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Effect of application voltage and cathode and anode positions at electroporation on the *in vitro* permeation of benzoic acid through hairless rat skin

Maki Yoshida (吉田牧), Kenji Mori, Tetsuya Watanabe (渡邊哲也), Tetsuya Hasegawa (長谷川哲也) and Kenji Sugibayashi (杉林堅次)

^aFaculty of Pharmaceutical Sciences, Josai University, ^bTsukuba Laboratories, Hisamitsu Pharmaceutical Co., Ltd.

The enhancing effect of electroporation on the *in vitro* skin permeation of benzoate was evaluated. Needle and ring electrodes made of Ag/AgCl were connected to an electrical power source, which produced exponentially decaying pulses. The needle electrode was kept in contact with the skin surface, and the ring electrode was positioned either on or under the skin. The electrical pulse was applied to abdominal hairless rat skin at 150 -600 V every minute from 4 to 6 h during the 10-h permeation experiment. Skin permeation of benzoate was promoted by electroporation and the effect was increased by application of higher voltage. No immediate recovery to the control flux, however, was observed for high voltage groups after turning off the voltage application. When the cathode and anode were separated by the skin membrane by setting in the epidermal and dermal sides, respectively, an iontophoretic effect may also play a role in benzoate flux. These results indicated that the drug permeation by electroporation is the result of passive diffusion and an iontophoretic effect as well as the electroporation effect.