Influence of Pediatric Syrup on the Shear bond Strength of Composite Resins

MP Mondragon-Bernal, RJ Scougall-Vilchis, R Contreras-Bulnes, U Velazquez-Enriquez, LE Rodriguez-Vilchis

ABSTRACT

Objective: Observe the effect of pediatric medications on surface bovine enamel and analized shear bond strengths (SBS) of composite resins.

Methods: One-hundred thirty five bovine teeth were used to evaluate SBS, whereas 10 teeth were used to observe them under a Scanning Electron Microscope (SEM) specimens and randomly assigned to 5 groups (n=27), according to the immersion solutions: GI: artificial saliva, GII: Paracetamol, GIII: Ibuprofen, GIV: Amoxicillin and GV: Metronidazole. Immersion cycles in medicines were undertaken under a 1-min agitation, which was performed three times daily, during 28 days. In all groups enamel was conditioned with a phosphoric acid and composite resin blocks were bonded to enamel surface. Samples were stored (37°C, 24 hours), tested, and statistically analyzed, with significance predetermined at $p \leq 0.05$. The adhesive remnant index (ARI) was also evaluated and analyzed.

Results: The SBS of group II (10.8 ± 4.8 MPa) was higher significantly than group III (7.6 ± 2.6 MPa). The other groups showed no differences (group I: 9.4 ± 1.5 MPa, group IV: 9.0 ± 3.3 MPa and group V: 9.1 ± 4.6 MPa). Significant differences in Adhesive Remnant Index (ARI) scores were presented among all groups, the frequencies of the scores 0 and 1 were common in all groups, the greatest amount of adhesive remnant was found in the group V, followed by group IV. On the other hand, a lower quantity of residual adhesive was observed in groups I, II and III. In SEM analysis be observed changes on enamel surface in GII and GIII, presenting an irregular pattern with increased porosity, the other groups exhibited no differences (GI, GIV and GV).

Conclusion: Ibuprofen might be considered as a higher erosive potential medicament and low effect on bonding strength compared with other studies regarding pediatric medications.

Keywords: Composite resins; enamel; erosion, pediatric syrup, shear bond strength

---

From: Autonomous University State of Mexico, School of Dentistry, Dental Research Center and Advanced Studies (CIEAO) Jesus Carranza corner Paseo Tollocan, Col University, ZC 50130 Toluca City, State of Mexico, Mexico.

Correspondence: Dr RJ Scougall-Vilchis, Faculty of Dentistry, Center for Research and Advanced Studies in Dentistry (CIEAO), University of the State of Mexico, Jesus Carranza corner Paseo Tollocan,Cologne University 50130 Toluca, MEX, Mexico. E-mail: rogelio_scougall@hotmail.com

INTRODUCTION

Drug therapy is an important factor for success of any kind of dental therapy. Pharmacotherapy has indispensable role in the treatment of many medical and dental diseases (1). Most oral diseases that occur in children are inflammatory conditions associated with pain. In this context, a significant percentage of dental pain originates from acute and chronic infections pulp source, so analgesics and antimicrobials are the foundation of pharmacotherapy in pediatric dentistry (2).

The use of liquid pharmaceutical preparations may be a daily routine, acidic preparations are often necessary to ensure physiological compatibility and to improve flavor for the children (3, 4). In addition to the acidic components, other factor such as prolonged and frequent ingestion, bedtime and between meals consumption, high viscosity and the collateral effect of reduced salivary flow, may be contribute to increase the risk for medication-induced dental erosion (5).

It has been reported that medications can affect enamel hardness, and cause morphological and roughness alterations, as a result, erosive conditions might affect the integrity of restorative materials, such as composite resins and ceramics (6, 7).

The clinical success of a restoration based composite resin will depend on the degree of bonding between the tooth enamel and the restorative material, there is information that the adhesion of dental adhesives to eroded dentin is compromised as compared to regular dentin, nevertheless; the behavior of these materials on enamel surface under erosive conditions are limited.

Therefore, due to prolonged use of oral medication in children, the purpose of this study was to evaluate the effect of pediatric medicines on surface bovine enamel *in vitro* and analized the shear bond strengths (SBS) of composite resins.

MATERIALS AND METHODS

Tooth selection and preparation of experimental specimens

The study protocol was reviewed and approved by the Research and Ethics Committee at the Autonomous University of the State of Mexico (UAEM).

