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NON-OPERATIVE TREATMENT OF NON-CAVITATED APPROXIMAL CARIOUS LESIONS OF PERMANENT CHILDREN'S TEETH

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SUMMARY

Aim: To apply and follow up in clinical conditions the success rate of microinvasive technique of infiltration with low viscosity resin ICON® (DMG) of non cavitated approximal caries lesions of permanent children's teeth for a period of one year.

Material and methods: The study included 18 children aged 7-16 years. They were divided into two groups - children with medium and high caries risk. The survey include 20 teeth with approximal non-cavitated enamel lesions up to the outer third of dentin (E1, E2, D1 – according to the manufacturer's instructions of ICON®). The size of the lesions was determined using bitewing radiographs and the activity - by Papilla Bleeding Index. The clinical application of the infiltr+ant (ICON® Caries Infiltrant Proximal, DMG) was conducted according to the manufacturer's instructions.

Bitewing radiographs were made at 6 and 12 months after infiltration in order to evaluate the success of the method. A test of the difference between two relative proportions and alternative test for analysis of the results were used.

Results: Our study confirm the hypothesis that this method of infiltration is equally successful for permanent teeth in patients with moderate caries risk as well as those at high caries risk.

Conclusion: This study is the first survey regarding the success of the application of ICON® for treatment of non-cavitated approximal carious lesions in permanent dentition of children in the country. Research in this direction should continue in order to increase the conviction that caries can be controlled and arrested in its earliest stages.

Key words: caries infiltration, permanent teeth, non-cavitated approximal carious lesions,

Philosophy of minimally invasive dentistry integrates prevention, remineralization, and minimal preparation during operative treatment, which actually guarantees the preservation of healthy tooth structures [1]. At its core minimally invasive treatment includes early caries detection and non-operative treatment of non-cavitated carious lesions [2].

It is known from epidemiology of caries that during childhood caries in fissures and pits dominate according to the indicator DMFT/dft. During adolescence, the proportion of proximal caries increases and dominates the calculation of the if DMFS-index is observed [3, 4]. Studies have found that about 50% more of approximal carious lesions were identified using bitewing radiographs compared with clinically diagnosed by visual examination [5, 6]. Authors recommend radiographic studies should be carried out selectively, based on the individual caries risk [7, 8, 9]. Pitts and Rimmer [10] found in a study that 60% of approximal caries which is radiographically proved as caries in the outer third of dentin have not yet cavitated enamel surface. The ability of clinicians to interpret radiographs has the greatest influence in the decision for the type of treatment [11]. Diagnosting caries as "active" or "inactive" has also a basic role for the treatment. Results of "Papilla Bleeding Index" (PBI) are also important indicators of proximal caries activity [12, 13].

Strategy for non-surgical treatments using "procedures for remineralization" "cover with sealants" or "infiltration with low viscosity resin" for initial carious lesions are an effective alternative for operative restorative approaches [14, 15, 16, 17], but they are not real alternatives in the attempt to reduce caries activity.

A relatively new technique for microinvasive treatment of non-cavitated carious lesions is the infiltration technique with **low-viscosity resin**. This microinvasive treatmet~~'s~~ method has great potential in Paediatric Dentistry [16, 18, 19]. The initial carious lesions can be arrested using resin infiltration [17, 20, 21, 22, 23]. Infiltration of caries lesions with this material is not intended to cover the lesion, but to fill the lesion's pores, the more deeper, the better [24, 25, 26, 27]. The main aim of the caries infiltration technique or **"caries infiltration"** is to use the possibility of this low viscosity light-curing resin material called "infiltrant" [28, 29] to penetrate into the pores of "the body of the lesion" and to close them. The method can be used for arresting the non-cavitated carious lesions developing on smooth approximal surfaces of the deciduous and permanent teeth. Current clinical results show good effectiveness of the method [15, 24, 29, 30, 31, 32, 33].

The aim of this study is to apply and follow-up clinically the success rate of the microinvasive technique of infiltration with low viscosity resin ICON® (DMG) of noncavitated approximal carious lesions in permanent children's teeth for a period of one year.

To achieve the aim, the following tasks were set:

- to apply in clinical setting the microinvasive infiltration technique for non-cavitated approximal carious lesions on 20 permanent premolars and molars using professional kit ICON® (DMG, Hamburg, Germany)

- determine the success rate of this infiltration technique in two groups of children - children with moderate and children at high caries risk.

Working hypothesis that we tested during the study was that the method of infiltration with ICON is equally successful for children with moderate and children at high caries risk in the permanent dentition.

