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Association Between Clinical, Para-Clinical and Environmental Indicators for Tooth Decay in Children with Pyelonephritis

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Abstract

Tooth decay is a multi-factorial disease. Its basic etiological factors are the enamel with its quality and quantity characteristics, cariogenic microorganisms of *Streptococcus mutans* and *Streptococcus sobrinus,* fermentable carbohydrates, time. Saliva plays the essential function of a co-factor for the dynamics of the carious process. Contemporary studies represent solid evidence of the anti-microbial effects of non-organic nitrates for some organs and systems, including the gastro-intestinal tract, oral cavity and skin. Bacterial infections of the urinary tract occur in different age, including the breast-feeding period and early childhood, and are often characterized with urine reflux dysfunction. The aim of this study is to investigate and evaluate correlations between some clinical, para-clinical and environmental indicators for tooth decay in children with pyelonephritis. Significant negative correlation between the number of carious lesions and pH and great negative correlation between the number of carious lesions and salivary nitrites have been established in the group of children with kidney disorder. These participants are characterized with extremely high positive correlation between the plaque index PLI and gingival index GI; significant negative correlation between the index of PLI and salivary pH level; significant negative correlation between PLI and salivary nitrites. There is a definite accent on the considerable interrelations between the number of cavity and non-cavity carious lesions, level of oral hygiene and gingival status, pH and nitrites in saliva and frequency of tooth-brushing in children suffering from the renal disorder of pyelonephritis.

Keywords: Clinical indicators; Environmental factors; Para-clinical parameters; Tooth decay; Pyelonephritis in children

Introduction

Bacterial infections of the urinary tract occur in different age, including the breast-feeding period and early childhood, and are often characterized with urine reflux dysfunction. This infectious process affecting the excretory system is ranked second in incidence preceded by respiratory tract infections in child's age. Principally, the condition of fever and symptoms of anemia with undifferentiated origin is related to the disease of pyelonephritis [1]. A ratio of 4, 6 to 10% of all the hospitalized children are suffering from urinary tract infections [2]. The diagnosis of pyelonephritis in pre-school and school age is associated to symptoms of intoxication, fever attacks, paleness, pain discomfort in the lumbar-sacral region, miction-dysuric disorder, secondary enuresis [3]. In terms of established symptomatic pyelonephritis there is an urgent necessity of parenteral antibiotic therapy based on antibiogram. In cases of non-manifested symptoms can be applied combined medicines of Trimethoprim- Sulfamethoxasole (Biseptol, Trimezol). The duration of antibiotic treatment equals to 10 days, and in condition of severe infections- up to 14 days [3-5].

Tooth decay is a multi-factorial disease. Its basic etiological factors are the enamel with its quality and quantity characteristics, cariogenic microorganisms of Streptococcus mutans and Streptococcus sobrinus, fermentable carbohydrates, time. Saliva plays the essential function of a co-factor for the dynamics of the carious process [6]. If not treated, the disease of tooth decay is accompanied by specific pain symptoms, with considerably negative impact upon quality of life in the aspect of physical state, psychological and emotional comfort, behavioral patterns and social activities [7]. Tooth decay is determining as an infectious disease with behavioral samples-related nature. Among the main etiological factors for that disease is accentuated on the role of both microorganisms, Streptococcus mutans and Streptococcus sobrinus [8,9]. The process of dental plaque accumulation is associated to increase of the concentration of these acids-producing and acidophilic species with great cariogenic potential. In condition of intensive metabolism these microbes produce acids which cause decrease of the pH level and induce the destructive process of de-mineralization of enamel [10-12]. Regarding the traits of dental plaque as a medium of favorable conditions for caries, lots of investigations have been performed about the role of regular tooth-brushing procedures controlled by parents for efficient prevention of the disease. Other researches concern the necessity of utilization of additional oral hygiene products and means for ensuring proper mechanical reduction and chemical control of dental plaque [13-15].

