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CURRENT SITUATION OF TOOTH DECAY AND EFFECTIVENESS OF INTERVENTION TO RESTORE THE EARLY – STAGE TOOTH DECAY DAMAGE USING FLUOR GEL AMONG 12-YEAR-OLD STUDENTS AT THAI NGUYEN PROVINCE

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INTRODUCTION

Tooth decay is one of the most common diseases in the community with a very high rate of people suffering, sometimes accounted for over 90% of the population. In Vietnam, according to the 2001 dental baseline survey among 12-year-old children, there were 56.6% of them suffering from tooth decay. Tooth decay tends to increase, especially in rural and mountainous areas, where population economic conditions and knowledge about oral health are limited. Thai Nguyen is such a mountainous province. According to the dental survey in Tuyen Quang province in 2004, the rate of permanent tooth decay among 12-year-old children was 64.06%. Factors such as knowledge, attitude, and practice about oral health care also have certain effects on the incidence of tooth decay in the community.

Many studies have been implemented to invest the situation of tooth decay, but most still applied the standard diagnosis set issued by the World Health Organization (WHO) in 1997. In 2005 at the National Tooth decay Conference in the United States, the scientists have summarized and launched the international tooth decay assessment and detection system ICDAS II. Based on ICDAS II, tooth decay can be diagnosed at a very early stage when cavities were not yet formed and in particular, can be completely recovered if the re-mineralization process is stronger than the demineralization process by applying the measures using Fluor. However, studies on the current situation of tooth decay in Vietnam are still mainly based on WHO 1997 standards, so they do not properly and fully reflect the recent situation of the disease. This leads to losing of time, economic and manpower costs for disease treatment due to having to perform welding, filling cavities instead of case early detection for early treatment in the community.

In recent years, there are many methods to help early diagnosis of tooth decay in community, including fluorescence technology. DiagnoDent fluorescent laser machine supports the detection of tooth decay level with the accuracy of over 90%. The sensitivity and specificity of this method in detection of dentin lesions were 0.97 and 00.15, respectively.

Several scientific studies have demonstrated the role of Fluor in enhancing re-mineralization and in the treatment of early tooth decay damage. Marino V.C. et al in 2003 found that Fluor reduced the incidence of tooth decay by 28%. According to research carried by Vu Manh Tuan, Fluor gel has reduced by 78.6% permanent tooth decay in the early phase and returning it to normal stage.

However, fluoride application is still limited and studies on the effectiveness of Fluor in early tooth decay treatment on permanent teeth in Vietnam were very limited, excepted only one study.

Based on above-mentioned situation, we carried out the study on "Current situation of tooth decay and effectiveness of intervention to restore the early-stage tooth decay damage using Fluor gel among 12-year-old students at Thai Nguyen province" with following objectives:

1. To describe the current situation of tooth decay and the relationship with knowledge, attitude and practice of dental health care among 12-year-old students in Phu Luong district, Thai Nguyen province, in 2016.
2. To evaluate the effectiveness of interventions to restore early-stage caries damage using Fluor gel among 12-year-old students in the study area in the period 2016-2017.

New contributions and science, practical value of the thesis

The study showed that the diagnosis of tooth decay according to ICDAS II and DD laser can reveal more about the cavity iceberg, in order to limit the errors in diagnosis skills of the examiners in the community. According to WHO diagnosis, the dental caries was detected in 75.7% pupils, but according to ICDAS II this was 87.1% and by applying DD fluorescent laser light this rate was raised up to 98%. The caries status of the tooth groups diagnosed by WHO, ICDAS II, and DD laser showed that the caries mainly concentrated in the molar tooth group with chewing surfaces. The rate of 6th tooth caries according to WHO was accounted for 60.6%, according to ICDAS II it was 86.3% and raised up to 93.1% according to DD laser. Rate of tooth decay was lower among the pupils with good knowledge than those with unsatisfactory knowledge. There was a relationship between the knowledge and tooth decay with OR <1.

After 6 months of intervention by using 1.23% Fluor gel on tooth decay at early stage, the decay missing filled teeth index (DMFT) among the intervention group decreased from 3.44 to 2.3 and after 12 months to 1.84 with statistically significant difference. In the control group, this index has been found increased significantly from 3.1 to 4.73 and reached 4.51 after 12 months. The intervention effectiveness was not different among men and women groups. The recovery of D1 tooth decay at early stage after 6 months and 12 months was found by two trends, one was not progressing, and other was returning to normal. There was only 1 out of 114 cases of intervention group showed with the aggravation. The

level of effectiveness of gel flour also makes teeth become more resistant to caries, shown by the average DD index of 4.1 after 12 months for the D1 group.

The structure of thesis

The thesis consists of 145 pages excluding references and appendices, 74 tables, 15 pictures and 3 diagrams. Of which 2 pages for Introduction, 26 pages for Literature Overview, 28 pages for Study subjects and research methods, 30 pages for Research results, 15 pages for Discussion, 2 pages for Conclusion and 1 page for Recommendations.

