COMPARATIVE EVALUATION OF TOOTH SURFACE MORPHOLOGY USING PIEZOELECTRIC SCALER V/S SONIC SCALER – AN IN VITRO SCANNING ELECTRON MICROSCOPE STUDY

DISSERTATION

Submitted to

BABU BANARASI DAS UNIVERSITY,

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In the partial fulfilment of the requirements for the degree

of

MASTER OF DENTAL SURGERY

in

PERIODONTOLOGY

By

Dr RAHUL ANAND

Under the guidance of

Dr MONA SHARMA

PROFESSOR AND HEAD

Batch 2020-2023

Year of submission 2023

Enrolment no: 1200328003

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled " **COMPARATIVE EVALUATION OF TOOTH SURFACE MORPHOLOGY USING PIEZOELECTRIC SCALER V/S SONIC SCALER – AN IN VITRO SCANNING ELECTRON MICROSCOPE STUDY** " is a bonafide and genuine research work carried out by me under the guidance of **Dr MONA SHARMA,** Professor and Head, Department of Periodontology, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

Date: 15/02/2023

Place: Lucknow

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Dr RAHUL ANAND

CERTIFICATE BY THE GUIDE

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I hereby declare that the **Babu Banarasi Das University** shall have the right to preserve, use and disseminate this dissertation in print or electronic format for academic/research purpose.

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Dr Rahul Anand

DEDICATED TO MY FAMILY

Acknowledgement

"Whatever is not obtained from the Guru, cannot be obtained from elsewhere. With the grace of the Guru one indeed gets everything".

I owe my deepest gratitude to my guide ***Dr.Mona Sharma****, M.D.S. Professor and Head, Department of Periodontology, Babu Banarasi Das College of Dental Sciences, Lucknow, who patiently provided the vision, advice and encouragement necessary for me to proceed through and complete my dissertation. Her vast knowledge and ability to achieve excellence has proved to be very valuable throughout. Thank you, ma'am, for the inspiration and always believing in me, even when sometimes I didn't believe in myself. I have learned many things from her which I cannot express. It's like a deep ocean. She made me a better, more thoughtful person and helped me see that I can be more. I am grateful to her for shaping me into who I am now. Her keen surveillance and unflinching support has made this dissertation possible.*

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Last but not the least, I thank the Almighty ***"God"*** *without whose blessings I would not have made it up to here.*

Dr Rahul Anand

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LIST OF ABBREVIATIONS

et al.	et alia (And others)
FESEM	Field emission scanning electron microscope
LTSI	Loss of Tooth Substance Index
Mm	Millimetre
Nm	Nanometre
NSPT	Non-Surgical Periodontal Therapy
Pa	Pascal
Pd	Palladium
Pt	Platinum
Pvt.Ltd.	Private and limited
RCI	Remaining Calculus Index
RTLSI	Roughness Loss of Tooth Substance Index
SEM	Scanning Electron Microscopy
SRP	Scaling and Root Planing

Abstract: -

In order to achieve a biologically acceptable root surface and maintain the healthy tooth surfaces, the initial step in periodontal treatment is to remove bacterial deposits and calculus from the tooth surfaces. The degree of root surface roughness during scaling and root planing is a point to consider for maintenance because it has been discovered that bacterial plaque attaches easily to the rough root surfaces after treatment. Our study was to compare tooth surface morphology using piezoelectric scaler and sonic scaler this was a in vitro SEM study. The objectives of the study was to assess the tooth surface roughness produced by sonic scaler and ultrasonic scaler and to compare both. Roughness Loss of Tooth Substance Index (RLTSI) and Remaining Calculus Index (RCI) scoring criteria were used. The study was conducted on the extracted teeth which were later mounted on the ideal edentulous casts. All the four quadrants were assigned randomly to avoid bias. After the procedure all the samples of both the groups were sagitally segmented for the SEM analysis.In this present in vitro study of comparison between two devices sonic and piezoelectric we can conclude that both the devices used for scaling were effective in mechanical debridement but after analyzing the SEM images of tooth surface it was clear that Group A samples where scaling was performed with piezoelectric ultrasonic scaler the surfaces were much more smooth when compared with Group B surfaces where scaling was done with sonic scaler. After observing the SEM images, it was clear that there were less amounts of calculus depositsseen in Group A than in Group B.

INTRODUCTION

In order to achieve a biologically acceptable root surface and maintain the healthy tooth surfaces, the initial step in periodontal treatment is to remove bacterial deposits and calculus from the tooth surfaces.

Basic periodontal therapy aims to eliminate supra- and subgingival plaque, which will enable efficient self-performed plaque management[1].

The degree of root surface roughness during scaling and root planing is a criterion to consider for maintenance because it has been discovered that bacterial plaque attaches easily to the rough root surfaces after treatment [2,3].

In the past, handheld equipment were generally used to achieve this goal till sonic and ultrasonic (sickle, curettes, chisel, files, and hoes) Scalers were created for general scaling and supragingival removal of stains and calculus[4].

Since the 1950s, researchers have examined the use of ultrasonic and sonic scalers in periodontal therapy. These devices have demonstrated a number of benefits, including decreased instrumentation time per tooth[5], and improved accessibility in furcation defects[6].

Power-driven scalers include sonic and ultrasonic scalers. Vibrations with frequencies between 25000 and 42000 Hz are produced by the oscillation generator's high vibrational energy being transferred to the scaler tip. The amplitude is in the 10 to 100 μm range. Under cooling water, microvibration breaks and eliminates calculus[3]. The effectiveness of ultrasonic and sonic scalers in eliminating calculus from the tooth surfaces varies[7].

Ultrasonic scalers convert electrical energy into mechanical energy thereby dislodging calculus from the tooth surface. When electricity passes over the surface of crystals stored inside the hand-piece, the dimensional changes in the crystals cause the piezoelectric units, which work in the 25 000–50 000 Cps range, to reactivate. Tip movement that is predominantly linear in direction is produced by the ensuing vibration[8,9].

Sonic scaler known as air-turbine devices run at low frequencies between 3000 and 8000 cycles per second (Cps). Tip movement is primarily orbital and is based on a simple, inexpensive mechanism[7]. As a result of the release of air pressure required for movement of tip sonic scalers have a high intensity noise level. However, these sonic scalers are an inexpensive armamentarium in the dental practice, can be mounted on the air rotor attachment of the dental chair, making it convenient to use[10].

The objective outcome of periodontal instrumentation is to remove plaque and calculus efficiently without damaging the surface of the tooth.

Both the types of scalers ultrasonic and sonic offer a straightforward and affordable technique.

Hence in the current in vitro study, a comparison was made to check for any surface irregularities produced by sonic and ultrasonic scalers on tooth surface established by scanning electron microscope.

Aim & Objectives of the study:

AIM: -

To evaluate and compare the surface roughness of teeth using ultrasonic and sonic scalers

OBJECTIVES: -

1. To assess the tooth surface roughness and flakes of remaining calculus after scaling by sonic scaler.

2. To assess tooth surface roughness and flakes of remaining calculus after scaling by ultrasonic scaler.

3. To make a comparison of tooth surface roughness and remaining calculus after scaling by ultrasonic and sonic scalers.

Review of literature:

Lie T, Leknes KN (1985)[11]in this study three air turbine scalers were compared to each other and to an ultrasonic instrument (CAVITRON®) on medium and maximum power setting. The amount of remaining calculus, roughness and loss of tooth substance were estimated by means of well-defined index systems (RCI and RLTSI).The results revealed significant differences between the instruments with respect to the amount of remaining calculus. There were also significant differences between roughness and loss of tooth substance produced by CAVITRON® at maximum power setting and that produced by the other instruments. No differences were found with regard to the time required to clean the test surface

Jotikasthira NE, Lie T and Leknes KN (1992)[12]conducted a study onflat root surface areas of formalin-stored mandibular incisors withplaque and calculus were scaled by sonic or ultrasonic instruments or by a new reciprocatingscaling insert for the EVA/PROFIN system. The test areas were photographedby SEM and coded micrographs were independently graded by threeexaminers using the RCI (Remaining Calculus Index) and the RLTSl (RoughnessLoss of Tooth Substance Index). The findings revealed that the sonic scalers as agroup removed calculus more completely but also left significantly more roughnessand loss of tooth substance than the other instruments tested. The reciprocating insert gave resultssimilar to those of the ultrasonic.

Schenk G, Flemmig TF, Lob S, Ruckdeschel G, Hickel R (2000)[13]conducted a study to assess the antimicrobial effects of a sonic and ultrasonic scaler generally used for subgingival scaling on gram negative and gram-positive periodontopathic bacteria.The assessed sonic scaler and themagnetostrictive ultrasonic scaler usedfor subgingival scaling did not showany bactericidal effect on A. actinomycetemcomitansP. gingivalis, C. rectus,and P. micros in vitro. Therefore,the results of the studyindicated that the clinical efficacy of sonicand ultrasonic scalers is primarily dueto the mechanical removal of subgingivalplaque.

Busslinger A, Lampe K, Beuchat M, Lehmann B. A (2001)[14]They compared a magnetostrictive ultrasonic scaling instrument with a piezoelectric ultrasonic scaling instrument and a handcurette regarding time taken, calculus removal, tooth surface roughness, and SEM examination before and after instrumentation.They concluded that piezoelectric ultrasonic scaler was more efficient than the magnetostrictive ultrasonic scaler in removing calculus but left the instrumentedtooth surface rougher.

Kocher T, Langenbeck N, Rosin M, Bernhardt O(2002)[15]The purpose of thisstudy was to describe the conditions and requirements for the three-dimensional roughness measurements of tooth roots using a laser profilometer. They conclude that roughness values are strongly dependent on the measurement conditions and the results of one study cannot be directly compared to another. In addition, it was found that two-dimensional measurements are sufficient for characterizing root surfaces

Petersilka GJ, Draenert M, Mehl A, Hickel R, Flemmig TF (2003)[16]conducted a study to evaluate a novel sonic scaler tip for subgingival root surface instrumentation combining high efficiency in calculus removal with minimized risk of root damage through subgingival debridement. They concluded that the novel scaler tip appears to be significantly more efficient in calculusremoval and less damaging to the root surface than the assessed conventional tip.

Obeid PR, D'Hoore W, Bercy P (2004)[17]conducted astudy to evaluate in vivo the effectiveness of scaling androot planing of a power-driven mechanism (ultrasonic and sonic scaler) compared with hand instrumentswith a split-mouth design after 3 and 6 months.They concluded that mechanized root planing with power-driven instruments, as effective as the usual procedures (hand and sonic instruments), represents a satisfactory and alternativemeans of nonsurgical root therapy.

Ribeiro fv, CasarinRC, NocitiJúnior FH, SallumEA, SallumAW, CasatiMZ (2006)[18]

They conducted comparative in vitro study of root roughness after instrumentation withultrasonic and diamond tip sonic scaler. They concluded that diamond-coated sonic tips and ultrasonic universal tipsproduce a similarroughness surface that is higher than thatproduced by hand curettes.

Santos FA et al (2007)[19]conducted study to investigate the effectiveness of different ultrasonic instruments on the root surface. Fourteen patients with 35 single root teethdesignated for extraction were recruited to the present study. Teeth were assigned to four experimental groups: group 1, piezoelectric ultrasonic device; group 2, magnetostrictiveultrasonic device; group 3, hand instrumentation; and group 4, untreated teeth (control). After instrumentation, the teeth were extracted and the presence of residual deposits (roughness and root surfaces characteristics) were analyzed.SEM analysis revealed a similar root surface pattern for the ultrasonic devices, but curettes showed many instrumental scratches

Arabaci T, Çiçek Y, Canakçi CF (2007)[20]they reviewed the safety, efficacy, role and deleterious side-effects of sonic and ultrasonic scalers in mechanical periodontal therapy.

