Clinical Study Regarding the Property of Composite Resin, Sealants, using VISTACAM iX

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Purpose of the articleto carry out an epidemiological study on the use of sealing as a method of preventing dental caries and to assess the tightness and integrity over time of composite resins used to seal pits and fissures using the VistaCam iX intraoral fluorescence camera. Based on the premise that dentists do not have enough confidence in sealing pits and fissures as a method of preventing dental caries, we assessed if sealing is used in current practice as a prevention metod of tooth decay, and we measured, with high performance intraoral camera such as the VistaCam iX device, the tightness and integrity of composite resin seals.

Keywords: sealing, resin composite, intraoral fluorescence, preventive, caries risk, ICCDAS

Although sealing of pits and fissures is included by WHO among the four methods of dental caries prevention, general and local fluoridation, food hygiene and oro-dental hygiene, being the most effective prophylactic method against occlusal caries, [1] it is still insufficiently applied in current medical practice by dentists in Romania[1,2]. A Cochrane systematic review of 16 trials found that first permanent molar teeth sealed with resin-based sealant had 78% less caries on occlusal surfaces after 2 years and 60% less after 4-4.5 years compared to unsealed molars.[3]

The relief of the occlusal surfaces of the lateral teeth, as a possible contributing element to the occlusal caries, has attracted the attention of dental practitioners since the beginning of the last century. Clinical observations have led to the idea that tooth decay is directly related to the shape and depth of the occlusal pits [3-5].

Dental sealants were introduced in the 1960s as part of the preventive dental programs. Sealing is a method widely described in literature as a simple, safe and effective clinical procedure in terms of cost / benefit and, therefore, it is highly recommended. The longevity of sealant coverage defines the effectiveness of sealants [6,7]. Among the determinants for sealant retention, an incomplete removal of plaque debris can cause lack of adhesion at the sealant-enamel interface [4-7]. To prevent marginal gap and secondary caries, it is extremely important to remove the biofilm extremely well before applying the sealing material. The adhesion and retention of the sealing material are essentially derived from the micromechanical interlock since there is very little chemical interaction between the resin and the enamel. Different procedures for treating enamel and dentin are currently under discussion to optimize penetration of the material into fissures and good adhesion to the cavity walls [8-10].

According to Siegel, before making a seal, we must keep in mind the followingkey positions.Among other recommendations:

1. Caries risk assessment of the individual and the tooth are important as determinants of sealant need.

2. Caries risk on surfaces with pits and fissures may continue into adulthood; therefore, post-eruptive age alone should no longer be used as a major criterion for sealant decisions. 3. Sealants should be used to prevent caries in at-risk teeth (preventive sealants). 4. Sealants should be used to treat teeth with questionable caries or definite caries confined to the enamel pits and fissures (therapeutic sealants). 5. Sealed teeth need to be evaluated periodically for sealant integrity and retention.

The necessity of recall and maintenance for sealants is based on an understanding that partial loss of sealant leads to a surface equally at risk for caries than one never sealed [6,7, 11,12].

Another study of . Cochrane Oral Health Group show that after 2 years, 3.1% of the teeth sealed with Vitremer, 4.3% of the teeth sealed with Revolution, and 6.7% of the teeth sealed with Dyract Flow, were carious or filled. Caries was defined as active white spot lesion (translucent enamel alteration) or presence of a microcavity (diameter under 1.5 mm across fissure) or large cavity or filling. After 2 years, sealants were totally retained on 47% of the tooth surfaces sealed with Vitremer, on 76% of the teeth sealed with Revolution, and on 58% of teeth sealed with Dyract Flow Cochrane Oral Health Group.Of course, whenever we review literature studies, we must take into account the vital importance of patient behavior and how it respects oral hygiene instructions and physician's technique as significant factors in the success of sealing.Most of the time, working with very young patients can be extremely difficult, as they are mostly non-cooperative, and this can lead to ineffective sealing from the start.Some clinicians and some clinical investigators are not skilled with young patients, leading to a bias about the success of sealants on children. We must advocate for the acceptance of sealant placement on any tooth, primary or permanent, that is judged to be at risk for pit or fissure caries. The challenge, then, for any clinician is to provide the service in the most appropriate and correct way, working with the patient to assure patient compliance and careful methodology to the application of sealants, so sealant therapy should be a prominent recommendation [9,10,13].