CHAPTER 1: INTRODUCTION

1.1. Some concepts

Tooth decay is bacterial infection occurred at calcified organization, characterized by demineralization of inorganic components and destruction of the organic components of hard tissue. The decrease in pH leads to demineralization that increases the distance between the hydroxyapatite crystal particles, the loss of minerals at below the enamel surface, the clinical damage that loses 10% of the minerals known as early-stage cavities.

1.2. Standard diagnosis of tooth decay in the community

* *WHO standard for tooth decay diagnosis*: Teeth are diagnosed as caries if detected a crack, breakdown in tooth enamel by visual-tactile examination using only moderate force, having sensitization and a feeling of softness, porous.

* *Caries diagnosis criteria according to ICDAS II:*

Table 1.1. **The international caries detection and assessment system (ICDAS)**

Code	Description
D0	Healthy
D1	Chalky white spots (after 5 seconds air drying)
D2	Discoloration on enamel (wet teeth)
D3	Localized enamel breakdown (broken dentine
D4	Underlying dark shadow from dentine

D5	Distinct cavity with visible dentine
D6	Extensive distinct cavity with visible dentine (>1/2 tooth surface)

** Tooth decay diagnosis by using DIAGNOdent*

Table 1.2. Tooth decay diagnosis by DIAGNOdent [95]

Value indicative of machine	The level of caries	Corresponding to ICDAS
0-13	No caries or beginning of enamel caries.	D0
14-20	Enamel carries is shallow or stop progressing tooth decay. Require the re-mineralized with Fluoride	D1
21-30	Enamel caries extending. Require minimal intervention and remineralization by fluoride or other measures using F to restore, control tooth decay risk factor	D2
31-99	Large and deep lesions, deep holes have been opened in 60% of cases. Filling to restore damage	From D3 and above
X	Tooth surface exclusion	

1.3. Epidemiology of tooth decay

1.3.1. Worldwide

According to WHO, the global tooth decay rate has decreased but not disappeared, with the disease trend decreasing in developed countries and increasing in developing countries. The rate of dental caries is high in the fissure and fissure areas, reducing the rate of tooth decay in smooth surface. According to the WHO, the quality of life decreased related to poor oral health care. The high incidence of tooth decay is also related to socio-economic circumstances such as children from ethnic minorities, poor families, and immigration.

1.3.2. In Viet Nam

The rate of tooth decay is at a high level and tends to increase, especially in rural and mountainous areas. According to Tran Thi Bich Van et al., result of a study conducted on middle school students in Ho Chi Minh City, using the ICDAS cavity assessment and detection system, showed that at the level of S3 (caries from dentine), the rate of caries was 67.1% and the average number of S3MT-MR was 4.29; at the S1 level (enamel and dentin caries), the rate of caries was 99.3% and the average number of S1MT-MR was 13.12. Obviously, if considered the dental caries at S3 level according to WHO criteria, more than 30% of early caries could be missed for prophylaxis treatment at the beginning.

Currently, fluoride is used as an effective tool to protect teeth, support teeth in reducing the risk of caries, and at the same time remineralize and repair damaged tooth enamel structures from an early stage without the intervention by drilling teeth, in addition, fluoride also works to slow down the progression of tooth decay.

CHAPTER 2. STUDY SUBJECTS AND METHODS

2.1. Subject of study

Subject for the study to describe the current situation of dental caries and its relationship with knowledge, attitude and practice of oral care were 12-year-old pupils of 2 secondary schools Hop Thanh and Duong Tu Minh.

For the intervention study, the subjects were the 12-year-old student having early-stage cavities (D1, D2) discovered from a cross-sectional study of 350 students.

2.2. Study design

2 designs were applied: a cross sectional descriptive and a community-controlled intervention design.

2.3. Study time and place

The study was conducted from February 24, 2016 to March 10, 2017 at 2 secondary schools Hop Thanh and Duong Tu Minh, Phu Luong district, Thai Nguyen province.

2.4. Study sample size

Sample size for a cross sectional descriptive design**:**

$$n = Z^2_{(1-\alpha/2)} \frac{pq}{d^2} DE$$

Of which: n was minimal sample size, $z_{(1-\alpha/2)}$ was confidence coefficient at a probability level of 95%, p was an estimated rate of permanent caries among a 12-year-old student (p = 76.3%), q was the estimated rate of permanent caries among the 12-year-old pupils (q = 23.7%), d was desired accuracy of 5%, DE was a design coefficient = 1.2.

The sample size was calculated as 333 students. In fact, 350 pupils were enrolled in the study.

Sample size for a controlled community intervention design:

$$n = \frac{\left\{ z_{1-\alpha/2}\sqrt{2\bar{P}(1-\bar{P})} + z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)} \right\}^2}{(P_1 - P_2)^2}$$

Of which: $Z_{(1-\alpha/2)}$ was the confidence coefficient at the 95% probability level (1,96), $Z_{1-\beta}$ was the sample force (=80%), P_1 was the rate of early-stage permanent tooth decay of the intervention group, estimated to be 50% after 12 months of follow-up. P_2 was the rate of early permanent caries of the control group, estimated to be 75% after 12 months of follow-up; P: $(P_1+P_2)/2$, n_1 was the sample size of intervention group, and n2 was the sample size for control group. According to above formula, the minimum required sample size for the 2 study groups was n = n2 = n1 = 105 students, the total number of students for the two groups in the intervention study was 210 students. In fact, 213 students were included in study, of which 107 students were in the control group and 106 students were in an intervention group.

