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Evaluation of the use of PEEK material in a knee joint endoprosthesis insert by FEM analysis

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Abstract. This study contains a comparative analysis of two polymers: PEEK and UHMWPE. A stress distribution pattern in a knee joint endoprosthesis insert was determined for both materials. A numerical model of the insert generated by means of the SOLIDWORKS software was used in calculations. For the purpose of the calculations it was assumed that the insert is loaded consistently and symmetrically, and the value of the load applied was determined for a person of a total weight of 120 kg.

Keywords: endoprosthesis; finite elements methods; polyetheretherketone; implant devices

1. Introduction

The ageing population increases demand for medical services. Knee joint replacement is one of the most frequent operations in orthopaedic surgery. The procedure involves the replacement of structures damaged or destroyed (due to illness or accidents) with a specially designed and manufactured implant. The demand for such procedures is growing, leading to a constant increase in the number of patients awaiting such operation (Moran and Horton 2000). Patient life expectancy after the surgery is also on the rise. Consequently, implants must enable an increasingly longer safe service life. It is necessary to design new, improved and more durable prostheses.

A complete knee joint endoprosthesis consists of a tibial component, a femoral component, a patellar component and a polymer insert (spacer) (see Fig. 1). The polymer insert is the weakest part of the implant (Gierzyńska-Dolna and Nabrdalik 2005). For this reason, work on the improvement of knee joint endoprostheses focuses on the insert. In order to enhance its durability, research concentrates on the improvement of polyethylene, as well as replacing it by other, more durable materials.

This study analyses the capabilities provided by the potential use of polyetheretherketone (PEEK) as a material forming the polymer insert-the most vulnerable component of a knee joint endoprosthesis. The assessment of PEEK in the study takes into account the implantation capabilities of the material. FEM-based numerical analysis involves a comparison between PEEK and the

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