The sealing of pits and fissures as a prophylactic measure is insufficiently used in Romania. The results of

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the largest population assessment campaign aged 6-12 years (byDumitrache A.) show that only 8.5% of the children examined had sealing at the molars [1,2].The management of pits and fissures for caries prevention has become a complex topic indentistry, a subject that involves the confluence of research data in various fields such as dentalmaterials, diagnosis, caries epidemiology, microbiology. Planning the treatment of what was onceconsidered asimplesealing now involves a series of decisions such as:

- the risk assessment for the patient, tooth and occlusal surface;
- How to prepare the pits and fissures surfaces (if the prepatioan is indicated)
- What tipe of bonding to use?
- What sealing material to use?
- How to maintain the sealing?

An important parameter in the evaluation of the clinical success of sealant materials is the marginal adaptation, mainly at the sealant margin. Etching procedures might increase adhesion to enamel of sealant materials, allowing better marginal adaptation . The presence of a marginal gap can lead to marginal staining, which can be considered the first sign of sealant failure . Marginal gap may also imply that there is no occlusal surface isolation against oral microorganisms and, consequently, risk for the development of dental caries is increased. Traditional methods of evaluating the integrity of the dental sealants, such as visual and probing inspection, have been found to have far from optimal performance. These methods cannot identify gaps, adaptation or failures into the internal structure of sealants, which can cause des-adaptation, infiltration and loss of material [8-13].

Visual inspection, though essential for tooth surface evaluation, also shows low sensitivity andspecificity. Tactile examination employs a sharp probe exploring occlusal surfaces to assess tooth texture and/or shape but is not able to detect the deeper pit and fissure lesions; furthermore, some authors demonstrated that pressure used to analyze tooth surfaces may generate iatrogenic damage. The limit of the traditional tactile/visual inspection is the subjective judgment andit is also required a proper competence of the examiners, in order to obtain an objective evaluation of the dental surfaces without leading to mistakes due to pigmented or fluorosis areas or DDE (developmental defects of enamel) , that could trick the eye of not enough experienced clinician. Currently, for the diagnosis of initial carious lesions is employed the dental caries examination criteria ICDAS II(International Caries Detection and Assessment System, through training/ calibration sessions, has standardized traditional visual/ tactile methods to achieve a high inter and intra-examiner reliability. It was created by the need to systematize the scientific international literature results [8,12-14,].

Sealing materials

In addition to preventing caries on teeth surfaces, sealants are in-creasingly considered as an active agent in controlling and manag- ing caries on the occlusal and approximal surfaces (Splieth 2010). The first material used for pit and fissure sealing was methyl cyanoacrylate (Cueto 1967). Later, a viscous resin (BIS-GMA) was developed by Buonocore (1970) and this material formed a basis for the development of numerous resin-based sealants/ composites available today. Later, in the 1990s, novel materials called compomers (polyacid-mod- ified composite resins) were introduced (Nicholson 2007; Ruse 1999).[12,13]

Glass ionomer sealing materials are made from glass ionomeric cements and can be chemically bonded to the structure of the teeth. These materials are widely used because of their fluoride release properties. They have the advantage of being less sensitive to moisture, making them a potential alternative to resin-based sealants when moisture control is a problem. However, the tooth retention rate decreased compared to resin based materials (Simonsen 2002). Materials with glass ionomers may be conventional (chemically treated) or modified, in which conventional GICs are combined with component resins that are treated with light (Anusavice 2013, Arrondo 2009) [12,13].