Derdilopoulou FV, Nonhoff J, Neumann K, Kielbassa AM (2007)[21]they compared the microbiological effects of hand instruments, Er:YAG-laser, sonic, and ultrasonic scalers in patients with chronic periodontitis. They concluded that the four nonsurgical treatment modalities – curettes, Er:YAG laser, sonic, and ultrasonic scalers resulted in a significant reduction of the amounts and prevalence of the periodontal pathogens 3 months after therapy. Six months after active periodontal therapy, the amount of bacteria increased again to a varying extent in each treatment group and for each species.

Casarin RC, Ribeiro FV, Sallum AW, Sallum EA, Nociti-Jr FH, CasatiMZ(2009)[22]They evaluated the root surface defect produced by hand curettes and ultrasonic tips with different power settings. Forty root surfaces were divided into 4 groups according the treatment: Gracey curettes, ultrasonic scaler at 10% power, ultrasonic scaler at 50% power and ultrasonic scaler at 100% power**.**They concluded that ultrasonic instrumentation produced a similar defect depth to that of hand instrumentation, with a smaller contact area between the instrument andthe root surface, independently of the power setting used for scaling.

Yousefimanesh H, Robati M, Kadkhodazadeh M, Molla R. A (2012)[23]Their study revealed that applying a piezoelectric scaler with 200 g of lateral force leaves smoother surfaces than a magnetostrictive device with the same lateral force. FORCES

Kumar P, Sonowal ST. Scaler Tip Design and Root Surface Roughness (2015)[24]They evaluated the effects of different ultrasonic tip design on root surface roughness post scaling. They concluded that large surface universal ultrasonic tips produce a more rough surface on the root surface than a thin probe type of tip. It means roughness on the root surface is inversely proportional to the surface area of the scaler tips

Kumar P, Das SJ, Sonowal ST, Chawla J (2015)[25]They compared the root surface roughness after root planing performed with gracey curette and by ultrasonic scalers (Satelec P-5 Booster) set at different power modes. They concluded that the mean roughness was found to be the highest in group where Scaling and Root Planing was performed using ultrasonic scaler at low power mode whereas the lowest surface roughness was seen on the samples where SRP was performed using ultrasonic scaler at medium power mode. The surface roughness in group where SRP was performed with ultrasonic scaler at high power mode was found to be similar to that of group in which root planing was carried out using curette

Vengatachalapathi H, Naik R, Rao R, Venugopal R, Nichani AS (2017)[26]Their study aimed to evaluate the influence of scaler tip wear and different working parameters, i.e., lateral force, power setting and tip angulation, on the roughness of root surfaces following treatment with piezoelectric ultrasonic scaling devices. Their study highlighted that scaler tip wear strongly influences the root surface roughness when used at higher tip angulation, lateral force and power settings.

Al Ankily M, Makkeyah F, Bakr M, Shamel M (2020)[27]Their study investigated the effects of hand and ultrasonic instruments made of stainless steel and titanium on the surface properties of enamel. They concluded that Scaling using ultrasonic stainless steel tips produced the least amount of surface roughness and damage, whereas titanium curettes and tips produced more aggressive changes on the enamel surface in vitro.

Muniz FW (2020)[28]systemically review the literature on the effect of hand and sonic/ultrasonic instruments used for the non-surgical treatment of periodontitis. They concluded that periodontal treatment performed with hand and sonic/ultrasonic instruments may have similar results.

Mahiroglu MB, Kahramanoglu E, Ay M, Kuru L, Agrali OB (2020)[29]**:** Their study was to compare the root surface wear and roughness, resulted from the professional dental hygiene instruments, including ultrasonic dental scalers, rubber prophy cups, and nylon bristle brushes, on the extracted human mandibular incisor teeth. They conclude that magnetostrictive and piezoelectric ultrasonic scalers result in similar wear and roughness effects on root surfaces when used under the same conditions. Changes in the application parameters of ultrasonic scalers may lead to significant differences in their impacts on root surfaces. They observed that, under the same time period, the change in the power setting parameter has a more significant effect than the change in the angle, especially on roughness results.

KARACA EÖ, TUNAR OL (2021)[30]They evaluated the profilometric evaluation of the changes in root surface roughness created by different types of ultrasonic tips and mechanism of action. They concluded that the root surface roughness with the investigated ultrasonic system significantly depends on the selection of handpieces and tips. Within the limits of this study, fine and delicate tips with linear oscillating movement may be considered as the choice of insert for subgingival instrumentation due to the gentler mechanism of action than the conventional ultrasonic scalers.

MATERIALS AND METHODS: -

This study was done at the Birbal Sahni Institute of Palaeosciences Research Institute and the Department of Periodontology of BBDCODS, BBDU, Lucknow. 30 teeth with Grade II and Grade III mobility that were periodontally compromised were extracted.

Inclusion criteria: -

1. Grade II or Grade III mobile teeth extracted in patients suffering from chronic periodontitis.

Exclusion criteria:

1. Fractured teeth indicated for extraction.

ARMAMENTARIUM: -

- Mouth mirror
- UNC 15 periodontal probe
- Tweezer
- Explorer
- Extracted teeth
- Piezoelectric scaler (Woodpecker DTE D3) ™
- Sonic scaler (Waldent air scaler) ™
- Micromotor with straight hand piece
- Disc bur
- Scanning Electron Microscope (JEOL JSM 7610f)

Study Design:

The research was conducted at the Department of Periodontology, BBDCODS, BBDU, Lucknow.

30 freshly extracted teeth with supra and sub gingival calculus were collected. Each tooth was thoroughly rinsed under tap water and was brushed lightly with a soft bristle tooth brush for a minute to remove any blood or food debris and was stored in 0.9 % saline.

The samples collected were randomly assigned to two groups namely,

1. Group A- 15 extracted teeth where scaling and root planing was done by ultrasonic scaler.
2. Group B- 15 extracted teeth where scaling and root planing was done by sonic scaler.

The extracted teeth were then mounted on edentulous casts with the help of modelling wax and the arch was randomly divided into two groups as mentioned above. The quadrant were assigned to sonic and ultrasonic scaling by randomization (chit system) to eliminate any bias 1st and 3rd quadrant was scaled by sonic scaler and 2nd and 4th quadrant with ultrasonic scaler. After scaling and root planing tooth surfaces were made smooth and calculus free.

After SRP, all 30 samples were sagittally segmented using a micromotor device and disc bur. The samples were stored in separate saline bottles marked Group A and Group B. The samples were then scanned under a scanning electron microscope (SEM) after air drying.

The SEM study was carried out in Birbal Sahni Institute of Palaeosciences Research Institute, Lucknow.

Scanning Electron Microscope Procedure -:

To endure a high vacuum, the samples were fully dried (10-5 Pa). For the purpose of mounting samples, the side opposite the site of interest was flattened. Double-sided adhesive tape was used to attach the samples to a metallic mounting stub that was approximately 12.0 mm × 12.0 mm in size. Once the samples were in the sputter coater, they were all automatically coated with a thin layer metal palladium and platinum alloy coating (Pt/Pd) which is a conductive metal that ranged in thickness from 20 nm to 30 nm. The coating was applied to the specimen to boost conductivity in the SEM and prevent the accumulation of high voltage charges on the specimen.

The samples were then taken out of the sputter coater and examined with a field emission electron scanning microscope (FESEM) (JEOL JSM 76610f, JEOL India Pvt. Ltd.). Once more, each sample was mounted on a 12.0 mm × 12.0 mm stub holder and fastened with a tight screw. The electron beam was then directed through a series of coil-shaped electromagnets in place of the FESE microscope's lenses while the sample was kept in a vacuum chamber. As a result, the image created in this way was viewed as a TV image or as a photograph. The purpose of keeping the sample in vacuum was, since electron travel faster in vacuum this helps in creating the photograph or the image. The whole surface of each specimen in Groups A and B was scanned to obtain a comprehensive understanding of the surface topography of each specimen.

The scaled area was subsequently investigated through SEM, and a number of indices were determined. For each surface, pictures were obtained at 50x, 200x, 500x and 2000x magnification.

50x magnified images were used to assess the indices as it provided a larger area for the observation of the surfaces.

Roughness Loss of Tooth Substance Index (RLTSI) given by Lie and Leknesin 1985

The micro surface roughness on the tooth surface was evaluated visually with SEM photographic prints at magnification 50x& 200x. Scoring criteria is as follows;

0: Smooth and even surfaces or slightly roughened, but without signs of instrumental marks.

1: Mostly slightly roughened areas with some corrugated regions but no obvious Instrumental marks.

2: Definitely corrugated areas and some instrumental marks, but also relatively even areas.

3: Definitely corrugated surface with instrumental scratches over most of the areas.

Remaining Calculus Index (RCI) given by Meyer and Lie in 1977

The amount of remaining calculus was evaluated visually with SEM photographic prints at magnification 50x. Scoring criteria is as follows;

0: No calculus remaining on the root surface

1: Small patches of extraneous material, probably consisting of calculus

2: Definite patches of calculus confined to smaller areas

3: Considerable amounts of remaining calculus, appearing as one or a few voluminous patches or as several smaller patches scattered on the treated surface.

