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QUALITY OF INJURED TEETH HYGIENE INDEX AS A NEW APPROACH TO ASSESSING THE QUALITY OF HYGIENIC CARE

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The study focuses on evaluating oral hygiene care for injured teeth in children, with the development of the Quality of Injured Teeth Hygiene index. The research targeted children aged 8 to 12, whose teeth, due to traumatic injuries, were immobilized with wire-composite splints. The Quality of Injured Teeth Hygiene, Silness-Loe, and Sulcus Bleeding indices were used to compare the quality of care for injured and healthy teeth to determine the most informative approach. The results demonstrated that the Quality of Injured Teeth Hygiene index showed a stronger correlation with the Sulcus Bleeding indicator, indicating its sensitivity to local inflammatory changes in injured areas. It was found that the use of Quality of Injured Teeth Hygiene index allows dentists to monitor oral hygiene status and adjust recommendations to improve care for injured teeth, thus enhancing treatment effectiveness and reducing the risk of infectious complications.

Key words: children, biofilm, oral hygiene, trauma, traumatic dental injuries, splinting of teeth, tooth damage.

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ІНДЕКС ЯКОСТІ ГІГІЄНІЧНОГО ДОГЛЯДУ ЗА ТРАВМОВАНИМИ ЗУБАМИ, ЯК НОВИЙ ПІДХІД ДО ОЦІНКИ ЯКОСТІ ГІГІЄНІЧНОГО ДОГЛЯДУ

Дослідження присвячено оцінці гігієнічного догляду за травмованими зубами у дітей, для чого було розроблено індекс якості гігієнічного догляду за травмованими зубами. Основна увага приділялася дітям віком від 8 до 12 років, у яких через травматичні ураження зуби були зафіксовані дротяно-композитними шинами. Для порівняння якості догляду за травмованими та здоровими зубами використовувалися індекси якості гігієнічного догляду за травмованими зубами, Silness-Loe та кровоточивості ясенної борозни, з метою визначення найбільш інформативного підходу. Отримані результати показали, що індекс якості гігієнічного догляду за травмованими зубами краще корелює з показником індексу кровоточивості ясенної борозни, що свідчить про його чутливість до місцевих запальних змін у травмованих ділянках. Виявлено, що використання індексу якості гігієнічного догляду за травмованими зубами дозволяє стоматологам контролювати стан гігієни та адаптувати рекомендації для покращення догляду за травмованими зубами, підвищуючи ефективність лікування і зменшуючи ризик інфекційних ускладнень.

Ключові слова: діти, біоплівка, гігієна порожнини рота, травма, травматичні ураження зубів, шинування зубів, пошкодження зубів.

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The oral hygiene status significantly impacts the progression of diseases affecting the hard tissues of teeth and periodontal tissues. The factor of uncontrolled dental biofilm accumulation is particularly important for the positive outcome of treatment for traumatic dental injuries, including luxations, avultions and root fractures [4, 5, 6, 10]. In all these cases, immobilization (splinting) of the injured teeth is performed, securing them to stable adjacent teeth. Maintaining proper oral hygiene, especially around the injured teeth, helps minimize the impact of pathogenic and opportunistic microorganisms in the oral cavity on the affected periodontal areas [9]. However, children and their parents often fail to provide adequate hygiene care for injured teeth due to pain or discomfort in the trauma area or fears of interfering with the healing process [8]. The assessment of traditional oral hygiene indices in such children is often challenging and less informative, while monitoring individual oral hygiene requires an objective evaluation to predict the quality of trauma treatment.

The purpose of the study was to develop and test a method for assessing the level of oral hygiene care for teeth with wire-composite splints as a component of comprehensive examination and treatment for dental trauma.

Materials and methods. The study was conducted in 2021–2024 at the Department of Pediatric and Preventive Dentistry at Bogomolets National Medical University. 16 children aged 8 to 12 years with traumatic dental injuries participated in the study. They received immobilization with wire-composite splints due to luxations, avulsions, and root fractures of permanent teeth.