Hybrid sealing materials, such as compomers and giomers, are a combination of resins and GIC. The composites are poly-acid-modified composites and the giomers are urethane resin fluorinated materials containing pre-reacted glass ionomeric filler particles (Carol 2015). These are relatively newer materials, and data on their cavity preventive effects are limited [12].

The resin-based sealing materials can be classified into four generations based on their content and the polymerization method. The first generation materials were activated with cyanoacrylates using a 365 nm ultraviolet light source. Due to degradation observed in the oral cavity over time, these sealing substances are no longer available (Pinkham 2005). The second generation of resin sealants contain BIS-GMA or products based on urethane dimethacrylate, which are self-polymerising or chemically treated (Donly 2002, Pinkham 2005). Third-generation sealing material contains a di-ketone initiator and a reducing agent for initiating polymerization and is visible with activated light (Sanders 2015). Fourth generation materials are based on fluorine-releasing resins, which have a potential extra benefit in caries prevention (Donly 2002) [12,13].

Experimental part

Materials and methods

In this study,wereexaminated 59 dental units (molars and premolars) from a group of patients aged 6-13 years, girls and boys. The inclusion criteria in the study were: - age 6-13 years old; - to present molars and premolars with sealings of pits and fissures and made with resin materials 3 to 24 months ago; - good oral hygiene;-without general illness.Patients whose dental surfaces were with enamel defects and poor oral hygiene were excluded from this group. Patients who met the study criteria completed and signed the study agreement. We made the anamnesis to record dental history and to determine the sealing age. After the endooral clinical examination, dental units for analysis were established.

For this study we used the intraoral fluorescent camera with autocalibration function, VistaCam iX, Durr Dental, Bietigheim-Bissingen, Germania, that presents a database software support for the electronic recording of the patient and the following interchangeable heads.

Cam interchangeable head for intraoral images:

-Macro interchangeable head for magnifying images 120x

-Proof interchangeable head makes caries and plaque visible on occlusal and smooth surfaces

-Proxi interchangeable head helps diagnose approximal caries

-Polymerisation interchangeable head for light hardening

The dental units set for the study were analyzed with VistaCamiX Macro, which features 470000 pixel resolution, 120x zoom and 8 LEDs and VistaCamiX Proof with 4 LEDs and 405 nm [12] that allows accurate localization of

carious activity and its depth. [11]The VistaCamiX camera ledssends a blue-violet high energy light beam at 405 nm on the occlusal surface of the tooth. At this wavelength, porphyrins produced by cariogenic bacteria senda red light that contains less energy as opposed to healthy enamel that emits a green light. Caries tissue and healthy tissue emit fluorescence at different intensities when excited by a light with different wavelengths.[10,11]Fluorescence is recorded by the camera, transferred and processed by a software (DBSWIN, DURR), and then saved. The digital image presents the different shades with numerical scores between 0 and 3, estimating the extent and depth of carious demineralization. Working with this principle, the VistaCamiX fluorescence camera can improve the diagnosis of so-called *hidden caries*. In particular, occlusive carious lesions of both permanent and temporary teeth, located behind an intact clinical area of the tooth, can be detected. This significantly improves the diagnosis and decision on the necessary treatment: observation, remineralization or invasive treatment [11, 15,16]. The device is easy to handle in general practice and provides a non-invasive occlusalcaries. After the establishment of the dental units, they were isolated, air-dried and evaluated with VistaCamiX Macro and Proof [10-12,15- 18].

The sealing material has been assessed, having the ICDAS (International Caries Detection and Assessment System) scoring system parameters - for the Macro interchangeable head and the DBSWIN program scale for Proof interchangeable head [8,11].

