International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 23s, 2025
https://www.theaspd.com/ijes.php

Efficiency of two different polishing methods On Enamel: A Scanning Electron Microscope Study

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Abstract

Objective:*The present clinic al study aim edtocompareth effect softwo polishingmethodairpolisherandrubbercuponthe tooth enamel surface.*

Materials and Methods:
Thirtyanteriorteeth(maxillaryandmandibular)under wentultrasonicscalingandrootplaning,were cleanedwithdistilledwater,andstoredin10%formalin.Teethweremountedonacrylicblocks,exposingonlythecrownwith a flattened lingual surface. Control samples remained unpolished,while test samples were polishedusingeither air polishing orrubbercupmethods.Teethweresectionedmesiodistallyintoenamelslabsusingalow-speed(2500–3000rpm)water-cooled diamonddisc.Specimenswereair-dried,gold-sputtered,andexaminedunderascanningelectronmicroscope(SEM)at1000x magnification (20.0 kV, 25 mA). Enamel surface conditions were scored based on SEM photomicrographs.

Results: *A statistically significant difference in enamel surface scores was found between the rubber cup and air polisher groups (Chi-square = 7.200, p = 0.007). Rubber cup polishing resulted in smoother enamel surfaces with significantly less debris compared to air polishing and scaling alone.*

Conclusion:*Rubbercuppolishingproducesasmootherenamelsurfacewithreduceddebriscomparedtoairpolishing,making it more effective for enamel finishing after scaling.*

Clinical Relevance: *Air polishing offers advantages like reduced operator and patient fatigue, shorter procedure time, and betterplaqueremovalin hard-to-reachareas(e.g., furcation's,flutings,androotproximities) comparedtorotaryinstruments.*

Keywords: *Polishing, Rubber Cup, Air Polisher, Enamel, Surface Roughness, Scanning Electron Microscopy*

INTRODUCTION

Period ontaldiseasesarecomplex,multi-factorialconditionsprimarilycausedbytheaccumulationandcolonizationofdiverse microorganismsontoothsurfaces,particularlyatorbelowthegingivalmargin.[1]Effectivetreatmentrequiresco mprehensive removal ofsupra- and sub-gingival calculus and biofilm, which also forms a fundamental aspect of periodontal maintenance therapy.Debridementisachievedusinghandinstruments,sonic,orultrasonicscalers.[2]However,even when performedby skilled and experienced clinicians, these procedures may result in surface irregularities or residual staining on teeth.

Toothpolishing,aroutine componentoforalprophylaxisindentalpractice,involvesthesmootheningoftoothsurfacesto enhance their gloss and luster. Among professional methods for plaque and stain removal, conventional rubber cup prophylaxis and air powder polishing are considered the most effective.[3] For over fifty years, the rubber cup with prophylactic paste has been the most widely adopted technique.[4]

The primary goal of polishing is to create a smooth tooth surface that resists plaque accumulation, thereby supporting effective periodontal maintenance after scaling. Currently, both manual and engine-driven tools such as the Porte polisher, polishing strips, rubber cups, bristle brushes, air polishers, and the vector systemare employed in combination with various prophylacticpastes. Amongthese, usingrubbercupswithpolishingagentsremainsthemostcommon.However,air-powder polishing systems are increasingly gaining popularity due to their innovative design, ability to access hard-to-reach areas, improved efficiency,and reducedoperatorfatigue.Nevertheless,theiruseiscontraindicated inpatientssensitiveto aerosols or those requiring restricted sodium intake.[5]

Whileextensiveresearchexistsregardingthefinishingandpolishingofrestorative materials,lessemphasishasbeenplaced on the polishing of natural enamel surfaces that play a critical role in oral health. [6–8] Rubber cups with prophy angles remainacost-effectiveoption,howeverexcessivepressureorimpropertechniquecanresultin removingthethincementum layer, particularly in the cervical region. To mitigate heat generation and surface damage, polishing should be performed using the least abrasive paste, intermittent pressure, and careful control of rotation speed, pressure, and duration.[9]

