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Clinical Assessment of Erosive Tooth Wear Objective Outcome Measures

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Abstract

The purpose of this study was to determine whether enamel surface texture can be used as objective and quantitative measurements to detect and monitor erosive tooth wear (ETW) as an adjunct to the subjective Basic Erosive Wear Evaluation (BEWE) that is commonly used today. This longitudinal observational clinical study enrolled 32 subjects with a sample of n = 584 teeth. Conventional dental microwear surface texture parameters (surface complexity, roughness, and anisotropy - Asfc, Sa, Str, respectively) (were generated using white-light scanning confocal profilometry) from the buccal surfaces of each tooth accepted to the study. I personally scanned and analyzed n = 176 of these specimens. Data were generated for patients at initial (baseline) visit and 12 months follow up (M12). Texture attributes were then compared with BEWE scores generated by an experienced clinician and enamel thickness measurements of the same samples generated using CP-OCT imaging. Results indicate that as enamel thickness decreased, BEWE scores, Sa, and Str increased. Asfc showed no significant change. The change in surface texture was significantly correlated with change in BEWE (r = -0.15-0.16, $p < 0.001$), but not with changes in enamel thickness (r = 0.02-0.09, $p > 0.06$). There was a greater increase in Sa and Str in teeth with BEWE progression. The findings of this study suggest that surface texture parameters be used to predict ETW severity.

Introduction

Erosive tooth wear (ETW) is a dental condition in which individuals experience tooth structure loss due to chemo-mechanical wear processes (1). This wear process can result from acids in the oral cavity (originating either intrinsically or extrinsically) that weaken the enamel and dentin surfaces of the teeth. This weakening makes teeth vulnerable to wear from abrasive forces such as mastication (chewing) and toothbrushing (2). Tooth form, esthetics, and function can all be compromised because of ETW's irreversible nature (3). In the United States, the National Health and Nutrition Examination Survey reported that ETW affects approximately 46% of teenagers (4) and 80% of adults (5). Despite this, no specific diagnostic criteria or evidence-based management guidelines exist for ETW. At this moment, the diagnosis and treatment of ETW is based on visual examination and subjective indices (6). Because of this, most cases of ETW are not discovered until it has reached advanced stages.

Though this condition is extremely prevalent worldwide, the main method of identifying erosive tooth wear is by visual examination. This method is subjective and ineffective until late in the disease process, as a result, most erosive tooth wear is not identified until it is too late. The damage caused by erosive tooth wear results in pain and extreme damage to the tooth and its function. In order to repair this damage, one must undergo complex and costly procedures (17). This study's goal is to begin to develop new, objective methods for early detection and diagnosis of erosive tooth wear so that the damage can stop before it progresses.

For this study, participants were selected based on their risk of erosive tooth wear and dietary habits by examiners at the Indiana University School of Dentistry. The researchers at the Indiana University School of Dentistry then took high-resolution molds of the tooth surface at initial (baseline) visit and after 12 months (M12 follow-up). In addition, these researchers/clinicians assigned Basic Erosive Wear Evaluation (BEWE) scores to individual samples and measured their enamel thickness using standard protocols (see below). Molds were sent to The University of Arkansas where the Ungargrad clinical team (Troy Bartels, Camille Kita, and I) scanned and analyzed them for microwear textures. Results indicate that some microwear texture attributes faithfully reflect erosive wear score and that this quick, inexpensive, and non-invasive method of analysis, using supplies available in every dental practice in the US today, holds promise as a new tool to diagnose and monitor the progression of erosive tooth wear in vulnerable patient populations.

Materials and Methods

Study Design

This study was a longitudinal observational analysis conducted at the Oral Health Research Institute of the Indiana University School of Dentistry (IUSD). A total of 32 subjects were enrolled in the study. Of these 32, 29 subjects had been previously diagnosed with dry mouth at The Center for Oral Diagnosis and Treatment, IUSD, or another IUSD clinic. The remaining 3 subjects were control subjects without a dry mouth diagnosis. It should be noted that the original study called for a larger control sample, but COVID restrictions prevented recruitment and enrollment of the number of patients originally expected. Nevertheless, when teeth are taken individually, the ultimate sample size conferred the power necessary to test hypotheses.

The surfaces of all incisors, canines, premolars, and first molars were examined and classified using the BEWE index based on the severity of existing ETW (score 0: no erosion, 1: loss of surface texture enamel, 2: enamel loss of <50% of surface area, 3: enamel loss of >50% of surface area). Subjects also completed a self-questionnaire about their diet and behavioral habits to identify factors that would put them at risk of ETW. With this information, subjects at a high risk for ETW were selected to participate in the study. The subjects' teeth were then evaluated for the objective outcome measurements of surface texture and enamel thickness at baseline, 3 months (M3), 6 months (M6), 9 months (M9), and 12 months (M12).

