A DEVICE TO CONTROL IMPLANT AND BONE-CEMENT TEMPERATURES IN CEMENTED ARTHROPLASTY

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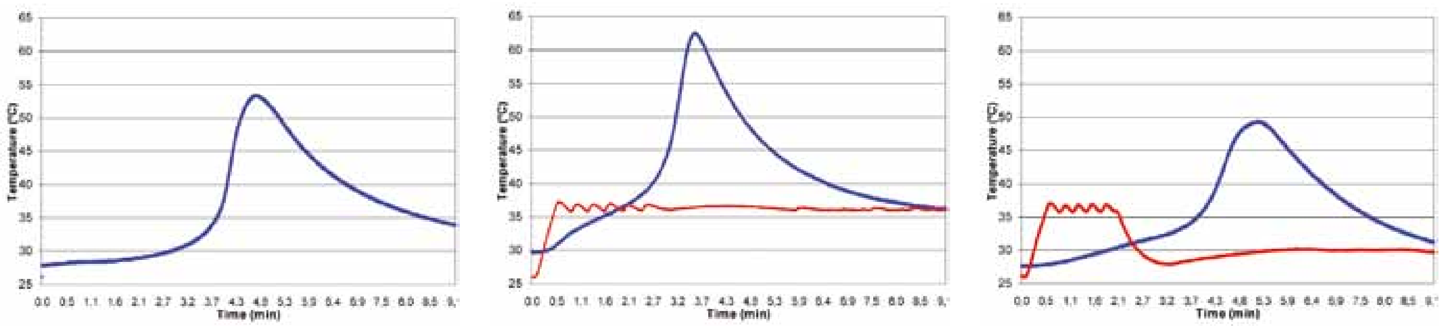

At present, most of the orthopaedic implants used in articular reconstruction are fixed to host bone using acrylic bone-cement. Bone-cement polymerization leads to an exothermic reaction with heat release and consequent temperature rise. The increase of temperature in the bone beyond the tolerated limits can develop osteocyte thermal necrosis and ultimately lead to bone resorption at the cement-bone interface, with subsequent loosening of the implant. Another issue that plays an important role in implant loosening is debonding of the cement from the implant initiated by crack formation at the interfacial voids. Moderate pre-heating of the implant is expected to reverse the direction of polymerization, and has the ability to reduce interfacial void formation and improve interfacial shear strength. To increase the implant temperature at the initial cementing phase in order to reduce interfacial void formation, and subsequently, cool the implant in the latter cement polymerisation phase to prevent the possibility of bone thermal necrosis, a new automated electronic device was designed to be use in cemented joint replacements. The developed device (Figure 1) was specifically designed for the knee arthroplasty. The device controls the heat flux direction between the tibial-tray and the atmosphere through the "Peltier effect", using peltier tablets. The device is placed on the tibial-tray during the cementing phase and starts to heat it in a first phase, promoting the polymerization that initiates at the warmer cement-implant interface. In a second phase, the heat flux in the Peltier tablets is inverted to extract the heat generated during cement polymerization. The device efficiency was evaluated by cementing several tibial-trays in bovine fresh bone and measuring the tray and cement temperatures. The temperature results (Figure 2) showed that the device increases and maintains the implant temperature above room temperature at the initial cementing phase, while in the subsequent phase it cools the tibial-tray and cement. Significant differences were found for peak cement temperatures between the tests performed with and without the device. The device showed its capacity to promote the beginning of cement polymerization at the implant interface contributing towards improving interfacial shear strength, and in reducing the peak cement temperature in the subsequent polymerization process, thus contributing to the prevention of the bone thermal necrosis effect. Currently the device is patented (INPI-Nº 103799) and licensed by UA to the LTelectronic company.

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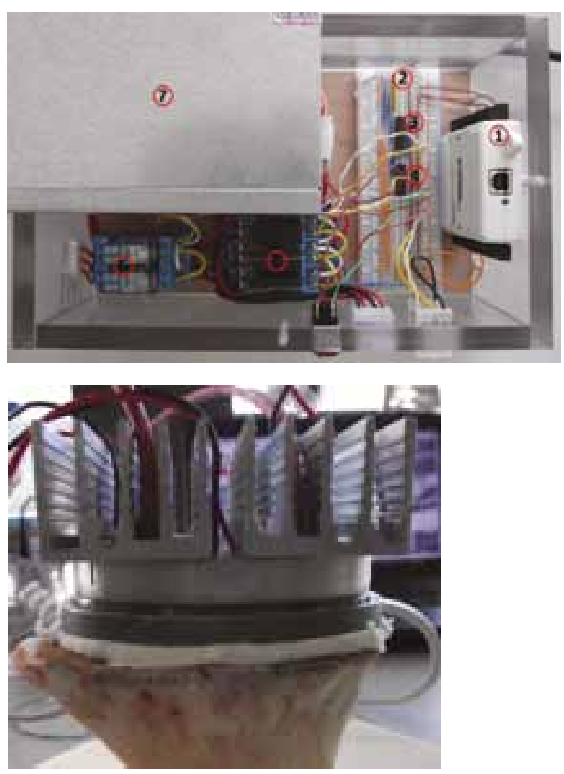

FIGURE 1
Control Unit (left) and heat exchanger (right) in contact with implant during the cementing process.

FIGURE 2
a) Bone-cement temperature without device use (normal cementing process).
b) Bone-cement (blue) and tibial-tray (red) temperatures only with heating phase c) Bone-cement (blue) and tibial-tray (red) temperatures with heating and cooling phases (complete cycle).