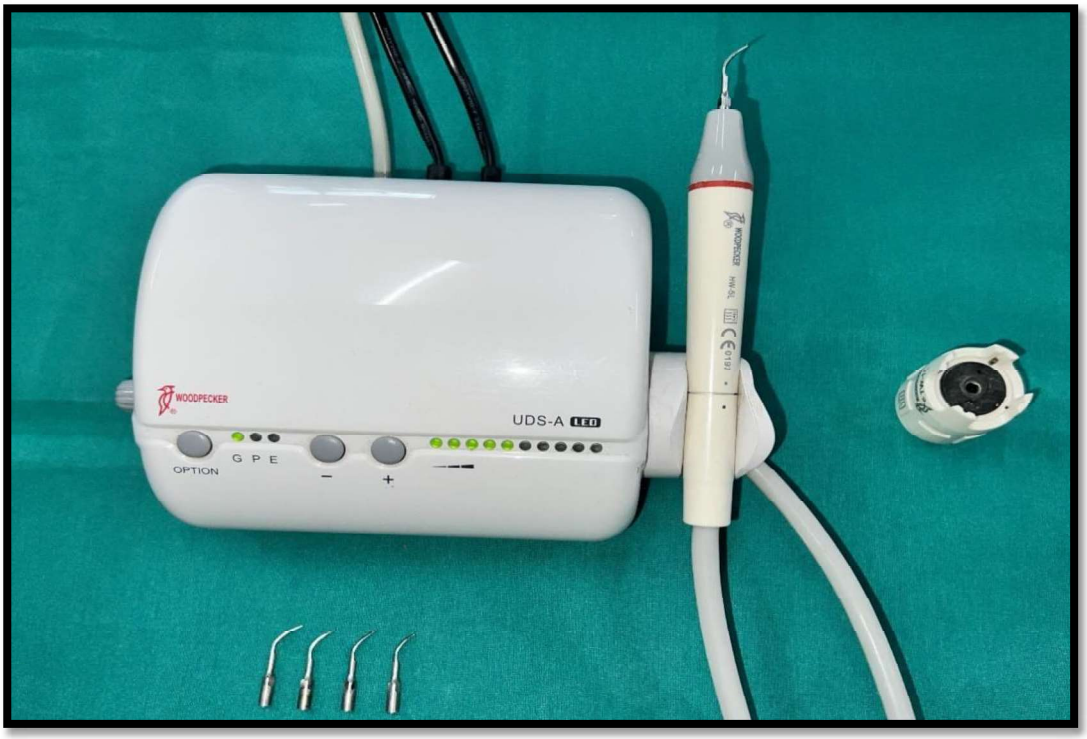


Fig 1: Group A- Piezoelectric ultrasonic device

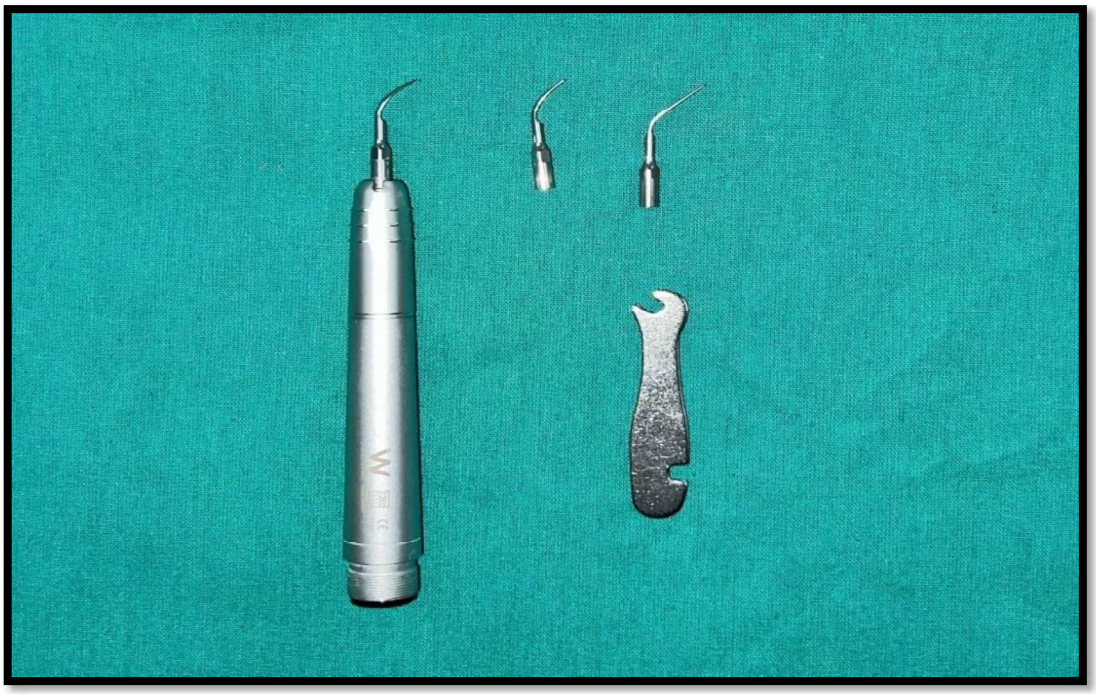


Fig 2: Group B- Sonic scaler device

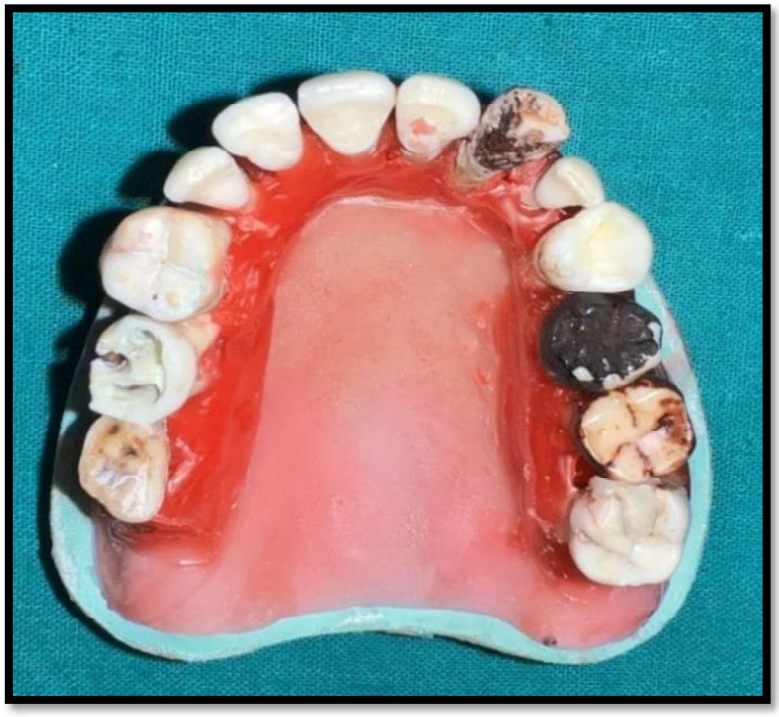


Fig3: Extracted teeth are arranged on the maxillary ideal cast

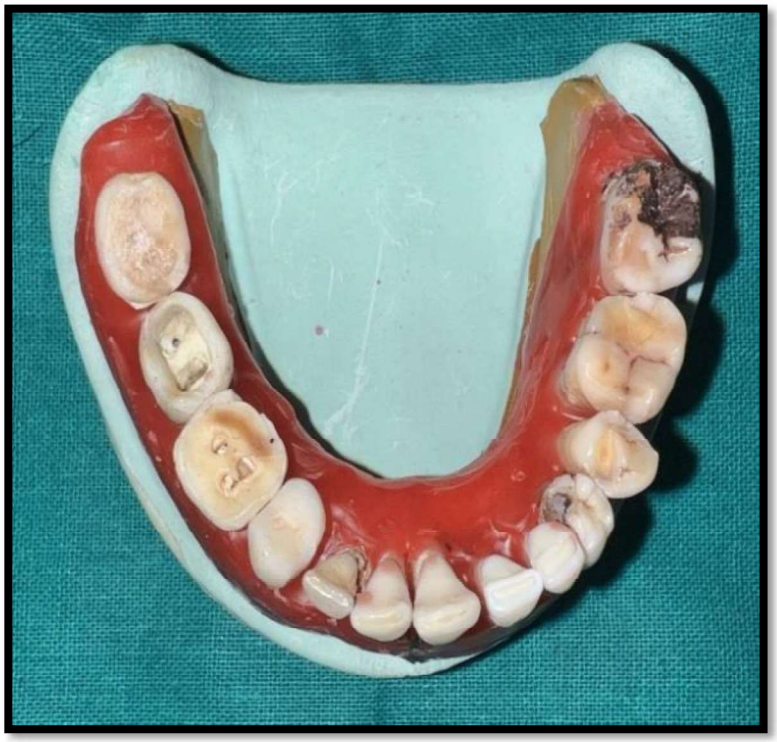


Fig 4: Extracted teeth are arranged on the mandibular ideal cast

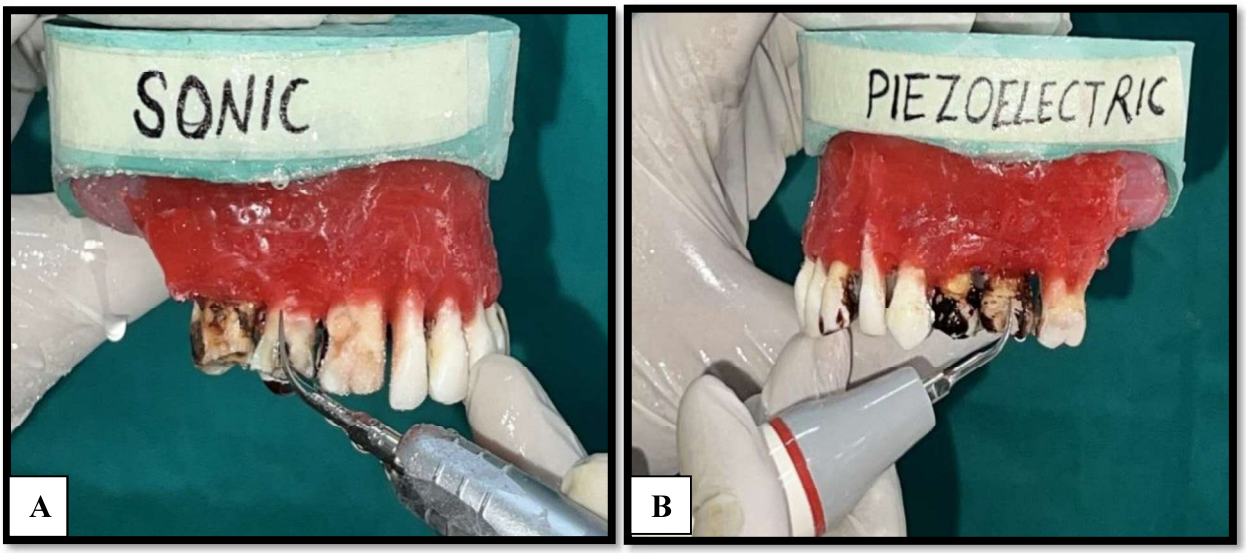


Fig 5: Scaling procedure performed in 1st quadrant with sonic scaler (A) and 2nd quadrant with piezoelectric ultrasonic scaler (B) in maxilla.

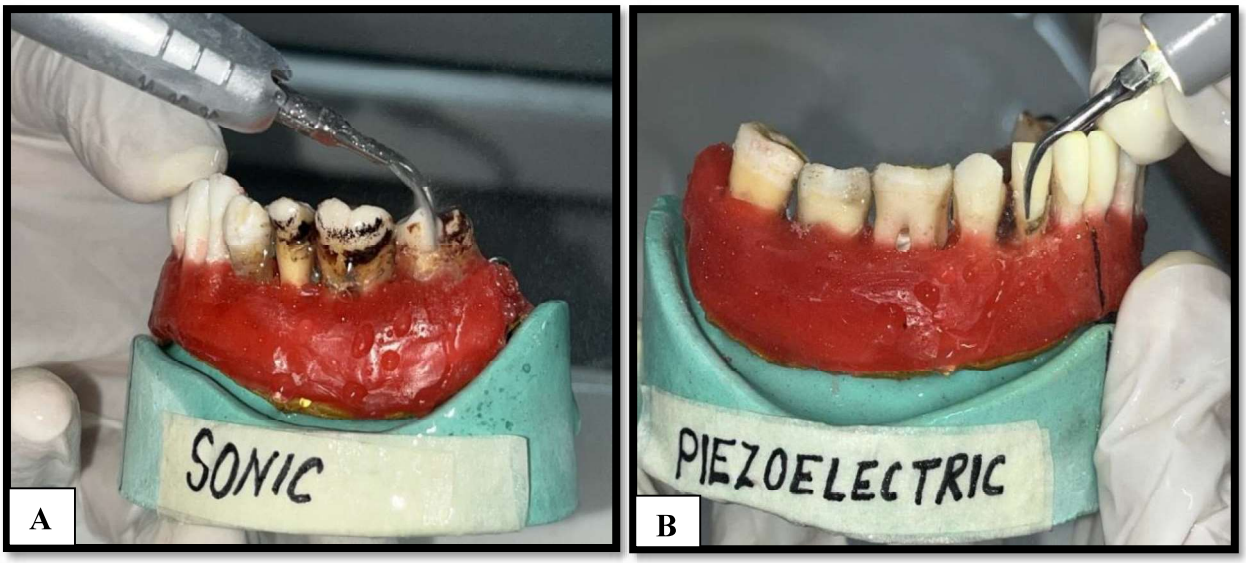


Fig 6:Scaling procedure performed in 3rd quadrant with sonic scaler (A) and 4th quadrant with piezoelectric ultrasonic scaler in mandible (B).