Study Participants

The Indiana clinical team led by Dr. Hara selected the study participants. Subjects were selected based on whether they met the required qualifications. Subjects being considered as high-risk for ETW had to have at least 8 BEWE scorable teeth, at least one ETW lesion (BEWE greater than or equal to 1), and have been previously diagnosed with dry mouth. Control subjects had to present with a salivary flow rate of greater than or equal to 0.8mL/min when stimulated and greater than 0.2mL/min not stimulated. Both control and high-risk subjects had to have indicated consumption of acidic agents in their dietary questionnaire. If the study dentist determined a subject had any untreated cavities or periodontal disease, they were not allowed to participate further in the study.

The assumed number of teeth per subject was 8, and the sample size calculation estimated a need for the participation of 68 subjects. 60 of these subjects would need to have a dry mouth diagnosis and 8 would need to have normal salivary flow (controls). For subjects at a high risk for ETW (dry mouth), an estimated 10% were BEWE 3, 20% were BEWE 2, 30% were BEWE 1, and 50% were BEWE 0.

Clinical Study Procedures

First, researchers from the Indiana University School of Dentistry collected the medical history, consent, dietary, and behavioral habit questionnaires from study participants. Examiners from the Indiana University School of Dentistry determined whether an individual could participate in the study after examining their oral tissues and assigning their BEWE scores. Individuals qualified to participate in the study then had impressions taken to create the CP-OCT tray guides and returned a week later for their initial (baseline) visit. At the baseline and month 12 follow-up visits, polyvinylsiloxane impression material (President Jet Regular and Light Body, Coltene/Whaledent AG, Altstätten, Switzerland) was used to create impressions of the mandibular and maxillary arches for each subject for surface texture analysis.

BEWE Scoring (Conducted by the Indiana clinical team, led by Dr. Anderson Hara)

The surfaces of all incisors, canines, premolars, and first molars were examined and classified using the BEWE index based on the severity of existing ETW (score 0: no erosion, 1: loss of surface texture enamel, 2: enamel loss of <50% of surface area, 3: enamel loss of >50% of surface area). Subjects also completed a self-questionnaire about their diet and behavioral habits to identify factors that would put them at risk of ETW. With this information, subjects at a high risk for ETW were selected to participate in the study. The subjects' teeth were then evaluated for the objective outcome measurements of surface texture and enamel thickness at baseline and 12 months (M12).

Enamel Thickness Analysis (conducted by the Indiana clinical team, led by Dr. Anderson Hara)

Custom CP-OCT imaging tray guides were made for each subject. Little holes were created in these trays at the area of focus of the buccal surface (central middle third of the surface). Red nail varnish was applied to the outline of these holes to make focusing on the correct area of a subject's mouth easier. Each subject maintained the same CP-OCT imaging tray guide for the entirety of the study.

In addition, a portable dental CP-OCT system with a handheld probe (Santec Inner Visions IVS-300-S-L-C; Santec Corp., Komaki, Japan) was used to produce three-dimensional enamel scans. The system contained a swept source laser with a center wavelength of 1310 ± 30nm, high scan rate of 30kHz, maximum lateral probe scanning area of 5 x 5mm, and a working distance of 1mm. These scans were generated by trained clinical researchers.

Surface Texture Analysis (University of Arkansas)

The surface texture analysis was performed as a collaboration between myself, Camille Kita, Dylan Elkington-Stauss, and Troy Bartels (all UA honors students). I scanned and analyzed a total of 176 surfaces. A total of n = 584 teeth were analyzed by the Ungargrad clinical team, of which I personally scanned, measured, and analyzed 176 specimens.

We received the impressions of each subject's dental arches and scanned each surface using white-light scanning confocal profilometry (Neox, Sensofar LLC, CT, USA) to generate a point cloud. The scans focused on the central area of the middle third of the buccal surface. The planimetric work envelope for each scan was 242 x 181μm^2 with a lateral point spacing of

0.17µm in directions x and y. The vertical step was 0.2µm and resolution of less than 2nm and was used to measure three locations in this area. After these scans were captured, I analyzed them using surface texture analysis software, MountainsMap 8 (Digital Surf, Besançon, France) with an additional dental microwear texture analysis module on a computer. The measurements of area-scale fractal complexity (7) (Asfc (complexity)) and; ISO 25178 standards for texture aspect ratio (Str (anisotropy)), and arithmetical mean height (Sa (roughness)) were calculated for the point clouds by the software. They were then used to characterize the scale-sensitive complexity, anisotropy, and roughness of the buccal surface. These variables were used because prior findings support their ability to distinguish dental wear types by surface texture (8, 9, 10).

