Numerical Estimation on Active Implantable Medical Device EMI Due to Near-field Exposure of Sub-6 GHz 5G Frequency band Using Finite Element Analysis

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Electromagnetic interference (EMI) effects of various radiofrequency (RF) devices such as cell phones on implantable cardiac pacemakers and implantable medical devices such as implantable cardioverter-defibrillators (ICDs) have been investigated [1,2]. Based on these investigations, some guidelines for preventing EMI effects have been established.

We investigate the difference in EMI characteristics in the vicinity of a slot antenna and a dipole antenna using a numerical pacemaker model embedded in a simulated human torso used in EMI evaluation tests [3].

It is known from previous studies that the structure of the connector circuit, which is the connection point between the pacemaker body (CAN) and the lead, has a significant influence on the coupling with the external electromagnetic field in the cell phone frequency band. However, there are no reports that specifically evaluate this in Sub-6 GHz 5th generation mobile communications system (5G) frequency bands. In this study, a numerical model that accurately reproduces the structure of the pacemaker/lead connector circuit based on the actual device is used to evaluate the interference-induced voltage due to the electromagnetic field in the vicinity of the slot and dipole antennas (Figure 1).

In the case of dipole antennas, the maximum value of interference induced voltage was observed when the antenna was placed at the center of the lead connector. On the other hand, in the case of slot antennas, it was confirmed that the interference induced voltage tended to be larger when the antenna was positioned slightly off the center of the lead connector. The reason for this phenomenon is thought to be that the end of the slot antenna, which has a stronger magnetic field, is closer to the center of the lead connector, resulting in stronger coupling. In addition, the interference induced voltage by the slot antenna was larger in the evaluation results at several frequency bands, suggesting that the magnetic field had a dominant effect on the interference induced voltage.

The evaluation data can contribute to the validation of the implantable medical device EMI study's evaluation method.

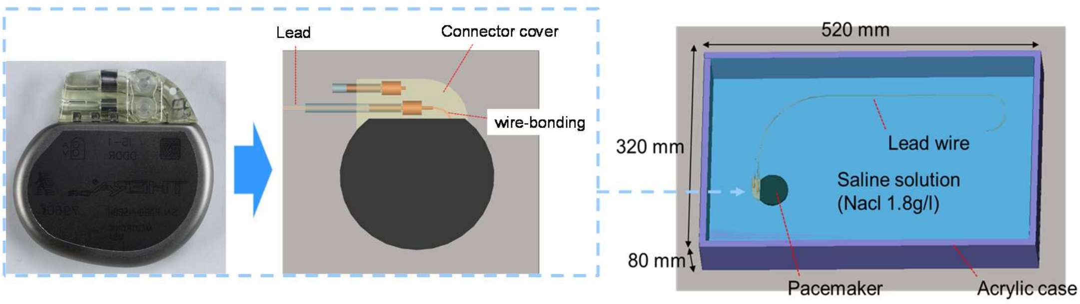

Figure 1. Numerical pacemaker and torso phantom used for FEM simulation.

Acknowledgements

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References

[1] W. Irnich, L. Bats, R. Muller, and R. Tobisch, "Electromagnetic interference of pacemaker by mobile phones", PACE, vol. 19, pp. 1431-1446, Nov. 1996.

[2] J. Wang, O. Fujiwara, T. Nojima: “A model for predicting electromagnetic interference of implanted cardiac pacemakers by mobile telephones,” IEEE Trans. on Microwave Theory and Techniques, Vol. 48, Iss. 11, pp.2121-2125, 2000.

[3] ANSI/AAMI PC69:2007 Active implantable medical devices-Electromagnetic compatibility-EMC test protocols for implantable cardiac pacemakers and implantable cardioverter defibrillators.