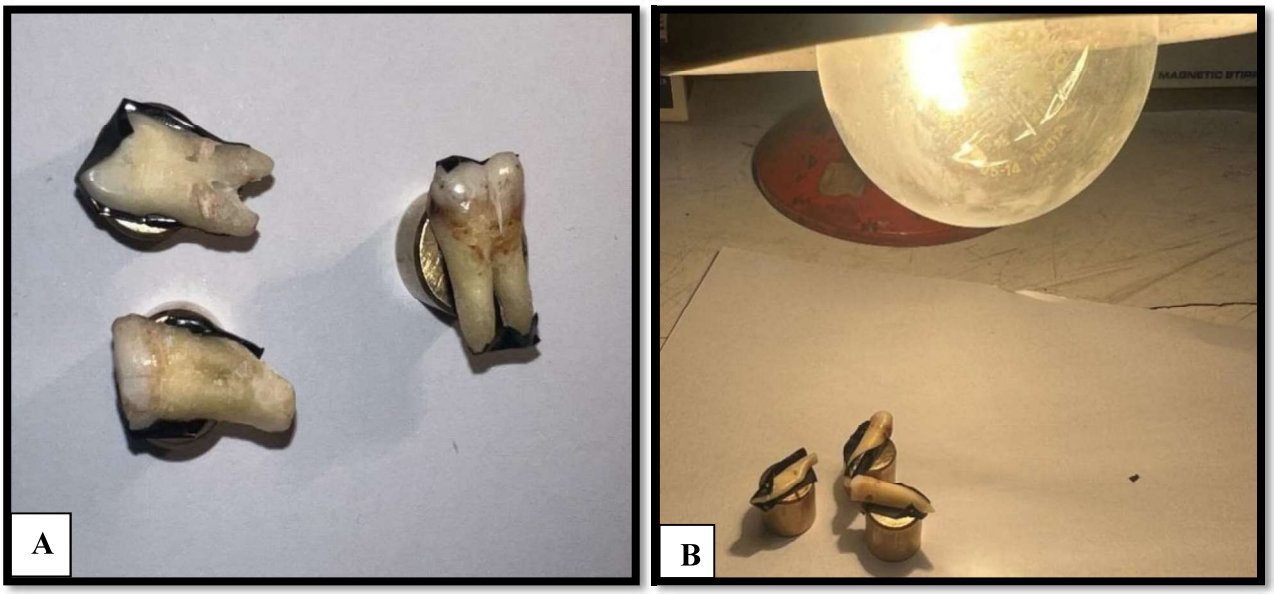


Fig 7:(A) Samples were mounted on the stub and were made stable with double sided tape. (B)Samples left for drying to remove any moisture

Fig 8: Sputter coater machine

Fig 9: Field Emission Scanning Electron Microscopy

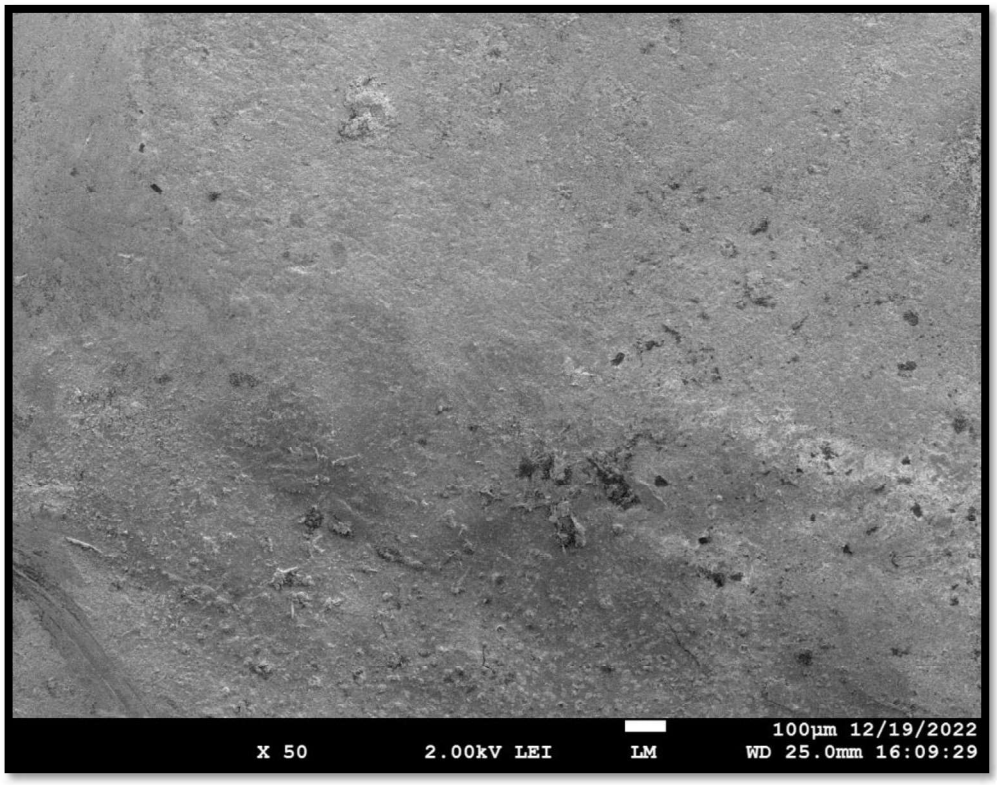


Fig 10: Group A tooth surface at 50x after scaling

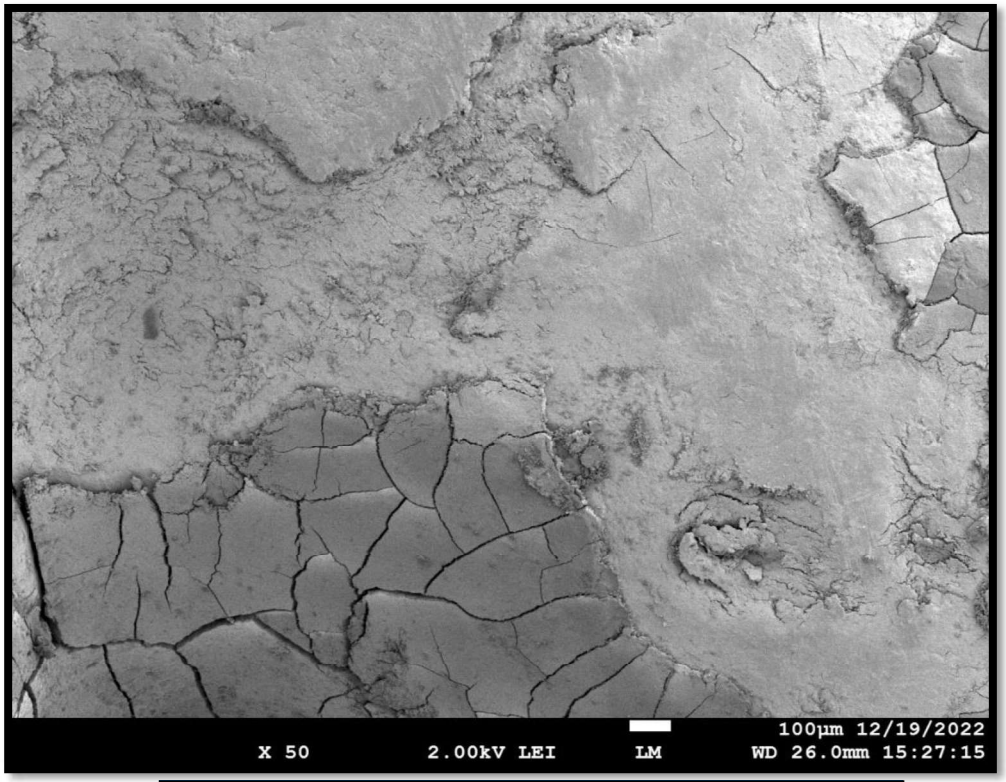


Fig 11: Group B tooth surface at 50x after scaling

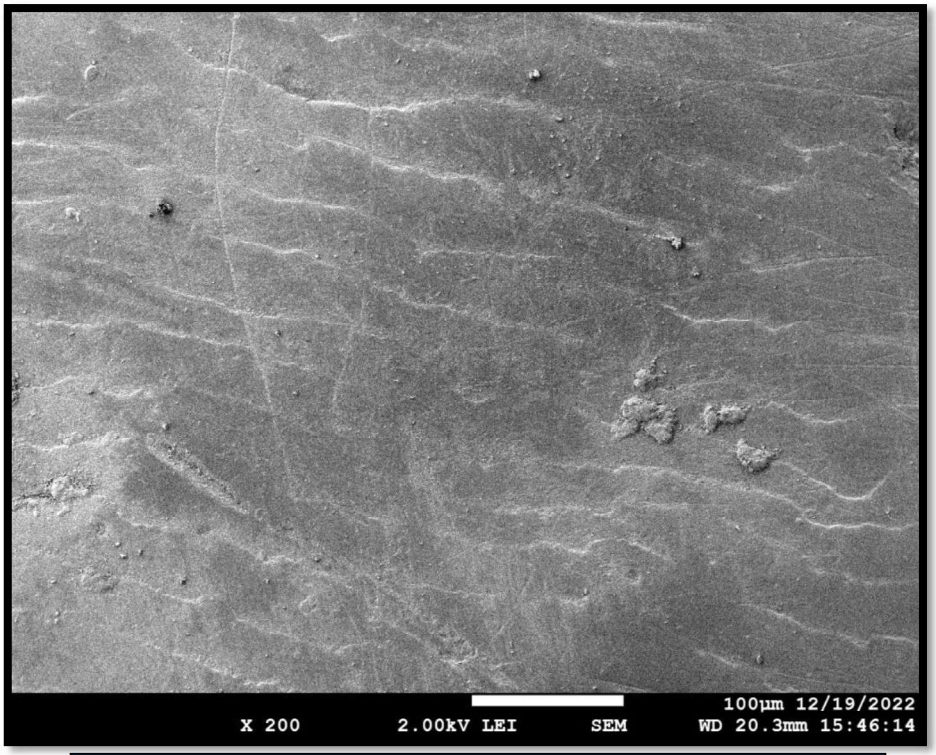


Fig 12: Group A tooth surface at 200x after scaling

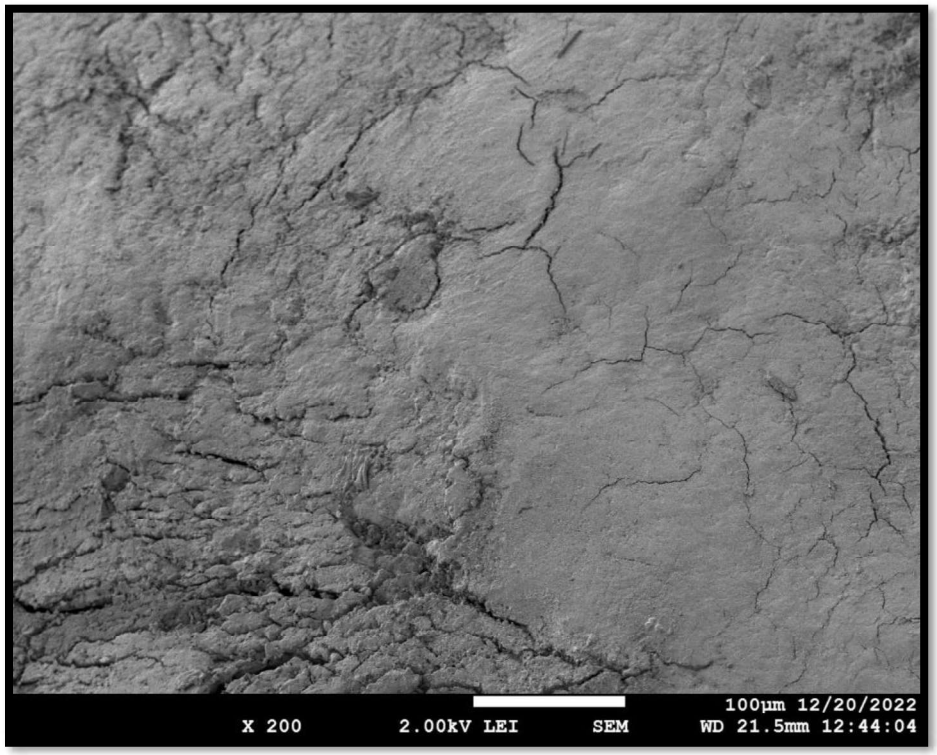


Fig 13: Group B tooth surface at 200x after scaling

RESULTS AND OBSERVATIONS:

The study was conducted in the Department of Periodontology, BBDCODS, Lucknow and the SEM study was conducted in Birbal SahniInstitute of Paleosciences Research Institute. The aim of the study was to evaluate and compare the surface roughness of teeth using ultrasonic and sonic scalers. The samples were divided into group A and group B, each samples were scored individually according to the RLTSI given by Lie and Lekness in 1985 and RCI given by Meyer and Lie in 1974.