A total of 135 freshly extracted bovine teeth were collected and stored in a solution of 0.2% (wt/vol) thymol. One-hundred twenty five teeth were used to evaluate the SBS, whereas 10 teeth were used to be treated for observation on SEM. The criteria for tooth selection included intact enamel surface without any fracture produced during the extraction procedure. The teeth were fixed in acrylic resin, to aligning the labial surface of the tooth to be parallel to the force during subsequent bond strength testing.

The teeth were randomly assigned to one of the five groups (n=27group) as follows: group I: Control (artificial saliva); group II: Paracetamol; TEMPRA® (Bristol-Myers Squibb; New York, USA); group III: Ibuprofen; MOTRIN® (Janssen-Cilag; Madrid, Spain); group IV: Amoxicillin; AMOBAY® (BAYER; Leverkusen, Renania del Norte-Westfalia, Germany) and group V: Metronidazole; FLAGYL® (Sanofi Aventis; Paris, France).

Immersion Cycles

The following immersion cycling protocol was adopted to simulate a usual number of intakes: the specimens were immersed with the exposed area up for 1 min in 10ml of the medication, under agitation (30 rpm) by a magnetic stirrer, 3 times daily with 8-h intervals between the immersion cycles, during 7 days (21 immersion cycles). After each immersion cycle, the specimens were washed with an electric toothbrush and toothpaste for kids and maintained in artificial saliva at 37 °C, until the next immersion cycle. In the next 2 days, the specimens were stored in relative humidity. This process was repeated for 4 weeks, totalizing 84 immersion cycles.

Bonding procedure

The specimens were prepared for the SBS Test. To support this test, composite resin blocks were built; Z350XT Universal Restorative Filtek ™ (3M ESPE, Monrovia, USA) approximately with a dimension 4 mm^2 (1mm to 5mm in height), each block were polymerized 20 seconds using an LED unit and was applied in all groups according to the manufacturer's instructions.

The teeth were pumiced with fluoride-free paste (Pressage, Shofu Inc, Kyoto, Japan) and rubber prophylactic cups, washed with water, and air-dried. The enamel was conditioned with Phosphoric Acid at a concentration of 37%. The acid gel was applied on the enamel for 15 sec, rinsed thoroughly with a forceful air-deionized water spray, and dried with compressed air, immediately after blotting, applied one coat of adhesive for 15 sec with gentle agitation using a fully saturated applicator, then gently air thin for 5 sec to evaporate solvent and was light-cured for 10 seconds. Finally the composite resin blocks were bonded to enamel surface. This adhesive technique was chosen to show high values of adhesion strength.

Shear Bond Strength (SBS) Test

An occluso-gingival load was applied to produce a shear force at the resin-tooth interface. This was accomplished using the flattened end of a steel rod attached to the crosshead of a universal testing machine (Autograph AGS-X, Shimazdu, Kyoto, Japan). The bond strengths were measured at a crosshead speed of 0.5 mm/min, and the load applied at the time of fracture was recorded in MPa.

Adhesive Remnant Index (ARI)

Once the composite resin blocks had been debonded, the enamel surface of each tooth was examined with a stereoscope (Nikon, Tokyo, Japan) at a magnification of 10x to determine the

amount of residual adhesive remaining on each tooth, enamel fractures were also analyzed. The ARI scores were recorded with the following scale used: 0 = no adhesive left on the tooth, 1 = less than half of the adhesive left on the tooth, 2 = more than half of the adhesive left on the tooth, and 3 = all adhesive left on the tooth.

Scanning Electron Microscopy Analysis (SEM)

Ten teeth were used for preparing specimens of the enamel surfaces exposed to the different medication evaluated in this study. The teeth were chemically fixed, dehydrated, freeze-dried, and coated with gold (SC7620 Mini Soputter Coater. Quorum Technologies Ltd. Company. Kent UK.) The specimens were then observed under SEM (JEOL, JSM-6510LV, Tokyo, Japan).

Statistical analysis

Descriptive statistics including the mean, standard deviation, and ANOVA multiple comparisons with significance predetermined at $p \leq 0.05$ were calculated for the SBS analysis and the Scheffé post-hoc test were used to compare shear bond strengths between individual bonding/debonding sequences. In addition, the chi-square test was applied to evaluate the ARI.

