Design and realization of a surf prosthesis

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The objective of this R&D work is to design, model, analyze and manufacture a surf prosthesis suitable for Mr Geoffroy Moucheboeuf. More specifically, the proposed solution will be used in the context of the competitions of the handi-surf league.
The subject suffered a car incident in 2020 and he is currently having his left leg amputated a few centimeters above the knee.

The prosthesis, topic of this study, should allow the patient to walk on both the road and the sand (to allow the displacement from his car to the seaside) as well as to ensure the practice of surfing.

The position assumed by the patient in water is of the type "goofy": the amputated limb is in the back, see Fig. 1.

Fig. 1: Surf position assumed by the patient

To ensure this configuration, the prosthesis must allow the activation of the artificial knee and ankle joints. Such a solution is not currently available.

A first study of morphable surf prosthesis was carried out in 2021 as part of two M1 level internships lasting 2 months. The developed concepts of knee and ankle joint mechanisms will be exploited and improved to achieve the manufacture of a first example of a surfing prosthesis.

The work will be divided into several phases:

1. Drafting of a specification in accordance with the patient's wishes. Particular attention will be paid to the activation of the joint systems to ensure that the prosthesis can be easily changed from one configuration to another without the use of special tools and within a few

minutes (e.g. from walking to surfing configuration). The mechanisms should also be corrosion resistant and waterproof. The weight should not exceed 1 kg.

2. Evaluation of the positioning angles of the femur and tibia in the surf position, taking into account the tolerances.
3. Proposal of two knee and ankle joint solutions satisfying the constraints of the specifications.
4. Preliminary analysis of the loading conditions of the prosthesis and evaluation of the maximum dimensions and choice of materials to be used. Selection of the solution chosen to proceed to the detailed analysis.
5. Computer Aided Design (CAD) of the selected solution, simulation of the knee and ankle joint mechanisms in walking and surfing configuration.
6. Finite element (FE) analysis of the connection components in a commercial code (Ansys/Abaqus) under the loading conditions defined in point 4. Verification of the design with respect to the maximum stresses and strains defined in the specifications.
7. Drawing of the assembly parts for manufacturing.
8. Production of a reinforced polymer prototype for static testing and validation.
9. Fabrication of the prosthesis, static and dynamic ground test followed by a water test

Dossier

CV and MSc grades to be sent to:

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