In the last decade there has been a tendency of exponentially increased interest oriented to the time-saving and minimally invasive assays based on the properties of saliva as a diagnostic medium in clinical conditions [16-20]. In norm saliva is related to maintenance of the dynamic equilibrium of homeostasis, providing protection for hard teeth structures and soft tissues in oral cavity [21-24]. Salivary ingredients' concentrations of calcium and phosphate ions, glycoproteins, trace of albumin, urea, ammonia, bicarbonates, immunoglobulins and enzymes influence on the dynamics of carious process [25-27]. Contemporary studies represent essential evidence of the anti-microbial effects of non-organic nitrates for some organs and systems, including the gastro-intestinal tract, oral cavity and skin [28,29].

The aim of this study is to investigate and evaluate correlations between some clinical, para-clinical and environmental indicators for tooth decay in children with pyelonephritis.

Material and Methods

Subject of the current study are 21 patients from 0 to 18 years of age, both males and females, with the diagnosis of the kidney disorder of pyelonephritis. These children were hospitalized at the Department of Pediatrics at the University Hospital "St. Marina" in Varna, Bulgaria. A control group of 10 children without common health disorders is also included into the investigation. This study received ethics approval by the Human Ethics Committee of the Medical University-Varna. Declaration of informative consent was assigned by a parent or legal guardian of each of the participants into the study.

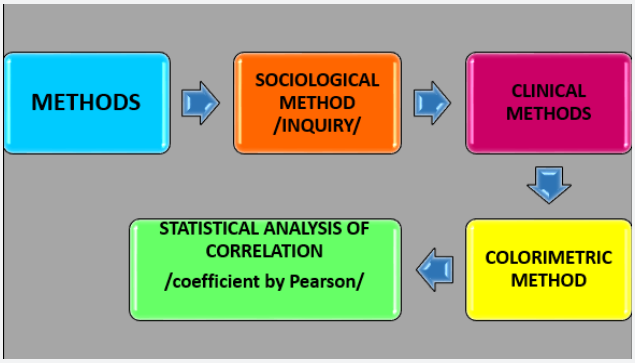

Figure 1: Interrelations between methods applied in the study.

A combination of different methods has been implemented in the context of the study. By the means of the inquiry we obtain information about the common health status of the individual, age, oral hygiene habits, diet regime with accent on intakes of sugar-containing foods and drinks. The clinical methods concern registration not only of cavity lesions of irreversible destruction of hard dental structures, but also record of no-cavity carious lesions of the type of caries incipience, indicated as D1a and D1b according to the classification system by ICDAS [10]. The level of plaque accumulation and status of gingival tissue have been evaluated by application of the indices of PLI Silness-Lõe and GI Lõe-Silness. Colorimetric method of determination of the level of salivary pH and nitrites was used. For assessment of interrelations between different indicators the statistical method of correlation based on the coefficient by Pearson was implemented (Figure 1 & 2).

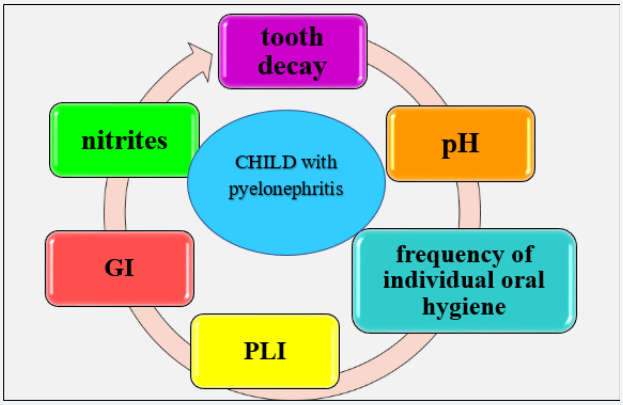

Figure 2: Clinical, para-clinical and environmental indicators for tooth decay in children with diagnosed pyelonephritis.