RESULTS

Shear bond strength (SBS) test

The SBS mean values expressed in MPa, and descriptive statistics are shown in Table 1.

Data for shear bond strength (MPa) to enamel showed statistical differences with the ANOVA analysis (p=0.042). The Scheffé post-hoc test showed that the SBS of group II (10.86 ±4.82 MPa) was higher significantly than that group III (7.61 ±2.62 MPa). However when compared to the

control group did not show statistically significant differences (group I: 9.49 ±1.59 MPa, group II: 10.86 ±4.82 MPa, group III: 7.61 ±2.62 MPa, group IV: 9.06 ±3.34 MPa and group V: 9.16 ±4.67 MPa).

Adhesive remnant index (ARI)

The scores indicating the amount of adhesive remaining after debonding are shown in Table 2. The chi-square comparisons of the ARI scores among all of the groups (χ^2=9.481) indicated that the groups were significantly different (p<0.05). The frequencies of the scores 0 and 1 were common in all groups, the greatest amount of adhesive remnant was found in the group V, followed by group IV. On the other hand, a lower quantity of residual adhesive was observed in groups I, II and III. Also worth mentioning that did not show any marker ARI 2 and 3; and there was no fracture of enamel.

Scanning electron microscopy analysis

SEM micrographs of enamel immersed in the pediatric medicines and artificial saliva are presented in Figure 1.

Enamel surface morphology of non exposed medicines control group showed a smooth and unchanged surface with scratch on enamel surface(A), similar to that observed in the GIV and GV group micrographs (D and E). On the other hand surface of enamel specimens exposed to GII and GIII was intact with increased porosity, were observed an irregular pattern of surface destruction was located in the vicinity of prismatic pattern of destruction (B and C).

DISCUSSION

Pharmacotherapy is necessary in pediatric dental care, previous studies have shown that analgesics like paracetamol, ibuprofen and antimicrobial agents, mostly amoxicilin and metronidazol, were the mainstay in pharmacotherapy in pediatric dentistry (1, 2, 4, 9, 10).

These particular pediatric syrup were chosen for several reasons: they are frequently use, they have a pH level below the critical limit for demineralization of tooth enamel (pH < 5.5) (3, 11, 12). Finally, the syrup can reduce enamel hardness of primary teeth, influence enamel roughness, cause morphological enamel alteration (13), which could affect the SBS of composite resins.

It has been demonstrated that bovine enamel can be successfully used to study enamel bond strength (14), because it has been observed that histologically , they are the most similar to human enamel (15, 16). In this context, diverse studies have been carried out with bovine teeth, and there are numerous original articles published in literature (17-19). Therefore it was decided to work with bovine specimens in this study.

The shear test was performed with a universal testing apparatus, similar to the procedure of others (8). Results of this study indicated that the SBS of group II (10.8 MPa) was higher significantly than that group III (7.6 MPa). We believe the erosive defects caused by Paracetamol and Ibuprofen on enamel, as shown by SEM, has a negative effect on resin retention, it might be due to frequent exposure to acidic substances that could cause an imperfect acid etching pattern.

Hammad SM et al (20) and Rugg-Gunn et al (21), compared the erosive capabilities of acidic soft drinks. They determined that had erosive potential. On the other hand, Tupalli AR et al (3) evaluated ten commonly used pediatric liquid medications and determined that the medications cause etched prism pattern followed by crater formation and sporadic rod ends. Which means that

frequent use of both acidic drinks such as pediatric medicines cause demineralization in the enamel surface. This supports our results in the present study.

When the surface was eroded, challenges the parameters of bond strength. Rougher surfaces play a relevant role in the adhesion mechanism, as they are favorable for promoting more intense interlocking to the enamel. According to the data of this study, no difference was noted compared to the control group. However, the highest average SBS observed in group II (10.86 ± 4.82 MPa) is below the average minimum for conciderarse a good SBS ranging from 20-40 MPa. (22, 23) This shows that the erosion has a negative effect on adhesion enamel-resin.

The ARI scores one indicated that in the group V (44%) followed by group IV (24%) the cohesive failures were predominant. However, adhesive failures were more present on the other groups, could suggest the presence of poor interlocking, as the interface was broken.

