Fully implantable blood pressure sensor for hypertonic patients

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In Germany approximately ten million people suffer from high blood pressure. About 1% of these patients can hardly be stabilized on drugs and a long time monitoring is advisable. A system consisting of an implant and an external reader station is presented to realize a long term monitoring for these patients. The implant consists of a newly designed sensor chip integrated at the head of a catheter (Ø 1.1 mm) and a telemetric unit. The sensor-tip is placed into the femoral artery while the telemetric unit is implanted into the subcutaneous tissue. Thus the disturbance inside the blood vessel and the distance for wireless communication are kept as small as possible to obtain optimal parameters. The implant is supplied with energy wirelessly via inductive coupling from the external reader station. Data is readout from the external station with approx. 30 Hz and an overall accuracy of ± 2 mbar.

Approximately ten million people suffer from hypertension (high blood pressure) in Germany [1]. About 1% of these patients can hardly be stabilized on drugs and a long term monitoring is advisable. Up to now conventional extracorporeal systems are used which tend to be a handicap for affected patients due to their size especially at night. A system consisting of an implant and an external reader station was developed to realize a comfortable 24/7 monitoring for these patients without these drawbacks of the extracorporeal systems. The implant is designed to be placed into the femoral artery (see figure 1).

The implant consists of two parts, a sensor-tip and a telemetric unit (see figure 2) [2]. Measurement of pressure is obtained with a new monolithically integrated capacitive CMOS pressure sensor. The sensor chip is integrated at the tip of a twenty-centimeter long medical catheter (outer diameter: 1.1 mm, see figure 3). This tip is electrically connected to the telemetric unit, which includes the communication chip and passive components. Data and energy are transferred via inductive coupling. The sensor tip inserted into the blood vessel is designed as small as possible to avoid clotting and minimize the flow resistance. The telemetric unit implanted just underneath the skin guarantees optimal transmission parameters due to the transition through a minimum of skin layers.

Calibrations of the implants show excellent communication characteristics and accuracies: The external station receives the measured pressure data with a frequency of about 30 Hz. The calibrations show an overall accuracy of better than ± 2 mbar (see figure 4) at a reading distance of up to 10 centimeters.
First experiments with an implant could be successfully completed. The implant was placed in the right femoral artery of a vascular model [3]. For reference a conventional Mammendorfer Sensor was placed in the left artery. An artificial heart is pumping the model fluid (37°C heated water) through the system. The wirelessly recorded data of the implant match perfectly to the reference data of the Mammendorfer Sensor. The results are shown in figure 5. First in-vivo experiments were performed and will be published soon.

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