Sodiumbicarbonate,whenmixedwithwatertoformaslurry,hasdemonstratedeffectivenessinremovingdentalstainsand plaque. In aqueous form, it ionizes to release HCO_3^- ions, which neutralize acids through reaction with H^+ ions. Its mild abrasivenessand alkalinitymake it aversatile and safeagent for useon enamel, amalgam, gold, porcelain, andorthodontic appliances—though it is not recommended for composites, glass ionomer, or luting cements.[10]

Despite the widespread use of various polishing techniques, limited research has been conducted to evaluate and compare

Their effect sonenamelattheultrastructurallevel.Therefore,thepresentstudyutilizesscanningelectronmicroscopy(SEM) to assess and compare the microtopography of enamel surfaces following polishing with two different systems: the rubber cup and the air polisher.[11]

MATERIALSANDMETHOD

Atotalof30periodontallyinvolvedhumanteethwereextracted, collected, and section edtoobtain 30enamelsamples. Teeth with prosthesis, fracture, showing signs of external resorption, caries, abrasion, and erosionof teeth were not included in the study. Immediately following extraction, allteethunderwentultrasonicscalingand rootplaningusing Graceycurettes(#1–2 and #3–4) to remove anyremainingsoft tissue and surface debris. The teeth were then rinsed thoroughlywith distilled water and stored in 10% neutral buffered formalin at room temperature until further use. To prepare enamel specimens, each tooth was sectioned longitudinally along the mesiodistal axis using a water-cooled diamond disc mounted on a contra-angle handpieceoperatingatalowspeed(2500–3000rpm).Thesectioningwasperformedtoobtainuniformenamelslabsfromthe crown portion of each tooth.

GroupingandSurfaceTreatment

The samples were divided into control and test groups. Control group specimens as a group C were not subjected to any polishingprocedure.Testgroupspecimenswerefurtherdividedintotwosubgroupsbasedonthepolishingtechniqueemployed rubber cup as group A and air polisher as group B.

MountingofSamples

Eachspecimenwasembeddedinaself-cureacrylicresinblocksuchthatonlythecrownportionremainedexposed.Thelingual cingulum area of each tooth was reduced and flattened to create a standardized and uniform enamel surface for subsequent analysis.

Dehydration

The term dehydrationis used to describe the removal of water. Conventional SEM demands that water and organic fluidseither must be removed from samples or immobilized before they are examined and analyzed.

SEM EVALUATION:

- Thephotomicrographswereassessed onthebasisoftheirsurfaceconditionsand judgeaccordingtothefollowing criteria:

SCORINGCRITERIA:abrasiononenamelwasmeasuredaccordingto**Kontturi-NärhiV,MarkkanenS,Markkanen H et al [12]**

1 Noabrasionwithsmoothnormal enamel

2 Mildabrasionwithfewmicropitsorprismends(amyloplasticpits)visiblebetweenperikymata lines.

3 Severeabrasionwithdistinctperikymatalines,manyprismsendsormicropitsvisibleonthew holesurfaceoccasional fracturing of perikymata edge.

OBSERVATIONANDRESULT

STATISTICAL ANALYSIS:

Thestatisticalanalysiswascarriedoutusing Jamovi (Version 2.6.26; Jamovi Project, 2024). Thedescriptivestatisticswere calculated as frequencyand percentage. The comparison ofenamel scores amongthe studygroups was doneusingchi-squaretest.The level of significance for the present study was set at a P-value of less than 0.05.

COMPARISONOF ENAMEL SCORE

Table 1 shows the comparison ofenamel scores among the studygroups. Achi-squares test ofindependence was conducted to examinetherelationshipbetweenenamelscores andthegroups(rubbercup,airpolisher,andcontrol).Thefollowingtableshowsthe distributionofenamelscoresacrossthethreegroups.