Each participant's data on the studied index of quality of injured teeth hygiene (QITH) [1], and the oral hygiene status index by J. Silness and H. Löe (1964, 1967), were determined and compared. The indices were measured on days 1, 7, and 14 after splinting. The Sulcus Bleeding Index (SBI) was used as a control parameter to assess the informativeness of these indices. The selection criterion for the SBI was its ability to evaluate two signs of mucosal healing: bleeding of the gingival sulcus and swelling of the marginal gingiva.

The statistical analysis of the available data on the sample objects was conducted using specialized statistical software MedStat v. 5.2 (Free Software Licence, Ukraine) and EZR on R Commander v. 1.64 (Free Statistical Software, Jichi Medical University, Japan).

The distribution of the available data was checked for normality using the Shapiro-Wilk test. Data with a normal distribution are presented in the form (M±SD), where M represents the arithmetic mean and SD represents the standard deviation. A 95 % confidence interval (95 % CI) was also calculated.

The Student's t-test was applied to determine the statistical significance of differences in cases of pairwise comparisons of related groups of statistical observation objects with a normal distribution. The correlation between variables was studied using the non-parametric Spearman's rank correlation coefficient calculation method. All calculations were performed considering a two-tailed critical region. Differences in the characteristics of statistical observation objects and/or correlations between them were considered statistically significant at a significance level of $p<0.05$ (assuming the critical value of statistical significance is 0.05).

Results of the study and their discussion. Method for Determining the QITH Index.

Teeth assessed for biofilm thickness include all teeth with a fixed wire-composite splint (Fig. 1), as well as an equivalent number of adjacent teeth on the same jaw on the teeth to the left of the injured teeth for right-handed patients and to the right of the injured teeth for left-handed individuals (Fig. 2).

Fig. 1. Photo of biofilm thickness assessment on splinted teeth.

Fig. 2. Photo of biofilm thickness assessment on adjacent teeth.

Surfaces on which biofilm thickness is assessed: surfaces where the splint is attached (usually vestibular surfaces, though cases of lingual splint fixation are also possible), approximal surfaces, as well as corresponding surfaces on healthy teeth.

Areas where biofilm thickness is assessed: tooth surfaces above and below the level of the splint (between the gingival margin and the wire-composite splint, and between the splint and the incisal edge).

Evaluation Criteria:

0 – Plaque is not visually noticeable and is not detected when probing the tooth surface;

1 – Plaque is not visually noticeable, but a small amount of plaque is visible on the tip of the probe after moving it along the tooth surface;

2 – Plaque is visually detectable and also present on the tip of the probe after moving it along the tooth surface;

3 – Intense plaque buildup, including in the interdental spaces and on the gums.

The tooth with the highest index value on any of the studied surfaces and areas is identified, and this value is conditionally accepted as the index for all splinted teeth. The plaque thickness index on healthy teeth is determined as the average value of the indices of each examined tooth, taking into account the measurement of biofilm thickness on three surfaces (proximal, and either vestibular or oral, depending on the location of the splint on traumatized teeth). The plaque thickness (ranging from 0 to 3) on each of the three tooth surfaces is assessed, and the obtained values are summed and divided by 3 to obtain the biofilm index for one tooth. The values of individual teeth are then summed and divided by their number to determine the average index value.

The calculation method:

The obtained data are entered into the formula:

Y=X/Z*, where:

X – thickness of plaque on splinted teeth (detected maximum value on the surface; can be 1, 2, or 3; for correct calculations, a value of 0 should be considered as 0.1). **Z** – average plaque thickness on non-splinted teeth, in a quantity that corresponds to the number of splinted teeth; can vary from 0 to 3; for correct calculations, a value of 0 should be considered as 0.1.

