces of 41, 42, 43).

After thorough isolation the assistant applied the CSA(operator blinded) to designated area. After 15 seconds, the operator performed hand scaling of area. Investigator recorded patient comfort and operator effort on VAS.

Figure 1 : Chemico-Mechanical hand scaling technique

1A: Pre-scaling
1B: Isolation & application of CSA
1C: Hand scaling - 15-30 Scaler (Hufriedy)
1D: Post hand scaling

Visual Analogue Scale (VAS)

A: VAS for assessment of Efforts
B: VAS for assessment of Patient Discomfort

SEM Evaluation

Ten mandibular anterior teeth with a band of calculus and Grade III mobility as previously indicated for extraction due to a hopeless periodontal prognosis, were carefully extracted and scanned. Later another scan was done post CSA application. The calculus was then removed using a hand scaler and cut in-half and cut surface was scanned for penetration of CSA into the calculus.

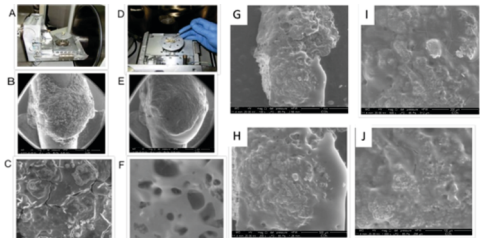

Figure 2 : Scanning electron microscopy(SEM) scan with and without Cal Sol application

2A: Specimen of tooth with calculus in SEM machine
2B: 37x - Irregular surface topography
2C: 500x - Cracks on calculus surface
2D: CSA application
2E: 37x - tiny black spots on a relatively uniform surface of calculus
2F: 500x - the black spots are pores on the surface having typical honeycomb like appearance
2G: 100x cut section of calculus showing CSA coating the surface and entering inside
2H: 200x ingress of CSA in calculus
2I: 500x CSA in areas around cracks and fissures of calculus surface
2J: 1000x surface pores and cracks and solution surrounding these areas

RESULTS

The study evaluated effect of CSA on calculus for hand scaling procedure.

Baseline conditions of all patients were similar allowing the post therapy values to be compared. The data is non-parametric with comparisons between matched samples. Hence the non-parametric test -Wilcoxan rank/sum test was chosen for statistical analysis.

A 95% confidence interval was constructed for the proportion of times this choice corresponded to the test product side. Alpha was set at 0.05.

Recorded Operator comfort

The distribution is approximately normal, therefore, the Z value of -5.3731 was used. The result is significant at the p-value equal to 0; $p \leq 0.05$.

Recorded Patient discomfort experienced during the hand scaling procedure

The distribution is approximately normal. Therefore, the Z value of -5.2788 was used. the p-value is 0. The result is significant at $p \leq 0.05$ (Table 1).

Table 1 : Analysis of Data

	Operators comfort	Discomfort experienced by the patients
W value	0	6.5
Mean Difference	-1.11	0.37
Sum of Positive ranks	0	6.5
Sum of negative ranks	741	734.5
Z value	-5.3731	-5.2788
Mean (W)	370.5	370.5
Standard Deviation (W)	68.95	68.95

Comparison of mean VAS values show a marked reduction in VAS scores with respect to both, patient discomfort and operator efforts on the CSA application side (Figure 3).

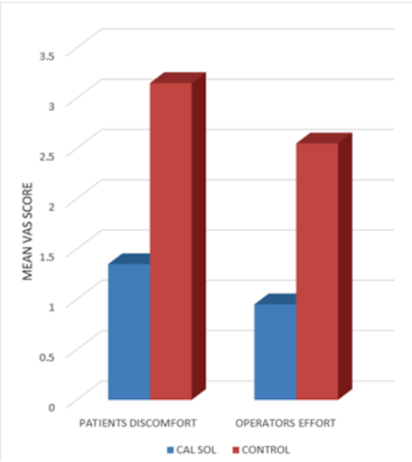

Figure 3 : Comparison of mean VAS scores of Patient's discomfort and Operator efforts.

SEM analysis

At 37x magnification calculus deposits demonstrated pits and roughened surface (Fig 2B). On CSA application presence of dark circular voids appeared in regions of pits (Fig 2E).

The 500x magnification the cracks and pits on surface (Figure 2C) were seen as dark circular voids and pores in the calculus mass resembling a honeycomb (Figure 2F).

The cut section scan shows the seepage of the solution inside the calculus matrix traversing the entire thickness (Figure 2G-H). Higher magnification shows the solution present in areas of cracks and holes within the calculus matrix (Figure 2I-J).

DISCUSSION

Early researchers postulated that tooth structure damage caused by improper instrumentation could be minimized if a satisfactory calculus removing product could be developed.[9]

The split mouth design of this study has the advantage of cases that provided their own controls, which decreased the inter-subject variability. Also, the operator was blinded to prevent any bias on effort for scaling from the operator's side. The test area corresponded with the site for greatest accumulation of supragingival calculus[17] where deposition is generally symmetrical[18]

The use of citric acid - advocated for root conditioning at pH 1- has shown effective debris removal and connective tissue attachment, especially at the root-calculus interface[19]. Also, the surface showed characteristic layered-like to honeycomb appearance. Similar patterns were seen in this study.

A CSA would allow less pressure to be exerted against the tooth surface, therefore, reducing undesirable side effects. The process of chemically facilitating hand instrumentation would also lessen operator hand fatigue and make the instrumentation procedure more acceptable to patients.

Study design limitations were considered and controlled for, but could not be completely eliminated. No harmful morphological changes were observed, either to the soft tissues initially or during healing or to the tooth surface itself. As there are differences between supragingival and subgingival calculus, it may not be possible to anticipate the same results on subgingival calculus.

The SEM analysis depicts significant alteration of calculus surface. The dark halos seen in low magnification actually were seen as small holes in higher magnification This confirms CSA penetration inside the calculus along the organic layers weakening the calculus architecture and aiding its effortless removal.

The uncontrolled variant such as force used during instrumentation was accounted for by keeping the same operator while also blinding the operator as to the CSA placement. In addition, the force applied corresponded to the operators effort during hand scaling was a parameter that was evaluated. Patient variables like the mineral content of calculus, the time since it formed, mouth opening, salivary flow, tooth morphology were accounted for by using a split mouth design. The limitations of the study include a small sample size, which increased the chances of Type II error. As the subgingival calculus presents different composition and various anatomic challenges, results of this study should be extrapolated to subgingival calculus deposition area with caution.

Within the limitations of the study, the results conclusively show the softening action of CSA after topical application to human calculus. The SEM analysis demonstrates the mechanism by which this effect was seen. The authors support the novel chemico-mechanical technique and use of CSA for hand scaling.

ACKNOWLEDGEMENTS

The authors acknowledge Dr. C. F. Cox, Phoenix Dental Inc., MI. for providing the CSA samples for this study. The authors also acknowledge ICON Analytical Equipment Pvt. Ltd. for SEM scans. There were no conflicts of interest of any of the authors regarding the same.

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