

# Bone Temperature during Drilling

Subject: Medicaltechnology

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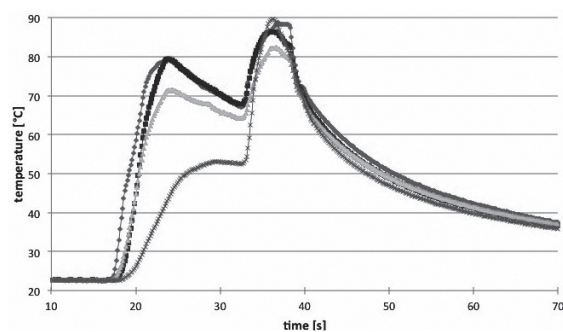
Surgeons drill bone every day around the world. But there is the danger to overheat the bone during drilling. If the bone temperature reaches 47 °C, the bone structure will change irremediably and will deteriorate the health of the bone and the stability of the future implant. The features of the drilling parameters, especially the cooling system during bone drilling have an importance to keep a low temperature during bone drilling.

## Objectives

This study aims to determine the influence of the drill bit design and of the drilling parameters during bone drilling with a focus on the efficiency of an external cooling system.

## Description

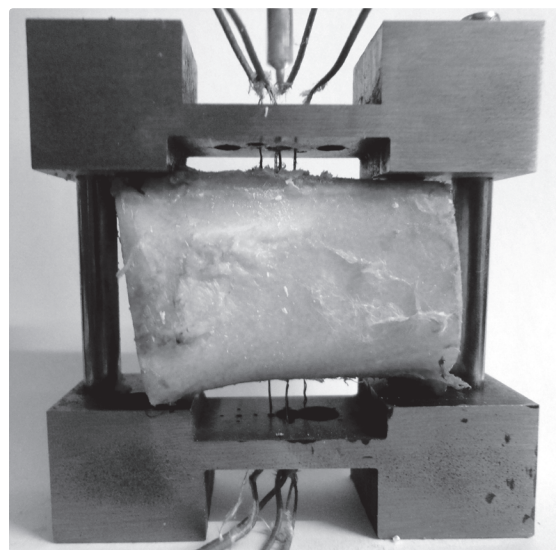
A laboratory drilling system was developed to acquire temperature data. The system composed of two trays where water at 37 °C circulates, reproducing the body environment with a fixation system, has been designed. Synthetic samples made from Polymethyl-methacrylate (PMMA or Plexiglas) reproducing the bone are fixed with a retaining jig to the main tray. Thermocouples positioned radially to the drill bit acquire the temperature during drilling. A Data Acquisition System (DAQ) records the data on the computer for analysis. With infrared thermography, another way to measure the temperature was used to observe the temperature evolution during drilling. Additionally, calculations of the power during drilling have been performed and the heat produced during drilling was modeled with a finite elements methods (FEM) software to compare the modeling with the observations.



Temperature vs time measured at the upper cortical layer

## Results

After studying the rotational frequency and the feed rate for drilling in PMMA, tests were performed with porcine bones for the determination of the efficiency of the cooling system. The results demonstrate a decrease of temperature with an increase of the rotational frequency, a decrease of temperature with an increase of the feed rate and a strong decrease of 40 °C with the cooling system. A new behavior of the temperature during bi-cortical bone drilling was observed : heat is produced during drilling the upper cortical layer resulting in a first temperature peak. During drilling the lower cortical layer, heat is produced there and transported by the drill bit to the upper cortical layer resulting in a second temperature peak. The simulation confirms the results from the drilling experiments.



Bone drilling with temperature measurement under laboratory conditions



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