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Design and Biomechanical Analysis of a Transtibial Prosthesis for Cyclists of the Colombian Team Paralympic

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Abstract : The training of cilsitas with some type of disability finds in the technological development an indispensable ally, generating every day advances to contribute to the quality of life allowing to maximize the capacities of the athletes. The performance of a cyclist depends on physiological and biomechanical factors, such as aerodynamic profile, bicycle measurements, connecting rod length, pedaling systems, type of competition, among others. This study particularly focuses on the description of the dynamic model of a transtibial prosthesis for Paralympic cyclists. To make the model, two points are chosen: in the radius centers of rotation of the plate and pinion of the track bicycle. The parametric scheme of the track bike represents a model of 6 degrees of freedom due to the displacement in X - Y of each of the reference points of the angles of the curve profile β, cant of the velodrome α and the angle of rotation of the connecting rod φ. The force exerted on the crank of the bicycle varies according to the angles of the curve profile β, the velodrome cant of α and the angle of rotation of the crank φ. The behavior is analyzed through the Matlab R2015a software. The average strength that a cyclist exerts on the cranks of a bicycle is 1,607.1 N, the Paralympic cyclist must perform a force on each crank about 803.6 N. Once the maximum force associated with the movement has been determined, it is continued to the dynamic modeling of the transtibial prosthesis that represents a model of 6 degrees of freedom with displacement in X - Y in relation to the angles of rotation of the hip π, knee γ and ankle λ. Subsequently, an analysis of the kinematic behavior of the prosthesis was carried out by means of SolidWorks 2017 and Matlab R2015a, which was used to model and analyze the variation of the hip angles π, knee γ and ankle of the λ prosthesis. The reaction forces generated in the prosthesis were performed on the ankle of the prosthesis, performing the summation of forces on the X and Y axes. The same analysis was then applied to the tibia of the prosthesis and the socket. The reaction force of the parts of the prosthesis varies according to the hip angles π, knee γ and ankle of the prosthesis λ. Therefore, it can be deduced that the maximum forces experienced by the ankle of the prosthesis is 933.6 N on the X axis and 2.160.5 N on the Y axis. Finally, it is calculated that the maximum forces experienced by the tibia and the socket of the transtibial prosthesis in high performance competitions is 3.266 N on the X axis and 1.357 N on the Y axis. In conclusion, it can be said that the performance of the cyclist depends on several physiological factors, linked to biomechanics of training. The influence of biomechanical factors such as aerodynamics, bicycle measurements, connecting rod length, or non-circular pedaling systems on the cyclist performance.

Keywords : biomechanics, dynamic model, paralympic cyclist, transtibial prosthesis
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