Statistical Analyses (conducted by Dr. George Eckert of the Department of Biostatistics at the Indiana University School of Medicine)

Associations between microwear texture attribute values (Asfc, Str, Sa) and both BEWE scores and enamel thickness measurements were evaluated using Spearman correlation coefficients. Linear mixed-effects models created from the longitudinal follow-up assessments were used to track changes in surface texture and enamel thickness. Teeth with changes in BEWE were compared to those without in follow-up. The number of teeth in each group with changes in surface texture and enamel thickness parameters were compared using a linear mixed-effects model. All test results were assessed using a two-tailed 5% significance threshold.

Results

The study included a total of 32 subjects. 29 of these subjects had dry-mouth diagnoses and 3 subjects did not have dry-mouth diagnoses (control). 9 of the 29 subjects with dry mouth had normal unstimulated salivary flow rates and 18 of the 29 had normal stimulated salivary flow rates. 597 teeth were scorable for BEWE at the baseline assessments. Of these 597, 584 were able to be scanned for microwear textures (again, I personally scanned and analyzed 176 of these specimens). Enamel thickness analysis was completed on 531 of these teeth.

The BEWE scores for dry mouth subjects at baseline and M12 are listed in Table 1. For each surface, BEWE scores were higher at M12 than the baseline ($p < 0.001$). Enamel thickness decreased from baseline to M12, while Sa (roughness) and Str (anisotropy) increased. There was no change in Asfc (complexity). The results of the control subjects are included in Table S1. However, the control subjects' results were not used in any statistical analyses within the control group, or in comparison with the dry mouth patients because there were not enough recruited to participate in the study.

ETW Outcomes	Baseline	12 months	p-value
Asfc (complexity)	1.25 (0.80)	2.35 (5.94)	0.857
Sa (roughness)	207.04 (121.24)	375.61 (213.62)	<0.001
Str (anisotropy)	0.48 (0.17)	1.23 (1.35)	<0.001
Enamel Thickness	1060 (25)	1040 (25)	<0.001
$BEWE_{Buccal}$	0.88 (0.61)	1.08 (0.48)	<0.001

Table 1. Erosive tooth wear (ETW) outcomes (mean and standard deviation) at baseline and 12 months in dry-mouth subjects.

Table 2 compares the data of each testing parameter at baseline and M12. Asfc correlated with both Str and BEWE. Sa correlated significantly with Str and BEWE. However, it only correlated with the baseline of Asfc, not M12.

ETW Outcomes		Baseline			M12		
		N	r	p-value	N	r	p-value
Asfc	Sa	584	0.63	<0.001	440	0.04	0.464
	Str	584	0.12	0.005	473	-0.42	<0.001
	Enamel Thickness	506	-0.02	0.676	491	-0.08	0.090
	$BEWE_{Buccal}$	584	-0.11	0.006	506	0.09	0.046
Sa	Str	584	0.27	<0.001	391	0.22	<0.001
	Enamel Thickness	506	-0.01	0.889	417	0.09	0.071

	$BEWE_{Buccal}$	584	-0.14	0.001	428	-0.13	0.007
Str	Enamel Thickness	506	0.07	0.104	445	0.17	<0.001
	$BEWE_{Buccal}$	584	-0.04	0.398	459	-0.14	0.002

Table 2. Comparison between microwear parameters, and between each and enamel thickness and BEWE results from baseline and M12.

The comparisons of each of the longitudinal changes of the individual testing parameters are listed in Table 3. The comparisons revealed that ΔAsfc (change in complexity) correlated with ΔStr (change in anisotropy), ΔSa (change in roughness), and ΔBEWE. ΔSa (change in roughness) correlated with both ΔStr and ΔBEWE. ΔStr correlated with ΔBEWE, and none of the changes in the surface texture parameters (Asfc, Str, Sa) correlated with enamel thickness.