Both the groups were statistically analyzed and compared as given below: -

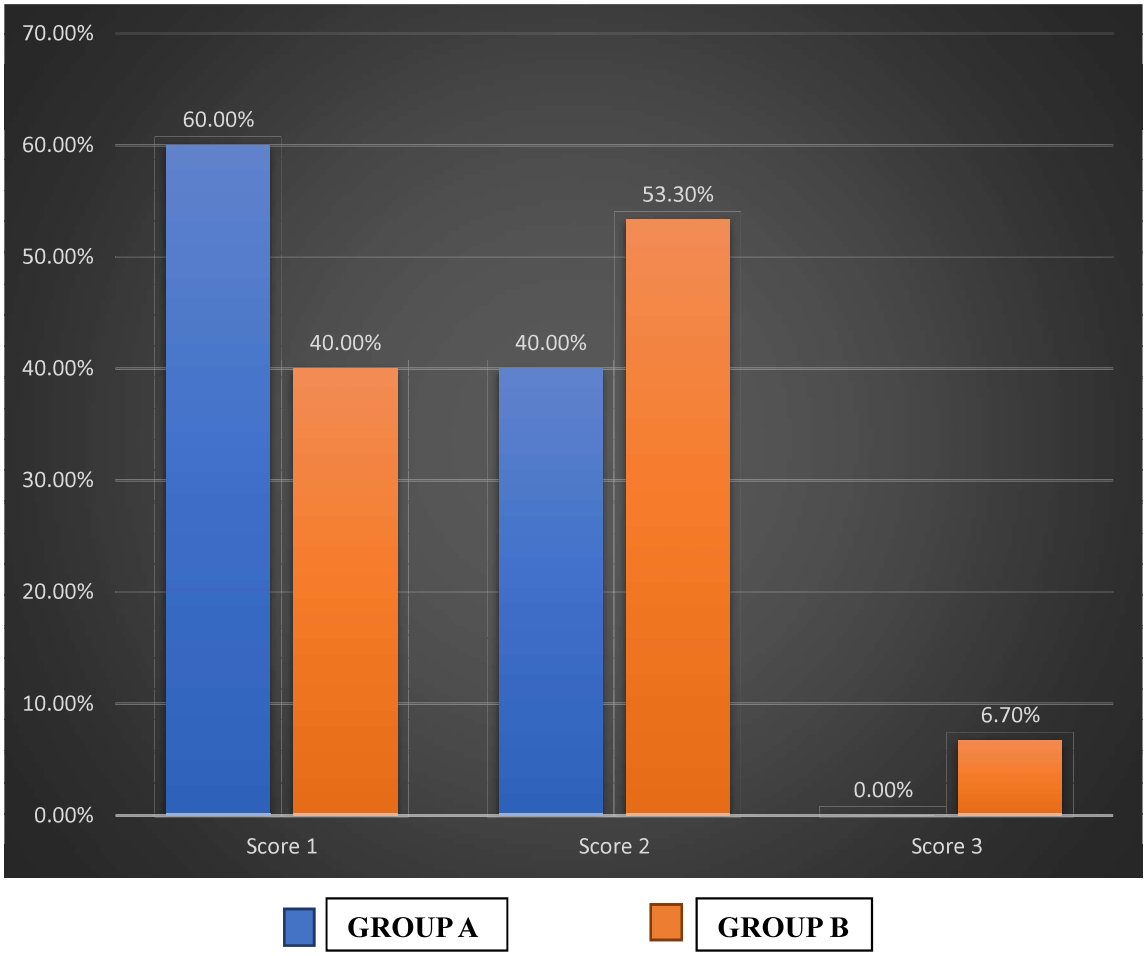
TABLE 1: INTERGROUP COMPARISON OF RLTSI BETWEEN TWO SYSTEMS

Groups	Score 1	Score 2	Score 3	Chi^2 Value	P value	Significance
Group A	9	6	0	1.880	0.390	Non-Significant
	60.0%	40.0%	.0%			
Group B	6	8	1			
	40.0%	53.3%	6.7%			

P value < 0.05

In Group A, it was seen that 60% of the samples had cleaner surfaces with less instrument marks, and 40% of samples showed more instrument marks with slightly corrugated surfaces. Whereas Group B had 40% of samples with cleaner surfaces, 53.3% samples showed slightly more uneven surfaces and 6.7% samples even showed definitely corrugated surfaces.

The difference in tooth surface smoothness was more in Group A. However, on statistical analysis this difference was not significant as evidenced by P value obtained. (P value= 0.390)



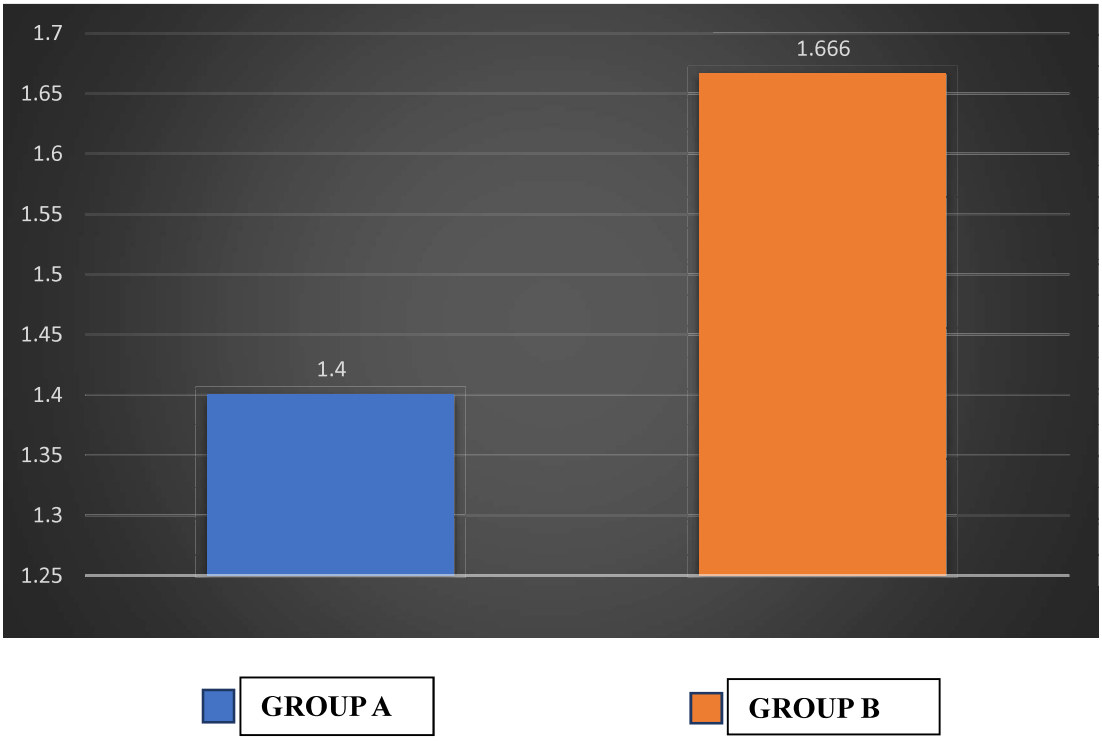
Graph 1: Intergroup comparison of RLTSI between Group A and Group B

TABLE 2: INTERGROUP COMPARISON OF MEAN VALUES BETWEEN TWO GROUPS

Groups	Mean	Std. Deviation	Std. Error Mean	P value	Significance
Group A	1.400	0.507	0.130	0.207	Non-Significant
Group B	1.666	0.617	0.159		

P value < 0.05

The mean score based on RLTSI was 1.400 with standard deviation of 0.507. The mean score in the sonic group was 1.666 with the standard deviation of 0.617. The difference in roughness between the groups was statistically non-significant when analyzed using the independent t test (p=0.207)



Graph 2: Intergroup comparison between the mean values of Group A and Group B

TABLE 3: INTERGROUP COMPARISON OF RCI BETWEEN TWO SYSTEMS

Groups	Score 0	Score 1	Score 2	Score 3	Chi^2 Value	P value	Significance
Group A	2	10	3	0	7.923	0.047	Significant
	13.3%	66.7%	20.0%	.0%			
Group B	0	5	8	2			
	.0%	33.3%	53.3%	13.3%			

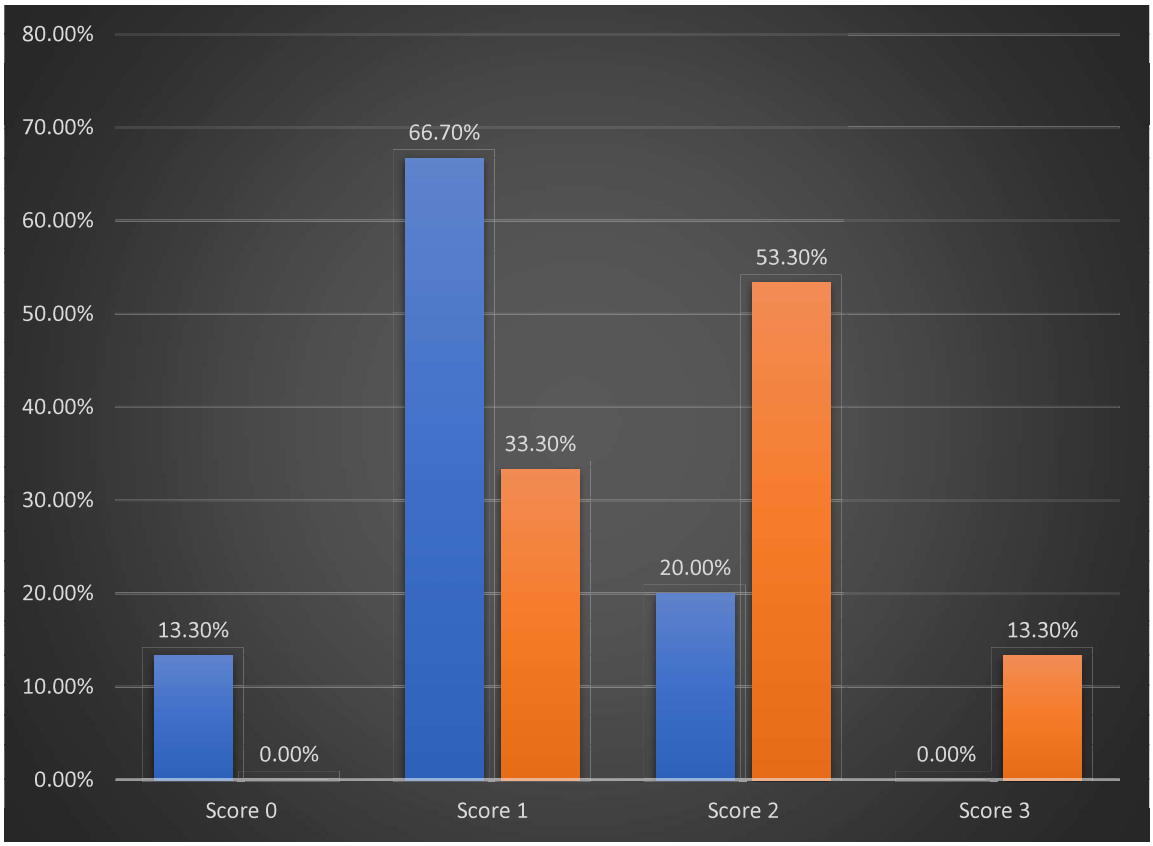
P value < 0.05

When the amount of remaining calculus on the tooth surface was assessed, it was seen that 13.3% of samples in Group A had no calculus remaining on the teeth, Group B had no samples without calculus. 66.67% of samples In Group A had small patches of calculus scattered and 33.3% in Group B had the same.20% in Group A had definite patches of calculus confined to smaller areas whereas Group B had 53.3%.

