Transepidermal drug delivery: a new treatment option for areata alopecia?

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Abstract

Background: Transepidermal drug delivery (TED) is a new potential method in dermatology. Permeability alterations induced by ablative fractional resurfacing have been described with the aim to increasing the delivery of different substances into the skin. Objective: To evaluate clinical response and side effects of TED in areata alopecia (AA) treatment using ablative fractional methods associated with acoustic pressure ultrasound (US) to deliver triamcinolone solution into the skin. Methods and Materials: Five cases of AA underwent treatment which comprised of 3 steps: 1) Ablative fractioned RF or CO2 laser 2) topical application of triamcinolone 3) acoustic pressure wave US. The number of sessions varied according to the clinical response, ranging from one to six sessions. Results: All patients had complete recovery of the area treated. Two of them treated with ablative fractional RF + triamcinolone + US had complete response after three and six sessions. The other two treated with ablative fractional CO2 + triamcinolone + US had complete response after one session. Conclusion: Fractioned ablative resurfacing associated with acoustic pressure wave US is a new option to areata alopecia treatment with good clinical result and low incidence of side effects.
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Short title: Transepidermal drug delivery in areata alopecia

Abstract

Background: Transepidermal drug delivery (TED) is a new potential method in dermatology. Permeability alterations induced by ablative fractional resurfacing have been described with the aim to increasing the delivery of different substances into the skin. Objective: To evaluate clinical response and side effects of TED in areata alopecia (AA) treatment using ablative fractional methods associated with acoustic pressure ultrasound (US) to deliver triamcinolone solution into the skin. Methods and Materials: Five cases of AA underwent treatment which comprised of 3 steps: 1) Ablative fractioned RF or CO2 laser 2) topical application of triamcinolone 3) acoustic pressure wave US. The number of sessions varied according to the clinical response, ranging from one to six sessions. Results: All patients had complete recovery of the area treated. Two of them treated with ablative fractional RF + triamcinolone + US had complete response after three and six sessions. The other two treated with ablative fractional CO2 + triamcinolone + US had complete response after one session. Conclusion: Fractioned ablative resurfacing associated with acoustic pressure wave US is a new option to areata alopecia treatment with good clinical result and low incidence of side effects. Key words: transdermal administration, alopecia, radiofrequency, ultrasound, CO2 laser

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INTRODUCTION
The stratum corneum acts as a barrier that limits the penetration of substances through the skin \(^1\). Low-frequency ultrasound (US) and, more recently, microneedle array \(^3\) have been described to improve skin permeability. The use of fractional ablative methods with lasers\(^5\) has been described with the aim to creating micro-channels in the epidermis to increase permeability of drugs topically applied.

Alopecia areata (AA) is the most common cause of non-scarring alopecia. It is suspected to be an autoimmune disease with a genetic predisposition. Environmental and ethnic factors seem to be involved\(^7\). Steroids are widely used to treat AA and intralesional triamcinolone is a very effective method\(^8\).

In this study we reported five cases of areata alopecia treated with ablative fractional resurfacing associated with acoustic pressure wave US. This procedure included three steps: 1- micro-channels were created in the epidermis through an ablative method: radiofrequency (RF) or CO\(_2\) laser. 2- triamcinolone was topically applied on the perforated skin. 3- US was applied over the steroids to push this drug into the dermis through the pre-formed micro-channels.

METHODS
A prospective study was carried out to evaluate the clinical efficacy of applying steroids through transepidermal delivery by skin resurfacing associated with US in five patients with AA. To produce micro-channels in the epidermis we used two different techniques (ablative RF and fractional CO\(_2\) laser). The same steroid and the same US were applied on the skin after both ablative techniques (RF and CO\(_2\)).

The sessions were done every 3 weeks until we could observe clinical improvement on the patch, ranging from 1 to 6 sessions. All patients were submitted to dermatologic exam every month during the first 6 months, and were recruited to a final exam 12 months after the last session. They were advised not to use any other treatment during the study.

The degree of clinical improvement was evaluated according to a quartile scale of improvement as following: no improvement; 1-25%- minimal improvement; 26-50%- moderate improvement; 51-75%- marked improvement; 76-100% - excellent improvement\(^9\). Side effects such as pain and atrophy were evaluated on a 3-point scale (0= absent, 1= mild, 2= moderate, 3=severe). Digital photographs (Sony DSC-H9 – Super Steady Short 8.1 MP) were taken at baseline and at each follow-up visit to document clinical response.

