Biol. Pharm. Bull., 26, 1508-10 (2003)

The effects of calcium chloride and sodium chloride on the electroporation-mediated skin permeation of fluorescein isothiocyanate (FITC)-dextrans in vitro

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We previously reported the substantial synergic effects of electroporation and electrolytes, particularly those containing $CaCl_2$ on the skin permeation of the model low-molecular weight compound, calcein. We then investigated the effects of electroporation (300 V, 10 ms x10 times) and 150 mM NaCl or $CaCl_2$ on skin permeation of higher molecular weight compounds, fluorescein isothiocyanate (FITC)-dextrans (FD-4, FD-10 and FD-40; average molecular weight, 4.4, 9.6 and 35.6 kDa, respectively) using excised hairless rat skin. The observed steady state flux of FD-4 was 1.3 pmol/cm^2/h after electroporation without NaCl or $CaCl_2$. The flux did not differ greatly from that without electroporation. In contrast, a much higher steady state flux was observed after electroporation with NaCl or $CaCl_2$ (2.5 and 8.2 pmol/cm^2/h, respectively). For FD-10 and FD-40, no flux was detected with electroporation in water (without electrolytes) or without electroporation. On the other hand, high skin permeation was observed after electroporation in NaCl or $CaCl_2$ solution (FD-10: 7.5 and 18.2 pmol/cm^2/h, FD-40: 4.5 and 9.3 pmol/cm^2/h in NaCl and $CaCl_2$, respectively). The effects of $CaCl_2$ on FD permeation were greater than those of NaCl. The present finding suggests that electroporation application in the presence of electrolytes, particularly $CaCl_2$, was very effective in increasing transdermal delivery of water-soluble macromolecules.