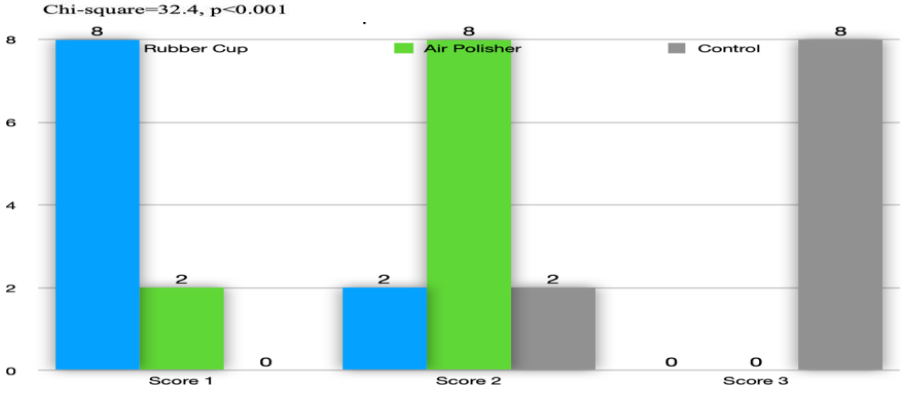
Theresultsindicatedastatisticallysignificantassociationbetweenenamel score and groups (Chisquare=32.4, p<0.001), indicated that enamel scores varied significantly

GRAPH1:COMPARISON OFENAMELSCORES AMONGTHESTUDY GROUPS

Table 1. Comparison of enamel roughness scores among the study groups

	Group		
Enamel Score	**Rubber Cup(Gr A)**	**Air Polisher(Gr B)**	**Control(Gr C)**
1 (No abrasion)	8 (80%)	2 (20%)	0 (0%)
2 (Mild abrasion)	2 (20%)	8 (80%)	2 (20%)
3 (Severe abrasion)	0 (0%)	0 (0%)	8 (80%)
Total	10 (100%)	10 (100%)	10 (100%)

Chi-square=32.4, p<0.001



COMPARISONBETWEENRUBBERCUP(GROUPA)ANDAIRPOLISHER(GROUP B)

Table2. showedthattherewasastatisticallysignificantdifferenceinenamelscores between rubbercupandairpolisher(Chis quare=7.200,p=0.007),indicatingthat enamelscoresvariedsignificantlybetweenthesetwostudygroups.Theproportionof samples with score 1 (no abrasion) was significantlyhigher in rubber cup group (80%) compared to air polisher group (20%). Similarly, theproportionofsampleswith score2(mild abrasion) wassignificantlyhigher in airpolisher group (80%)compared to rubber cup (20%).

Table 2. Comparison of enamel roughness scores between rubber cup and air polisher

	Group	
Enamel Score	**Rubber Cup(Gr A)**	**Air Polisher(Gr B)**
1 (No abrasion)	8 (80%)	2 (20%)
2 (Mild abrasion)	2 (20%)	8 (80%)
Total	10 (100%)	10 (100%)

Chi-square=7.200, p=0.007

COMPARISONBETWEENRUBBERCUP(GROUPA)ANDCONTROL (GROUPC)

Table3.Theproportionofsampleswithscore1(noabrasion)wassignificantlyhigherin rubbercupgroup(80%)compared to controlgroup (0%).Similarly, theproportionof samples with score3 (severeabrasion) wassignificantlyhigher in control (80%) compared to rubber cup (0%).

Table 3. Comparison of enamel roughness scores between rubber cup and control

	Group	
Enamel Score	**Rubber Cup(Gr A)**	**Control(Gr C)**
1 (No abrasion)	8 (80%)	0 (0%)
2 (Mild abrasion)	2 (20%)	2 (20%)
3 (Severe abrasion)	0 (0%)	8 (80%)
Total	10 (100%)	10 (100%)

Chi-square=16.000, p<0.001

COMPARISONBETWEENAIRPOLISHER(GROUPB)ANDCONTROLGROUP(GROUPC)