MATERIAL AND METHODS:

The study included 18 children aged 7-16 years with permanent teeth which have non-cavitated approximal lesions. Informed consent for participation was signed by parents.

Criteria for selection of children:

- **Children at moderate and high caries risk** - individual assessment (assessment was made applying the tool for caries risk assessment used in the Department of Paediatric Dentistry, FDM, MU-Sofia).

- **Children with active participation** – children, who after the procedure should maintain oral hygiene by brushing, fluoride toothpaste and dental floss.

Criteria for selecting teeth

- permanent teeth with non-cavitated approximal carious lesions in the enamel up to the outer third of dentin according to bitewing X-rays (E1, E2, D1 – according to the manufacturer's instructions of ICON®).

Bitewing radiographs for diagnosis of non-cavitated approximal lesion and evaluation of its depth were made with X-ray apparatus for dental X-rays Siemens, model 8458747 x 1744 with the following parameters: 70 kV/7 mA. Films Primax RDX-58E soft with size 2/3 and 3/4 cm were used with X-ray holders Kerr/Kwik - bite with ring. The radiographic criteria for determining the depth of approximal carious lesions (by Kidd et al. [7] were compared with those of the manufacturer of Icon (E1, E2, D1):

D1: radiolucency in the outer half of the enamel = E1

D2: radiolucency in the inner half of enamel, including lesions that extend to, but not beyond the enamel-dentin border = E2

D3: radiolucency in dentine – radiolucency beyond enamel-dentine border, but no visible involvement of dentin = D1

Interpretation of the X-ray image was made by a specialist radiologist, using light box and magnification of 2.5 x.

- "Active lesion" – according to the Papilla Bleeding Index (PBI) score of Saxer and Muhleman (score1, 2, 3, 4). Bleeding after probing the sulcus is a sign of inflammation. We accept the hypothesis that when there is inflamed gingiva and papilla, the approximal carious lesions is active.

Clinical application of infiltrant (ICON® Caries Infiltrant Proximal, DMG) is done according to the manufacturer's instructions:

- teeth are professionally cleaned using dental prophylaxis paste and floss;

- teeth are separated with special separators in order to create access to the proximal carious lesions;

- etch gel is applied for 120 s and after that it is removed by washing with air - water spray. The lesion is dried rigorously for a further 15 seconds with an air spray. To improve the drying of the lesion, an ethanol (Icon-dry) is placed over it for 15 seconds and evaporated using a pressurized air (for15 seconds);

- application of infiltrant (ICON® -Infiltrant) with a new applicator is made, The applicator is removed after 3 minutes and the contact area is cleaned from the residue of the material with interdental floss. Infiltrant is light cured for 40 seconds in the buccal, oral, and the occlusal surfaces. In order to improve the impermeability of the coating the infiltrant should be additionally applied for a second time for 1 minute. After removing the excess of the resin and after light curing the separating wedge is removed.

Filling in the patient's card

ICON material is not radiopaque. To record the infiltrated surfaces and the depth of the lesions during treatment, a card is completed and this card accompanies the patient at review appointments. This card is a component of the professional kit and contains:

- header - the name of the patient;

- dental chart - the treated area is charted;

- the treated tooth, the treated surface, the depth of the lesion and the date of the operation are recorded;

- the results of the bitewing radiographies are recorded too .

Instruction for patients. After the procedure is completed, the children and their parents were instructed to maintain personal oral hygiene using a toothbrush and fluoride toothpaste and interdental floss according to the routine methods.

Clinical examination was done by two doctors, experts in paediatric dentistry. "Calibration" of the research team was done in advance.

Criteria for assessing the success of infiltration held on 6 and 12 months follow ups:

- there is no difference between the size of carious lesions on the follow up radiographs taken on the 6 and 12 months compared to those from the diagnostic radiographs The diagnostic and follow up radiographs at 6 and 12 months are made using the same equipment and parameters, which are entered in an individual card that accompanies the patient in order all the radiographies to be comparable.

- no inflammation (bleeding) of the papilla adjacent to the treated carious lesions is noticed - PBI of Saxer and Muhleman - code 0.

Statistical methods:

In order to analyse the hypothesis that the method of infiltration with ICON® is equally successful in children at medium and high caries risk two tests for assessment of the proportions of success were used:

- Test for difference between two relative shares - based on approximation by a normal distribution;

- Alternative test - which does not implies any distri-

bution (Fisher exact **p** estimation). The test was used on the basis of simulation constructed from aggregate data.