2.5. **Calculate the effectiveness of intervention research:**

- Calculate efficacy index for intervention group and control group:

$$\mathbf{CSHQ\,\%} = \frac{|\,\mathbf{P2 - P1}\,|}{\mathbf{P1}}\ \mathbf{X\,100}$$

Of which: + EI: effective index of a group, calculate by %

+ P1: incidence rate before the intervention

+ P2: Incidence rate after intervention.

- *Difference in difference (DID):* = | A-B |

Of which: A was the difference in difference before/after the intervention of the intervention group; B is the difference in difference before/after of the control group

2.5. Intervention study

The study was conducted from February 24, 2016 to March 10, 2017. Deploying intervention phase 1 from April 5, 2016 to April 10, 2016 and intervention phase 2 from July 5, 2016 to July 10, 2016. 1st intervention assessment was conducted after 6 months: October 5, 2016 - October 20, 2016. Second intervention evaluation was performed after 12 months: March 5, 2017 - March 10, 2017.

Both the intervention group and the control group performed the centralized controlled brushing at the school, the students did not know what kind of cream they were allowed to brush, but the doctor directly provided cream for each child. A single blinding process was applied so 1.23% fluoride gel and children's P/S toothpaste were packaged in the same labeled (Mirafluor-Gel) tubes, before being given to children to use for brush, the code number known only by the researcher.

Both groups were allowed to brush their teeth on a fixed schedule: the time for each brushing time was 4 minutes, brushing once a day in the morning, each time for 5 consecutive days, each time was 3 months apart, so in total, 04 times were recorded in 12 months. Students were instructed to brush their teeth using the innovative Bass method. The amount of cream or gel per brush was equivalent to 0.66 gram.

1.3. Errors and control measures

To overcome the errors in information collection, participating doctors were agreed on the examination process and conclusions, the investigators were carefully trained in investigation principles, content, methods and skills. The input set was designed using Epidata software with inspection algorithms to avoid errors.

2.6. **Methods of processing and analyzing data**

For data entry, Epidata software version 3.1 was used. For data cleaning, processing and analysis, STATA software version 10.0 was used. The appropriate statistical tests were applied for interpreting research results. The intervention effectiveness was analyzed based on the difference in difference analysis. $p<0,05$ was considered as significance level.

2.7. Ethics in research

This study was conducted after being approved by scientific committee and ethics committee of the National Institute of Hygiene and Epidemiology

CHAPTER 3. RESULTS

3.1. Current situation of tooth decay and the relationship with knowledge, attitude and practice of dental health care among 12-year-old students in Phu Luong district, Thai Nguyen province, in 2016

3.1.1. General characteristics of study subjects

Table 3.1. General characteristics of the pupils involved in study

Characteristics	**Hop Thanh** shool		**Duong Tu Minh school**	
	n	**%**	**n**	**%**
Ethnicity:				
Kinh	13	7,8	68	37,2
Other	154	92,2	115	62,8
Sex:				
Male	99	59,3	87	47,5
Female	68	40,7	96	52,5

The rate of Kinh students in the two surveyed schools was very low, 7.8% in Hop Thanh school and 37.2% in Duong Tu Minh school, most of them were from the ethnic minorities.

The sex ratios at the two schools were similar, with no difference between the rates of boys and girls in each school.

3.1.2. Situation of permanent caries according to different categories among the pupils

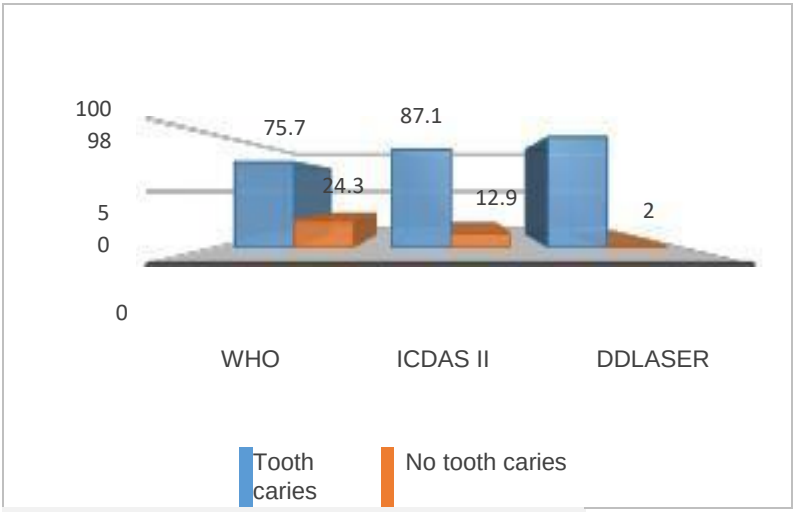

Fig 3.1. Rate of tooth caries among the pupils according to different categories

In a total of 350 pupils studied, according to 3 cavities classification methods, the decay detection rate increased in the chain from WHO to ICDASII and to DD laser. According to the WHO method, the tooth decay detection rate was the lowest with 75.7%. This rate was found increased according to ICDASII method up to 87.1% and the highest rate was obtained by DD laser method (98%).