CONCLUSION

Prevention of dental erosion caused by pediatric syrup can be done only by a group effort. Based on the findings of this study, it can be concluded within its limitations of an *in vitro* study, pediatric dentists must take care with medication administration, because the frequent exposure to the sucrose content in medicines can be observed changes in the enamel surface and the SBS of future restorations could be affected; and should consider this when choosing the restoration for each patient in order to provide quality treatment.

The availability of children's medicines in sugar-free form would enhance the prescribing of sugar-free medicines by dental and medical professionals, and parents and patients should be aware of risk of erosion during the use of some medicines and might also increase the risk of caries in children.

For Shear Bond Strength, dentists could perform further studies to evaluate other adhesion procedures, as well as different biocompatible materials. Pediatric dentists should use more scientific evidences to identify dental erosion in primary enamel to promote better adhesives procedures.

AUTHORS' NOTE

MP Mondragon-Bernal oversaw data collection, conducted data analysis, wrote manuscript and approved final version. RJ Scougall-Vilchis provided oversight to study, participated in data interpretation and revision of manuscript, and approved final version. R Contreras-Bulnes participated in study design, data analysis and interpretation, critically revised manuscript and approved final version. U Velazquez-Enriquez and LE Rodriguez-Vilchis participated in study design, interpretation of data and revision of manuscript and approved final version.

REFERENCES

1. Paudel KR, Sah NK, Jaiswal AK. Prevalence of pharmacotherapy in the department of pediatric dentistry. Kathmandu Univ Med J (KUMJ) 2010; 8(2): 190-194. [PMID:21209533]
2. Jayadev M, Karunakar P, Vishwanath B, Chinmayi SS, Siddhartha P, Chaitanya B. Knowledge and pattern of antibiotic and non narcotic analgesic prescription for pulpal and periapical pathologies- A survey among Dentists. J Clin Diagn Res 2014; **8**(7): 10–14. [DOI: 10.7860/JCDR/2014/9645.4536]
3. Tupalli AR, Satish B, Shetty BR, Battu S, Kumar JP, Nagaraju B. Evaluation of the erosive potential of various pediatric liquid medicaments: An in vitro study. J Int Oral Health 2014; 6(1): 59-65. [PMID: 24653605]
4. Poveda-Roda R, Bagán JV, Sanchis-Bielsa JM, Carbonell-Pastor E. Antibiotic use in dental practice. A review. Med Oral Patol Oral Cir Bucal 2007; 12(3): 186-192. [PMID: 17468711]
5. Scatena C, Galafassi D, Gomes-Silva JM, Borsatto MC, Serra MC. In vitro erosive effect of pediatric medicines on deciduous tooth enamel. Braz Dent J 2014; 25(1): 22-27. [PMID: 24789287]
6. Valinoti AC, Pierro VS, Da Silva EM, Maia LC. In vitro alterations in dental enamel exposed to acidic medicines. Int J Paetiatr Dent 2011; 21(2): 141-50. [PMID: 20961343 DOI: 10.1111/j.1365-263X.2010.01104.x]
7. Attin T, Wegehaupt FJ. Impact of erosive conditions on tooth-colored restorative materials. Dent Mater 2014; 30(1): 43-9. [PMID: 23962494 DOI: 10.1016/j.dental.2013.07.017]
8. Scougall-Vilchis RJ, Rios-Medina LG, Villareal-Camarena CY, Lara-Carrillo E, Salgado-Valdés A. Comparación de la resistencia al descementado del esmalte humano versus el

esmalte vacuno con un sistema de autograbado. Rev Esp Ortod 2013; 43(2): 74-78. [ISSN 0210-0576]

