Quantifying Uptake of Topical 4% Hydroquinone After 1440-nm and 1927-nm Non-ablative Fractional Diode Laser Treatment

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OBJECTIVE

- To quantify uptake of 4% hydroquinone serum using skin tissue pretreated with either a 1440-nm or 1927-nm non-ablative fractional diode laser

CONCLUSIONS

- Non-ablative fractional diode laser pretreatment with the 1927-nm wavelength resulted in greater uptake of hydrophilic 4% hydroquinone serum compared to the 1440-nm wavelength, despite lower peak power and pulse energy settings
- For the 1927-nm wavelength, higher power settings can cause greater superficial disruption to the stratum corneum and epidermis with subsequent uptake enhancement[1]
  - The current analysis demonstrates the ability of the 1927-nm wavelength to produce more favorable uptake, especially at the higher power setting
- Taken together, these results suggest that the 1927-nm wavelength may be used as laser pretreatment to enhance topical delivery, even for relatively hydrophilic topicals

SYNOPSIS

- Non-ablative fractional diode laser pretreatment can enhance transdermal delivery and uptake of topicals and minimize thermal side effects that are more typical of ablative laser therapy[1,2]
- Fractionation can create microscopic treatment zones that spare surrounding tissue and further minimize postprocedural downtime[1,2]
- Clinical practice may be improved by understanding the relationship between topical uptake and energy-device settings, such as wavelength, peak power, and spot density

METHODS

- Human donor skin tissue samples of 500-μm thickness were pretreated with a 1440-nm or 1927-nm laser (Clear + Brilliant® laser system; Solta Medical, Bothell, WA), or received no pretreatment (Table 1)

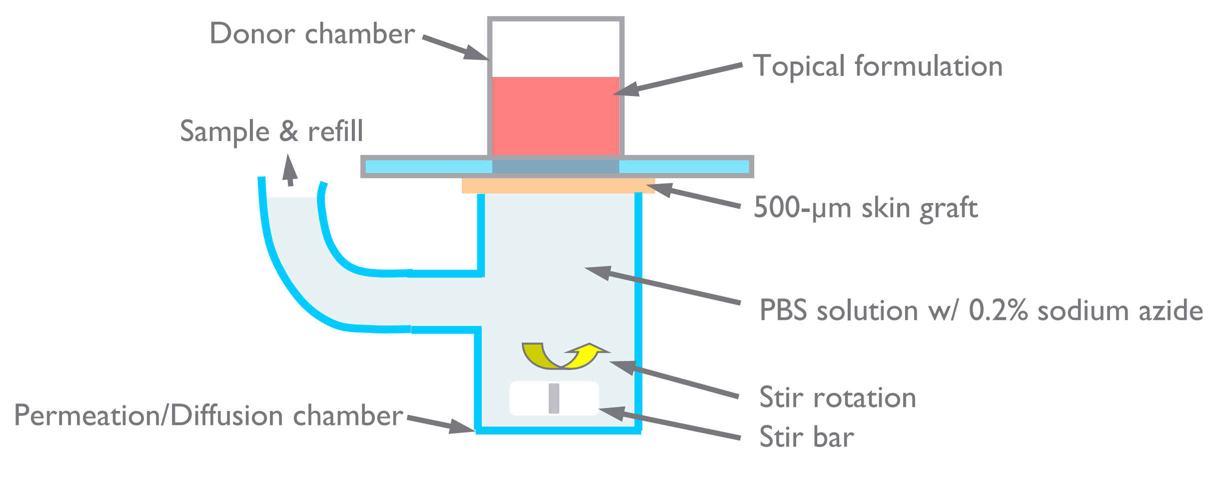
Table 1. Experimental Parameters for Uptake Analysis

Parameter	Setting		
Device wavelength, nm	1440	1927	1927
Spot density, MTZ/cm²	80	80	80
Peak power, W	1.2	0.6	1.0
Spot size, μm	130	130	130
Pulse energy, mJ	9.0	4.5	7.5

MTZ, microscopic treatment zones.