Results

We have established definite levels of correlation between the recorded clinical indicators, salivary para-clinical parameters and environmental factors among the participants into the investigation with the diagnosis of pyelonephritis:

a. Significant positive correlation between the number of registered carious lesions and the plaque index of PLI; great positive correlation between the number of carious lesions and the gingival index of GI;

b. Significant negative correlation between the number of carious lesions and pH; great negative correlation between the number of carious lesions and salivary nitrites;

c. Extremely high positive correlation between the plaque index PLI and gingival index GI; significant negative correlation between the index of PLI and salivary pH level; significant negative correlation between PLI and salivary nitrites;

d. Slight positive correlation between the number of carious spots and PLI; great negative correlation between GI and salivary pH; great negative correlation between GI and salivary nitrites; great positive correlation between the level of pH and nitrites in saliva; slight negative correlation between the number of carious spots and salivary nitrites (Table 1).

Based on application of the statistical method of correlation we have registered these levels of correlation between the same indices in children not suffering from common health disorders. Namely:

a. Great positive correlation between the number of carious lesions and PLI; significant positive correlation between the number of carious lesions and GI;

b. Significant negative correlation between the number of carious lesions and pH; great negative correlation between the number of carious lesions and the content of salivary nitrites;

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c. Extremely high positive correlation between PLI and GI; extremely high negative correlation between PLI and pH; extremely high negative correlation between PLI and salivary nitrites; great positive correlation between PLI and number of carious spots;

d. Great negative correlation between GI and pH; extremely high negative correlation between GI and salivary nitrites; significant positive correlation between GI and number of carious spots;

Table 1: Coefficient of correlation by Pearson between number of carious lesions, number of carious spots, PLI, GI, pH and salivary nitrites among children with pyelonephritis.

Correlation	Number of Carious Lesions	PLI	GI	pH	Salivary Nitrites	Number of Carious Spots/ Caries Incipience
number of carious lesions	1	0,633	0,729	-0,661	-0,760	-
PLI	0,633	1	0,917	-0,669	-0,510	0,203
GI	0,729	0,917	1	-0,838	-0,712	0,185
pH	-0,661	-0,669	-0,838	1	0,798	-0,014
salivary nitrites	-0,760	-0,510	-0,712	0,798	1	-0,155
number of carious spots/caries incipience	-	0,203	0,185	-0,014	-0,155	1

e. Extremely high positive correlation between salivary nitrites and level of pH into oral cavity;

f. Great negative correlation between the number of carious spots and pH; great negative correlation between the number of carious spots and salivary nitrites (Table 2).

Table 2: Coefficient of correlation by Pearson between number of carious lesions, number of carious spots, PLI, GI, pH and salivary nitrites among healthy children.

Correlation	Number of Carious Lesions	PLI	GI	pH	Salivary Nitrites	Number of Carious Spots/Caries Incipience
number of carious lesions	1	0,732	0,687	-0,661	-0,735	-
PLI	0,732	1	0,914	-0,952	-0,971	0,776
GI	0,687	0,914	1	-0,857	-0,919	0,609
pH	-0,661	-0,952	-0,857	1	0,972	-0,712
salivary nitrites	-0,735	-0,971	-0,919	0,972	1	-0,747
number of carious spots/caries incipience	-	0,776	0,609	-0,712	-0,747	1

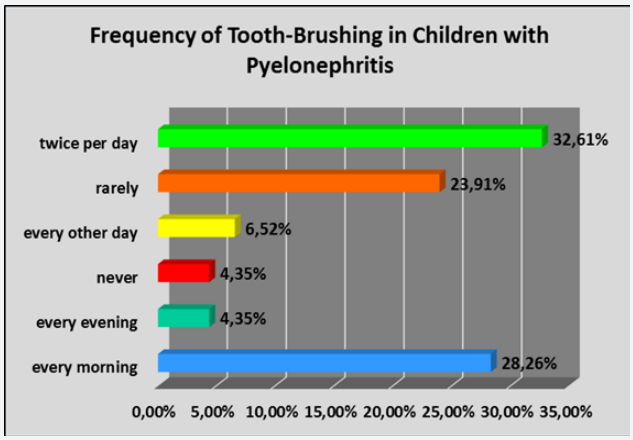

Figure 3: Frequency of Tooth-Brushing in Children with Pyelonephritis.

