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The significance of the formaldehyde cycle in the pathology of hard tissues of teeth

Znaczenie cyklu formaldehydowego w patologii twardych tkanek zęba

A lot of attention has been recently paid to studies of relationships between biochemical changes occurring in tissues and the radiological image of these tissues. In several papers (3–7) Tyihak showed that formaldehyde was not a side product in biological systems but rather a basic and indispensable component of biological processes. Research carried out by other authors revealed that formaldehyde level in cells of plant, animal and human tissues as well as in body fluids depends on physiological state of a given organism (1).

Formaldehyde (HCHO) is "a two–face molecule". On one hand, HCHO is a widely spread common environmental pollutant. On the other hand it has also been reported to be bound mainly in labile hydroxymethyl groups. It is a normal and indispensable component of various biological systems. It is more and more evident that there is a HCHO cycle in biological systems in which formation of the S–methyl group of L–methionine takes place through HCHO and the formation reactions (e.g. N–methylation of histamine by animal methyl–transferases). The high level of HCHO and the accumulation of N–methylated substances during the early development stages and in rapidly dividing cells as well as in spring e.g. in the leaves of trees are the result of intensive transmethylation reactions.

A number of rapid HCHO pathways in different tissues exists through labile hydroxymethyl groups linked to various acceptor molecules (e.g. L–arginine).

It follows from these facts that all biological systems possess a HCHO–yielding potential which can be originated from methylation and demethylation pro-

cesses alike. More detailed knowledge of these fundamental biotransformation steps will facilitate elucidation of certain perplexing phenomena.

On the basis of these research works, taking under account intracellular presence of HCHO, it was resolved to determine its presence in tissues of human teeth – physiological teeth and the ones with pathological changes and to compare the results with radiological image of the studied teeth.

MATERIAL AND METHODS

A special procedure of thin–layer chromatography (TLC) (2) has been used in order to determine HCHO level in various biological samples with dimedone as the acceptor of HCHO bound in different ways in these samples.

The analysis of the obtained results (Figs 1, 2) shows differences in HCHO values as formaldmethone (dimedone adduct) according to physiological and pathological state of teeth (Figs 3, 4, 5, 6, 7). In the studied material it was proved that high HCHO level was present in extracted deciduous teeth also with caries and in teeth of adults with extensive deep caries as well as in teeth extracted due to parodontosis. The analysis of digital radiography images of teeth extracted due to parodontosis revealed that these teeth had also carietic lesions which could influence the formaldehyde level in their tissues. It confirms the suggestion that caries can be of great importance in the process of formaldehyde release. Determined high formaldehyde level in carietic teeth was the reason of carrying out the experiment using the Shimadzu CS–9000, densitometer, $\lambda = 275\mu m$ with modern computer software CS–9001 version 2.0 which enabled increase of precision of determination as well as a modernized form of presentation of obtained results.

DISCUSSION

The obtained data clearly confirmed the presence of high formaldehyde level in carietic teeth (Fig. 1). Some other differences in formaldehyde levels in other groups of studied teeth can depend on physiological state of an organism.

Undoubtedly the determination in a series of experiments of high formaldehyde levels in carietic teeth indicates a fundamental role of this compound in teeth metabolism as well as paves the way to the possibility of next research works and new interpretations of dental caries.

The results of the experiments show that formaldehyde determination in hard tissues of teeth can be a valuable advice in studying metabolic processes in cells and tissues. The radiological analysis enables establishing correlations between obtained results in the form of formaldehyde level with extension of pathological processes occurring in hard tissues of teeth.