- Following laser pretreatment, an in-house 4% hydroquinone serum (hydrophilic formulation) was applied, and permeation was measured up to 24 hours after application (Figure 1)
- Laser-treated skin and untreated controls were analyzed using high-performance liquid chromatography at various time points up to 24 hours after application to measure cumulative permeation and retention and to quantify uptake of 4% hydroquinone serum
- Total uptake was calculated as the sum of the normalized cumulative permeation and retention in each sample

Figure 1. Study design for testing uptake of topicals on skin tissue.

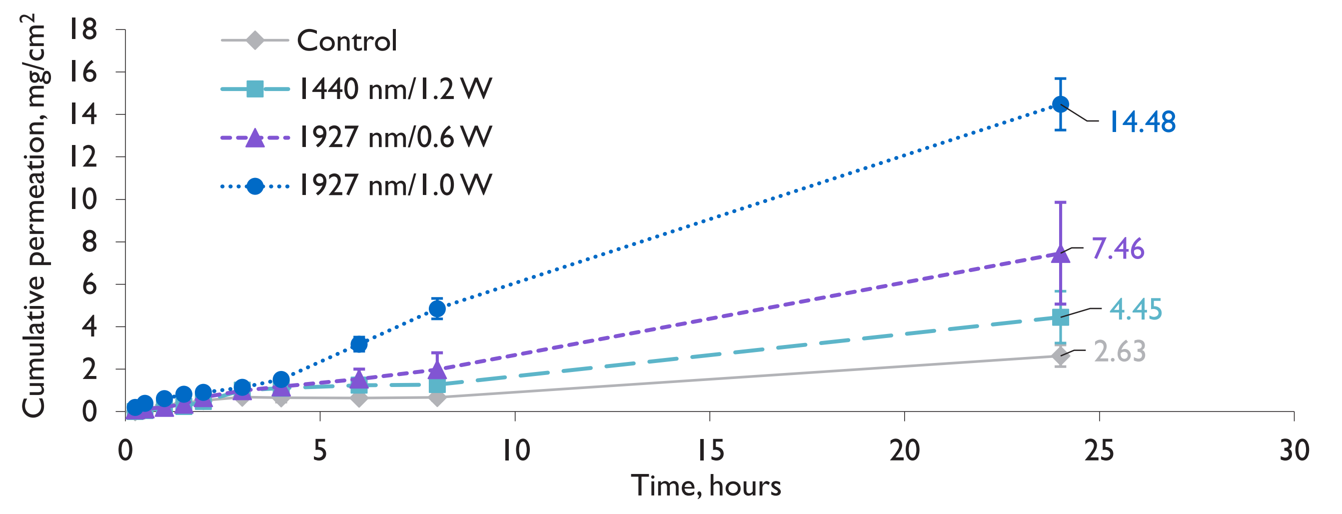


PBS, phosphate-buffered saline.

RESULTS

- Pretreatment with the 1927-nm wavelength resulted in greater cumulative uptake of 4% hydroquinone serum compared to the 1440-nm wavelength and untreated control (Figure 2)

Figure 2. Cumulative permeation of 4% hydroquinone serum at 24 hours after 1440-nm and 1927-nm pretreatment.



Values are mean ± standard deviation.

- Compared to untreated controls, topical uptake was
  - 1.8 times greater with 1440-nm (1.2-W) pretreatment
  - 2.7 times greater with 1927-nm (0.6-W) pretreatment
  - 4.6 times greater with 1927-nm (1.0-W) pretreatment
- The lower-power 1927-nm settings (0.6 and 1.0 W) were associated with 1.5- and 2.6-times greater uptake, respectively, compared to 1440-nm (1.2-W) pretreatment (Table 2)

Table 2. Uptake Ratios of 4% Hydroquinone With Various Laser Wavelengths and Power Settings

	1440 nm (1.2 W)	1927 nm (0.6 W)	1927 nm (1.0 W)
Control	1.77 ± 0.41	2.65 ± 0.24	4.60 ± 0.80
1440 nm (1.2 W)	—	1.50 ± 0.26	2.60 ± 0.61
1927 nm (0.6 W)	—	—	1.74 ± 0.63

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References: 1. Friedman et al. *J Drugs Dermatol.* 2020;19:s3-s11. **2.** Ganti and Banga. *J Pharm Sci.* 2016;105:3324-3332.

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