ANALYSIS OF POLYMERIC POLYCENTRIC PROSTHETIC KNEE JOINT

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ABSTRACT

Transfemoral amputation or loss of major lower limb joints such as knee and ankle results in functional loss and psychological depression due to reduced mobility and high energy expenditure during walking. More than 4 lakh transfemoral amputees estimated in India, which accounts for 8% of total physical disability. Majority of them belong to the economically weaker section, and approximately 90-95% of amputees do not receive any prosthesis due to high cost.

The present study aims to design a low cost, reliable and functional polycentric prosthetic knee joint for the transfemoral amputees. The design based on geometric data of the available knee joints was analysed using Finite Element (FE) method. Based on the findings of the FE analysis, the initial model was modified. A prototype of the knee joint was manufactured using 3D printing technology, and a single subject human trial was performed using this. Based on the trial, the junction of pylon adaptor was modified and tested on the human subject. The patient successfully walked with the new design without any failure of the joint. As the 3D printed prototype lacked strength, it was manufactured using the injection molding process. The mechanical strength of the final product was tested for compression, flexural, torsion and fatigue strength as per ISO 10328:2006 standard. The results reveal that the proposed design fulfil the ISO requirement without any failure with a service life of 2 years.

The clinical trial, including joint analysis of the proposed design, was performed after obtaining due approval from Human Ethics Committee. Kinematic, kinetic energy efficiency and quality of life were assessed and compared with the existing single-axis prosthetic knee. The kinematic performance of the proposed knee in terms of pelvic obliquity, knee varus angle, hip and ankle movement, and foot progression angle showed improved trends as compared to existing single-axis design. Kinetic data also indicates improvement in moments, ankle power and ground reaction forces. The energy expenditure was reduced, and the overall quality of life was improved using the proposed design as compared to the existing single-axis knee joint.
The proposed polymeric polycentric prosthetic knee joint is lightweight, reliable and offers a better option to the transfemoral amputees belonging to the low-income strata of the society.