



Analysis of porcine skin after single or multiple injections with insulin needles through optical coherence tomography

C.A. Santana¹, M.M. Amaral², A. Baptista¹, M.S. Ribeiro³, A.Z.de Freitas³, S. C. Nunez^{1*}

¹ Mestrado em Bioengenharia, Universidade Brasil, São Paulo, Brazil

² Engenharia Biomedica, Universidade Brasil, Sao Paulo, Brazil

³ Centro de Lasers e Aplicações, IPEN/CNEN, São Paulo, Brazil

* silvia.nunez@universidadebrasil.edu.br

Background, Motivation and Objective. Diabetes mellitus (DM) is a disease of great morbidity and mortality and its incidence has been increasing in a persistent way due to the modern lifestyle. The needles used for the application of insulin, despite having a low cost of production, have a negative environmental effect on their disposal since, incineration, which is the recommended form of disposal for these materials, generate atmospheric pollutants. Studies have demonstrated that both from a clinical and microbiological point of view, the reuse of these materials is safe at the domestic level. But despite some evidence the department of health in several countries have done frustrated attempts to incentive the reuse of insulin needles and syringes. Some medical organization claimed that pain and infection risks increase with the reuse, which can be truth if no educative and awareness campaigns are implemented. Pain studies are often subjective and personal tolerance levels play pivotal role on the outcome, on the other hand, to comprehend the damage inflicted into the skin by a new or an used needle may provide further information about the single or multiple uses of this needles. Therefore, the objective of this study was to evaluate hypodermic needle damage caused to the skin after successive penetration using porcine skin as a model mimicking human skin.

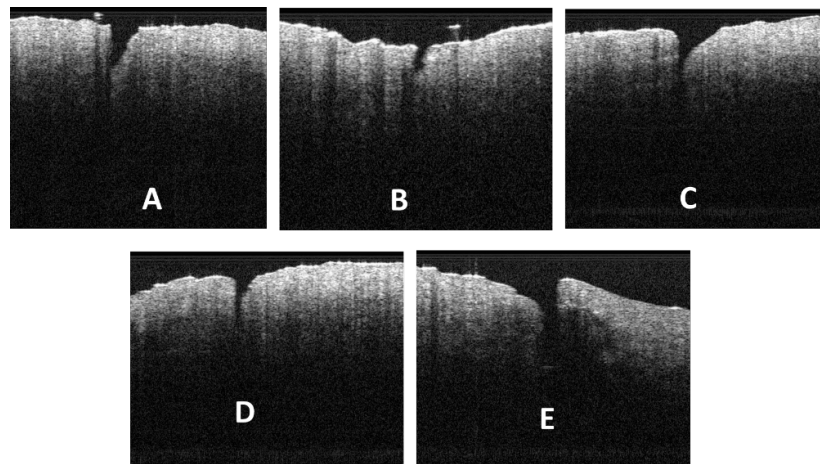
Methods. This research is an experimental study carried out on *ex vivo* skin using the technique of Optical Coherence Tomography (OCT). In this study we used skin from the abdominal region of pigs to mimic human skin based on the several similarities between species on this tissue. The skin was purchased from a reseller after the animal's death; therefore, this study was exempted from the appreciation of the research ethics committee for the use of animals (CEUA-Universidade Brasil). A piece of 30 cm by 15 cm of skin from the abdominal region of newly sacrificed pig obtained from a pig slaughterhouse in the city of Jaguariuna (Sao Paulo, Brazil) was used. The skin was kept in a refrigerated environment without freezing for about 12 h until the beginning of the experiments so there was no de-characterization of the skin layers or putrefaction. Fragments of approximately 5 cm X 5 cm were cut with dissection scissors. After the cut, the skin was marked with a permanent writing pen to localize the area that was perforated and imaged. The intact skin before the perforation was observed and the images stored to serve as control. The skin fragment was placed in a glass Petri dish for handling during all experiment. The needles and syringes were assembled and classified according to lot and manufacturer, 10 different batches obtained in the cities of Campinas (Sao Paulo, Brazil) and Sao Paulo (Sao Paulo, Brazil) were used. The needles were inserted perpendicularly (90°) towards the porcine skin according to the recommended technique for subcutaneous drug application. After each insertion, the sample was placed in the OCT (OCP930SR Thorlabs) device to obtain two-dimensional images.



Results. An example of the results obtained with the imaging done with the use of the OCT technique can be seen in Figure 1. In the conditions reported in this experiment it was found that in basically all the analysed samples the use of the needle for up to four times did not promote significant changes in the perforated skin. From the fourth injection on, needle quality and surface treatment make a difference in the results. Eight skin perforations in almost all types of needles already show a noticeable change in the homogeneity of the formed skin cavity and in the integrity of the superficial layer of the epidermis.

Discussion and Conclusions. According to the American Diabetes Society the diabetic patient is subject to several skin conditions regardless of tissue damage. The possible complications from repeated damage, even if superficial, cannot be overlooked. According to the referred society, diabetic patients are more prone to bacterial and fungal infections and any break in the barrier, promoted by the skin, can boost the entry and installation of potentially pathogenic microorganisms. In fact, the discussion of how many times a needle should or should not be used seems to be more related to the quality of the needle than the number of uses. We showed with our study that there is no noticeable difference on skin damage after four uses of the same needle, and a balance between environmental sustainability and patient safety has to be performed to understand how can health care systems worldwide should manage this important issue. According to our results insulin needles can be use for up to four times without noticeable differences on the skin damage.

Figure 1. OCT image of pig skin after perforation with hypodermic needle with different uses. In A needle in its first use, in B after two uses, in C three uses, in D four uses and in E after eight uses of the same needle.



Acknowledgment. The authors thanks Universidade Brasil and IPEN/CNEN for the support on the execution of this study

Keywords. Diabetes; optical coherence tomography; insulin; hypodermic injection; pig skin.