Group A showed no samples that had considerable amount of calculus remaining in one or few voluminous patches or several smaller patches. However, Group B had 13.3% samples exhibiting significant amount of remaining calculus.

These findings denote that Group A showed less or no calculus remaining after scaling on the surface as compared to Group B.

When statistical test (chi^2 test) was applied to this data, it was seen that this difference was statistically significant (P value- 0.047)



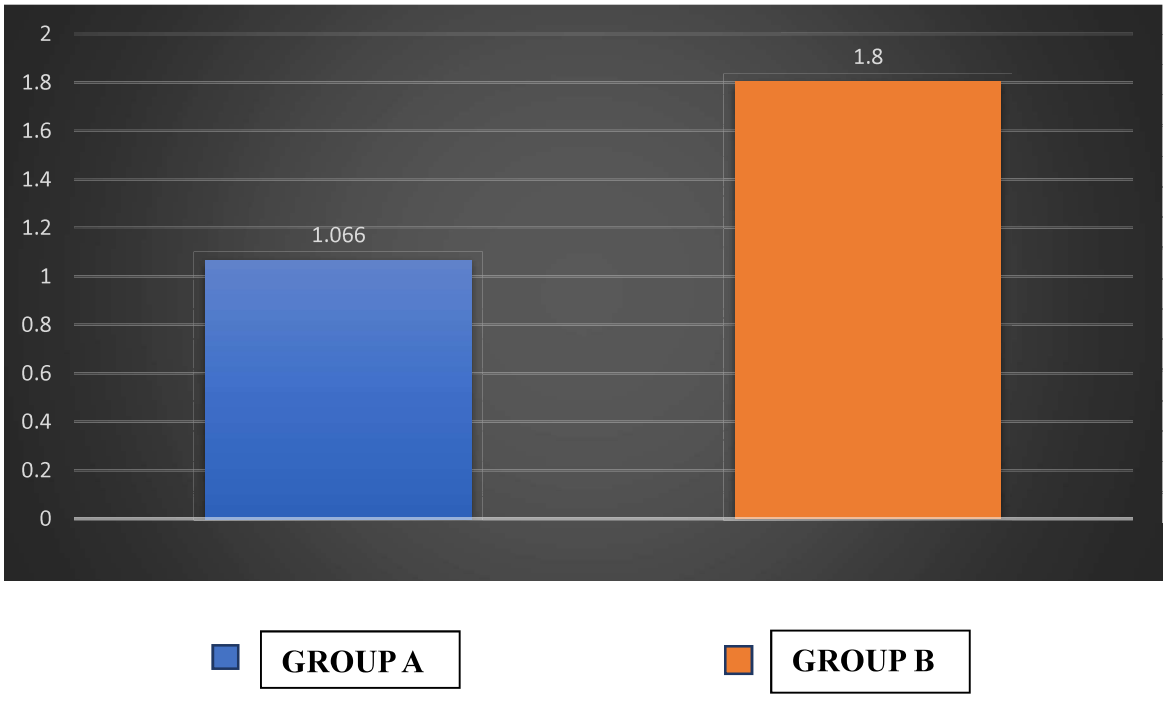
Graph 3: Intergroup comparison of RCI between Group A and Group B

TABLE 4: INTERGROUP COMPARISON OF MEAN RCI VALUES BETWEEN TWO GROUPS

Groups	Mean	Std. Deviation	Std. Error Mean	P value	Significance
Group A	1.066	0.5936	0.153	0.004	Significant
Group B	1.800	0.6761	0.174		

P value < 0.05

The mean score based on RLTSI was 1.066 with standard deviation of 0.593 The mean score in the sonic group was 1.800 with the standard deviation of 0.676. The difference between the groups was statistically significant when analyzed using the independent t test (p=0.004)



Graph 4: Intergroup comparison of mean RCI values between Group A and Group B

SEM OBSERVATION: -

SEM observation was done on both the groups after SRP and micrographs were taken at a magnification of 50x, 200x, 500x and 2000x and the surfaces of both the groups were examined for structure loss, amount of calculus remaining and scratches. The observation was done by three examiners.

SEM observation revealed that both the ultrasonic and Sonic instruments managed to remove the calculus deposits quite efficiently large deposits were rarely seen butsome small scattered areas of calculus deposits were seen on the samples of both the groups.

It was evident that Group A samples surfaces were smoother than group B and had less amount of remaining calculus deposits when compared with the group B sample surfaces

A general impression emerged that the ultrasonic was more efficient than the sonic scaling instrument in removing the calculus deposits moreover after analyzing the SEM micrographs both the groups surface showed some amount of tooth structure loss but on the surfaces of group B samples it was more evident.

From the results, it was observed that Group A had cleaner surfaces, less calculus remaining, and lesser instrument marks on the samples as compared to Group B.

DISCUSSION: -

Plaque and calculus removal by SRP is the ideal goal of periodontal instrumentation, Success of a periodontal therapy depends on the removal of hard and soft deposits from the root surfaces[31,32,33,34]. This is accomplished with either manual and / or power-driven scalers. Better instrument control and tactile perception for the operator are two benefits of manual scaling. However, it takes a lot of effort, time and the instrument needs to be resharpened frequently for effective results[35,36,37,38], To overcome these disadvantages, power driven instruments were seeked by clinicians and manufacturers. Power operated tools, such as sonic and ultrasonic scalers, have advantages such as access to the furcation areas and deep periodontal pockets, less operator fatigue, and shorter operating times[39].Due to minimal operator fatigue, similarity with hand tools in terms of effectiveness and efficient debridement, power-driven ultrasonic scalers and air-driven sonic scalers are mostly employed in everyday regular practice and they are just as effective as hand instruments[14,05,40,41,13,42,44].

The power driven instruments were initially intended for gross scaling and removal of supragingival calculus and stains, and majority of periodontal debridement was typically carried out with hand instruments in the past. Recent modifications to these power-driven devices have resulted in smaller diameter tips and longer working lengths, improving access to deep probing locations and making subgingival instrumentation more effective[45].

SRP machining methods are constantly being improved, and new tools are being brought to the trade. Since lately, sonic scalers (air turbine scalers) have been modified and re launched as an alternative to ultrasonic scalers, which have been in use for several decades.

Periodontal therapy with power-driven devices does have some benefits for the practitioner in terms of clinical outcomes, there are still certain difficulties that need to be resolved. Regarding the physical impacts of sonic and piezoelectric ultrasonic scaling devices on tooth surfaces, several findings have been demonstrated in the

literature.Dental calculus, plaque, and contaminated root cementum are currently removed by machine-driven tools (sonic and ultrasonic devices).[46,47,48,49,03] Limitations in tactile sensitivity, ambiguity regarding the effectiveness and sharpness of hand devices, uncontrolled root injury, and the length of time required to complete therapeutic goals are some of the challenges associated with calculus removal [50,51,5,40,48,52,41,43].

When doing subgingival instrumentation, removing bacterial deposits isjust as crucial as the amount of root substance removed, at times the clinician can end up with excessive root surface roughness that causes greater sub-gingival bacterial adherence. Therefore, smooth surfaces minimize occurrence of caries and periodontitis[3,52].

Sonic scalers are directly attached to the dental unit's air turbine outlet and the insert vibrates [53]between 6 and 8 kHz; These vibrations are produced by air pressure from the turbine flange of the dental unit. In order to achieve this, the air flow causes a pivoted hollow cylinder inside the handpiece of the sonic scaler to rotate, and the resulting vibrations are sent to the instrument tip. Depending on the manufacturer, the scaler tip vibrates almost in a circle with an amplitude of between 60 to 1000 μm. By modifying the handpiece's power, sonic scalers that have recently been invented may change and replicate the amplitude of the tip's vibrations. In addition, changing the turbine air pressure can have an impact on the vibration mode[54]. The stroke motion in Sonic scalers is orbital[20]. Water is necessary, though, to reduce the heat generated by the tip's friction. Another observation is that in sonic scalers all the sides of tip is active.A potential benefit of sonic scalers over ultrasonic scalers is that calculus is removed by localized hammering motions of the working end regardless of the position of the instrument tip in reference to the tooth.

The ultrasonic insert vibrates between 20,000 to 40,000 cycles per second and in order to produce vibrations, a quartz crystal is put within the handpiece of piezoelectric ultrasonic scalers. The bipolar structure of the quartz molecules enables it to expand or contract, and as a result, vibrate, when the quartz crystal is exposed to a high frequency alternating current. The vibration frequency of an instrument can range from 20 to 35 kHz. At an amplitude of 12 to 72 m, the vibration mode is typically linear, or on the

same level[55,56].Therefore, it is unlikely that all areas of the instrument tip will remove calculus to the same degree, and the pattern of calculus removal will either be a simple hammering or scratching one, depending on how the working end is positioned relative to the tooth surface.A change in amplitude but not frequency is possible with all ultrasonic scaler systems when power is adjusted directly at the unit. In sonic scalers, the air pressure affects both the frequency and the amplitude of the instrument tip vibration. It means to say that the ultrasonic scalers have an additional control box for its functioning, whereas in Sonic scalers it only requires air pressure for its functioning.It is known that the mechanical chipping action of the scaler tip is how ultrasonic scalers predominantly remove dental calculus and plaque. There are two more mechanisms that could help remove these deposits from the surface of the tooth. High-energy shockwaves in the first mechanism result in a phenomena known as cavitation, which is described as the oscillation of air bubbles and their subsequent implosion in a liquid media. Acoustic microstreaming patterns develop just below the scaler tip's surface in the second mechanism[19]. Ultrasonic devices have multiple actions like vertical motion, horizotal motion, curettage, lavage, cavitation and medication.

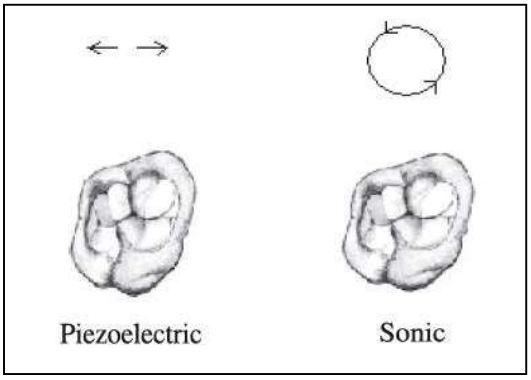


Fig 12: Movement of tip in sonic and ultrasonic (piezoelectric) power driven instruments

Since 1962, studies employing SEM in dentistry have been published, demonstrating the scanning electron microscopes (SEM) usefulness as a research tool[57].The majority of university research labs now have their own scanning electron microscopes, and the methods have substantially advanced.