Table 4. indicating that enamel scores varied significantly between these two study groups. The proportion of samples with score 2 (mild abrasion)was significantlyhigher in air polisher group (80%) compared to control group (20%). Similarly, the proportion ofsampleswith score3 (severeabrasion) wassignificantlyhigher in control group (80%)compared to air polisher group(0%). Theanalysisshowedthattherewasastatisticallysignificant differenceinenamelscoresbetweenairpolisherand control (Chisquare=13.600, p=0.001),

Table 4. Comparison of enamel roughness scores between air polisher and control

	Group	
Enamel Score	**Air Polisher(Gr B)**	**Control(Gr C)**
1 (No abrasion)	2 (20%)	0 (0%)
2 (Mild abrasion)	8 (80%)	2 (20%)
3 (Severe abrasion)	0 (0%)	8 (80%)
Total	10 (100%)	10 (100%)

Chi-square=13.600, p=0.001

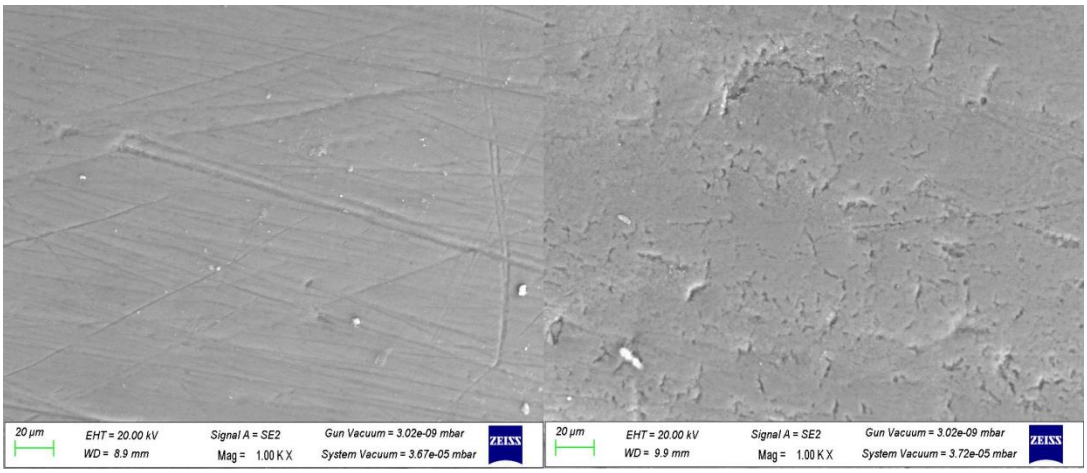


FIG9(i): RUBBERCUP(A)WITHENAMELSCORING1 (B)WITHENAMELSCORING2

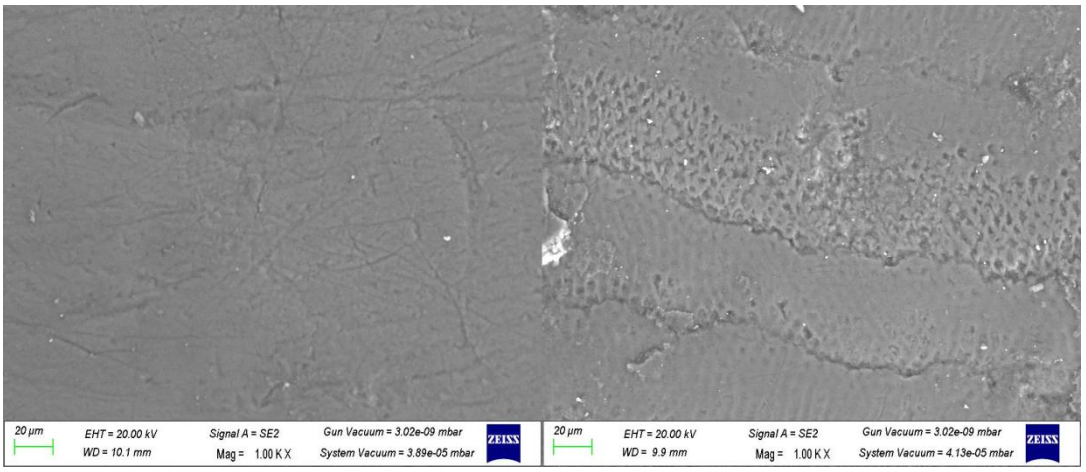


FIG9(ii): AIRPOLISHER(a)WITHENAMELSCORING1(b)WITHENAMELSCORING2

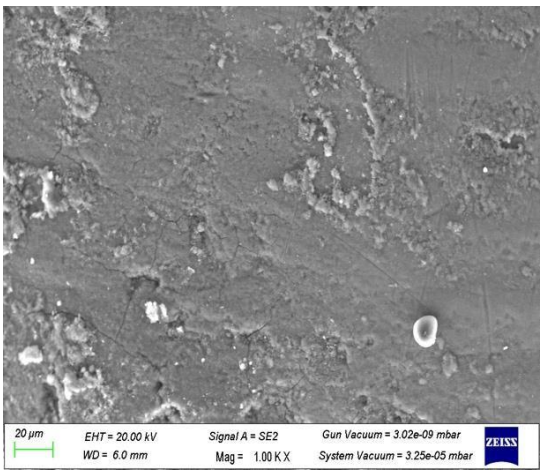


FIG9(iii):(a) GROUPC(CONTROLGROUP)WITHENAMELSCORING3

DISCUSSION:

Ithasbeenstatedthatscalingandrootplaningalonecannotreducethesurfaceroughnesstothatextentasitcouldb eachieved in combination with polishing.[13]

The present study was conducted to evaluate and compare the microtopographic changes on enamel surface subjected to polishingwith two differentpolishingsystems,i.e.,rubber-cup andair-polishingdevicebySEM under×1000 magnification. InourstudyGroupA(rubbercup)wasattachedtotheprophy-angle,operatingataspeedof2500-3000rpm.Althoughpressure of20psiisrecommendedwhileusingrubbercupwhereas forGroupB(airpolisher)anairsettingof80psi. isrecommended as stated by **Francis and Barnes** [14]

