ASSESSMENT OF SELECTED STRUCTURAL PROPERTIES OF ORTHODONTIC ARCHES

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Introduction

The most important requirements set for the arches are first of all its high biocompatibility, biostability and non-toxicity. To this day, the aspect that raises the most doubts in using the nickel-titanium arches in medicine is the risk of the nickel ions being released into the patient's body. Nickel can lead to allergic reactions in patients. It is the cytotoxic, genotoxic and carcinogenic element. Due to occurrence of the material heterogeneity and the high factor of the orthodontic arch roughness, the rate and quantity of the released nickel can gradually increase. Therefore, the applied material is still a subject of many experiments, and in the orthodontics it is applied only in a short-term therapy [1-3]. Due to this, in the present work, a particular attention was paid to the possible impact of orthodontic wires operation on quality of the material and function of human body.

Materials and Methods

For the planned studies the superelastic orthodontic arches from *Adenta* and *Ormco* producer were used. Each of them was made of the nickel-titanium alloy (NiTi) and it belonged to the IInd generation. The cross section of a singular sample in the initial state was rectangular of the 0,016" x 0,022" size.
The randomly selected orthodontic wires were divided to smaller sections and included in the resin. In order to reveal microstructure of the studied samples of orthodontic arches, the HF - HNO_3 – CH_3COOH agent was applied.
The tests were divided into two main stages. The first one concerned the tests on the orthodontic wire samples in the initial state. The purpose of the second one was testing the arches properties after 4-weeks exposal in the patient's mouth. The performed tests involved analysis of the chemical composition, microstructure tests before and after the surface etching, as well as analysis of the material contamination degree according to the Polish standard PN-64 / H-0410.

Results and Discussion

For the samples in their initial state from Adenta and Ormco, the analysis of the chemical composition, have shown about 55 % of nickel and 45 % of titanium.
Microstructure of the orthodontic arches material in the as delivered state from Adenta is characterised with appearance of clear needles of martensite. The similar situation is observed in the case of materials provided by Ormco producer.
The characteristic phase of the fine acicular martensite has also been observed in the case of samples after the 4-week exposal in mouth.

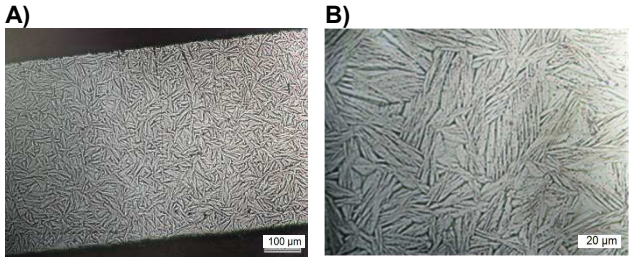

FIG. 1. The microstructure of the random selected nickel-titanium orthodontic arch from Adenta, where A) as delivered state, B) after the 4-week exposal in mouth. (LM)

The non-metallic inclusions, of the oxides and silicates type, have been observed in case of assessing the purity of orthodontic arches received from Adenta and Ormco in their initial state (TABLE 1). The microscopic tests of, randomly selected wires have shown appearance of the first of all the silicates of globular shape (KN), several locally laid non-brittle silicates (KK), and few point oxides (TP). The number and type of the inclusions was random and different for the randomly chosen arch.

TABLE 1. Results of the assessment of the contamination degree of the orthodontic arches from Adenta (A1,A2,A3) and Ormco (O7,O8,O9) producer - the non-etched, as delivered state, where TP- the point oxides, KN – the point silicates.

Brand Name	Sample	Indicator of non-metallic inclusion	
		TP	KN
Adenta	A1	2,00	3,90
	A2	3,70	2,70
	A3	3,40	2,80
Ormco	O7	1,50	1,75
	O8	2,80	1,10
	O9	1,30	3,00

A curious situation occurs when evaluating cleanliness of the material after its 4-week exposal in a patient's mouth. Independent of the arch producer, the tabular result summary did not make sense finally. It turned out that each operated arch was characterised with very small number of any non-metallic inclusions.

Conclusions

The observation of microstructure in each of the studied cases has shown presence of the very fine martensite needles. It is confirmed by the super elastic character of the material, among others the Ni-Ti alloys, which is featured by presence of the low-temperature (from about 4 to some 25°C) martensite phase.
The evaluation of the contamination degree for the orthodontic arches material in their non-etched state has shown the clear occurrence of non-metallic inclusions, mainly for the as delivered state. In the metallographic analysis of samples after oral exposure, these inclusions were definitely less. It may be the result of the everyday operation of the whole orthodontic appliance. Thus, some part of the material gets into the patient's organism, including the non-metallic inclusions, as well as the already mentioned allergenic nickel.

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