ICDAS It has been developed as an answer to the lack of a modern System, based in the evidence, oriented on prevention, that can be used for: Practice, Research, Epidemiology & Education. THIS SYSTEM was born from a wide International Group with collaboration of the academy, ORCA, FDI, ADA and NIH

ICDAS objectives are:

-To prevent new lesions from appearing

-To prevent existing lesions from advancing further

-To preserve tooth structure with:

-Non-operative care at more initial stages, and

-Conservative operative care at more extensive caries stages

-While managing risk factors &Recalling patients at appropriate intervals, with periodic monitoring and reviewing

ICDAS Sealing codes

0= not seald or restored

1= seald,partial

2= seald,full

ICDAS caries codes:

0= sound tooth surface

1= first visual change in enamel

2= distinct visual change in enamel

3=enamel breakdown, no dentine visible

4= dentinal shadow(non cavitated into dentine)

5= distinct cavity with visible dentine

6= extensive distinct cavity with visible dentine

In this study we used only ICDAS sealing codes and DSBWIN criteria.

DSBWIN assessment criteria

-<1 – green- sound enamel;

-1-1.5 – blue – initial caries,beginning enamel caries;

-1.5 - 2 red –enamel caries to enamel-dentine limit ;

-2 – 2.5 orange -dentine caries already passed ;

-> 2.5 yellow -deep dentin caries[11].

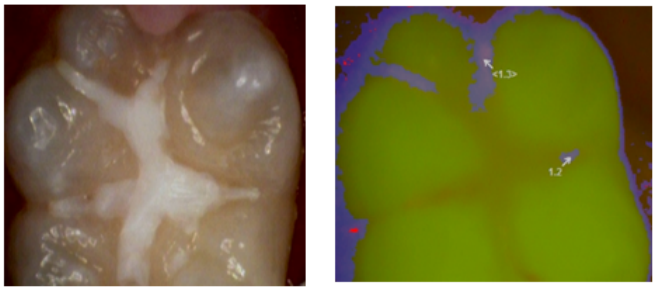

Fig.1 a) first molar inferior 4.6, sealing age 18 months, Image VistaCamiX Macro, b) Image VistaCamiX Proof, [15]ICDAS 14 = seald, partial , dentinal shadow (non cavitated into dentine)

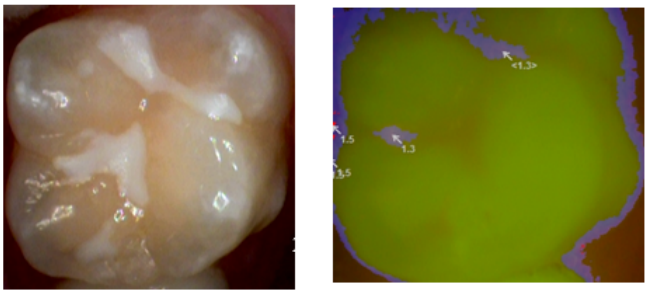

Fig.2 a)first upper molar 2.6 sealing age 12 months, Image VistaCamiX Macro, b) Image VistaCamiX Proof 1-1.5 – blue – initial caries,beginning enamel caries;[15] ICDAS 1A = seald, partial, first/ distinct change in enamel.

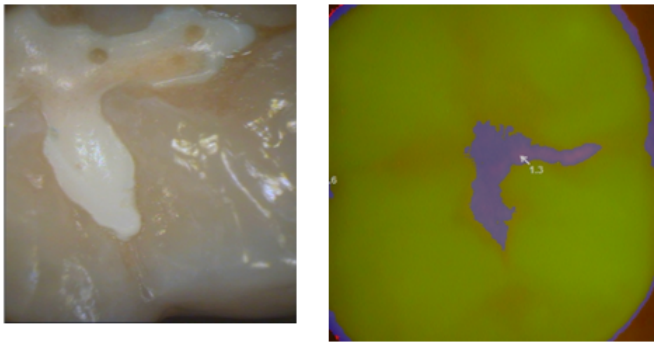

Fig.3 a) first inferior molar 4.6,sealing age 24months, image VistaCamiX Macro, b) Image VistaCamiX Proof 1-1.5 – blue – initial caries,beginning enamel caries; [15]ICDAS 13= seald, partial, 3=enamel breakdown, no dentine visible

Each patient participating in the study was given an evaluation sheet. Patients whose dental units have ICDAS code 2 have been recommended to return to control every six months, and those who have submitted sealing with marginal gap , marginal carious lesions or loss of sealing material have been recommended to restore sealing or restaurated, as the case.

