# BIOMATERIALS IN CORRECTION OF INGROWN NAILS – OVERVIEW OF CURRENT ISSUES

**WOJCIECH KARWOWSKI**

DEPARTMENT OF MEASUREMENT AND ELECTRONICS,
FACULTY OF ELECTRICAL ENGINEERING, AUTOMATICS,
COMPUTER SCIENCE AND BIOMEDICAL ENGINEERING,
AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY,
KRAKOW, POLAND
E-MAIL: WOJCIECH.JAN.KARWOWSKI@GMAIL.COM

*[ENGINEERING OF BIOMATERIALS 148 (2018) 64]*

**Introduction**

The problem of ingrown nails (Latin: Unguis incarnatus / Onychocryptosis) is known in scientific and medical literature [1,2] as this problem cause incapacitation and real pain for the patient and impossibility of normal functioning. However, apart from the surgical methods, there are many ones that are commonly used by the podiatry surgeries. The methods used in them - although also in medical facilities - are based mainly on the use of so-called "temporary" implants for correction of the nail plate [3]. A method involving such a practice is called Orthonyxia, which consists of implantation of a small metal (or other material) brace or plate onto the dorsum of the nail [4]. The method is characterized by high efficacy and non-invasive compared to classical surgical methods, which translates into better tolerance for patients and not excluding them from everyday duties [5]. However, to date, no work has been developed covering the entire subject in terms of materials. This review work is an initiation of research and ordering of issues.

**Materials and Methods**

In the discussed issue, we can distinguish two main areas - the area related to the parameters associated with the nail plate and the area associated with the biomaterial parameters used for Orthonyxia treatments. In the first area should be mentioned the basic dimensions of the nail plate as thickness, length, width, surface, and other more complex parameters such as the elasticity of the distal edge (border) of the nail, the length of protrusion beyond the nail bed, angle of curvature of the growth edge, surface structure and depth of possible ingrown nail plate into nail walls. Next, parameters of the surface topography and nail plate associated with its deformation such as transversal deformation and longitudinal deformation.

The tool appropriate to complete the listed parameters can be scientific device Nail StrainStress Meter NM 100 by Courage + Khazaka electronic GmbH.

On the other hand, we have a number of parameters related to the materials used. Widely used materials in Orthonyxia are braces plastic, plastic-silicone, fiberglass, gold (aesthetic area), steel and metal alloys from which the appropriate braces are made. The last of these, metal alloys, are among the most popular ones used in the last decade. Especially memory shape alloys used in orthodontics.

The problem, as in the previous area related to the nail plate itself, is that no mechanical and other parameters related to the forces released by the materials used and their effect on the biological environment of the application site, which is often a wound environment, are determined.

Therefore, it seems to be strategic to determine the basic operating parameters of the used metallic biomaterials with the shape memory as the chemical and physical structure of the alloy, electron activity, possible functional groups on the alloy surface, mechanical properties (Weibull module, Young's modulus, fracture energy, stiffness, hardness, elasticity, coefficient of friction), and susceptibility to corrosion. Also parameters related to surface topography of the alloy like roughness and porosity [6].

Further, issues related to the biocompatibility of the material should be considered, whereas materials used in the oral environment may behave completely differently than in the environment in which the foot works, often with the injured wound. It will also be important to determine the susceptibility to cell deposition and allergenic (oxidation of metal ions) or metallosis potential.

The above data in part may be completed from manufacturers of specific alloys. Others will have to be completed by performing tests in a suitable biomaterial laboratory.

This will allow to determine specific vectors of acting forces generated by the shape of a brace made of a particular selected biomaterial, on the nail plate in a given specific case of disease.

**Results and Discussion**

To determine whether Orthonyxia is an acceptable and effective alternative to surgery it is necessary to carry out research to determine how nail parameters, nail structure and duration of problem are in relation to the acting deformation force triggered by the specific biomaterial used for implantation.

Polish biomaterials/biomedical experiment, as part of world Orthonyxia studies, proposes a solution based on known problems to measure and collect all mentioned above necessary parameters to prepare a book of recommendations for all those professionaly involved in the area of Ortonyxia. We planned for the implementation of a broad clinical trial of >120 people, which aims to demonstrate effectiveness of collected and developed data.

**Conclusions**

There is a strong need to organize the whole of the Orthonyxia issues in terms of the applied biomaterials and their properties, and effects on correction of ingrown toenails. Mechanical, chemical and biological properties.

This will allow for more precise selection of biomaterials for specific cases of disease in relation to a person, and thus a higher efficiency with fewer complications and suffering on the part of the patient. Increasing efficiency should also affect the economic availability of the method, according to the premise that the less inefficient treatments, the lower the cost of treatment.

**Acknowledgments**

Acknowledgments for prof. Elżbieta Pamuła from Department of Biomaterials and Composites, Faculty of Materials Science and Ceramics, AGH University of Science and Technology in Krakow, Poland.

**References**

[1] A. Fernandez-Flores, A. Martínez-Nova, S. Salgado-Fernandez, Am J Dermatopathol. 2009 Jul; 31(5):439-45.
[2] A. Martínez-Nova, R. Sánchez-Rodríguez, D. Alonso-Peña, J Am Podiatr Med Assoc. 2007 Sep-Oct; 97(5):389-93.
[3] SW. Park, JH. Park, JH. Lee, DY. Lee, JH. Lee, JM. Yang, J Dermatol. 2014 Apr; 41(4):292-5.
[4] J. Harrer, V. Schöffl, W. Hohenberger, I. Schneider, J Am Podiatr Med Assoc. 2005 Nov-Dec; 95(6):542-9.
[5] S. Kruijff, RJ. van Det, GT. van der Meer, IC. van den Berg, J. van der Palen, RH. Geelkerken, J Am Coll Surg. 2008 Jan; 206(1):148-53.
[6] WA. Brantley, T. Eliades, Georg Thieme Verlag 2001; chapt. 1-3, 14-15.