Aproximately 1/3, namely 32.61 %, of the participants suffering from pyelonephritis perform regular individual oral hygiene procedures twice per day, morning and evening before going to bed. Simultaneously, never till the moment or rarely exercise the habit of tooth-brushing a ratio of 28.26 % of all the examined children with kidney disorder (Figure 3).

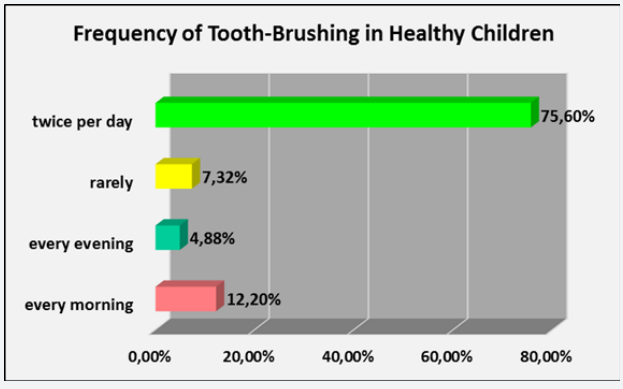

Figure 4: Frequency of Tooth-Brushing in Healthy Children.

In parallel, more than ¾, respectively 75.60%, of healthy children included into the study demonstrate steady and adequate oral-hygiene habits, with tooth-brushing each evening and morning. Rare procedures of tooth-brushing perform only 7.32 % of the included healthy controls (Figure 4).

Most of the children of both groups, more precisely 2/3 of these with the diagnosis of pyelonephritis and ½ of healthy controls, are characterized with weak /+/ concentration of nitrites in

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saliva. The highest concentration of nitrites, strong /+++/, concerns 3 of the patients with kidney disorder and 1 healthy child (Figure 5).

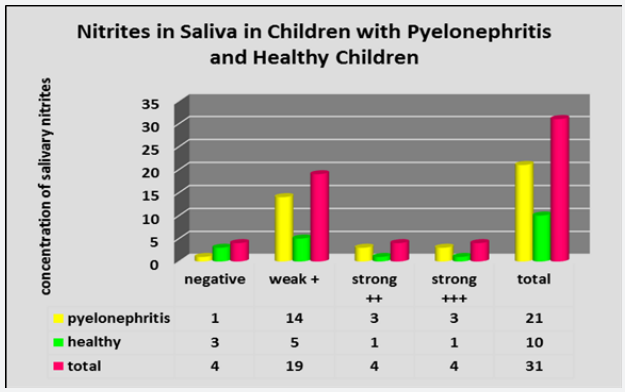

Figure 5: Nitrites in Saliva in Children with Pyelonephritis and Healthy Children.

Discussion

Scientific literature accentuates on the significance of the oral-hygiene status, respectively the quality of performed professional and individual oral hygiene procedures, as a basic criterion of assessment of tooth decay risk [30-33]. Dynamics of the level of oral hygiene cares plays the role of a definite risk-determining factor with variable nature [34]. Accumulation of considerable amount of dental plaque on surfaces of teeth correlates to intensified colonization of cariogenic microorganisms [35,36] and serves as a clinical sign of high risk for caries [22]. Motivation for maintenance of perfect oral hygiene, including oral-hygiene products appropriate for definite age periods, is essential tool of oral diseases' control not only on personal level, but also among pediatricians and general practitioners responsible for the common health of children [13-15].