An electron beam scans the surface of the sample to produce a variety of signals, the characteristics of which depend on many factors, including the energy of an electron beam and the nature of the sample. A beam of electrons hits the sample and the response is collected by a detector, as described by Saghiri et al[58]. SEM enables the visualization of images at high magnification (50x – 10,00,000x and above).In dentistry, where dental tissues and dental materials frequently have white or light hues, which makes the use of optical microscopes challenging, there is no use of light and the colour of the samples has no impact on the image.

Nonconductive specimens, such as teeth, composites, and ceramics, have a tendency to charge up when the electron beam scans them. This can lead to scanning faults and other image artefacts, especially in secondary electron imaging mode. To prevent these artifacts samples are typically coated with an ultra-thin layer of an electrically conductive material, usually gold or palladium and platinum alloy (in our study we used Pt/Pd coating). This layer is applied to the sample either by low vacuum sputter coating or by high vacuum evaporation. During electron irradiation, coating prevents the object from accumulating static electric charge. Coating, according to Saguiri et al[58]: (a)improves signal and surface resolution, particularly with samples of low atomic number (Z); and (b) because backscattering and secondary electron emission near the sample surface cause resolution to produce higher quality images.

The aim of this study was to evaluate and compare the efiiciency in terms of surface roughness of teeth and remaining calculus on teeth using piezoelectric ultrasonic and Sonic scalers. In our study 30 samples were selected with adequate amount of calculus deposits and were divided into two groups. In Group A scaling was done on 15 samples by piezoelectric ultrasonic device and in group B where scaling was done on 15 samples by sonic device.

A comparison was made between both the groups based upon SEM photomicrographs. Visual inspection of standardized micrographs and scoring in accordance with predetermined criteria were used to determine the amounts of residual calculus and tooth substance loss by multiple operators, in order to get a different point of view.

Clearly, this approach is susceptible to the flaws present in subjective assessments made by different examiners.

On intergroup comparison of RLTSI it was found that in Group A 60% of the samples had cleaner surfaces with less instrument marks whereas in Group B only 40 % of the samples had cleaner surfaces. So, it was clearly seen that there was less tooth surface roughness seen in ultrasonic group as compared with sonic group. A study by Cross - Poline et al has shown that piezoelectric system was more efficient for calculus removal

On intergroup comparison of RCI between two groups we found that the percentage of calculus remaining on the tooth surface of group A (no calculus remaining) on the teeth was 13.3 % on the other hand in group B there were no samples without calculus. Thus, according to the scoring of RCI we found that group A samples surfaces were more calculus free than group B samples. This shows that ultrasonic devices were much more efficient in removing the calculus as compared with the sonic device.

Studies that examined the change in root surface roughness during SRP using various instruments supported our findings, linking ultrasonic scalers to smoother root surfaces[59,60,61,62,41,63,64]. Ultrasonic was used to perform the most delicate instrumentation in the current study. Only minor variations were found after instrumentation when compared to the uninstrumented root surface's baseline roughness. Even smoother surfaces than the baseline could be produced by experienced operators with ultrasonic scalers.

Arabaci et al stated that tip angulation at zero degree in piezoelectric units lead to minimal root damage. These units, however needed to be used with very high lateral forces and high power settings for effective subgingival debridement. Hence in order to produce minimal root surface damages, piezoelectric units should be used at 0.5N, low or medium power settings and at close to zero degree angulations.[20]

Sonic scalers or air driven scalers are portable and inexpensive as compared to the piezoelectric scaler but they have a major disadvantage like they produce more sound and have less clinical power. Whereas in piezoelectric ultrasonic scaler the tip doesn’t

leave the tooth surface which helps in decreased tooth roughness, gingival distention and patient's comfort also enhances.[65]

In another study by Loos et al, they concluded that instrumentation with the sonic instrument took slightly longer than with the ultrasonic instrument 4.0 against 3.3 min per tooth[53]

In another study by Kumar et al, the highest root surface roughness was discovered in groups where SRP was carried out using an ultrasonic scaler in low power mode (Ra 1.56 0.95 m)[24]. The root surface roughness was 0.75 0.15 m, which was comparable to that after applying curettes (0.77 1.12 m), whereas operating in high power mode resulted in the lowest surface roughness (Ra 0.02 0. m). The argument put out by the authors to explain this result is that root surface instrumentation utilising ultrasonic scalers at a medium power setting reduces the requirement for excessive lateral 02 pressure while also enabling the operator to work with sound tactile perception.

Root surface damages/scratches compromise the tooth structure and at the same time contribute to rough surfaces for further plaque accumulation. Hence the degree of roughness of the root surface following a scaling treatment is a consideration to take into account for maintainance[3,66].

Leknes et.al. (1996) showed how the subgingival microbial colonization was greatly impacted by the roughness caused by subgingival instrumentation. Then as a smooth surface is less prone to build plaque than a rough surface, it may be beneficial to have a smooth root surface close to the gingival margin.

This conclusion might have been influenced by the Hawthorne effect[67], which affects participants' conduct by their knowledge of their participation in a study and leads to extra cautious instrumentation.

It is a prevalent belief that inexperienced users work with powered devices at higher power levels or exert more pressure to achieve more efficacy[68] and, as a result, cause more accidental root surface damage, particularly when using ultrasonic scalers[11,69].

In order to achieve a successful healing outcome that encourages gingival fibroblast migration and attachment, instrumenting the affected root surface correctly and effectively will continue to be crucial. Only the combination of both hand- and machine-driven instruments—especially in cases with advanced and uneven attachment loss in multi-rooted teeth and/or limited deep pockets—enables a sufficient outcome to do this. Additionally, a recent in vivo investigation from Aspriello et al[63]. demonstrated that the successful cleaning of the root surfaces was accomplished more quickly with the use of a combination of curettes and an ultrasonic device than with single-handed instrumentation. Despite the fact that powered devices are essential for treating periodontal disease, their usage is not without risk[70], particularly because they are the main source of splatter and aerosol production in dental offices. As a result, the benefits and drawbacks of using various instruments alone or in combination should be explored[71], while additional research is still needed to determine how these combined instrumentations affect the loss of root material and surface roughness[72].

CONCLUSION: -

In this present in vitro study of comparison between two devices sonic and piezoelectricwe can conclude that both the devices used for scaling were effective in mechanical debridement but after analyzing the SEM images of tooth surface it was clear that Group A (piezoelectric ultrasonic scaler) the surface were smoother when compared with Group B (sonic scaler). Also after observing the SEM images it was clear that there were less amounts of calculus deposits seen in Group A than in Group B.

However, if consideration is not given to the tool employed, sometimes a wrong practice that we might think is simple to us may cause tooth damage or tooth loss, and some pathologies which may be reversible or in worse condition even irreversible, can occur both in the patient and the operator. Therefore, it is always advisable to utilize sonic and ultrasonic devices while considering any potential negative side effects.

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ANNEXURE – I

BABU BANARASI DAS UNIVERSITY
BBD COLLEGE OF DENTAL SCIENCES, LUCKNOW

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

(Revised)

The project titled **"Comparative Evaluation Of Teeth Surface Morphology Using Piezoelectric Scaler v/s Sonic Scaler- An In Vitro Scanning Electron Microscope Study"** submitted by **Dr Rahul Anand** Postgraduate student in the **Department of Periodontology** for the Thesis Dissertation as part of MDS Curriculum for the academic year 2020-2023 with the accompanying proforma was reviewed by the Institutional Research Committee in its meeting held on **14th September, 2022** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

Decision: The MDS Protocol is approved by the Institutional Research Committee.

Prof. Dr. Puneet Ahuja
Chairperson

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow-226028

Dr. Mona Sharma
Co-Chairperson

ANNEXURE – II

BABU BANARASI DAS UNIVERSITY
BBD COLLEGE OF DENTAL SCIENCES, LUCKNOW

BBD UNIVERSITY

BBDCODS/IEC/09/2022 **Dated: 16th September, 2022**

Communication of the Decision of the IXth Institutional Ethics Sub-Committee Meeting

IEC Code: 17 (Revised)

Title of the Project: Comparative Eevaluation Of Teeth Surface Morphology Using Piezoelectric Scaler v/s Sonic Scaler- An In Vitro Scanning Electron Microscope Study.

Principal Investigator: Dr Rahul Anand **Department:** Periodontology

Name and Address of the Institution: BBD College of Dental Sciences Lucknow.

Type of Submission: Revised, MDS Project Protocol for Thesis Dissertation

Dear Dr Rahul Anand,

The Institutional Ethics Sub-Committee meeting comprising following members was held on 15th September, 2022.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry
2.	Dr. Praveen Singh Samant Member	Prof. & Head, Department of Conservative Dentistry & Endodontics
3.	Dr. Jiji George Member	Prof. & Head, Department of Oral Pathology & Microbilogy
4.	Dr. Amrit Tandan Member	Professor, Department of Prosthodontics and Crown & Bridge
5.	Dr. Rana Pratap Maurya Member	Reader, Department of Orthodontics & Dentofacial Orthopaedics

The committee reviewed and discussed your submitted documents of the current MDS Project Protocol in the meeting.
The comments were communicated to PI, thereafter it was revised.

Decision: The MDS Protocol is approved by the Institutional Ethics Sub-Committee.

Forwarded by:

PRINCIPAL
Babu Banarasi Das College of Dental Science
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow-226028

Prof. Dr. Puneet Ahuja
Principal
BBD College of Dental Sciences
BBD University, Lucknow

16/9/22

Dr. Lakshmi Bala
Member-Secretary
Institutional Ethics Sub-Committee (IEC)
BBD College of Dental Sciences
BBD University, Lucknow

Member-Secretary
Institutional Ethic Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow-226028

ANNEXURE - III

दूरभाष/Telephone : 0522 - 2742903, 2742902
फैक्स/Fax : 91-0522-2740485, 2740098
ई–मेल/E-mail : registrar@bsip.res.in
वेबसाइट/Website : www.bsip.res.in / www.bsip.india.org

1946

बीरबल साहनी पुराविज्ञान संस्थान
BIRBAL SAHNI INSTITUTE OF PALAEOSCIENCES
53, विश्वविद्यालय मार्ग,
53 University Road,
लखनऊ-226 007
Lucknow-226007
(भारत) (INDIA)

(भारत सरकार के विज्ञान एवं प्रौद्योगिकी विभाग का एक स्वायत्तशासी संस्थान)
(AN AUTONOMOUS INSTITUTE UNDER DEPARTMENT OF SCIENCE & TECHNOLOGY, GOVERNMENT OF INDIA)

संख्या
No. .....BSIP/SA/(SEM)/2022-23/ C- 735

Speed Post

दिनांक
Dated 07.12.2022

Prof. Dr. Puneet Ahuja
Principal
BBD College of Dental Sciences
BBD University
Lucknow

विषय / Subject : क्रमवीक्षण इलेक्ट्रॉन सूक्ष्मदर्शी सुविधा का उपयोग / **Utilization of SEM Facility in BSIP**

महोदय / महोदया / Dear Sir/Madam,

With reference to your Letter No. Nil dated November 02, 2022 requesting therein to provide SEM Facility. I am directed to inform you that the above facilities can be provided to Dr. Rahul Anand, M.D.S. 3rd year student **on payment basis** on the following rates:

संस्था / सम्बद्ध शोध अध्येता / प्रायोजित परियोजना / चिकित्सा विश्वविद्यालय / **Paid Research Scholars of Universities/ PG Colleges:**

a)	प्रक्रमण एवं स्थापना / Sample Processing and mounting	Rs. 250 per sample
b)	स्वर्ण पैलेडियम परतबंदी / Gold Palladium coating	Rs. 300 per stub
c)	नमूना परीक्षण एवं फोटोग्राफी / Sample examination and photography	Rs. 300 per exposure

*विश्वविद्यालय / स्नातकोत्तर विद्यालय के अदत्त शोध अध्येता / ****Unpaid Research Scholars of Universities/ PG Colleges:**

a)	प्रक्रमण एवं स्थापना / Sample Processing and mounting	Rs. 250 per sample
b)	स्वर्ण पैलेडियम परतबंदी / Gold Palladium coating	Rs. 150 per stub
c)	नमूना परीक्षण एवं फोटोग्राफी / Sample examination and photography	Rs. 100 per exposure
	एकल स्पेक्ट्रमी के ई डी ए एक्स प्रभार / **EDAX charges for single spectrum**	Rs. 1000 per spectrum
	क्रांतिक बिंदु सुखाना / **CPD (Critical point drying)**	Rs. 500 per sample

*एकल अदत्त विद्यार्थियों के रेट संबंधित विभागाध्यक्ष का प्रमाण–पत्र प्रस्तुत करने पर ही लागू होंगे / **The rates of Unpaid Research Scholar will be applicable subject to production of Certificate from the concerned Head of the Department.