ETW Outcomes		N	r	p-value
ΔAsfc	ΔSa	429	0.17	0.001
	ΔStr	460	-0.34	0.001
	ΔEnamel Thickness	430	0.09	0.065
	$\Delta BEWE_{Buccal}$	494	-0.15	0.001
ΔSa	ΔStr	380	0.23	<0.001
	ΔEnamel Thickness	373	0.09	0.075
	$\Delta BEWE_{Buccal}$	418	0.16	0.001
ΔStr	ΔEnamel Thickness	387	0.02	0.643
	$\Delta BEWE_{Buccal}$	447	0.16	<0.001
ΔEnamel Thickness	$\Delta BEWE_{Buccal}$	472	0.03	0.473
$\Delta BEWE_{Buccal}$	$\Delta BEWE_{Occlusal}$	129	0.15	0.100
	$\Delta BEWE_{Lingual}$	518	0.32	<0.001
	$\Delta BEWE_{Max}$	553	0.61	<0.001

Table 3. Overall correlations between change (Δ) (M12- Baseline) in ETW outcome measurements.

Finally, comparisons of the ETW outcomes (parameters) were made between teeth with and without ETW progression between baseline and M12 and are listed in Table 4. Whether or not a tooth presented ETW progression was determined by BEWE examinations. These comparisons revealed that there were no significant differences in the change of surface texture complexity (ΔAsfc) or change in enamel thickness over time. However, teeth with more ETW progression (higher BEWE score) showed a larger change in Str and Sa than teeth with no ETW progression.

ETW Outcomes	BEWE Increase	N	Mean (SD)	P-value
Asfc	No	362	0.60 (4.28)	0.77
	Yes	132	0.92 (6.97)	
Sa	No	309	137.32 (251.12)	0.006
	Yes	109	234.42 (246.48)	
Str	No	322	0.65 (1.28)	<0.001
	Yes	125	1.28 (1.45)	

Table 4. Comparisons between teeth with vs without BEWE changes (M12-baseline).

The MountainsMap 8 software also generated images of the surface texture of the teeth. Figure 1 is an image of the surface texture of a tooth (subject 0031 LL3) at the baseline visit analyzed by Dylan Elkington-Stauss. Figure 2 is an image of the same tooth surface (subject 0031 LL3) at the month 12 visit that I analyzed. There is a visible difference in the surface texture of the tooth from baseline to M12.

Figure 1. S0031 LL3 Dylan Elkington-Stauss

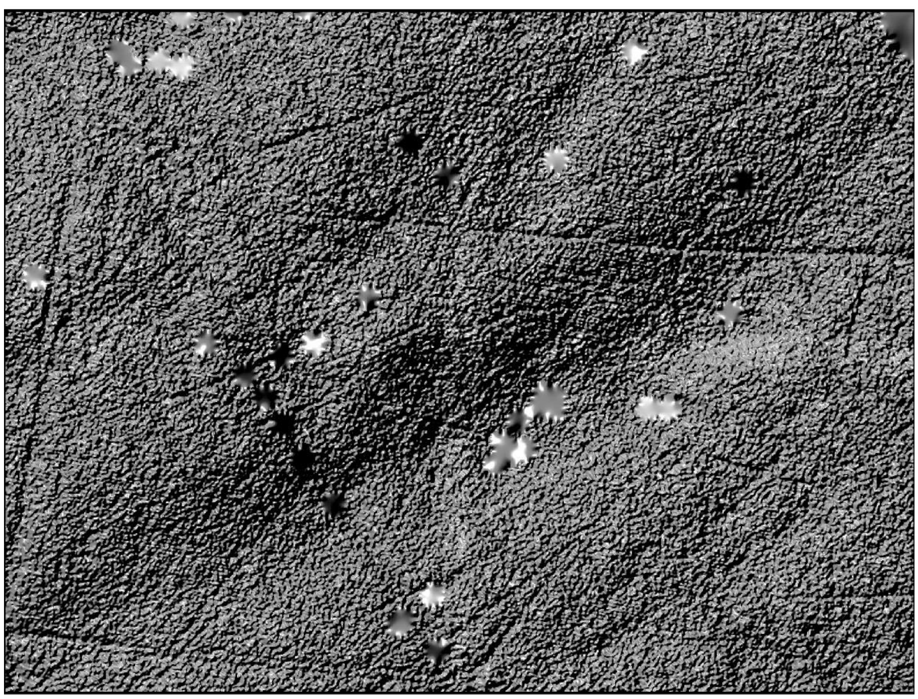

Figure 2. S0031 Elizabeth Wewers

Discussion

The traditional approach to ETW assessment (BEWE) is subjective and qualitative, so there can be inconsistencies between clinicians in scoring. Furthermore, by the time BEWE reveals ETW, there has been substantial damage done to the teeth. A quantitative, non-invasive, inexpensive, and quick method of ETW assessment is needed for diagnosis and monitoring to improve patient outcomes. The results of this thesis underscore the notion that microwear texture analysis might provide a viable approach. Significant associations between ETW and microwear textures clearly support further exploration of this approach for clinical application.