Table 3.2. Tooth decay situation of different tooth groups found by different classification categories

Tooth group	**Class. method**	Tooth decay		**No tooth decay**	
		Number	**Rate %**	**Number**	**Rate %**
Tooth No 1	WHO	6	1.7	344	98.3
	ICDAS II	11	3.1	339	96.9
	DD laser	8	2.3	242	97.7
Tooth No.2	WHO	29	8.3	321	91.7
	ICDAS II	39	11.1	311	88.9
	DD laser	30	8.6	320	91.4
Tooth	WHO	9	2.6	341	97.4

No.3	ICDAS II	10	2.9	340	97.1
Tooth No. 4	WHO	50	14.3	300	85.7
	ICDAS II	149	42.3	201	57.7
	DD laser	153	43.7	197	56.3
Tooth No. 5	WHO	76	21.7	274	78.3
	ICDAS II	131	37.4	219	62.6
	DD laser	131	37.4	219	62.6
Tooth No. 6	WHO	212	60.6	138	39.4
	ICDAS II	302	86.3	48	13.7
	DD laser	326	93.1	24	6.9
Tooth No. 7	WHO	93	26.6	257	73.4
	ICDAS II	215	61.4	135	38.6
	DD laser	241	68.9	109	31.1

Among the tooth groups surveyed, rate of caries detected by DD laser method was the highest and mainly concentrated in the molar group such as tooth number 6 and No.7.

3.1.3. The relationship between knowledge, attitude, and practice about oral care for tooth decay

Bảng 3.3. The relationship between knowledge, attitude and practice about oral care for tooth decay determined by odd ratio analysis

School	Hop Thanh	Duong Tu Minh	Total
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Knowledge	0.01 (0.001- 0.195)	0.17 (0.02- 1.88)	0.03 (0.01- 0.29)
Attitude	3.20 (0.15-67.14)	51.57 (0.89-2990.44)	4.10 (0.21-81.12)
Practice	0.44 (0.04- 4.47)	0.39 (0.02-8.06)	0.58 (0.07-4.94)

The knowledge was found related to tooth decay [OR=0.03 (0.01- 0.29)] but the attitude or practice of pupils were not related to tooth decay in this study.

3.2. Effectiveness of intervention to restore early-stage caries with 1.23% fluoride gel

3.2.1. DMFT, DMFS indicators

Table 3.4. DMFT indicators of control and intervention groups by the time

	Group	Before intervention (n±SD)	6 months after intervention (n±SD)	12 months after intervention	p12	p13
DT	Gel fluor	2.67±1.39	1.24±1.27	0.64±0.84	-2.65	-2.96
	Control	2.57±2.01	3.79±2.55	3.5±2.36		
DMFT	Gel fluor	3.44±1.76	2.3±2.02	1.84±1.75	-2.77	-3.01
	Control	3.1±2.18	4.73±2.94	4.51±2.73		

After 6 months of intervention with 1.23% Fluor gel on early-stage decay teeth, the DMFT of the intervention group has decreased from 3.44 to 2.3 and down to 1.84 after 12 months. This distinction is very statistically significant. While in the control group, this indicator has increased from 3.1 to 4.73 after 6 months and raised to 4.51 after 12 months statistically significant.

Table 3.5. DMFS indicator intervention by Gel Fluor and control group by the time

	Group	Before intervention	6 months after intervention	12 months after intervention	DID1	DID2
DT (n±SD)	Gel fluor	3.78 ±2.05	2.01±2.26	0.79±1.13	-2.36	-3.28
	Control	3.65 ± 3.1	4.24 ± 3.05	3.94 ± 2.85		
	Gel fluor	4.58 ± 2.33	3.37 ± 2.26	2.46 ± 2.48	-2.29	-2.98

DMFT	Control	4.2 ±3.25	5.28 ± 3.44	5.06 ± 3.25		
DID1: Different in different at before and 6 months after intervention DID2: Different in different at before and 12 months after intervention						

The DMFS detected in Fluor Gel intervention group was found to decrease from 4.58 to 3.77 after 6 months and to 2.46 after 12 months statistically significant.

3.2.2. The effectiveness of 1.23% Flour Gel on restoration of the decay at tooth number 6.

Table 3.6. Effectiveness of interventions at the deep level of D1, D2 of tooth group 6 over time

Deep level	Time	Intervention effect (%)			
		R16	**R26**	**R36**	**R46**
D1	After 6 months	7,5	19,8	18,4	17,1
	After 12 months	24,7	45,2	34	41,6
D2	After 6 months	0,7	6,8	3,2	12,5
	After 12 months	25,8	47,3	24	32,5

Table 3.6 showed the effectiveness of intervention increased significantly after 12 months in comparison to that obtained at 6 months after intervention for tooth decay of D1 and D2 degrees.