9. Dar-Odeh NS, Abu-Hammad OA, Al-Omiri MK, Khraisat AS, Shehabi AA. Antibiotic prescribing practices by dentists: a review. Ther Clin Risk Manag 2010; 21(6):301-6. [PMID: 20668712]
10. Obu HA, Chinawa JM, Ubesie AC, Eke CB, Ndu IK. Paracetamol use (and/or misuse) in children in Enugu, South-East, Nigeria. BMC Pediatr 2012; 12:103. [PMID: 22812400 DOI: 10.1186/1471-2431-12-103]
11. Passos IA, Sampaio FC, Martínez CR, Freitas CHSM. Sucrose concentration and pH in liquid oral pediatric medicines of long-term use for children. Rev Panam Salud Pública 2010; 27(2): 132-7.
12. Babu KL, Rai K, Hegde AM. pH of medicated syrups – does it really matter? – an in vitro study: Part II. J Clin Pediatr Dent 2008; 33(2): 137-42.
13. Nankar M, Walimbe H, Ahmed Bijle MN, Kontham U, Kamath A, Muchandi S. Comparative evaluation of cariogenic and erosive potential of commonly prescribed pediatric liquid medicaments: an in vitro study. J Contemp Dent Pract 2014; 15(1): 20-5. [PMID: 24939259]
14. Oesterle LJ, Shellhart WC, Belanger GK. The use of bovine enamel in bonding studies. Am J Orthod Dentofacial Orthop 1998; 114(5): 514–519. [PMID: 9810047]
15. Teruel Jde D, Alcolea A, Hernández A, Ruiz AJ. Comparison of chemical composition of enamel and dentine in human, bovine, porcine and ovine teeth. Arch Oral Biol 2015; 60(5):768-75. [PMID: 25766469 DOI: 10.1016/j.archoralbio.2015.01.014]

16. Krifka S, Börzsönyi A, Koch A, Hiller KA, Schmalz G and Friedl KH. Bond strength of adhesive systems to dentin and enamel--human vs. bovine primary teeth in vitro. Dent Mater 2008; 24(7):888-94. [PMID: 18155759]

17. Mota CS, Demarco FF, Camacho GB, Powers JM. Tensile bond strength of four resin luting agents bonded to bovine enamel and dentin. J Prosthet Dent 2003; 89(6):558-64. [PMID: 12815349]

18. Wang L, Casas-Apayco LC, Hipólito AC, Dreibi VM, Giacomini MC, Bim Júnior O Rios, et. al. Effect of simulated intraoral erosion and/or abrasion effects on etch-and-rinse bonding to enamel. Am J Dent 2014; 27(1): 29-34 [PMID: 24902402]

19. Reis AF, Giannini M, Kavaguchi A, Soares CJ, Line SR. Comparison of microtensile bond strength to enamel and dentin of human, bovine, and porcine teeth. J Adhes Dent 2004; 6(2): 117-21. [PMID: 15293420]

20. Hammad SM, Enan ET. In vivo effects of two acidic soft drinks on shear bond strength of metal orthodontic brackets with and without resin infiltration treatment. Angle Orthod 2013; 83(4): 648-52.

21. Rugg-Gunn AJ, Maguire A, Gordon PH, McCabe JF, Stephenson G. Comparison of erosion of dental enamel by four drinks using an intraoral appliance. Caries Res 1998; 32: 337–343

22. Contreras Bulnes R y Scougall Vilchis RJ. Salud y enfermedad bucal: avances científicos Vol.1 Capitulo 5: Principios de adhesión mínimamente invasiva en ortodoncia. México: Ediciones EÓN; 2016.

23. Guzman H: Biomateriales odontológicos de uso clínico. Ed. Ecoe, 2°edición Bogotá, Colombia, 1999

Table 1: Mean bond strength values (MPa) and descriptive statistics

Group	n	Mean	SD	Max	Min	Scheffé test*
I (Control)	25	9.49	1.59	12.78	6.22	C
II (Paracetamol)	25	10.86	4.82	24.88	2.82	A-C
III (Ibuprofen)	25	7.61	2.62	14.1	3.07	B-C
IV (Amoxicilin)	25	9.06	3.34	19.58	4.66	C
V (Metronidazole)	25	9.16	4.67	23.16	4.12	C

*Scheffé post-hoc multiple comparisons (1-way ANOVA); $p = 0.05$. Groups with different letters are significantly different from each other.