नोट – भारत सरकार के समय–समय पर प्रतिमानक (Norms) के अनुसार जी.एस.टी @18% देय होंगे / **Note: GST @18% will be charged extra as per the Government of India Norms from time to time.**

परिलक्ष्य पत्र के दिखाने पर ही सुविधा का उपयोग दिनांक 05, दिसंबर, 2022 को किया जा सकता है / He may utilize the SEM Facility on December 05, 2022. GST NO. 09AAATB6882H2ZF

He may bring one CD-R of 700 MB for Loading images.

भवदीय / Yours faithfully,

HOD - to take note
Received on 12/12/2022

07/12/2022

(संदीप कुमार शिवहरे / Sandeep Kumar Shivhare)
रजिस्ट्रार / Registrar

आंतरिक प्रतिलिपि / Copy to: संयोजक, इलेक्ट्रॉन सूक्ष्मदर्शी समिति / Convener, Electron Microscopy Committee, BSIP, Lucknow the time to be allotted keeping in view Institute requirements

ANNEXURE – IV

Babu Banarasi Das College of Dental Sciences

(Babu Banarasi Das University)

BBD City, Faizabad Road, Lucknow –227105(INDIA)

1. Title of the project: COMPARATIVE EVALUATION OF TOOTH SURFACE MORPHOLOGY USING PIEZOELECTRIC SCALER V/S SONIC SCALER – AN IN VITRO SCANNING ELECTRON MICROSCOPE STUDY

2. Name of the department/address of the investigator: Department of periodontology, BBDCODS
3. Name of Faculty (Guide/Co-Guide) with designation and department:
   Guide -Dr. Mona Sharma
   (Professor and Head)
   Dept of Periodontology
4. Date of approval by Institutional Research Committee (IRC) (PI enclose approval letter along with finally approved research proposal):
5. Sources of funding: Self
6. Study related information:
   (i) Place of Study:
   (a) BBDU
   (b) BIRBAL SAHNI INSTITUTE OF PALEOSCIENCES
   Kindly attached Consent letter from the concerned faculty/clinician of other Institution.
   (ii) *In-vitro studies on human subjects*: Please specify if it is body fluid blood/tissues/teeth.
   (a) Bile, Saliva etc. [ ]
   (b) Teeth, please specify type [ ]
   (c) Tissue, Human gingival fibroblasts [ ]
   (d) Use of stored or leftover specimens [ ]
   (e) Any other [ ]
   (iii) *In-vivo* study on human subjects:
   (a)Intervention [ ]
   (b)Drugs [ ]
   (c)Implants [ ]
   (d)Any other.g .X-rays/ultrasound/etc [ ]
   (vi) Vulnerable subjects.
   (a) Pregnant Woman [ ]
   (b)Elderly [ ]
   (c)Terminally ill [ ]
   (d)Physically/mentally challenged [ ]
   (e)Children under 18 [ ]
   (f)Students [ ]
   (g)Orphans [ ]
   (vii)Survey of human subject:
   (a) Verbal questionnaire [ ]

(b) Non-invasive examination [ ]
(c)Invasive procedures [ ]
(viii)SEA(Sereve Adverse Events)reporting:
(a)Is there a plan for reporting of adverse events [ ]
If yes it will be done to Institution(s) []IEC[ ] All [ ]

Ethical issues involved in the study:

No issues involved as it is an in vitro study.

7. Do you need exemption from obtaining Informed Consent from study subject–if so give justifications

In following case sex emption can be requested:

a. Audits of educational practices.
b. Research on microbes cultured in the laboratory.
c. Research on immortalized cell lines.
d. Computer Simulation and Dental Materials.
e. Analysis of data freely available in public domain.
f. Any other.

8. Whether Consent forms and Participant Information Document in English and in Hindi are enclosed?
-Not required

9. Conflict of interest for any other investigator(s)(if yes, please explain in brief)

10. We the undersigned, have read and understood this protocol and here by agree to conduct the study in accordance with this protocol and to comply with all requirements of the ICMR guidelines (2006)

Signature of the Investigator: Date:

Signature of the Guide &Co-Guide of the Department: Date:

Signature of the Head of the Department: Date

(Note: The investigator must provide information to the subjects in a simple language and it should address the subjects, in a dialogue format

ANNEXURE -V

MASTER CHART

ULTRASONIC SCALER		
TOOTH SAMPLE	**RLTSI SCORE**	**RCI SCORE**
1	1	1
2	2	1
3	1	0
4	1	1
5	2	1
6	1	2
7	2	1
8	2	2
9	1	2
10	1	1
11	2	0
12	1	1
13	2	1
14	1	1
15	1	1

SONIC SCALER		
TOOTH SAMPLE	**RLTSI SCORE**	**RCI SCORE**
1	2	3
2	1	2
3	2	1
4	2	2
5	1	2
6	1	1
7	2	2
8	2	3
9	1	2
10	2	1
11	3	1
12	2	2
13	1	2
14	1	2

Scoring criteria based upon following indices and SEM observation

Roughness Loss of Tooth Substance Index (RLTSI) given by Lie and Leknesin 1985

The micro surface roughness on the tooth surface was evaluated visually with SEM photographic prints at magnification 50x& 200x. Scoring criteria is as follows;

0: Smooth and even surfaces or slightly roughened, but without signs of instrumental marks.

1: Mostly slightly roughened areas with some corrugated regions but no obvious Instrumental marks.

2: Definitely corrugated areas and some instrumental marks, but also relatively even areas.

3: Definitely corrugated surface with instrumental scratches over most of the areas.

Remaining Calculus Index (RCI) given by Meyer and Lie in 1977

The amount of remaining calculus was evaluated visually with SEM photographic prints at magnification 50x. Scoring criteria is as follows;

0: No calculus remaining on the root surface

1: Small patches of extraneous material, probably consisting of calculus

2: Definite patches of calculus confined to smaller areas

3: Considerable amounts of remaining calculus, appearing as one or a few voluminous patches or as several smaller patches scattered on the treated surface.

ANNEXURE-VI

STATISTICAL ANALYSIS

The data for the present study was entered in the Microsoft Excel 2007 and analyzed using the SPSS statistical software 23.0 Version. The descriptive statistics included mean, standard deviation. The level of the significance for the present study was fixed at 5%.

The intergroup comparison for the difference of mean scores between two independent groups was done using the unpaired/independent t test and difference in the frequencies was compared using the chi square test

The Shapiro–Wilk test was used to investigate the distribution of the data and Levene's test to explore the homogeneity of the variables. The data were found to be homogeneous and normally distributed. Mean and standard deviation (SD) were computed for each variable

Mean

$$\overline{X} = \frac{\Sigma X}{N}$$

Where:

$\overline{X}$ = the data set mean

$\sum$ = the sum of

X = the scores in the distribution

N = the number of scores in the distribution

Range

$$range = X_{highest} - X_{lowest}$$

Where:

$X_{highest}$ = largest score

X_{lowest} = smallest score

Variance

$$SD^2 = \frac{\Sigma(X - \overline{X})^2}{N}$$

The simplified variance formula

$$SD^2 = \frac{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}{N}$$

Where:

SD^2 = the variance

$\sum$ = the sum of

X = the obtained score

$\overline{X}$ = the mean score of the data

N = the number of scores

Standard Deviation (N)

$$SD = \sqrt{\frac{\Sigma(X - \overline{X})^2}{N}}$$

The simplified standard deviation formula

$$SD = \sqrt{\frac{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}{N}}$$

Where:

SD = the standard deviation

$\sum$ = the sum of

X = the obtained score

$\overline{X}$ = the mean score of the data

N = the number of scores

Shapiro Wilk Test

he null-hypothesis of this test is that the population is normally distributed. Thus, if the *p* value is less than the chosen alpha level, then the null hypothesis is rejected and there is evidence that the data tested are not normally distributed. On the other hand, if the *p* value is greater than the chosen alpha level, then the null hypothesis (that the data came from a normally distributed population) can not be rejected (e.g., for an alpha level of .05, a data set with a *p* value of less than .05 rejects the null hypothesis that the data are from a normally distributed population – consequently, a data set with a *p* value more than the .05 alpha value fails to reject the null hypothesis that the data is from a normally distributed population).[4]

Like most statistical significance tests, if the sample size is sufficiently large this test may detect even trivial departures from the null hypothesis (i.e., although there may be some statistically significant effect, it may be too small to be of any practical significance); thus, additional investigation of the *effect size* is typically advisable, e.g., a Q–Q plot in this case.[5]

Independent t-test

Independent t Test can be used to determine if two sets of data are significantly different from each other, and is most commonly applied when the test statistic would follow a normal distribution. The independent samples *t*-test is used when two separate sets of independent and identically distributed samples are obtained, one from each of the two populations being compared

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left(\frac{(N_1 - 1)s_1^2 + (N_2 - 1)s_2^2}{N_1 + N_2 - 2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

Where X1 =Mean of the first Group, X2 =Mean of the Second Group

Chi Square Test

Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to a specific hypothesis. When an analyst attempts to fit a statistical model to observed data, he or she may wonder how well the model actually reflects the data. How "close" are the observed values to those which would be expected under the fitted model? One statistical test that addresses this issue is the chi-square goodness of fit test. This test is commonly used to test association of variables in two-way tables, where the assumed model of independence is evaluated against the observed data. In general, the ***chi-square test statistic*** is of the form

$$X^2 = \sum \frac{(\text{observed - expected})^2}{\text{expected}}$$

If the computed test statistic is large, then the observed and expected values are not close and the model is a poor fit to the data

ANNEXURE -VII

PLAGIARISM REPORT

Ouriginal
by Turnitin

Document Information

Analyzed document	word dessertation rahul.docx (D158434465)
Submitted	2/12/2023 11:29:00 AM
Submitted by	Dr Mona Sharma
Submitter email	maniona2@bbdu.ac.in
Similarity	7%
Analysis address	maniona2.bbduni@analysis.urkund.com

Mona
15/02/23