Kidney disorders can be associated to nitrites in their function of biomarker with diagnostic value [37]. In concentrations not toxic for the human organism nitrites inhibit metabolic substrates of Str. mutans and other acids-producing microorganisms of A. naeslundii and L. casei [38]. In the context of our study among the examined children with diagnosed state of pyelonephritis there has been established great negative correlation between the number of carious lesions and nitrites in saliva. Significant negative correlation has been recorded between the plaque index PLI and the content of nitrites in saliva. Between the gingival index GI and concentration of salivary nitrites has been registered great negative correlation. Great positive correlation has been evaluated between the level of pH and nitrites in saliva. Simultaneously, slight negative correlation has been calculated between the number of carious spots and nitrites in saliva. The obtained results into our investigation ascertain the role of salivary nitrites as an essential protective factor against caries-related pathogenic micro-flora into oral cavity, including in children suffering from pyelonephritis and healthy ones [39]. Our results correspond to regularities determined by other authors. Namely, people characterized with high concentration of nitrites in saliva and oral micro-flora with great capacity for reduction of nitrates to nitrites, are less affected by caries in comparison to those with low level of salivary nitrates and suppressed activity of transformation of nitrates to nitrites [40]. It has been established that nitrites, produced by residual bacteria of the dorsal surface of the tongue, have cytotoxic and cytostatic effects against pathogenic microorganisms responsible for tooth decay [40-42] and periodontal diseases [43]. Salivary glands have the properties to react against processes of periodontal destruction by the means of mechanisms stimulating the protective potential of saliva [44-45]. Some authors accentuate on the diagnostic capacity and functionality of nitrites in saliva as a biomarker for renal disorders [37].

According to data represented by A. Ivanova, A. Krasteva-Panova and Z. Krastev the average value of pH in mixed saliva in adults is equal to 6,7, and in children it amounts to 7,2 [46]. The level of pH and buffer capacity in saliva influence the ions' exchange during processes of de- and re-mineralization of enamel, resulting in oversaturation of the medium with calcium and phosphate ions in condition of pH=7 and in combination with fluorides. On the other hand, the concentration of hydrogen cations upon the dental surfaces have impact upon the process of de-mineralization [47,48].

The infectious diseases of the urinary tract system, including pyelonephritis, are inflammatory processes and their adequate therapy serves as an inevitable prerequisite for proper recovery of the organism [3-5]. Among medicines of first choice of treatment are antibiotics of the classification units of penicillin's and cephalosporins in combination with antipyretics and non-steroid anti-inflammatory drugs. A study devoted to the influence of prolonged application of amoxicillin during the period of early childhood accentuates on its role for disturbed mineralization of enamel in permanent teeth. The deterioration of the process of enamel matrix formation and mineralization has been ascertained as a predisposing factor for increased caries activity of dentition among patients going through these therapy protocols [49]. Morphological alterations of enamel vary in wide range in clinical conditions- from findings of minimal loss of enamel manifested as isolated, single grooves, dots, furrows and pits, to generalized locations of de-mineralized rough, porous or cracked enamel surface. The histological analysis represents ameloblasts without adequate organization, with increased quantity of vacuoles into cytoplasm and slightly elongated nuclei with decreased condensation. The dosage-dependent effects of amoxicillin upon ameloblasts reflect negatively on their proper function, particularly during the stages of mineralization and maturation, causing quality- and/or quantity-related defects of hypo-mineralization [50]. Other authors identify infectious diseases in child's age and exposure of children to various environmental toxins as etiological factors related to the occurrence of demarcation zones of disturbed opacity of enamel surface, often associated to manifestation of enamel hypoplasia. The diffusive regions of altered transparency and lack of smoothness correlate to prolonged usage of antibiotics of penicillin's group (amoxicillin) in condition of high frequency of acceptance [51].

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Parallel to the definite intensity of application of antibiotics and corticosteroids in state of infectious and autoimmune diseases, the dynamics of body temperature curve and frequent episodes of sub-febrile and febrile disorder can also make an impact on processes of formation of hard teeth tissues. The disturbance of balanced and coordinated build-up of specific architectonics of apatite crystals is related to the considerable vulnerability of enamel to a great variety of cariogenic factors in oral cavity [52].

Conclusion

In conclusion, there is a definite accent on the considerable interrelations between the number of cavitated and non-cavitated carious lesions, level of oral hygiene and gingival status, pH and nitrites in saliva and frequency of tooth-brushing in children suffering from the renal disorder of pyelonephritis.

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