Table 3.7. Progression of caries tooth - 6 of D1 degree after 12 months intervention

Tooth No.	Group	Percentage of progression level								Total
		No change (D1)		Better (D0)		Progressing up (D2)		Progressing up (D3)		
		Number	%	Number	%	Number	%	Number	%	
Tooth No 6 upper right	Fluor Gel	4	15.4	22	84.6	0	0	0	0	26
	Control	0	0	0	0	7	63.6	4	36.4	11
Tooth No 6 upper left	Fluor Gel	5	25	15	75	0	0	0	0	20
	Control	7	36.8	0	0	11	57.0	1	5.3	19
Tooth No 6 lower right	Fluor Gel	12	29.3	28	68.3	0	0	1	2.1	41
	Control	24	72.7	0	0	8	24.2	1	3	33
Tooth No 6 lower left	Fluor Gel	9	33.3	18	66.7	0	0	0	0	27
	Control	26	78.8	0	0	7	21.2	0	0	33
Total	Fluor Gel	30	26.3	83	72.8	0	0	1	0.9	114
	Control	57	59.4	0	0	33	34.4	6	6.2	96
p=0.000										

Evaluation results conducted at 12 months after intervention showed that, for those with deep D1 degree, there was no case of worsening at any tooth, the rate of teeth restored to D0 was much higher than that obtained at the time of 6 months after intervention; the rate of constant teeth of D1 degree has decreased compared to that of 6 months follow up after the intervention. With the control group, the rate of tooth decay progressed to D2, D3 was much higher than that of 6 months ago. None of the cases restored well to D0 degree.

Table 3.8. Progression of tooth No. 6-caries at D2 degree after 12 months intervention

Tooth number	Group	Percentage of progression level								
		No change (D2)		Better (D0)		Better (D1)		Progressing up (D3)		Total
		Number	%	Number	%	Number	%	Number	%	
Tooth No 6 upper right	Fluor Gel	2	16.7	5	41.7	5	41.7	0	0	12
	Control	5	50	0	0	0	0	5	50	10
Tooth No 6 upper left	Fluor Gel	0	0	0	0	5	100	0	0	5
	Control	11	73.3	0	0	0	0	4	26.7	15
Tooth No 6 lower right	Fluor Gel	10	38.5	4	15.4	12	46.2	0	0	26
	Control	23	79.3	0	0	0	0	6	20.7	29
Tooth No 6 lower left	Fluor Gel	16	55.2	6	20.7	7	24.1	0	0	27
	Control	24	85.7	0	0	0	0	4	14.3	28
Total	Fluor Gel	28	38.9	15	20.8	29	40.3	0	0	72 100 %
	Control	63	76.8	0	0	0	0	19	23.2	82 100 %
p=0.000										

For teeth at D2 degree, the improved rate toward D0 and D1 degree after 12 months of intervention among the group using Fluor gel for brushing was found to increase significantly compared to the time before 6 months, there was no case progressed up to severe D3.

With the control group, there were no cases restored well to D0 or D1, 14.3% - 50% progressing to D3 remained unchanged at D2.

Table 3.9. The average change in DD index corresponding to caries levels of the right upper 6th tooth in the 1.23% Fluor Gel using group over time

	Time	Average value	Standard deviation	Min	Max	p
DD index corresponding to caries level D1	Before	15.43	1.501	14	20	P12:0.000 P13:0.000 P23:0.000
	6 months after intervention	11.03	3.548	0	15	
	12 months after intervention	4.10	5.067	0	14	
DD index corresponding to caries level D2	Before	24.21	2.424	21	29	P12:0.000 P13:0.000 P23:0.000
	6 months after intervention	17.36	3.954	10	22	
	12 months after intervention	11.71	6.438	0	21	

In the Fluor gel intervention group, the mean DD laser index of clinically diagnosed permanent tooth surfaces decreased sharply from 15.43 ± 1.501 at the time before fluorine brushing to 4, 1 ± 5.067 after 12 months intervention. This difference is statistically significant with $p < 0.01$.

On the caries lesions diagnosed at D2 level, the mean corresponding DD laser index decreased from 24.21 ± 2.424 before intervention to 11.71 ± 6.438 after 12 months of intervention. This difference is statistically significant with $p < 0.05$

Table 3.10. The average change in DD index corresponding to caries levels of the right upper 6th tooth in the control group over time

	Time	Average value	Standard deviation	Min	Max	p
DD index corresponding to caries level D1	Before intervention	16.33	1.988	14	20	P12:0.000 P13:0.000 P23:0.000
	6 months after intervention	22.6	4.837	14	31	
	12 months after intervention	29.13	8.262	14	46	

	Time	Average value	Standard deviation	Min	Max	p
DD index corresponding to caries level D2	Before intervention	24	2.357	22	28	P12:0.018 P13:0.003 P23:0.005
	6 months after intervention	29.8	7.495	24	45	
	12 months after intervention	35.7	11.431	27	55	

In the control group that used PS toothpaste, the mean DD Laser index of clinically diagnosed permanent tooth surfaces at D1 (discoloration after 5 seconds of blow dry) doubled from 16.33 ± 1.988 at the time before brushing to 29.13 ± 8.262 after 12 months followed up. This difference is statistically significant with $p < 0.01$.