The present in vitro study was intended to evaluate the effect of Sodium Bicarbonate on enamel surface topography. Thirty extractedteethweretakenforthestudy.TeethaffectedbyperiodontitiswithgradeIIImobilitywereextractedfrom thepatients with no history of systemic disease. Teeth affected by caries were excluded in this study as it could have adversely affected therootsurfacetopography.Teethwithimmediatepasthistoryofscalingandroot planingwereexcludedastheywouldhave altered the enamel surface. Teeth with attrition, abrasion and erosion were also excluded as they have shown to produce secondary changes in tooth structure like alteration in mineral composition and formation of sclerotic dentine. The sample teethwerethoroughlycleanedwithultrasonicscalersandhandscalers.Afterscalingthesampleswerestoredinsali netoavoid dehydration of the specimens. Acrylic blocks were prepared according to each specimen size. Each sample was mounted in acrylic block so as to leave one surface of the clinical crown exposed which is in accordance with the study conducted by **Zoya Chowdary et al (2018).**[11]

Thirty samples were divided into three groups with 10 samples in each group. These sampleswere randomly grouped by a Lottery method depending upon type of polishing method used. In our study sodium bicarbonate–based powder ($NaHCO_3$) wasusedasapolishingagentbothforairpolisherandrubbercupasitisregardedasthefirstpowdertobeusedfor polishing. $NaHCO_3$ powders are processed to form a powder with a particle size of up to 60µm. However, patients with conditionsaffectedbysodiumintake,airpolishingwith$NaHCO_3$basedpowders iscontraindicated.Butsincethiswasanin- vitro study this drawback of sodium bicarbonate was of no consequence.[15]