In this study we want to see what is happening with the sealing material from composite resins in time (3, 6, 12, 18, 24 months), when it begins to lose its tightness and properties. After the teeth analysis, we found that at 3 and 6 months no sealing changes occurred, but already over 12 months, there are rare cases in which sealing is still tight and changes occur, including carious lesions. For this we gathered information from Preventive Dentistry Department from Faculty of Dental Medicine Timisoara, between march to nov. 2018 and we selected 59 dental unities, who qualified for this study.

The database was obtained using the Microsoft Excel program. For the statistical analysis we used the SPSSv25 and the Microsoft Excel software. In the first part we run same descriptive statistics analysis, grouping our patients after time periods, or dental unities. The aim of the study was to see if the time periods can influence the caries

Table 1

DESCRIPTIVE STATISTICS FOR THE TIME PERIOD VARIABLES

Statistics	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Range	Minimum	Maximum	Count
Time period	12	1.04	12	3	7.98	63.62	21	3	24	59

behavior. The database contains information about their dental unities, sealing age, results from VistaCamiX and Proof of VistaCamiX to perform an epidemiological study on the use of sealing as a method of dental caries prevention and to assess the tightness and integrity over time of composite resins used to seal ditches and fossils. From descriptive statistics we observe that our time period inspection is between 3 months and 24 months.

During time period mentioned above we inspected the following dental unities as describes the figure 4.

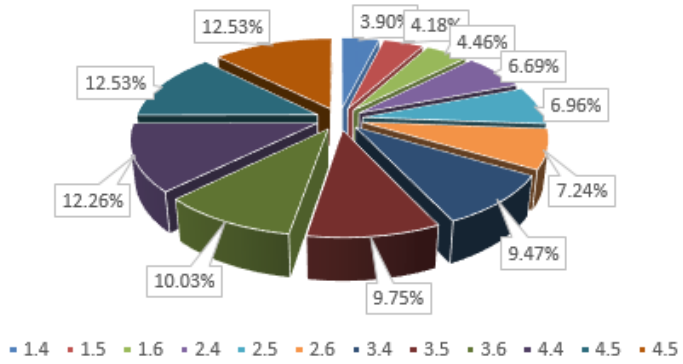

Fig. 4. The distribution of our dental unities inspected in our study

The next step after the data collection is to organize it into a meaningful form by constructing cross-tabulation tables and analysed using the chi-square test (χ^2). It allows us to have a glance at the entire data conveniently and it shows whether the observations are high or low and also whether they are concentrated in one area or spread out across the entire scale that we used.

For inspection with VistaCamiX Macro we used ICDAS II standard code: X_1X_2, where X_1 - is the ICDAS code for sealing: 0 - without seals or restorations; 1 – sealed partially; 2 - fully sealed and X_2 is the ICDAS code for carious lesions: 0 - healthy, undetectable dental surface after drying (5 s) and lack of any other non-carnal phenomena; 1- change in limited enamel to dyed and dyed stains visible only through drying; 2- visual distinct change in wet enamel, wider than the crack area and of pits (opacity or coloring); 3 - discontinuity of localized enamel, no visibly damaged dentin or shadowed underlying area; 4 - subjected shaded area located in dentine, with or without enamel discontinuity; 5 - cavity distinct from the visibility of the dentin, open cavity involving less than ½ of the surface; 6 - extensive cavity with dentine involvement, deep, as width implies more than ½ of the surface. Due to the insignificant difference between level 1 and 2 we have considered both cases together and we market it with *A* letter.

