

# THERAPEUTIC METHODOLOGY FOR THE PREVENTION OF ASEPTIC LOOSENING OF PROSTHESIS

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## Introduction

Aseptic loosening of the hip prostheses is a common long term diagnostic, affecting 7-13% of the patients [Poorter, 2006].

Current instrumented prostheses just monitor biomechanical quantities. Although aseptic loosening detection systems have already been developed, they have not yet been implemented. Soares dos Santos et al. (2012) have proposed a methodology to design smart implants based on failure monitoring and mechanical stimulation of bone, using piezoelectric mechanisms.

Although piezoelectric films can stimulate bone cells *in vitro* and *in vivo* [Reis, 2012], its implementation is difficult because the movement of the piezoelectric film is required, which in turn can cause the growth of fibrous tissue instead of bone [Kienapfel, 1999].

This paper proposes a new therapeutic methodology to design prostheses with the ability to prevent failures by aseptic loosening through the electrical stimulation of bone cells, at the bone-implant interface.

## Methodology

The medical use of electric stimulation is well accepted nowadays and it is applied *in vivo* for the treatment of bone disorders. *In vitro* studies have shown the ability of the electric fields to stimulate bone cells growth and bone formation [Hartig, 2000]. Bone cells are sensitive to a large range of electric field magnitudes, frequencies, number of applied cycles and stimuli duration [Haddad, 2007].

Generation of energy, aseptic loosening monitoring and telemetric communication systems were already designed as subsystems of a smart implant [Soares dos Santos, 2012].

An instrumented hip prosthesis is being developed comprising a therapeutical subsystem, based on the electrical stimulation of bone cells at the bone-prosthesis interface. This therapy must convert states of loosening into states of without-loosening (Figure 1). The physician will be able to use a therapeutic command structure, located outside the human body, to analyse failures and prescribe

therapeutic commands (amplitude, frequency, number of loading cycles and stimuli duration) suitable for each failure condition, according to the physiologic and failure data provided by the monitoring subsystem.

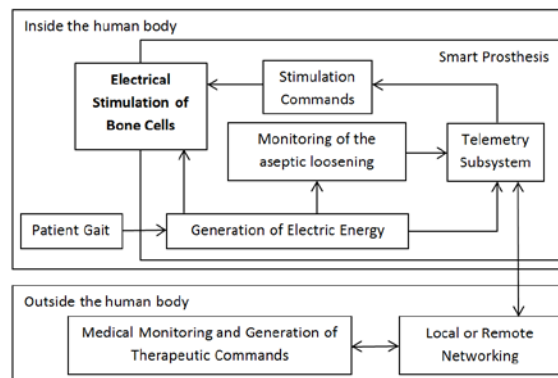


Figure 1: New Therapeutic Methodology for Smart Hip Prostheses

## Discussion

Despite the evidence that electrical stimulation promotes the bone cells proliferation, differentiation and protein expression, more studies must be conducted in order to identify the parameter ranges for the optimal stimulation of each bone cell type and corresponding developmental stage. Design, modelling and experimental validations must be performed to identify the best instrumental solution for the appliance of electrical fields at the surface of smart hip implants.

## References

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