Ourstudydemonstratedthatrubbercuppolishingproducedminimalabrasiononenameltranslatingintobetter smoothenamel surfaces as compare to air polisher. For enamel score 1, Rubber cup group had a significantly higher tendency compared to Air polisher group, suggestinga potential trend toward better

enamel preservation with the rubbercup. The results indicate a statisticallysignificant association between enamel scoreand groups(Chi-square=32.4,p<0.001). Theresultsobtainedinthe presentstudywereinaccordancewiththestudiesconductedby**BaileyandPhillips**,[16]**Kontturi-Närhi*etal.*,**[12]**Petersson*etal.*,**[17]**Han,**[18]**Agger*etal.*,**[19]**Castanho*etal.*,**[20]**andSahrmann*etal.*,**[21]demonstratingthatairpolisherincreases the surface roughness as well as the debris on both enamel surface. The abrasiveness may be due to the shape of sodium bicarbonatepowderparticleandalsoduetothehighpressureofthe airpolisher,theparticlesareblastedonthetoothsurface. Although in our in vitro study, rubber cup was better in producing minimal invasion on enamel, but clinically it has been shown that air polishing system perform better sub gingivally as stated by **Petersilka GJ et al** [22].

The results obtained in the present study in control group where only scaling and root planing was done showed increase surfaceroughnessaswellasthedebrisonenamelsurfaces.Theresultsshowedthatthecontrolgrouphadasignificantlyhigher abrasion indexofscore 3 accordingto the criteria as statedby**Kontturi-Närhi VandMarkkanen S et al** [12]. which further suggestingthat thisgroup had the most enamel abrasion as compared toother test groups. Air-powder polishers useslurryof distilledwaterandvariouspowders.Airpolisherhand-pieceisattacheddirectlytotheair/waterconnectororasaseparateunit or in combination with ultrasonic scalers.[23]It has overcome conventional rubber cup polishing paste systems as it is more convenientforsubgingivalplaqueremovalanditreachessurfacesthatareinaccessibletoarotarydevice.[24]Ithas beenfound that air polishing reduces the operator and patient fatigue, requires less time, It also removes plaque from inaccessible areas that are otherwise difficult for rotary instruments to reach like furcation's, flutings and close root proximities Whereas disadvantages are that it cannot be used in patients with respiratory, renal or metabolic disease, infectious disease, children, diureticsorlongtermsteroidtherapyandaerosolsgeneratedbyair-polishingmaypresentaninfectioncontrolhazard.Hence, a pre procedural rinse is always recommended along with aerosol reduction devices.[25]

On comparison of rubber cup polishing and air-polishing methods, various studies revealed that the effectiveness of air- polishing to the rubber cup polishing for bacterial plaque and stain removal demonstrate that both methods are equally effective."Althoughbothmethodswerereportedtocausesomegingivaltrauma.[26]**'Garcia-GodoyandMedlock**[27]have studiedand reported hatairpolishersaremoreeffectiveforplaqueandstainremovalinpitsand fissures.But sinceourstudy wasconfinedtolabialorbuccalsurfaces,wefoundrubbercuppolishing tobemoreeffective. Majorityofthephotomicrophs from the Group A i.e., Rubber cup shows 80% no abrasion with smooth normal surface (Score 1) and very few nearly 20% photomicrophs show mild abrasion (Score 2) whereas Group B i.e., Air polisher photomicrophs show 20% smooth normal surface (Score1)and80%withmicropitsandmild abrasion(Score2) accordingtothescoringcriteria as statedby**Kontturi- Närhi V and Markkanen S et al**.[12]Results of the present study indicate that polishing with a rubber cup was effective in producing minimal enamel abrasion as compared to air polisher on labial or buccal surfaces.

CONCLUSION:

Consistent mechanical removal of bacterial plaque is essential for preserving periodontal health. Many periodontal treatmentscanresultinroughenedtoothsurfaces, whichcanpromoteplaquebuild-upandleadto gingivalinflammation. Research findings indicate that the rubber cup method results in a smoother enamel surface and significantly less debris when compared to both air polishing and scaling with root planing. While the air polisherwaseffectiveatremovingplaque and stains, the rubber cup was superior in terms of surface smoothness, making it a more efficient polishing technique.

However,furtherstudieswithlargersamplesizesandstandardizedpressureapplicationforpolishingmethodsarenecessary to confirm these findings.

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