For VistaCamiX Proof inspection we used analysis scale of DBSWIN software and we classified the obtained results based on their scores according with the table 2:

Table 3 shows the cross-tabulation of the Vista Cam iX Macro and Vista Cam iX Proof and the applied standard scores described above for inspections.

Of the teeth examined with Vista Cam iX Macro,44.1% exhibited no visible sign of caries (20 code), most of the cases were detected in the between 3 and 6 months (see table 3). Dentine caries was detected in 5.1% of the teeth (14 code) during 18-24 months. The total number of surfaces were examinated also with Vista Cam iX Proof but the result concludes to 45.8% (green code) theets with no visible sign of caries and 6.8% (red code) theets with dentine caries in the same time period of inspections.

Cross tabulation of Vista Cam iX Macro and Proof with the reference standard is presented in Table 4 per dental unities inspected. According to the results obtained, 6.8% (n = 4) of the teeth had dentine caries on 3.6 and 4.6 dental unities in the months 18-24. In the same time, the study performend with Vista Cam iX Macro concludes that the 3.6, 4.6 but with different codes of classification which

Table 2

CLASSIFICATION OF FLUORESCENCE IMAGES, OBTAINED BY VISTA PROOF, ACCORDING TO THE DEPTH OF CARIES LESIONS

Color	Lesion depth	Classification according to the manufacturer	Classification
Green	<1	Healthy enamel	Absence of caries
Blue	1≤x<1.5	Early cavity lesion present on the surface of the enamel	Presence of caries
Red	1.5≤x<2	Carious lesion present at the enamel-dentine junction	Presence of caries
Orange	2≤x<2.5	Carious lesion present in the dentine underlying the junction	Presence of caries
Yellow	x≥2.5	Carious lesion present in deep dentin	Presence of caries

Table 3

CROSS TABLES DISTRIBUTION FOR VISTA CAM IX MACRO AND VISTA CAM IX PROOF INSPECTIONS/ TIME PERIOD

VistaCamiXMacro							
		Sealing age					
		3	6	12	18	24	**Total**
VistaCamiXMacro	1A	0	0	1	0	0	1 (1.7%)
	13	0	0	0	2	8	10 (16.9%)
	14	0	0	0	1	2	3 (5.1%)
	15	0	0	0	0	1	1 (1.7%)
	20	14	10	1	1	1	26 (44.1%)
	2A	0	3	8	6	0	18 (30.5%)
VistaCamiXProof							
		Sealing age					
		3	6	12	18	24	**Total**
VistaCamiXProof	Green	14	10	1	1	1	27 (45.8%)
	Blue	0	3	9	8	8	28 (47.5%)
	Red	0	0	0	1	3	4 (6.8%)

Code	Dental unities		Presence of caries	Absence of caries	
Vista iX Cam Macro					
1A	1.6	Count	0	1	1
		% of Total	0.0%	1.7%	1.7%
13	1.5, 1.6, 2.6, 3.5, 3.6, 4.5, 4.6	Count	0	10	10
		% of Total	0.0%	16.9%	16.9%
14	3.6, 4.6	Count	0	3	3
		% of Total	0.0%	5.1%	5.1%
15	3.6	Count	0	1	1
		% of Total	0.0%	1.7%	1.7%
20	1.4, 1.5, 1.6, 2.5, 2.6, 3.4, 3.5, 3.6, 4.4, 4.6	Count	26	0	26
		% of Total	44.1%	0.0%	44.1%
2A	4.6, 4.5, 4.4, 3.6, 3.5, 3.4, 2.6, 2.5, 1.5, 1.4	Count	0	18	18
		% of Total	0.0%	30.5%	30.5%
Vista iX Cam Proof					
Green	1.4, 1.5, 1.6, 2.4, 2.5, 2.5, 3.4, 3.5, 3.6, 4.4, 4.6	Count	27	0	27
		% of Total	45.8%	0.0%	45.8%
Blue	1.4, 1.5, 1.6, 2.5, 2.5, 3.4, 3.5, 3.6, 4.4, 4.5 4.6	Count	0	28	28
		% of Total	0.0%	47.5%	47.5%
Red	3.6, 4.6	Count	0	4	4
		% of Total	0.0%	6.8%	6.8%