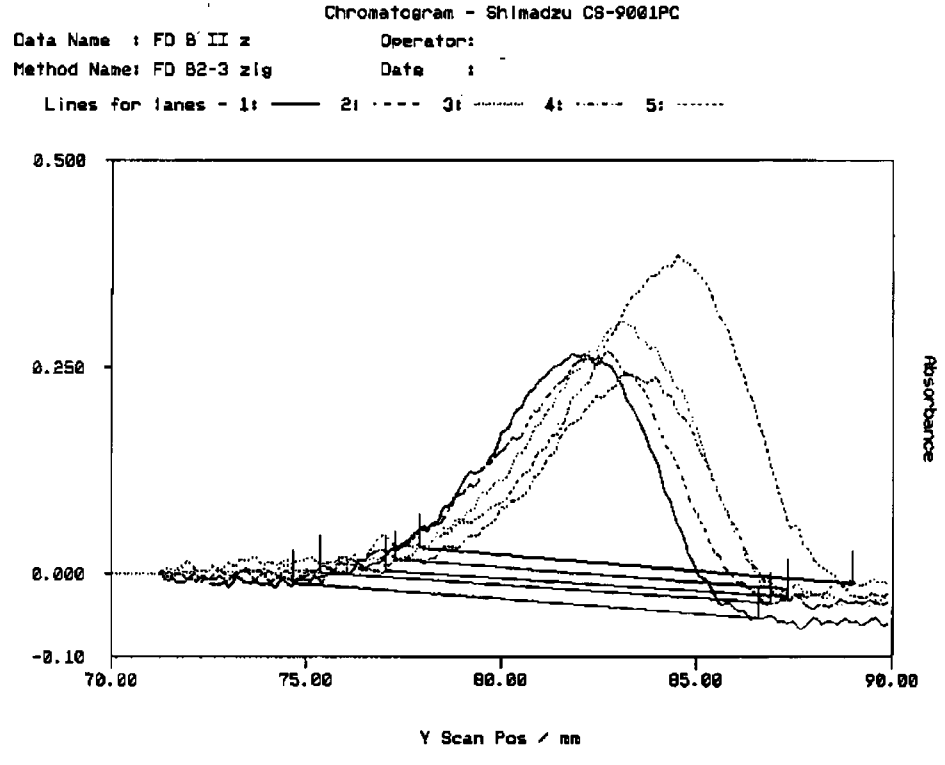

Fig. 1. Densitograms of formaldmethone (dimedone adduct) in samples: 1. deciduous teeth (I), 2. ortodonthic teeth (II), 3. parodontal teeth (III), 4. retained teeth (IV), 5. carietic teeth (V)

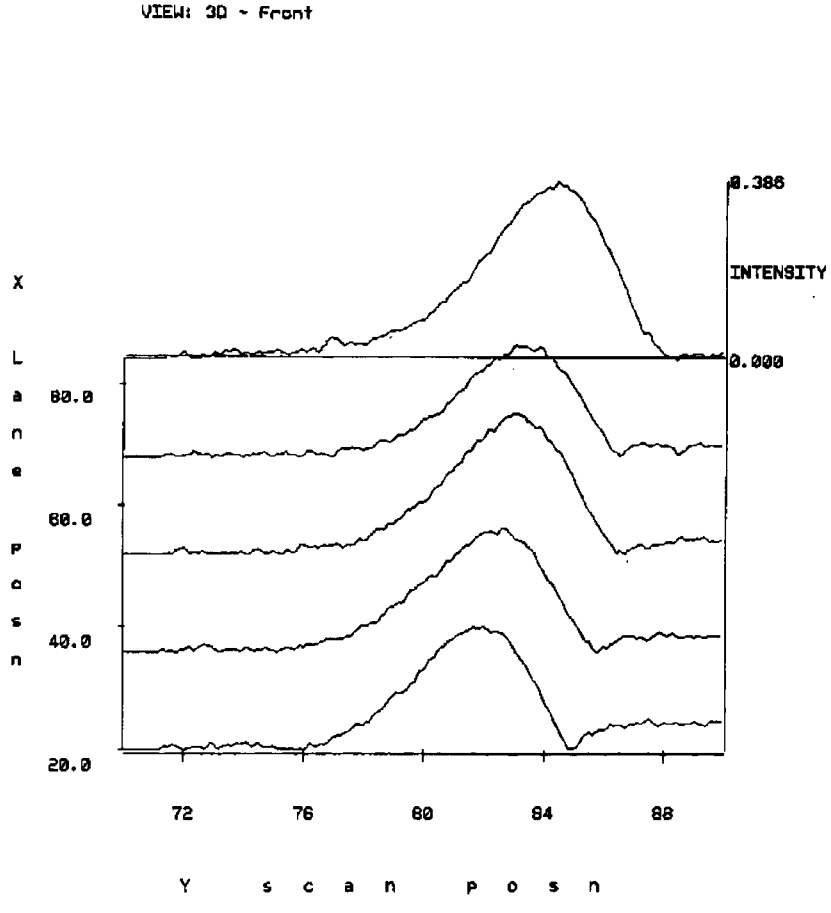

Fig. 2. Transformation of formaldmethone densitograms in analysed samples (designations as in the previous figure)

