Animal Experiment of High-Efficient Miniaturized Implantable Loop Antenna

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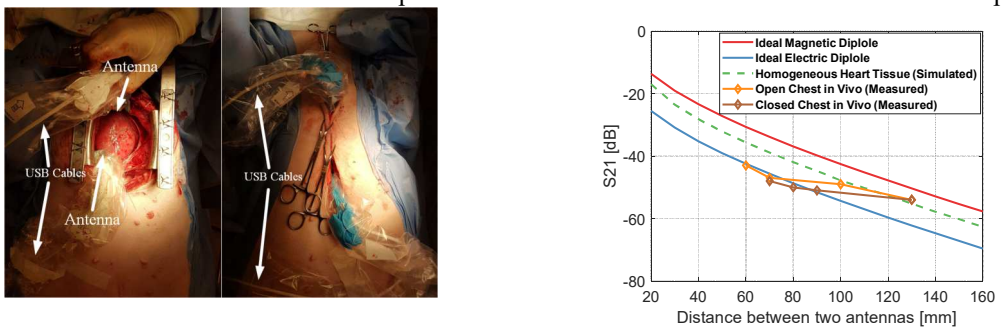
Miniaturized implantable antenna with high efficiency is advantageous in view of power supply efficiency as well as communication efficiency for wireless Implantable Medical Devices (IMDs), for example, wireless Leadless Cardiac Pacemaker (LCP). An implantable planar electrically coupling loop magnetic antenna is developed, as shown in Fig. 1 with diameter of 12mm and height of 0.4mm, operating in the Medical Implant Communication Service (MICS) band of 402-405 MHz. Electrically small antenna can be concluded for this miniaturized design taking into account the effective wavelength in the operating lossy tissue. The smaller the electric size of the antenna is than 1 radian, the more it converges to a small magnetic dipole [1].

(a) (b)

Figure 1. (a) Fabricated prototype of the designed antenna (soldered with SMA connector); (b) Simulated and measured reflection coefficients.

To verify the performance of the radiation performance of the antenna, the in-vivo animal experiments are conducted on a pig weighing 65 kg, as shown in Fig. 2 (a). Two same type implanted antennas are located at different places of the heart to measure the transmission coefficient between them. The designed loop antenna regarding as the small magnetic dipole will cause less ohmic loss associated with tissue conductance for magnetic antenna than that of electric antenna, which is because that the near field of magnetic antenna is dominated by magnetic field resulting in less thermal loss comparing with electric antenna whose near field is dominated by electric field. For comparison, the transmission coefficients between ideal electric dipoles and those between ideal magnetic dipoles are calculated based on the equation proposed in [2]. As shown in Fig. 2 (b), it is obvious that the transmission coefficient between ideal magnetic dipoles are larger that between ideal electric dipoles. Based on the animal experiment results, taking into consideration of antenna loss (dielectric and metal), variations of electric properties of real animal heart and reflection and scattering from other tissues, the measured transmission coefficients of the loop antenna are still better than that of the ideal electric dipole.



(a) (b)

Figure 2. (a) Photographs of in-vivo animal experiments; (b) Simulated and measured transmission coefficients between two implanted antennas.

References

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