Design and Optimization of a Wrist Powered Upper Limb Prosthesis

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Abstract

The primary function of a prosthetic device is to provide assistive support for patients with upper or lower limb amputation. Among the upper limb amputations, most of the patients with trans-metacarpal amputation avoids the use of prosthetics due to the high cost and complex nature of the commercially available prosthetics. These commercially available prostheses lack certain features, like adaptive grasp and comfort. In order to overcome these problems, 3D printing has shown a promising path in developing quick and customizable solutions using modern technology. Despite the importance of adaptive grasp in a prosthesis, literature shows that studies related to improving adaptive grasp seems to be limited. The purpose of this study is to improve the adaptive grasp mechanism used in mechanical prosthesis to effectively utilize the limited angle of the wrist to produce enough gripping force for better functionality. The typical angle of motion of the healthy person, the limitations and complications occurring were found and the effects of trans-metacarpal amputation to the motion of the wrist were analysed. According to the findings the design of the prosthesis was started using Computer Aided Designing (CAD) software and necessary improvements needed were taken into consideration during the design phase of the new prosthesis and the mechanism. The proper material was selected to be used in the 3D printer and the prosthesis was printed and tested for adaptive grasp and comfort. Whipple Tree mechanism was used to improve the adaptive grasp through proper force distribution. It was found that this kind of prosthetic hands will help the amputee to grasp complex shaped objects which cannot be grasped by commercially available prosthetic devices. Moreover, the 'Flexi' material will give enough comfort to the amputee during operation.

Keywords: Trans-Metacarpal Amputation, 3D Printing, Adaptive Grasp, Mechanical, CAD