Table 4
CROSS TABLES DISTRIBUTION FOR VISTA CAM IX MACRO AND VISTA CAM IX PROOF INSPECTIONS/ DENTAL UNITIES

means that the both results are clear and performed high accuracy of inspection. In the same time the result of absence of carries with the same inspections are slow different (with Vista Cam iX Macro we have all 12 dental unites studied in different time periods and for Vista Cam iX Proof we obtained 11 dental unities on specific time periods) (table 3 and 4).

Based on the aim of this study to assess the prevalenceof dental caries in different time periods and dental unties with different methods we applied statistical Chi-square test to evaluate and compare results. This first results for Pearson Chi-Square test for bivariate relationships between time period and dental unities (Predictor Variable) and model covariates for Vista Cam iX Macro and Vista Cam iX Proof, demonstratesthat was no statistically significant difference ($p>0.05$) between the accuracy of Vista Cam iX Macro and Proof for all dental unities.

Among the different examination methods for a higher confirmation of result we applied ROC Analysis—The AUC at all caries as shows the table 5. It is confirmed in all diagnostic methods no statistical significantly differences between AUCs caries categories ($p>0.05$).

Table 5
DIFFERENCE OF RECEIVER OPERATING CHARACTERISTIC CURVES OF THE METHODS APPLIED, BASED USED EXAMINATIONS

Area Under the Curve (AUC) results			
Diagnostic method	AUC	Std. Err.	95% CI, LB-UB
Vista Cam iX Macro	1.000	.000	1.000-1.000
Vista Cam iX Proof	.985	.018	.950-1.000

Figures 5 show theROC curves of the two methods applied in detecting enamel, or dentin lesions, with a significantly smaller AUC than between Vista Cam iX Macro and Proof ($p<0.001$) at all cariescategories.

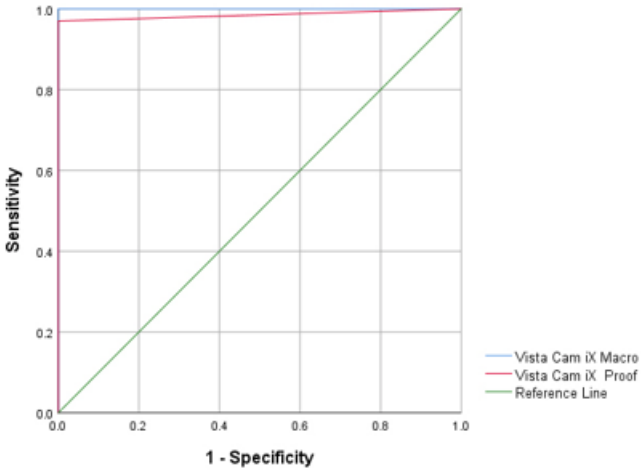

Fig. 5. Receiver Operating Characteristic curves of the diagnostic methods applied

Conclusions

Due to the fact of analysis performed we conclude that the sealing material present tightness and maintains its properties between 3 and 6 months. After 12 months some changes occur like colouration,marginal gap or even carious lesions. Dental sealing is anmethod of prevention, but must be periodically evaluated. For an accuracy diagnosis the use of the intraoral camera, VistaCamiX and Proof, is the most precise.The reliability of the two diagnostic methods was excellent, with a small higher precision for Vista Cam iX Proof then Vista Cam iX Macro. Vista Cam iXProof cutoffs inspected in this study resulted in a better performance of the device for the detection of enamel and dentin lesions as compared with Vista Cam iX Macro.

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