On tooth decay lesions diagnosed at D2 (the brown or milky discoloration observed on the teeth when the tooth surface is wet), the corresponding DD laser index increased sharply from 24 ± 2.357 at beginning of intervention study taken place to 11.71 ± 431 after 12 months followed up. This difference is statistically significant with $p < 0.05$

CHAPTER 4: DISCUSSION

4.1. Current situation of tooth decay and the relationship with knowledge, attitude and practice of dental health care among 12-year-old students in Phu Luong district, Thai Nguyen province, in 2016

Our research has deployed over 350 students at Duong Tu Minh and Hop Thanh secondary school of Phu Luong district, Thai Nguyen province to detect the rate of dental cavities assessed by different classification criteria. At the same time, interviewing students to know the status of their knowledge, attitude and practice on oral prevention. In the two surveyed communes, the majority of students belong to ethnic minorities, only a very small percentage were Kinh people.

We conducted a survey and assessment of caries according to 3 different classification methods: WHO standard, ICDAS II, and DD Laser. Among 350 subjects, according to WHO classification, the rate of caries of the two different schools was statistically significant difference. In particular, the tooth decay rate in case among students of Hop Thanh school was 64.7% lower that obtained among the pupils at Duong Tu Minh school (85.8%). However, according to ICDAS II classification, the incidence of caries of both schools increased and there was no statistical difference between the two schools.

In fact, the WHO classification is the fast method for use in the community with high sensitivity for the cases of tooth decay at D3, D4 degrees. This classification has certain implications for areas that are far from medical facilities and have limited oral health care, especially the area under our investigation. However, in the deep state of D1, D2, the detection of caries is limited by this method. The results of our study were much higher than that obtained in the 2001 oral health survey with the incidence of tooth decay among 12-year-old children was 56.6% and the SMT score was 1.87. This showed the limit effectiveness of school dentistry programs.

According to ICDAS II and DD Laser classification, the decay detection rate was much higher and over 90% in both schools. This is understandable because with these 2 methods, in addition to detecting tooth decay, we also assess the level of tooth decay clearly and objectively. Therefore, early detection of permanent caries using these 2 methods is very effective.

Our research results showed that the highest rate of tooth decay in teeth number 6 according to all 3 different classification methods. The results obtained by Le Ba Nghia et al. showed the high rate of decay happened the lower 6-jaw teeth (58.5% and 57.9%) followed by the upper 6-jaw teeth (36.1% and 34.6%) respectively. This result was lower than the result of our study. When examining and classified by ICDAS II standards, Hoang Tu Hung et al showed that 35% of examined students had decay in tooth number 6. This result was lower than the result obtained by Nguyen Thi Thu Ha et al. (41.5%) and lower than our results. This difference can be explained by the difference in the age of the study subjects. The older you get, the more cavities accumulate.

The reason for this result may be that the 6-jaw teeth is in the most important chewing position with the main chewing force placed. These are the earliest permanent molars, so the rate of decay is also the highest. It is also because of the importance of the 6-jaw teeth that the extraction intervention is very limited to apply, but often advised to use conservation measures. In this study, we also chose tooth number 6 for early intervention Fluor gel.

• **DMFT index:** In Bui Quang Tuan's study, the mean DMFT index in 12-year-old children was 0.96 ± 1.41. In which, the average DMFT for boy was 0.85 ± 1.28; for girls was 1.41 ± 1.63. Our study found that the DMFT was significantly higher than the above mentioned study. However, this level is still within the average range prescribed by WHO.

• **DMFS Index:** This index has not been studied much in the assessment of oral health, especially in Vietnam excepted the study conducted by Vu Manh Tuan et al. on children aged 7-8 years old. According to this study, the DMFS obtained in 7-year-old children was 2.28 ± 2.09 and was increased to 3.85 ± 2.11 among 8-year-old children. In our study, the DMFS index was high among the surveyed students and there was no statistically significant difference according to their gender.

The relationship between knowledge, attitude, practice on oral health care and tooth decay situation: In the two surveyed schools, the percentage of students with good knowledge on oral health care was very low. 89.8% of students in Hop Thanh school and 74.3% of students in Duong Tu Minh school

did not have good knowledge concerning to this topic. In contrast, students of both schools have very good attitudes about oral care, in particular 97% and 100% of students in Hop Thanh and Duong Tu Minh, respectively, have good attitudes on oral health care. The majority of students in both schools showed to have good practice. Thus, knowledge, attitude and practice are not proportional to each other. This is slightly different when compared to the natural model. From this result it is possible to temporarily assume that students' attitudes and practices do not correspond to existing knowledge. But it might be due to our assessment has not yet achieved certain objectivity.

When considering the relationship between knowledge, attitude and practice of oral care and the rate of tooth decay, the analysis results showed that the students with unsatisfactory knowledge had a higher rate of tooth decay than the those with good knowledge. This is completely understandable. Similarly, the rate of cavities was inversely related to the attitudes and practices of the students at both schools. This raises the question of whether the dental educational interventions were completely effective? Or, students' knowledge and practice have a great distance so effective oral protection is also limited. However, the difference in the rate of caries among the groups of knowledge, attitudes and practices was not statistically significant.