Table 2: Distribution frequency and percentages of the Adhesive Remnant Index (ARI)

Group	n	0(%)	1(%)
I (Control)	25	22 (88)	3 (12)
II (Paracetamol)	25	21 (84)	4 (16)
III (Ibuprofen)	25	21 (84)	4 (16)
IV (Amoxicillin)	25	19 (76)	6 (24)
V (Metronidazole)	25	14 (56)	11 (44)

X^2= 9.481; df= 4; p=0.05

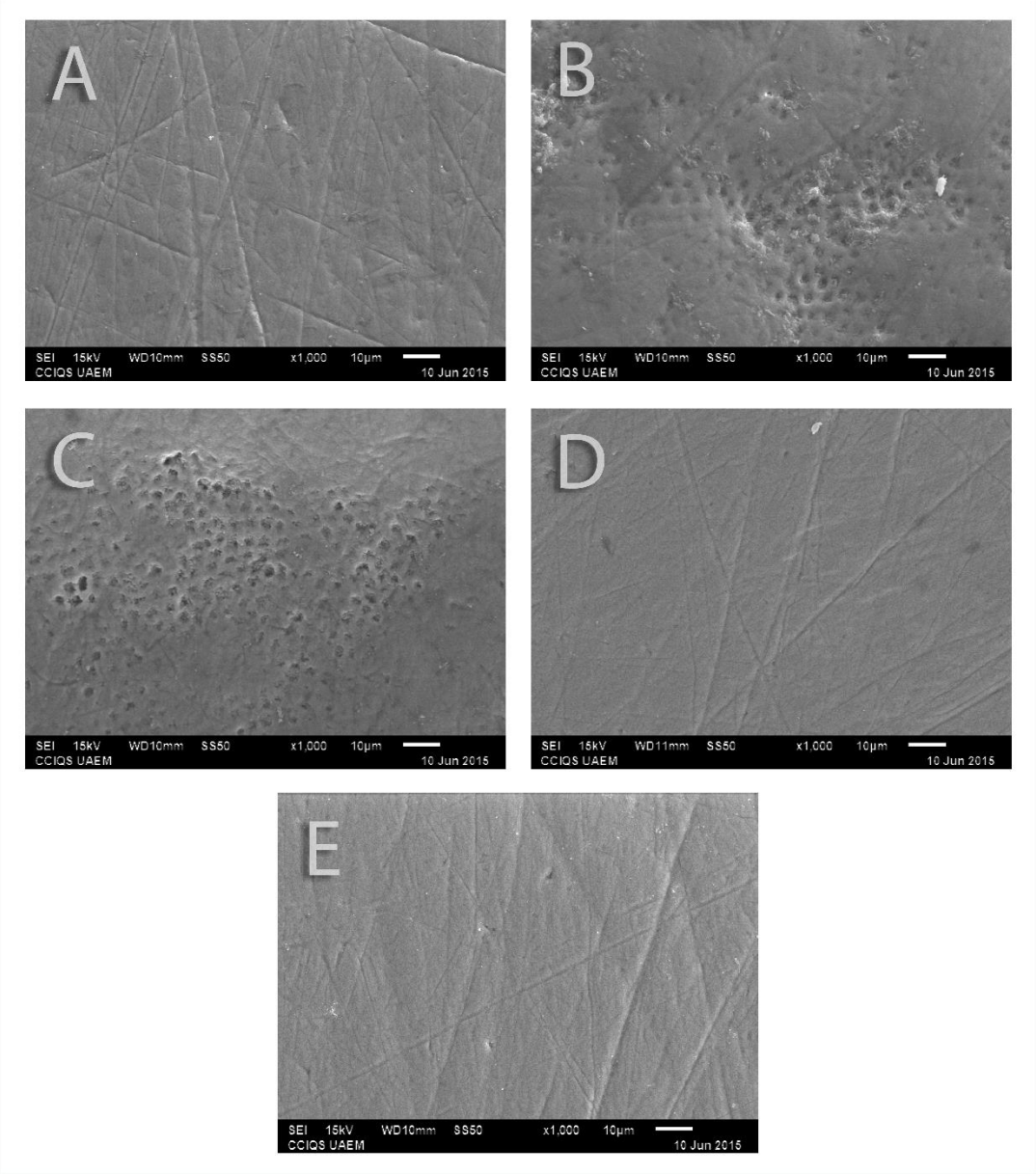

Figure: Qualitative analysis of the specimens enamel surfaces by scanning electron Microscopy after 28 days of the experiment. A: artificial saliva; B: Paracetamol; C: Ibuprofen; D: Amoxicilin; E: Metronidazole. On the pictures A, D and E it is observed a smooth and unchanged surface with scratch on enamel surface and the pictures B and C it shows an irregular pattern of surface destruction was located in the vicinity of prismatic pattern.