The Development of a Novel, Implantable Force Sensor

by

David Fiorella

An Abstract of a Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the degree of

MASTER OF SCIENCE

Major Subject: Biomedical Engineering

The original of the complete thesis is on file
In the Rensselaer Polytechnic Institute Library

Approved:

Dr. Eric Ledet, Thesis Adviser

Rensselaer Polytechnic Institute
Troy, New York

December, 2008
(For Graduation December, 2008)

ABSTRACT

The musculoskeletal system is affected by biomechanical forces more so than any other biologic system. These forces are required to maintain proper and health and function, but can also lead to pathologic disorders. While many of these pathologies are attributed directly to mechanical forces, it is often difficult to measure *in vivo* forces with a high degree of accuracy. Many researchers have attempted to characterize forces developed in the skeleton using simplified models that require assumptions to be made which inherently limit the relevance of the results. Other groups have attempted to measure these forces using various tools such as pressure films, strain gauges, MEMS pressure sensors and force sensing resistors, all of which have limitations. The purpose of this research was to develop a novel implantable force sensor for measurement of real time physiologic forces in the body.

The ideal sensor is a hermetically encapsulated, passive, wireless device of small size having the capability to provide real time force data. As a preliminary effort toward developing the ideal sensor, we have developed a wired capacitive force sensor for *in vivo* force measurement. Using a capacitor as the force transducer allows for future integration into a passive circuit, ultimately allowing for wireless communication. The sensor embodies a highly robust and adaptable design based on the physical principles governing the capacitance of a parallel plate capacitor.

The design of the sensor was optimized and the manufacturing parameters required to achieve that optimal design were characterized. Completed sensors have been tested to characterize their electrical and mechanical functioning in response to applied loads and in simulated *in vivo* environments. The sensors perform in a repeatable and predictable manner and show potential for future use in clinical research applications.