

Abstract

In this project we have shown that small needle electrodes can be used to characterize tissue with high spatial resolution and determine the anatomical position of a needle for clinical use. Invasive needle electrodes have different designs for a wide range of applications. We studied the electric properties of some commercial available needle electrodes. Fundamental knowledge about impedance and current distribution in monopolar needle electrode systems were gathered. Needle electrodes were then used to measure different tissue models in-vitro and in anesthetized pigs. Data gathering was done by monopolar measurements of complex impedance. In agreement with our previous analysis, only a few millimeters movement of the needle between tissues of different properties gave substantial changes in the measured impedance. These findings were used to develop a medical device prototype for the determination of needle position during insertion.

Methods

- Three electrode system – monopolar
- Insulated needle electrode – active area 0,3 mm²
- Frequency range – 10 Hz to 1 MHz
- Ultra Sound guided needle placement
- Measurements on 7 types of pig tissue in-vivo
- Repeated measurements on fat and muscle tissue in-vivo

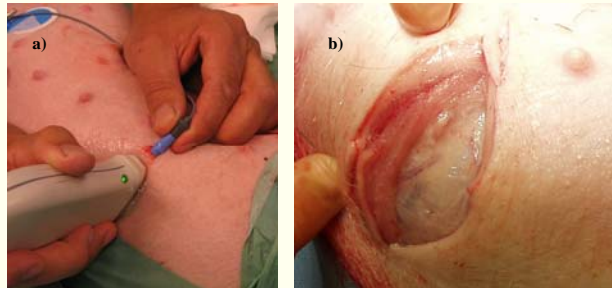


Fig. 1: In-vivo measurements on anesthetized pigs. The needles were placed with ultra sound guidance a), and directly in the tissue by cutting the skin b)

Results

- Distinct differences between 7 tissue types in-vivo
- Reproducible results with repeated measurements in fat and muscle

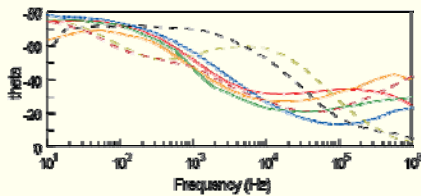
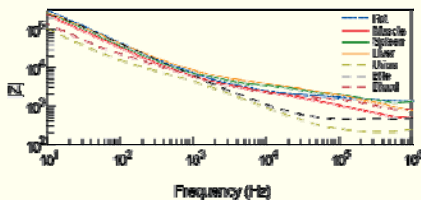


Fig. 2: In-vivo measurements in 7 different pig tissues in-vivo showed distinct difference between tissue types

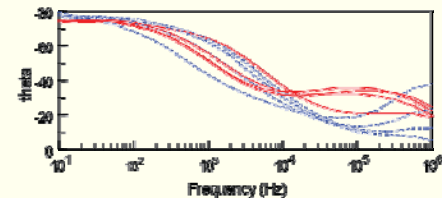
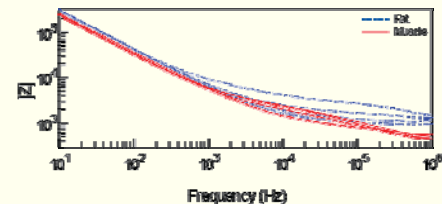


Fig. 3: Repeated measurements gave reproducible results

Conclusion

- New method for impedance guided needle positioning is feasible

Medical device prototype

A medical device prototype implementing our new method for impedance guided needle positioning is developed (fig. 4). Pilot tests gave good results (fig. 5).

Further gathering and analysis of data for development of reliable separation algorithms is done these days.

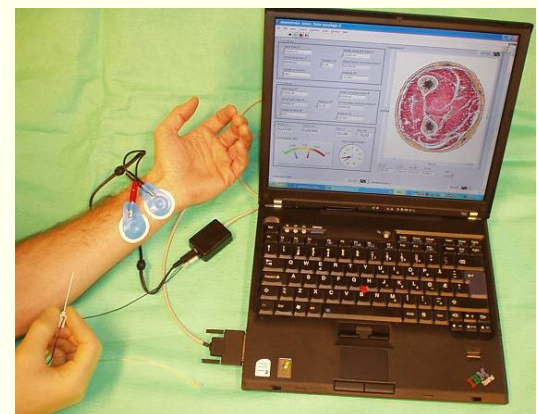


Fig. 4: A medical device prototype for impedance guided needle positioning is developed.

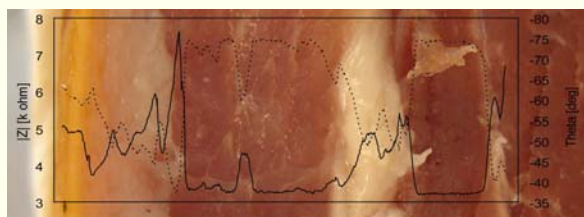


Fig. 5: The medical device prototype was tested on a bacon as a model. The module and phase (3 kHz) shows distinct differences between fat and muscle tissue in bacon.