# COMPARATIVE STUDIES OF SELECTED PHYSICAL AND MECHANICAL PROPERTIES OF TOOTH TISSUES FROM PRIMARY TEETH

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## Introduction

Damaged tooth tissues cause pain, which means that they are unable to fulfill their basic functions. Once damaged tissue never returns to its original state, therefore, in order to prevent further disease progression, the damaged tissue should be removed and reconstructed using dedicated materials. Dental tissue diseases more and more often concern children for whom it becomes necessary to introduce dental restorations in primary teeth.

The main task of the dental filling is to rebuild the continuity of the tissue and take over its functions. The selection of the appropriate material requires a good knowledge of the mechanical and physical properties of the tooth tissues. These properties, however, depend on many factors, such as: the type of teeth (permanent teeth and primary teeth), the patient's age, the content of minerals and genes.

The selected material should replace the tooth tissue as well as possible in terms of mechanical properties, a filling that is too weak may be damaged, it may fall out or crumble, while a filling with too high mechanical properties may destroy healthy surrounding tissues.

## Materials and Methods

The research materials were human primary teeth (N=12), consisting of: 1 pre-tooth (fetal tooth), teeth marked according to the Viohl classification (ISO-3950) as 63, 64 and 65 from children aged 2-6 years. The study used 2 preparations with caries (65_P), and 2 with Nano_Comfort filling. The Nano Comfort filling is composite hybrid filler, which is characterized by reduced polymerization shrinkage [1]. In order to determine the structural and physical properties, the scope of the research was divided into several stages. The first step was to register each of samples with a resolution of 9μm and lamp parameters 80kV/124μA, was performed using a SkyScan 1172 computer microtomograph by Bruker®.

This study allowed for the visualization of individual tooth tissues and filling, which in this case allowed to assess the quality of the connection between the tooth tissues and the filling. The next stage of the work was the measurement of the mineral density of dental tissues, carried out with the use of CTAn software and phantoms of a specific density. The last stage of the research was the measurement of Young's modulus (Olivier-Pharr method) and microhardness using the CSM MicroCombi Tester™ microhardness tester. On each of the teeth, measurement points were selected on the enamel and dentine, and on samples with filling, also points on the filling. The samples were loaded with the selected force of 300 mN with a break of 15 seconds after reaching the maximum value of the force.

## Results and Discussion

Based on obtained results, it can be seen that the values of hardness and Young's modulus are the highest for enamel, the values for dentin are approximately 3-5 times lower (FIG. 1), which is also consistent with the works of other authors [2]. The Young's modulus values for enamel ranged from 49 to 98.8 GPa, which gave a difference of about 50%, similarly in the case of microhardness, the values ranging from 270 to 569 HV. For dentin, these values ranged from 9.78 to 64.14 GPa, the results differed by a maximum of about 85%, and 54 to 282 HV, which is a difference of even 81%. The results obtained for the dentine of primary teeth are also lower than those obtained for enamel, for the Young's modulus by an average of 56%, for hardness of 65%.

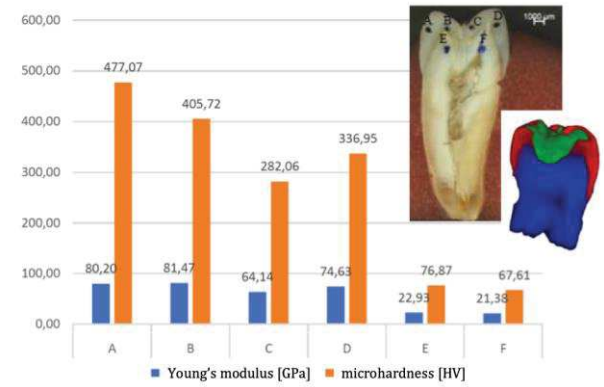


FIG. 1. Comparison of the Young's modulus and microhardness values for different regions of the exemplary tooth 85.

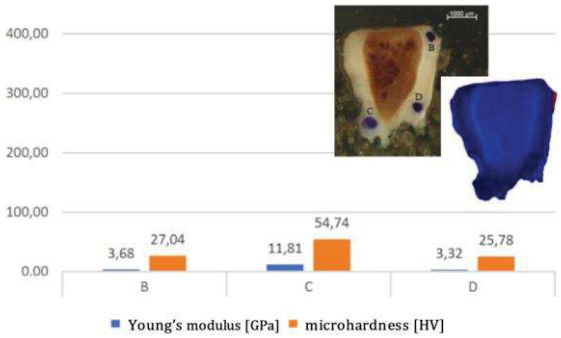


FIG. 2. Comparison of the Young's modulus and microhardness values for different regions of fetal tooth.

A very interesting case is also the fetal tooth, one of the alleged causes of which may be a deficiency of minerals in the mother during pregnancy (FIG. 2). This tooth is characterized by the lowest values of both Young's modulus (3-11 GPa) and microhardness (25-54 HV).

## Conclusions

The results for all examined tissues differed not only between the examined teeth, but even within the same tooth there were high differences between the results. The influence of the type of teeth (1-5), the age of patients and the condition of the teeth on the tested properties was also observed. The more developed and mature the tooth, the higher the mechanical properties - this is due to the fact that the incisors are responsible only for biting food, and the teeth located in the back part of the mouth are responsible for the mechanical processing of food. The jaw forces acting on the teeth when grinding food are greater than when biting bites.

## References

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