RESULTS:

Table 1 shows the distribution of groups of children and teeth with approximal lesions, according to the risk of caries - a group of children and teeth with a moderate and high risk of caries development. Bitewing radiographs determined the depth of carious lesions - E1, E2, D1.

Table 1. Distribution of children and teeth with approximal non-cavitated carious lesions

Study Groups	Caries risk				Noncavitated approximal lesions		
	Moderate		High				
	Children	teeth	Children	teeth	E1	E2	D1
Children with permanent teeth (7 -16 years old)	8	9	10	11	10	7	3

The results of "success" and "failure" treatment after an application of non-cavitated approximal carious lesions with infiltrant ICON® and one year of follow-up are presented in Table 2.

Table 2. Level of success rate and failure after treatment of non-cavitated approximal lesions in permanent teeth with ICON®

Caries risk	Number of teeth treated	After 6 months		After 12 months		Total	
		Success	failure	Success	failure	Success	Failure
Moderate risk 1	9	9 100 %	- 0 %	9 100 %	- 0 %	9 100 %	- 0 %
High risk 2	11	10 91 %	1 9 %	10 100 %	- 0 %	10 91 %	1 9%
P-test for Risk of caries P-alternative test (Fisher exact p estimation)	$P_{1:2}$= 0.368 $P_{1:2}$=1.000		$P_{1:2}$= 1.000 $P_{1:2}$=1.000		$P_{1:2}$=0.368 $P_{1:2}$=1.000		

The result from the assessment of the criteria "difference between the amount of caries lesions" is actually a result made from the include analysis of 60 bitewing radiographs; 20 of them were diagnostic, and 40 - control radiographs (20 radiographs were made 6 months after, and 20 were made 12 months after the application). No radiographic criteria were found to confirm the increase of size of the caries lesions in the permanent teeth with a moderate caries risk 6 months and 12 months after the application. In the group of permanent teeth with a high caries risk 6 months after the application only one tooth showed expansion of carious lesion. The other successful infiltrations successfully done, remained unchanged after the 12 months. All teeth with infiltration were assessed with code 0 according to PBI. At the end of the one-year follow-up the results showed that the method of infiltration in teeth with moderate caries risk was 100% successful and 91% in teeth with high caries risk.

Tests applied to assess the differences between the occurrence of success of treatment 6 months and 12 months after the application and respectively the total score for both groups (of moderate and high caries risk) in permanent teeth showed no evidence of occurrence of a statistically significant difference between the two groups for all three measurements - 6 months, 12 months and total (P> 0.05). Our study confirmed the hypotheses that the tested method of infiltration of permanent teeth is equally successful for patients at moderate and those at high risk of caries development.

DISCUSSION:

Treatment of caries using infiltration with low viscosity resin is a relatively new microinvasive treatment method with enormous potential in paediatric dentistry [14, 34, 35]. Short-term clinical results show good effectiveness of the method in caries lesions of approximal surfaces in permanent teeth. Stationing of development of the lesion within 1 to 2 years is reported [3, 30, 36, 37].

The high scores of "success" after administration of caries infiltration technique with ICON® in permanent den-

tition according to our trial we can explain with the following: children with permanent dentition have higher efficiency of caries prevention – consciousness for food and oral prevention and generally they are more responsible. And this leads to lower risk of deepening of the approximal lesions. The possibility of failure of the infiltrant requires strict professional control in order to prevent complications of dental caries. Another prerequisite for a possible failure is the inaccuracy of diagnostic X-ray method; sometimes the clinician could be misled to use the technique of infiltration. The survey results show that ICON® is suitable for use in the treatment of permanent teeth with an initial approximal caries. Our hypothesis that infiltration is equally successful nevertheless the degree of caries risk makes the caries infiltration a method of choice in the ambition for using minimally invasive methods of treatment of caries.

We understand that our experience in the application of the technique of infiltration is currently too short. We need to continue the follow of the cases in time and to increase their number in order to become more confident and convinced of the long-term best clinical outcome of infiltration technique for approximal lesions in the permanent dentition.

CONCLUSION

Progress in the evidence-based clinical dentistry provides sufficient facts for reducing the invasive techniques for dental caries treatment especially in childhood. Due to this, there is a great interest in the development and introduction into clinical practice the alternative non-invasive or minimally invasive methods, materials and procedures that are equivalent or even more effective than those based on recovery after the drilling. According to the knowledge of the staff, the present study is the first survey concerning the success of the ICON® to in treatment of non cavitated approximal carious lesions in permanent dentition of children in the country. Research in this direction should continue in order to increase the belief that caries can be controlled and arrested in its earliest stages.

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