Previous in vitro and in situ studies conducted outside of a clinical setting supported the use of enamel thickness and dental microwear texture parameters (Asfc, Str, Sa) to monitor and detect ETW lesion progression (8, 11, 12, 13). However, these previous studies were limited in their applicability because laboratory and experimental controls did not replicate clinical settings. The present study compared the objective outcome measurements to subjective BEWE index assessments in a clinical setting.

This study was limited from the original scope; because of recruitment restrictions related to Covid-19. The original intent was a longitudinal study with baseline and 3, 6, 9, and 12 months, and comparison of individuals previously diagnosed with hyposalivation (at a higher risk of ETW) with a control group (no hyposalivation). The control group (no hyposalivation) sample size was too small for statistical analysis in the end, as were the 3, 6, and 9 month samples. On the other hand, the number of teeth sampled was sufficient for comparison of hyposalivation patients at baseline and 12 months. Still, this lower enrollment number could have limited the amount of representation of variation between individuals in this study. On the other hand, the ETW is so varied between each tooth surface within individuals that it justifies moving toward a sample size based on tooth number ($n = 584$) instead of subject number.

In this study, all surfaces of every tooth were scored with BEWE, and the $BEWE_{Buccal}$ score was compared to the objective outcome measures (enamel thickness, surface texture). There was a significant increase in the BEWE scores ($p < 0.001$) of the hyposalivation population from baseline to M12 that indicated progression in ETW. Though significant, the mean increase was less than what had been anticipated in a high-risk population following one year. In the future, a longer study duration would be advantageous in discerning those at high and low risk for ETW progression.

The results of this study can be directly compared with those of the previously published laboratory/experimental study (12) of relationships between ETW and microwear texture attributes. In the previous study, Sa and Asfc increased with ETW, but Str did not (12). In the current clinical study, Sa values were higher in both control and M12 samples with higher BEWE scores, but Asfc and Str were not. On the other hand, when considering change in texture values between baseline and M12 follow-up (ΔAsfc, ΔStr, ΔSa), all three microwear attributes showed significant change with increasing BEWE between baseline and follow-up M12.

These results support the use of changes in Str, perhaps Asfc, and especially Sa as objective outcome measures to diagnose and monitor ETW. However, the fact that ΔAsfc tracked with change in BEWE score between baseline and M12 (Table 3) but Asfc was not correlated with BEWE *within* the baseline or M12 samples (Table 2) is confusing. Also, the fact that Str but not Asfc varied with BEWE in each sample and the opposite was the case in the previous laboratory/experimental study requires further study to explain. Hopefully, studies with more patient enrollment, a longer duration, and a smaller sampling interval will help clarify these apparent inconsistencies and allow microwear texture analysis to reach its potential for monitoring and diagnosing erosive tooth wear.

Conclusion

This study confirmed that surface roughness (Sa) and anisotropy (Str) can be used as an objective outcome measure to identify ETW progression and lesion severity at least on par with the subjective standard today, the BEWE index. That despite the limitations of the clinical study to diagnose and monitor ETW. In the future, studies that contain a larger and more diverse subject sample and contain repeat follow-up samplings at different time intervals should be used to get a better handle on the limits of Sa and Str for monitoring. Nevertheless, it is clear that microwear texture analysis holds promise for clinical diagnosing and monitoring of ETW in vulnerable patient populations and can potentially provide an inexpensive, non-invasive, and objective measure of its progress.

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Supplementary Materials

These are the raw data entries of the teeth I analyzed:

Screening #	Visit	Tooth #	# of teeth: 7	Sa micrometers	Str	asfc	done
S0015	M12	UR6	wont scan				
S0015	M12	[redacted]					
S0015	M12	UR4	wont scan				
S0015	M12	UR3	done	0.1825	0.2128	2.996	x
S0015	M12	[redacted]					
S0015	M12	UL1	done	0.1724	0.1751	2.136	x
S0015	M12	UL2	done	0.1391	0.2372	1.16	x
S0015	M12	UL3	done	0.1958	0.2054	1.659	x
S0015	M12	UL4	done	0.2522	0.3146	1.103	x
Screening #	**Visit**	**Tooth #**	**# of teeth: 24**	sa	str	asfc	done
S0023	M12	UR6	done	0.3979	0.6874	3.782	x
S0023	M12	UR5	done	0.3013	0.5315	4.276	x
S0023	M12	UR4	done	0.1065	0.3709	1.111	x
S0023	M12	UR3	done	0.5466	0.696	2.52	x
S0023	M12	UR2	done	0.1235	0.4319	1.351	x
S0023	M12	UR1	done	0.2335	0.6955	2.433	x
S0023	M12	UL1	done	0.08811	0.5444	1.249	x
S0023	M12	UL2	done	0.2485	0.3288	1.537	x

