Comparative Study of Conductive and Inductive Power Transmission Method on Misalignment for Application to Implantable Device

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A wireless power transmission technology to transmit power to an implantable medical device has been developed recently. An inductive power transmission using resonant coils can transmit power with a high efficiency through the human body when the centers of each coil are aligned exactly. However, it is impossible to maintain the alignment condition because an implantable device is located inside the human body, so a loss in transmission efficiency is inevitable. A conductive power transmission in which a transmission efficiency is less sensitive to an alignment condition. Instead of resonant coils, two pairs of electrodes which directly contact with the human body are used to transmit and receive power. A conductive transmission path is formed through the human body between the electrode pairs, so power is transmitted through a closed loop composed of the electrode pairs and the transmission path different from an inductive power transmission.

In this paper, transmission efficiencies of a conductive and inductive power transmission were compared under a misalignment condition. For measurement of transmission efficiency, the human body was modeled using beef and transmission efficiency was measured as changing a thickness of beef from 10mm to 70mm. A transmitting electrode of $74\times22mm^2$ and receiving electrode of $28\times12mm^2$ were used for a conductive power transmission. Also, resonant coils whose sizes were respectively almost the same as those of the electrodes were used for comparison of a transmission efficiency. Electrodes and resonant coils were located on the front and rear side of beef, and then signal losses were measured in the frequency range from 1 to 10 MHz under a misalignment condition: a center of a receiving electrode or coil was moved away from a center of a transmitting one up to 30 mm. Finally, signal losses were simulated to analyze a cause of change in transmission efficiency. Measured results showed that the misalignment condition caused decrease in transmission efficiency up to 35 % from its maximum in the case of an inductive power transmission. However, the corresponding decrease in the case of a conductive power transmission was less than 7%. Using an inductive power transmission, the high transmission efficiency can be achieved for a power transmission, but it is very sensitivity to an alignment condition. In contrast, a conductive power transmission can maintain almost the same efficiency under a misalignment condition, because a conductive path contributes to the transmission of power. Therefore, a stable transmission channel to transmit power inside the human body can be obtained using a conductive power transmission technology.