ELECTROMAGNETOPHORESIS: POTENTIAL FOR ENHANCED SKIN PENETRATION OF DRUGS AND COSMETICS

Heather A E Benson[1], Jeffery Edwards[2],Gayathri Krishnan[1], Sarika Namjoshi[1]

[1] School of Pharmacy, Curtin University ofTechnology,Perth, WA, Australia and

[2]OBJ Ltd, Perth, WA, Australia

Introduction

Dermaportation (DP) is a proprietary electromagnetophoresis technology (OBJ Ltd) that applies low energy pulsed electromagnetic fields to enhance the movement of substances through the skin. Skin permeation enhancement has been observed for therapeutic molecules including aminolevulinic acid[1], NSAIDs, caffeine, naltrexone hydrochloride, local anaesthetics and a dipeptide, Ala-Trp.

Objectives

The purpose of the present work was to investigate electromagnetophoresis on the skin permeation of caffeine, lidocaine HCl (LH), prilocaine HCl (PH) and naltrexone HCl (NTX).

Methods

Human epidermis and silicone membrane were mounted in vertical Franz type diffusion cells (Fig 1). The epidermal membrane was hydrated with PBS for 1h while the silicone membrane for 16h before commencing the permeation experiment. The donor compartment was filled with either caffeine in PBS (1mg/mL), LH in PBS (25 mg/mL), PH in PBS (25 mg/mL) or NTX in PBS (5mg/mL) and the receptor compartment was filled with PBS (pH 7.4). DP coils were placed around the donor compartment, 1mm above the epidermis and activated for either 0-4h (NTX), 0-0.5h (LH & PH) or 0-2h (caffeine). Control cells containing drug solution received no DP.

Methods

Sampleswere collected and analysed by HPLC with UV detection. The duration of the experiment varied from 0-8h for NTX and 0-4h for LH and PH.

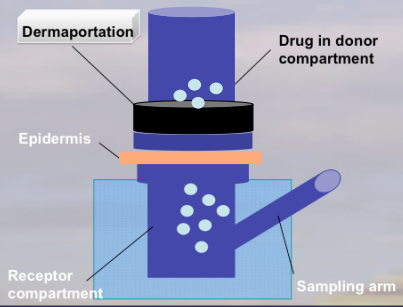

Fig.1: Franz-type diffusion cell with Dermaportation

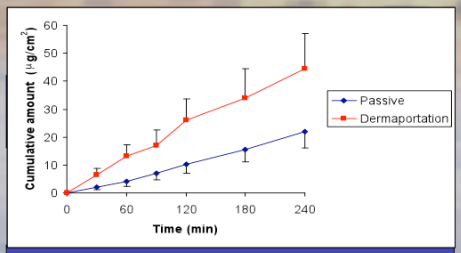

Fig. 2: Cumulative amount of PH permeated by passive diffusion or Dermaportation (mean ± SEM; n=5)

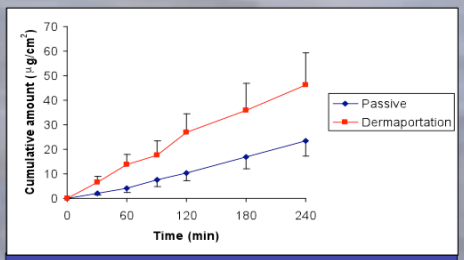

Fig. 3: Cumulative amount of LH permeated by passive diffusion or Dermaportation (mean ± SEM; n=5)

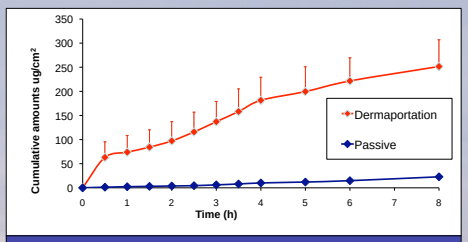

Fig.4:Cumulative amount of NTX permeated epidermis by passivediffusion or Dermaportation (mean ± SEM; n=8)

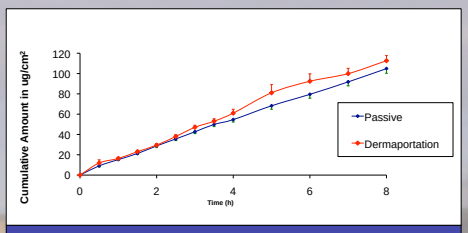

Fig.5:Cumulative amount of NTX permeated silicone by passive diffusion or Dermaportation (mean ± SEM; n=5)

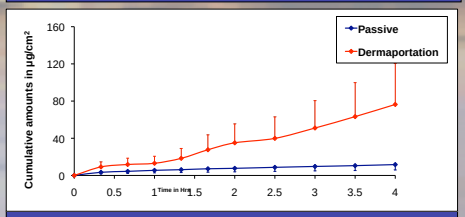

Fig.6: Cumulative amount of caffeine permeated by passive diffusion or Dermaportation (mean ± SEM; n=5)

Results

Low-energy pulsed electromagnetic fields enhanced the skin penetration of all the four compounds investigated in this study. An active push phase of greater penetration enhancement was seen during the application of magnetic energy with this reducing when the energy was terminated. This suggests that the enhancement effect on the skin is transient. Magnetic energy did not enhance silicone membrane permeation, suggesting that there is an interaction with the epidermal membrane.

Table 1:Skin permeation data of compounds with Dermaportation and passive treatment

	Caffeine		NaltrexoneHydrchloride		LidocaineHydrochloride		Prilocaine Hydrochloride	
Treatment	**DP**	**Passive**	**DP**	**Passive**	**DP**	**Passive**	**DP**	**Passive**
Area Under Curve of Mean cumulative permeation (mAu)	137.51	29.51	1786.76	119.62	5892.44	2593.81	5267.16	2444.53
Permeability coefficient Kp (cm/h)	2.4×10^{-2}	2.0×10^{-4}	6.3×10^{-2}	6×10^{-3}	7.72×10^{-3}	3.94×10^{-3}	7.35×10^{-3}	3.7×10^{-3}
Enhancement Ratio ER	11.70		10		2		1.98	

Conclusions

Dermaportation significantly enhanced the trans-epidermal delivery of caffeine, NTX, LH & PH in vitro when compared to passive diffusion. Magnetic energy enhanced permeation across human epidermis but not a synthetic membrane suggesting that the enhancement effect is related to the skin structure. The effect was transient. Investigation of the mechanism of enhancement is continuing.

Reference

1. Namjoshi et al. J Chrom B, 852: 49-55, 2007

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Curtin University of Technology