S0023	M12	UL3	done	0.1602	Not measured	1.507	x
S0023	M12	UL4	done	0.3095	0.4269	2.177	x
S0023	M12	UL5	done	0.1628	0.4477	2.047	x
S0023	M12	UL6	done	0.3422	0.515	1.668	x
S0023	M12	LR6	wouldnt scan	x	x	x	x
S0023	M12	LR5	done	0.1038	0.4896	1.917	x
S0023	M12	LR4	done	0.07711	0.4423	1.138	x
S0023	M12	LR3	done	0.2045	0.5031	1.506	x
S0023	M12	LR2	done	0.138	0.6947	3.545	x
S0023	M12	LR1	done	0.4213	0.6748	1.979	x
S0023	M12	LL1	wouldnt scan	x	x	x	x
S0023	M12	LL2	done	0.1526	0.4728	1.354	x
S0023	M12	LL3	done	0.08383	0.3248	1.103	x
S0023	M12	LL4	done	0.06549	0.4222	1.172	x
S0023	M12	LL5	done	0.1155	0.1606	1.244	x
S0023	M12	LL6	done	0.1862	0.7876	2.825	x
Screening #	**Visit**	**Tooth #**	**# of teeth: 18**				
S0024	M12	UR6	done	0.8959	0.4763	3.151	x
S0024	M12	[redacted]					
S0024	M12	[redacted]					
S0024	M12	UR3	done	0.1735	0.4687	1.424	x
S0024	M12	UR2	done	0.1344	0.3331	1.417	x

S0024	M12	UR1	wouldn't scan	x	x	x	x
S0024	M12	UL1	done	0.3023	0.238	5.907	x
S0024	M12	UL2	done	0.4133	0.3912	2.644	x
S0024	M12	UL3	done	0.4229	N/A	2.313	x
S0024	M12	[redacted]					
S0024	M12	UL5	wont scan	x	x	x	x
S0024	M12	UL6	won't scan	x	x	x	x
S0024	M12	[redacted]					
S0024	M12	LR5	done	0.2081	N/A	1.791	x
S0024	M12	[redacted]					
S0024	M12	LR3	done	0.1494	0.5855	1.856	x
S0024	M12	LR2	done	0.4586	0.664	3.919	x
S0024	M12	LR1	done	0.4265	0.5548	1.562	x
S0024	M12	LL1	done	0.2535	0.2766	2.021	x
S0024	M12	LL2	done	0.7131	0.7595	2.862	x
S0024	M12	LL3	done	0.1408	0.6268	1.356	x
S0024	M12	[redacted]					
S0024	M12	LL5	wont scan	x	x	x	x
S0024	M12	LL6	wont scan	x	x	x	x
Screening #	**Visit**	**Tooth #**	**# of teeth: 23**	sa	str	asfc	done
S0025	M12	UR6	not enough surface to scan				
S0025	M12	UR5	done	0.2644	0.4012	N/A	x
S0025	M12	UR4	done	0.06817	0.6132	0.8757	x

S0025	M12	UR3	done	59.07	N/A	0.4862	x
S0025	M12	UR2	done	0.1619	N/A	1.283	x
S0025	M12	UR1	done	0.06729	0.1686	0.8967	x
S0025	M12	UL1	done	0.4193	N/A	2.832	x
S0025	M12	UL2	done	0.09184	0.4866	1.06	x
S0025	M12	UL3	done	0.09929	N/A	0.9424	x
S0025	M12	UL4	done	0.1242	0.2133	0.7915	x
S0025	M12	UL5	wont scan				
S0025	M12	[redacted]					
S0025	M12	LR6	done	0.1028	0.6057	0.8023	x
S0025	M12	LR5	wouldnt scan				
S0025	M12	LR4	done	0.0846	N/A	0.5821	x
S0025	M12	LR3	done	0.1024	0.6623	0.5755	x
S0025	M12	LR2	done	0.1251	N/A	0.7501	x
S0025	M12	LR1	done	0.08582	0.3402	0.9311	x
S0025	M12	LL1	done	0.1081	0.6565	1.52	x
S0025	M12	LL2	done	0.07381	0.3319	1.242	x
S0025	M12	LL3	done	0.5409	0.6686	0.9185	x
S0025	M12	LL4	done	0.1027	0.4947	0.9238	x
S0025	M12	LL5	done	0.1986	0.3183	0.7465	x
S0025	M12	LL6	done	0.1041	0.3692	1.296	x
Screening #	**Visit**	**Tooth #**	**# of teeth: 16**				
S0026	M12	[redacted]					