Fig. 3. Digital radiography image of studied teeth - deciduous teeth

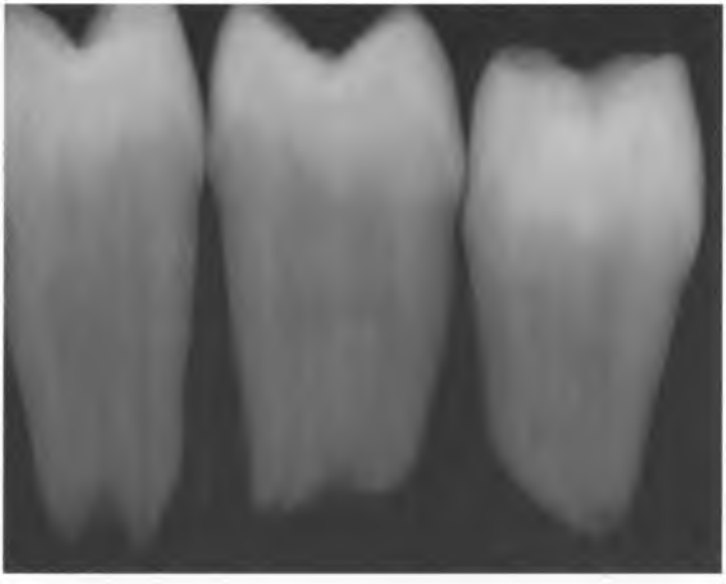

Fig. 4. Digital radiography image of studied teeth - ortodonthic teeth

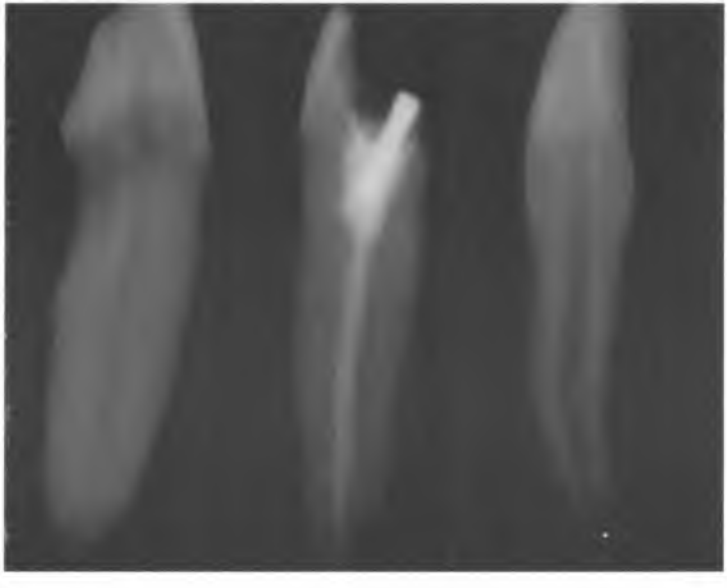

Fig. 5. Digital radiography image of studied teeth - parodontal teeth

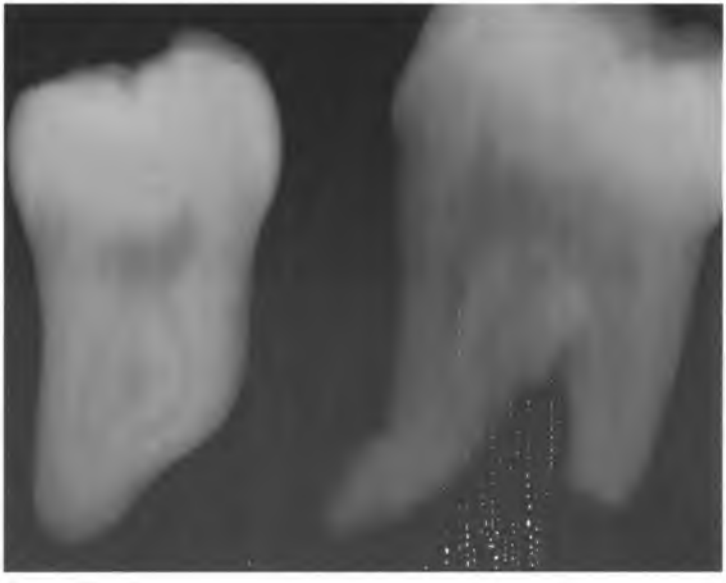

Fig. 6. Digital radiography image of studied teeth - retained teeth

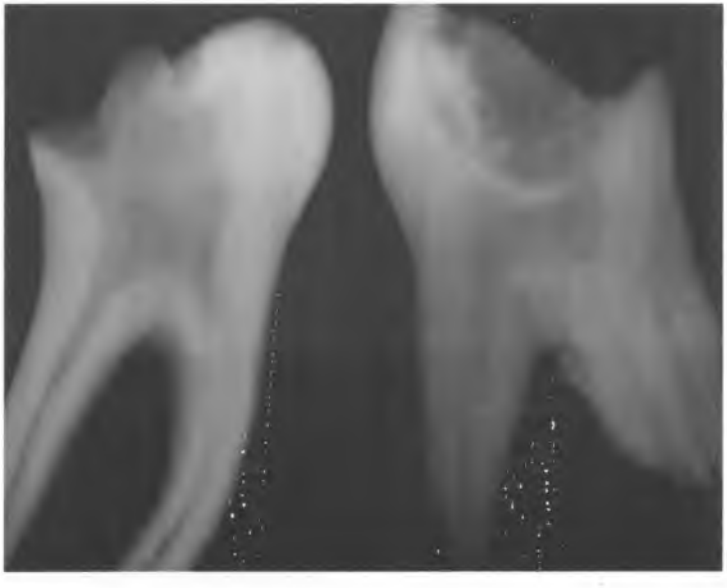

Fig. 7. Digital radiography image of studied teeth - carietic teeth

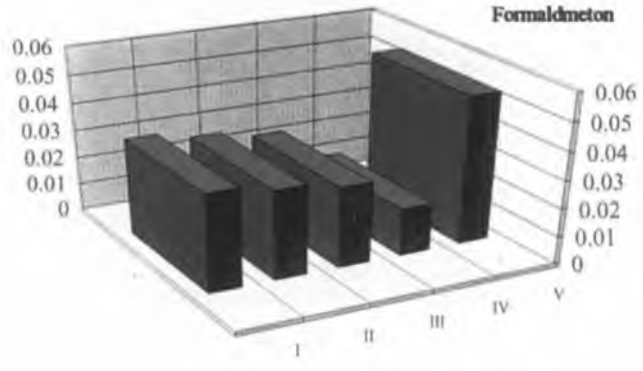

Fig. 8. Formaldmethone levels in analysed samples
(μg/20μl of extract)

CONCLUSIONS

The studies of metabolism of physiological and pathological hard tissues of teeth showed a fundamental relationship between their state and their formaldehyde levels. In the case of pathologically changed hard tissues the formaldehyde level increases, which is related to the type of pathology.

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STRESZCZENIE

W związku z tym, że formaldehyd (HCHO) jest podstawową i nieodzowną częścią procesów biologicznych, występuje w różnych stężeniach w komórkach tkanek roślinnych, zwierzęcych i ludzkich, postanowiono zbadać jego poziom w tkankach zębów ludzkich fizjologicznych i patologicznie zmienionych. Zastosowano specjalną, czułą metodę wyodrębniania HCHO z twardych tkanek zębów przy pomocy dimedonu. Oznaczanie stężenia formaldehydu wyodrębnionego z materiału biologicznego przeprowadzono metodą wysokosprawnej chromatografii (TLC) z zastosowaniem densytometru do oznaczeń ilościowych. Analizowano 5 różnych przypadków fizjologicznych i patologicznych zębów. Wykazano istotne zróżnicowanie poziomu HCHO w twardych tkankach zębów w zależności od ich stanu fizjologicznego. Zróżnicowanie poziomu HCHO skorelowano z obrazem radiologicznym zębów. Stwierdzono korelacje poziomu formaldehydu z rozległością procesów patologicznych tkankach twardych zębów (przede wszystkim próchnicy).