Interpretation of results:

The value of $Y > 1$ indicates poorer hygiene care of splinted teeth and the need for adjustments in individual oral hygiene, with a focus on the area of the injured teeth.

A value of Y < 1 may indicate greater attention by the patient to the hygiene of the injured teeth and the need for adjustments in individual oral hygiene in the undamaged areas of the dental arch.

A value of Y = 1 suggests that the patient does not distinguish the injured area during tooth brushing. Depending on the value of the numerator or denominator, it may be advisable to modify the individual hygiene approach (if the value is 1 or greater) or to approve the existing level of tooth care (if the numerator or denominator is less than 1).

The results of the study demonstrated the effectiveness of the developed method for assessing oral hygiene care for traumatized teeth in children, which may be useful for practicing dentists in managing patients with similar injuries.

Table 1 presents the mean and interval estimates of QITH, Silness-Loe, and SBI values for the group of pediatric patients (n=16) on the first, seventh, and fourteenth day of observation, as well as the corresponding values of relative reduction for each indicator over 14 days (RRI_14) and the statistical significance of differences in indicator values between day 1 and day 14 (p_{1-14}).

Table 1

Mean values and dynamics of changes in QITH, Silness-Loe, and SBI indices on days 1, 7, and 14 of observation

Index	Mean ± SD (95 % CI values)			RRI_14 (p_{1-14})
	Day 1	Day 7	Day 14	
QITH	2.0±0.7 (1.6−2.3)	1.5±0.5 (1.3−1.8)	1.2±0.5 (0.9−1.4)	41 % (p=0.003)
Silness-Loe	2.5±0.3 (2.3−2.7)	2.1±0.3 (1.9−2.2)	1.6±0.3 (1.4−1.8)	35 % (p<0.001)
SBI	1.8±0.6 (1.5−2.1)	1.0±0.5 (0.7−1.3)	0.3±0.3 (0.1−0.4)	83 % (p<0.001)

The comparison of central tendency indicators for paired related samples of QITH, Silness-Loe, and SBI indices for a group of patients (n=16) on day 1 and day 14, using Student's t-test with a two-tailed critical region, revealed a statistically significant reduction in the QITH index by 41 % (p=0.003), the Silness-Loe index by 35 % (p<0.001), and the SBI index by 83 % (p<0.001). The reduction in the QITH index more closely aligns with the reduction in the SBI index than with the dynamics of the Silness-Loe index. This reduction is clinically significant, as it indicates a decrease in biofilm volume and inflammation, which is important for preventing infectious complications in the area of traumatized teeth. This allows the clinician to monitor the dynamics of the indices with justification and to adapt recommendations according to the patient's individual response to oral hygiene care.

In Fig. 3, a box plot illustrates the range of values for QITH, Silness-Loe, and SBI indices on the first, seventh, and fourteenth day of observation during the dental treatment of a group of pediatric patients (n=16) with traumatic dental injuries.

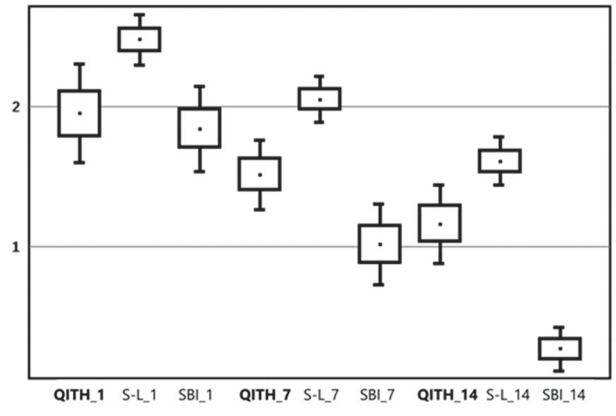

Fig. 3. Box plot of the QITH, Silness-Loe, and SBI indicator values on the first (QITH_1, S-L_1, and BI_1), seventh (QITH_7, S-L_7, and SBI_7), and fourteenth day (QITH_14, S-L_14, and SBI_14) of observation during dental treatment in a pediatric patient group (n=16) with traumatic dental injuries.

