8. Streszczenie pracy w języku angielskim

Currently, the surgical treatment of early-onset scoliosis (EOS) is based on the use of growth friendly techniques. They consist in placing suitably modelled implants in the spine, which correct the curvature of the spine multi-directionally with no inhibition of the natural bone growth. These include Traditional Double Growing Rods (TGR), Vertical Expandable Titanium Rib (VEPTR), and modern Guided Growth Systems (GGS). These implants are constructed from various materials, often titanium and its alloys. Titanium and its alloys are characterised by high mechanical strength and excellent chemical inactivity. The resistance of titanium to many oxidising chemicals, e.g. concentrated acids or gaseous chlorine, is a result of the formation of a protective passivation oxide layer on its surface. However, the mechanical forces acting on the implant and the electrochemical reactions taking place on its surface through contact of the implant with the extracellular fluid lead to damage and corrosion of the passivation layer. Consequently, tissues located in the immediate vicinity of the implant have a black greasy metallic coating visible to the naked eye. This phenomenon is especially visible in the case of the innovative GGS systems, which do not require frequent (every 6-9 months) procedures consisting in replacement or extension of implants attached to the spine, as is the case with the TGR or VEPTR systems. As demonstrated in literature reports, released titanium causes a number of undesirable biological reactions characteristic of grade IV hypersensitivity.

The aim of this study was to optimise the conditions of preparation of samples and quantitative analysis of titanium with spectroscopic methods in the biological material from patients of the Children's Orthopaedic Clinic, University Children's Hospital in Lublin, treated with the use of the TGR, VEPTR, and GGS systems. The analysed material consisted of tissues in direct contact with the implant, subcutaneous tissues (located approx. 0.5 cm under the skin incision area), blood, hair, and nails. The optimisation of the sample preparation conditions involved selection of a composition of the oxidising mixture that would cause complete mineralisation of the biological material without dissolution of implant particles present in the tissues bearing the metallic coating. To optimise the composition of the oxidising mixture, microwave mineralisation of titanium dust was carried out with the use of mixtures with different levels of nitric acid (V), hydrogen peroxide, and water. The optimised composition of the oxidising mixture allowed determination of only the ionic form of titanium in the

examined tissues formed in the process of implant corrosion. A procedure described in the literature was used for mineralisation of the blood, hair, and nails. The quantitative analysis of titanium in the obtained mineralisates was carried out with the use of Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS), Flame Atomic Absorption Spectrometry (FL-AAS), and Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). The following steps were undertaken to optimise the GF-AAS analysis conditions:

- the effect of the addition of various modifiers on the titanium-specific absorption signal was tested,
- the temporal-thermal program of the graphite furnace was optimised by determination of the dependence of absorbance on the temperature in the pyrolysis stage and on the temperature and duration in the atomization stage,
- the number of samples that can be determined in one cuvette before a substantial recovery decline caused by cuvette destruction was established,
- the range and number of measurement pixels were optimised and an appropriate mathematical model was selected for the best possible linearity, precision, and sensitivity of the method,
- the limit of quantification was determined experimentally

The following steps were undertaken to optimise the FL-AAS analysis conditions:

- an appropriate composition of the combustible mixture was selected and the following parameters were optimised: the position of the flame (atomisation zone) in relation to the optical path, the height of the analytical zone, and the oxidiser-reducer ratio in the combustible mixture,
- the effect of the ionising buffer on the titanium-specific absorbance value was assessed,
- the number of measurement pixels was optimised and an appropriate mathematical model was selected for the best possible linearity, precision, and sensitivity of the method

The following steps were undertaken to optimise the ICP-OES analysis conditions:

- the most sensitive analytical line was determined,
- an appropriate mode of reading the analytical signal was selected,
- gas flow for nebulisation and the plasma generator power were selected,
- the limit of quantification was determined experimentally

The optimised GF-AAS technique was used for quantitative analysis of titanium in mineralisates from tissues in direct contact with the implant, subcutaneous tissues, hair, and nails. Additionally, it was shown that the GF-AAS technique can not be applied for determination of the titanium content in blood directly with the method of standard addition. Given the appropriately high concentrations of titanium, the optimised FL-AAS method was used for quantitative analysis of titanium only in the mineralisates from the peri-implant tissues. The optimised ICP-OES technique was used for the quantification analysis of titanium in blood mineralisates.