SAFETY OF PORTACATH IMPLANTATION IN EVERYDAY'S LIFE: A FINITE ELEMENT STUDY

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Introduction

Chemotherapy is a significant therapeutic option in oncology. Usually, patients are subjected to this treatment for a mean time of 6 to 9 months during which chemotherapy cycles are administered every three weeks[1]. Due to the continuous venous access, throughout this time vessel integrity may be compromised by repeated venous access [2], [3]. To prevent this complication, in the last years total implantable venous access port have been developed; among these devices, one of the most used is Port-a-cath which is implanted subcutaneously under the clavicle. This device is composed by a reservoir from which drugs are delivered through a catheter into a big vein, such as the subclavian. Drugs are periodically loaded in the reservoir through subcutaneous injections without the requirement to locate a vein. Due to its position, the device is visible through the skin. This fact raises concerns in patients about the risk of damaging the device or the surrounding tissues during the practice of sport. The aim of this study is to simulate the interaction between the Port-a-cath and the surrounding tissue during normal implantation and under the impact of a ball during the practice of exercise to evaluate the safety of the device and the possibility of lesions in the surrounding soft tissue.

Methods

A patient-specific human torso model was obtained through segmentation process of CT-scans of a patient who received port-a-cath implantation. Within the torso, parts corresponding to skin, muscle, bones, cartilage, whereas internal organs were neglected. A cad model of the port-a-cath was created with the software Solidworks and correctly positioned inside the torso in correspondence with the CT images of the patient post-implantation as shown in Figure 1a.

The torso was discretized with tetrahedral elements and the components modelled as linear elastic materials with mechanical properties obtained from literature [4]–[7]. On the contrary, the port-a-cath was considered as rigid. The simulation was performed in two steps. In the first step, the implantation of the device was simulated by considering the interaction of the device with the muscle and the skin. In a second step, an impact with a soccer ball at 20 m/s recreating a shut of a young football player [4] was considered. Different impact angles were investigated ranging from a direct frontal impact to a shallow angle impact. [8]. All simulations were performed as explicit using the Finite Element software ANSYS-LsDyna.

Results

The results indicate that the area of influence of the port-a-cath after the implantation is limited to a small region around the port-a-cath, with the maximum stress located at the muscle (see Figure 1b). A frontal impact of the ball increases the peak stress around the porta by a factor of 16 and was found to be located at the muscle. The simulations also show that other tissues, such as bone and cartilage, were not excessively stressed by the impact of the ball even in presence of the portacath.

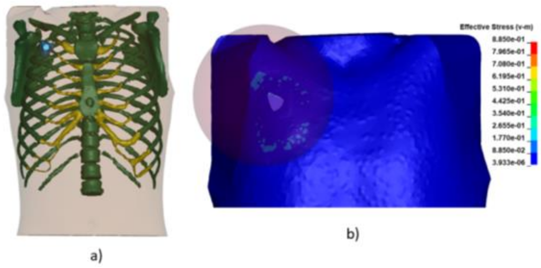

Figure 1: a) Torso with different parts and the port-a-cath; b) von Mises stresses [MPa] during the hit of the ball

The average stress in the muscle surrounding the device was extracted during the impact phase, resulting in a maximum peak stress of 0.22 MPa, which results lower than the threshold of 0.26 MPa for muscle damage [9].

Discussion

The results showed no damage to the tissues around the device on a patient-specific geometry giving proof of the safety of the device implanted in everyday life's activities.

References

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