S0026	M12	[redacted]					d
S0026	M12	[redacted]		sa	str	asfc	one
S0026	M12	UR3	wont scan				
S0026	M12	UR2	done	0.2051	0.5765	2.063	x
S0026	M12	UR1	done	0.1949	0.4665	2.397	x
S0026	M12	UL1	done	0.1034	0.2779	2.383	x
S0026	M12	UL2	done	0.697	N/A	7.877	x
S0026	M12	UL3	done	0.0855	0.1953	2.167	x
S0026	M12	UL4	done	0.07021	0.1635	2.481	x
S0026	M12	[redacted]					
S0026	M12	[redacted]					
S0026	M12	[redacted]					
S0026	M12	[redacted]					
S0026	M12	LR4	done	0.1773	N/A	4.143	x
S0026	M12	LR3	done	0.6486	0.2421	4.001	x
S0026	M12	LR2	done	0.4317	N/A	3.743	x
S0026	M12	LR1	done	0.2455	0.548	3.944	x
S0026	M12	LL1	done	0.1121	0.4656	2.458	x
S0026	M12	LL2	wouldnt scan				
S0026	M12	LL3	done	0.1142	0.2821	2.691	x
S0026	M12	LL4	done	0.1231	0.6763	2.843	x
S0026	M12	LL5	done	0.9954	N/A	2.015	x

Screening #	**Visit**	**Tooth #**	**# of teeth: 17**	sa	str	asfc
S0029	M12	UR6	done	0.554	0.5161	2.645
S0029	M12	UR5	done	0.6989	0.4014	2.71
S0029	M12	UR4	done	1.169	N/A	4.943
S0029	M12	[redacted]				
S0029	M12	[redacted]				
S0029	M12	[redacted]				
S0029	M12	[redacted]				
S0029	M12	[redacted]				
S0029	M12	[redacted]				
S0029	M12	UL4	done	0.6732	N/A	3.659
S0029	M12	UL5	done	0.6761	N/A	3.347
S0029	M12	UL6	yes but bad scan	3.124	N/A	2.875
S0029	M12	LR6	done	0.2238	0.3107	2.302
S0029	M12	LR5	done	0.2961	0.4321	2.799
S0029	M12	LR4	done	0.2367	N/A	3.121
S0029	M12	[redacted]				
S0029	M12	LR2	done	1.926	N/A	4.363
S0029	M12	LR1	done	0.7223	N/A	1.946
S0029	M12	LL1	done	0.8207	N/A	3.072
S0029	M12	LL2	done	0.7124	N/A	3.386
S0029	M12	LL3	done	0.4933	N/A	2.541
S0029	M12	LL4	done	0.5368	0.4122	2.571

S0029	M12	LL5	done	0.5195	0.3745	2.793
S0029	M12	LL6	done	0.5093	0.5486	3.26

Screening #	**Visit**	**Tooth #**	**# of teeth: 14**	Sa	Str	Asfc
S0031	M12	[redacted]		sa	str	asfc
S0031	M12	UR5	done	0.1731	0.7808	3.586
S0031	M12	UR4	done	0.1713	0.1445	4.454
S0031	M12	UR3	done	0.6269	N/A	5.447
S0031	M12	[redacted]				
S0031	M12	[redacted]				
S0031	M12	[redacted]				
S0031	M12	[redacted]				
S0031	M12	UL3	done	0.6477	N/A	4.199
S0031	M12	UL4	done	0.1849	0.3229	3.457
S0031	M12	UL5	done	0.1444	0.6491	3.462
S0031	M12	UL6	done	0.4434	N/A	4.268
S0031	M12	[redacted]				
S0031	M12	LR5	done	0.1241	N/A	3.13
S0031	M12	LR4	done	0.1201	0.304	2.799
S0031	M12	LR3	done	0.1646	0.3198	4.26
S0031	M12	LR2	done	0.3137	0.3592	2.773
S0031	M12	LR1	wont scan			
S0031	M12	[redacted]				
S0031	M12	[redacted]				