4.2 The effectiveness of interventions to restore early-stage caries damage using Fluor gel among 12-year-old students in the period 2016-2017

After the first evaluation of the incidence of caries, we selected students with cavities in both groups to conduct the intervention. The distribution of students in the control and intervention groups was relatively equal. There was no difference between the intervention group and the control group in terms of ratios of boys and girls to ensure the same conditions of the two groups.

The rate and degree of caries varied by tooth group and between the two study groups. However, the rate of tooth decay was the highest in the group of teeth No. 6. The difference between the two research groups on the rate of 6^{th} tooth decay was not statistically significant. Up to now, in Vietnam, only Vu Manh Tuan's research has evaluated the effectiveness of Fluor Gel in the prevention and treatment of early stage - tooth decay. However, our study evaluated more detail the effect of 1.23% Fluor gel on 6^{th} tooth damage, the

group of teeth most susceptible to decay and also the easiest treatment intervention.

• **DMFT index:** The intervention group that used 1.23% Fluor gel showed to have mean values of DMFT, DT, FT, and MT decreased compared to the time before intervention, 6 months after and lower down further at 12 months after the intervention. Meanwhile, in the control group, DMFT, DT and DMFT increased. The increase was most obvious after 12 months of intervention ($p < 0.05$). Our research results were similar to those obtained by Vu Manh Tuan. Our results reinforce the conclusion of Vu Manh Tuan, that the using of 1997 WHO standard for examining and taking diagnostic criteria showed to have DMFT index as a non-reversible index because DT (number of cavities) cannot be eliminated but converted to MT (tooth loss due to decay) or FT (tooth filled), so the DMFT always accumulates over time and does not revert. In our study, the effect of intervention was followed only for 12 months, but the change took place stronger than that of Vu Manh Tuan after 18 months. This result on one hand proved that the longer the intervention time, the lower decay rate has observed, this showed the clear effect of 1.23% Fluor Gel on tooth decay damage, however our study and the study of Vu Manh Tuan has not shown how long it takes to intervene for having the caries completely eliminated, as well as how soon after the early decay D1, D2 restored to D0 level, it must continue to have the preventive interventions action for avoid the recurrence and with what dosage for preventive interventions, these questions should continue to be studied in order to provide optimal prevention and treatment measures.

• **DMFS index**: DMFS and DS index of Gel Fluor treated group were found decreased after 6 months of intervention, this difference was statistically significant with $p < 0.05$. In contrast, in the control group, after 6 months of follow-up, the DMFS has increased ($p<0.05$) while the DS also decreased but not significantly ($p>0.05$). This trend continued after 12 months of intervention. Our results were also consistent with the results of Vu Manh Tuan and of Whitford.

The effectiveness of Gel Fluor on 6th tooth decay:

Survey result on the level of caries of the upper and lower teeth of both right and left sites showed the damage of D1 degree in all main teeth in both study groups. However, the results of interventions obtained at 6 months and 12 months after intervention in the 2 groups had opposite developments. Each 6th tooth has a different position and depends on the eating habits, so the decay characteristics and the effectiveness of the intervention also varied in depends. In all groups of teeth with D1 degree decay, after the intervention, the progression improved rate or remained unchanged rate in the Gel Fluor group were observed, no teeth were worse. In the control group, in addition to maintaining the level of decay, there were rates of severe condition worsening toward to D2, D3 degree.

DD Laser index in the group used Fluor gel decreased sharply after 6 and 12 months of intervention, while in the control group, this index increased sharply after 6 and 12 months followed up. In the initial deep group, the D1 level, the average DD decreased from 15.43 to 4.1. In the initial deep group D2 level, the average DD decreased from 24.21 to 11.71. Our results were in consistent with those obtained by Nguyen Quoc Trung et al.

Compared with previous studies, our research results demonstrated the effectiveness in reducing tooth decay rate by using of 1.23% Fluor gel. Even the decay rate among the students participated in our study was higher than that of the subjects of other studies, which could be explained because other studies used the criteria of clinical tooth decay score, so the mild caries was limited [75].

CONCLUSION

1. **Current situation of tooth decay and the relationship with knowledge, attitude and practice of dental health care among 12-year-old students in Phu Luong district, Thai Nguyen province, in 2016**

A total of 350 students who were diagnosed with caries by 3 different methods. Results showed very high rate of cavities among the surveyed students, in particular, 75.7% according to WHO diagnosis, 87.1%, according to ICDAS II and 98% by DD laser classification. Diagnosis of caries according to ICDAS II and DD laser revealed more clearly about the cavity undiscovered iceberg, in order to limit the error of skills of dental examiners in

the community. By using the ICDAS II classification, the rate of tooth decay among the pupils in both schools was found very high (84.4%-89.6%). Caries mainly concentrated in molars with chewing surfaces, where the main chewing function and easy to deposition food in the furrows. According to WHO, among the surveyed students, the determined rate of caries at 6th teeth was 60.6%, according to ICDAS II, this rate was 86.3% and raised up to 93.1% according to DD laser classification.