The examination of the correlation between the QITH, Silness-Loe, and SBI indices on the fourteenth day of treatment, using Spearman's rank correlation coefficient (R_S), revealed a strong negative correlation between the QITH and SBI indices, with an R_S value of -0.713 at a significance level of p=0.01. In contrast, the correlation between the QITH and Silness-Loe indices was weaker, characterized by a moderate Spearman's rank correlation of R_S = -0.424 (p=0.04). This may suggest that, compared to the Silness-Loe index, changes in the QITH index are more closely aligned with changes in the SBI index for the majority of patients. This indicates that the QITH index is reliable for clinical use in monitoring the hygiene status of traumatized teeth, as it reflects the improvements occurring during the healing process. Meanwhile, the less pronounced correlation between QITH and the Silness-Loe index highlights the suitability of using QITH specifically for monitoring traumatized areas.

The methodology of calculating the QITH index suggests its greater appropriateness for monitoring hygiene status specifically in cases of traumatic dental injuries. Depending on the value of Y > 1, Y < 1, or

Y = 1, it is possible to clearly identify the area with poorer hygiene and improve it. In contrast, the Silness-Loe index is used for a general assessment of the oral hygiene of the entire cavity, and its results may not fully reflect changes in the traumatized areas.

Considering the manipulation differences between right-handed and left-handed patients when brushing with a toothbrush [2], it is advisable to evaluate biofilm thickness on the teeth to the left of the injured teeth for right-handed patients and to the right of the injured teeth for left-handed individuals.

Research on oral hygiene in children with dental trauma has been conducted by specialists from various countries, as traumatic dental injuries require special attention to hygiene care to minimize the risk of complications and promote rapid healing [2, 3, 4, 8]. This study generally aligns with the conclusions obtained. The recommendations of the International Association of Dental Traumatology (IADT) [5] include guidelines for the care of injured teeth, particularly emphasizing hygiene maintenance to reduce inflammation and the risk of complications. Other existing studies use standard indices to monitor hygiene in patients with traumatic injuries [7]. However, these indices often do not account for the specifics of the injured areas, making them less accurate for such cases.

Based on foreign, domestic, and our own research, a specifically designed index for assessing the hygiene condition of traumatized teeth that require fixation with wire-composite splints, called the QITH index, was proposed. In the available literature, no studies were found dedicated to the development of specialized tools for assessing oral hygiene in cases of dental trauma. This index demonstrated high sensitivity to local changes in the trauma area, which other traditional approaches cannot provide. Therefore, the QITH index is promising for use in cases of traumatic dental injuries in children, as it allows for objective monitoring of hygiene conditions and timely adjustment of care in the post-traumatic period.

Conclusion

Thus, the QITH index serves as an objective and effective tool for assessing the hygiene status of traumatized teeth, especially in patients with wire-composite splints applied due to trauma. During the observation period, a significant 41 % reduction in the QITH index was achieved ($p=0.003$), indicating positive progress in the hygienic care of injured teeth. This indicator correlated with changes in the SBI index, which decreased by 83 % ($p<0.001$), signifying a substantial reduction in the inflammatory process in the trauma zone. In contrast, the overall hygiene index Silness-Loe, although reduced by 35 % ($p<0.001$), showed a weaker correlation with the SBI index ($RS = -0.424$) than the QITH index ($RS = -0.713$). This confirms the greater sensitivity of the QITH index to local changes in the trauma area. The use of the QITH index allows the dentist, in clinical practice, to accurately monitor the hygiene status of the injured area and promptly adjust individual hygiene recommendations, thus enhancing care effectiveness during the post-traumatic period, reducing the risk of infectious complications, and improving the prognosis for the treatment of traumatic dental injuries.

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