S0031	M12	LL3	done	0.5393	N/A	4.336
S0031	M12	LL4	done	0.5608	N/A	3.385
S0031	M12	[redacted]				
S0031	M12	[redacted]				
Screening #	**Visit**	**Tooth #**	**# of teeth: 16**	sa	str	asfc
S0032	M12	UR6	wont scan			
S0032	M12	UR5	terrible scan	1.763	N/A	3.411
S0032	M12	UR4	done	0.3407	0.1761	2.646
S0032	M12	UR3	done	0.2553	0.263	2.977
S0032	M12	[redacted]				
S0032	M12	[redacted]				
S0032	M12	[redacted]				
S0032	M12	UL2	done	0.1815	N/A	2.904
S0032	M12	UL3	done	0.3406	0.2077	2.748
S0032	M12	UL4	done	0.163	0.4492	2.505
S0032	M12	[redacted]				
S0032	M12	[redacted]				
S0032	M12	[redacted]				
S0032	M12	LR5	done	0.1968	N/A	1.737
S0032	M12	LR4	done	0.5308	0.351	2.713
S0032	M12	LR3	done.	0.6259	0.7775	2.651
S0032	M12	[redacted]				
S0032	M12	[redacted]				

S0032	M12	LL1	wont scan			
S0032	M12	LL2	done	0.7871	0.2607	3.826
S0032	M12	LL3	done	0.3018	N/A	2.308
S0032	M12	LL4	done	0.2694	N/A	2.472
S0032	M12	LL5	done	0.1316	0.3372	2.891
S0032	M12	LL6	done	0.4369	0.7297	2.952
Screening #	**Visit**	**Tooth #**	**# of teeth: 17**			
S0034	M12	[redacted]				
S0034	M12	[redacted]				
S0034	M12	[redacted]		sa	str	asfc
S0034	M12	UR3	done	0.2583	0.2512	3.473
S0034	M12	UR2	done	0.2013	0.7632	3.227
S0034	M12	UR1	done	0.212	0.3906	2.265
S0034	M12	UL1	done	0.1547	0.2701	2.32
S0034	M12	UL2	done	0.3085	0.7894	2.701
S0034	M12	UL3	done	0.3924	0.5536	2.288
S0034	M12	UL4	done	0.2282	N/A	2.09
S0034	M12	UL5	done.	0.3987	N/A	2.685
S0034	M12	UL6	done	0.2412	0.6363	3.949
S0034	M12	[redacted]				
S0034	M12	[redacted]				
S0034	M12	LR4	done	0.1839	0.5906	2.715
S0034	M12	LR3	done	0.1562	0.5368	2.72

S0034	M12	LR2	done	0.4135	N/A	2.645
S0034	M12	LR1	done	0.7134	0.8392	2.308
S0034	M12	LL1	done	0.7003	N/A	3.053
S0034	M12	LL2	done	0.3658	0.3601	3.1
S0034	M12	LL3	done.	0.5034	0.5604	3.705
S0034	M12	LL4	done	0.8365	N/A	4.041
S0034	M12	[redacted]				
S0034	M12	[redacted]				
Screening #	**Visit**	**Tooth #**	**# of teeth: 24**	sa	str	asfc
S0036	M12	UR6	done	0.1875	0.4186	2.303
S0036	M12	UR5	done	0.243	0.7599	3.305
S0036	M12	UR4	done	0.1664	0.7357	2.488
S0036	M12	UR3	done	0.1201	0.6455	3.474
S0036	M12	UR2	done	0.1952	0.6565	2.583
S0036	M12	UR1	done	0.1162	0.4342	2.377
S0036	M12	UL1	done	0.09637	0.1466	2.582
S0036	M12	UL2	done	0.09268	N/A	2.137
S0036	M12	UL3	done	0.07895	0.5124	2.771
S0036	M12	UL4	done	0.1974	0.7576	3.643
S0036	M12	UL5	done	0.284	0.5749	2.999
S0036	M12	UL6	done	0.2152	0.5287	2.533
S0036	M12	LR6	done	0.3235	0.5601	2.873
S0036	M12	LR5	done	0.512	N/A	2.129

S0036	M12	LR4	done	0.1189	0.5786	2.134
S0036	M12	LR3	done	0.3681	0.8866	2.777
S0036	M12	LR2	wont scan			
S0036	M12	LR1	done	0.2752	0.6913	2.816
S0036	M12	LL1	done	0.1736	0.4379	3.314
S0036	M12	LL2	done	0.3385	0.6332	3.028
S0036	M12	LL3	wont scan			
S0036	M12	LL4	done	0.1713	N/A	1.788
S0036	M12	LL5	done	0.0982	0.602	3.406