The average caries status of 12-year-old pupils in Phu Luong district, Thai Nguyen province was reflected in the study subjects' average index of decayed missing filled teeth (DMFT) and the index decayed missing filled surface (DMFS). In Hop Thanh school, an averaged nearly 3 decayed missing filled teeth (DMFT: 2.87) per student and more than 4 decayed missing filled surface teeth (DMFS: 4.34) were detected, In Duong Tu Minh school, these data were of higher value (DMFT: 3, 44 and DMFS: 4.49).

The rate of caries at large permanent molar teeth No. 6 was very high, 94% in Hop Thanh and 92.3% in Duong Tu Minh school. The permanent damage by caries of the 6th teeth was mainly concentrated on the chewing surface, with 56.1%, and 13.3% of outside lesion observed in early stage among the students of Hop Thanh school. At Duong Tu Minh school, these rates were 54.1% and 24.5%, respectively.

2/3 of surveyed students did not have good knowledge on oral health care. In case of Hop Thanh school, the rate of students having good knowledge was 10.2%, in Duong Tu Minh school this rate was 25.7%. However, the good attitude and good practices about oral care reflected in 97% of students showed to have good attitudes and over 86.6% of students expressed good practice on oral care according to the research evaluation.

In the students with achieved knowledge, the rate of caries was lower than those with unsatisfactory knowledge, showed the relationship between knowledge and caries with OR = 0.03 (0.01; 0.29).

2. The effectiveness of interventions to restore early-stage caries damage using Fluor gel among 12-year-old students in the period 2016-2017

After 6 months of intervention using 1.23% Fluor gel on early -stage caries, the average index of decayed missing filled teeth (DMFT) of the intervention group decreased from 3.44 to 2.3 and after 12 months to 1.84, this difference was statistically significant. While in the control group, this index increased, from 3.1 to 4.73 and after 12 months reached 4.51.

Before the intervention, on average, there were 4.2 teeth surface were found with cavities and fillings (DMFS), after 6 months of intervention, it was 3.37 in the intervention group and 5.28 in the control group. After 12 months of intervention, this index remained 2.46 in the intervention group and in the control group, it increased to 5.06.

The recovery rate of early stage-tooth decay in tooth No. 6 has been clearly expressed in restore progress from D1 and D2 degree to normal. In the intervention group, the proportion of normal teeth before the intervention was 57.5%, after 6 months it increased to 71.7% and after 12 months increased to 83%. The teeth No 26, 36, 46 also had similar results with statistical significance.

Two trends of restore the early stage D1 caries were found after 6 months and 12 months: not progressed and the restored back to normal. There was only 1 worsen case out of 114 cases in the intervention group.

In the intervention group, cases with tooth decay of the early stage D2 did not getting worse to D3 after 6, 12 months, of which 50 - 79.3% remained the level of decay, the rests (10.3-25%) were recovered back to D0, D1 degree. In the control group, 6.9 - 30% becomes worse.

The effectiveness of flour gel was also expressed in its role in enhance the resistance of teeth to caries, shown by the average DD index of 4.1 after 12 months among the D1 group.

RECOMMENDATION

In community oral survey, especially for 12-year-old children, the age that tooth decay occurs easy and the easiest to intervene, it is necessary to detect by highly sensitive methods and assess the level of tooth decay immediately, even at very early stage and can’t be difficult to detect clinically. We recommend to use the fluorescent laser method combining with ICDAS II standards for detection of early lesions.

Tooth 6 is a tooth that needs special attention in the oral health intervention program due to its physiological properties and its role in daily chewing. Tooth 6 is the most susceptible to decay and accounts also for the highest incidence among the permanent teeth. Therefore, it is necessary to guide children to properly take care of their teeth and to brush all teeth properly.

Parents play very important role in helping children practice proper oral hygiene, so it is necessary to organize the communication about dental health education for students' parents periodically during the school year, from then on the families, teachers and students themselves take measures to prevent caries. For areas with difficult and little attention to dental care such as Phu Luong Thai Nguyen, it is necessary to strengthen the educational programs aimed at changing people's perceptions.

1.23% Fluor gel has again been shown to be effective in preventing and reducing premature tooth decay. This measure should be promoted as a priority measure in the tooth decay prevention and treatment program.

LIST OF PUBLISHED SCIENTIFIC ARTICLES RELATED TO THE THESIS

1. Current status and relationship of tooth decay with knowledge, attitude and practice on dental care among 12-year-old students in Phu Luong district, Thai Nguyen province, 2014 - 2015. Journal of Vietnam Preventive Medicine, XXVI, No. 13 (186), 2016.
2. The effectiveness of intervention using 1.23% Gel-Fluor on the 6th tooth of secondary school students at Phu Luong district, Thai Nguyen in 2016. Journal of Vietnam Medicine, No. 2 (105), 2019.
3. The effect of Gel - Fluor 1.23% in the treatment of tooth decay in secondary school students at Phu Luong district, Thai Nguyen 2016. Journal of Vietnamese Medicine, vol. 477, issue 2