TECHNIQUES
• RF technique

The ablative fractional RF used was unipolar RF with a roller tip. The RF roller is 10 mm width wheel comprised of 6 cogs/discs that has 50 pins lined on each cog’s exterior rim. The 6 pins from each cog discharge micro-plasma causing perforation of the skin layer (holes of 100-150 \(\mu\)m in depth and 80-120 \(\mu\)m in diameter).

• CO\(_2\) laser technique
The roller tip of the fractional CO$_2$ laser slides on the skin surface, producing micro-channels (pixels). It triggers a short-duration pulse of fractionated light via special beam splitter lens with fixed gaps between each 7x1 pixel. It produces microscopic holes of 150-300 µm in depth and 125-150 µm in diameter.

- Impact US technique

The acoustic pressure module is comprised of a transducer, a sonotrode and a distal hollow. The distal surface of the horn creates vibrational cycles ("push-pull") on the triamcinolone. The mode of operation is based on mechanical pressure and torques by propagation of US wave (frequency: 27kHz), creating a hammering-like effect in the thin layer between the triamcinolone, the skin and the sonotrode.

PROCEDURE

Before each session, the area to be treated was cleaned with aqueous chlorhexidine. At first, ablative fractional RF or CO$_2$ was applied to promote fractioned ablation of the skin with the following parameters: RF roller tip with 45 watts and 4 passes (crossed); and CO$_2$ roller tip with 60 W, 60 mJ/pixel, spacing 1 mm, 2 passes (crossed). After this step, the medication (triamcinolone acetonide - 20 mg/ml) was dropped (0,1 ml/1 cm$^2$) on the skin surface pretreated by RF or CO$_2$. The last step was the US: 50 Hz (frequency of shocks) with 80% of impact intensity for one minute each 1 x 1 cm grid (Fig.1).

PATIENTS

Patient 1: A 23 year old man with an occipital patchy AA for 3 months was treated with fractional RF + triamcinolone + US - three sessions.

Patient 2: An 18 year old woman with multiple patches of AA on the parietal area for 12 years. All the patches were treated with fractional RF + triamcinolone + US - six sessions.

Patient 3: A 47 year old woman with an occipital patchy for one month was treated with CO$_2$ laser + triamcinolone + US - one session.

Patient 4: A 38 year old woman with one parietal patchy for three months was treated with CO$_2$ laser + triamcinolone + US - one session.

Patient 5: A 35 year old woman with AA for 12 years. Three patches were treated. One occipital patchy was treated with CO$_2$ laser + triamcinolone + US – one session. Another occipital patchy and one retroauricular patchy were treated with one session of different procedures as following: the occipital patchy was treated with CO$_2$ laser + triamcinolone, but without US; and the retroauricular patchy was treated with CO$_2$ laser isolated without triamcinolone or US. These lesions were treated with different protocols with the aim to having lesions control.

RESULTS

In all cases patients had an excellent improvement and only one patient (patient 2) didn’t sustained the result after 12 months of follow up. Patient 1 who was treated with ablative fractional RF + triamcinolone + US had a
complete recovery of the patchy after three sessions, and the result was maintained after 12 months (Fig. 2). Patient 2 was submitted to six sessions of ablative fractional RF + triamcinolone + US to achieve a complete response, and sustained the result for 3 months when had an infectious respiratory disease. The three patients treated with pixel CO$_2$ + triamcinolone + US (patients 3, 4 and 5) clinical improvement could be observed in the first month just after one session of treatment, maintaining the result after 12 months (Fig. 3). On the other hand, as patient 5 had two other patches treated with different procedures, she had different clinical responses. The complete clinical response could only be observed in the patchy treated with the complete procedure (CO$_2$ + triamcinolone +US). We could observe a minimal clinical improvement in the occipital patchy after fractional ablation (CO$_2$ laser) + triamcinolone without US (Fig. 4a1, 4a2), and any response was observed on the retro-auricular patchy treated with fractional ablation (CO$_2$ laser) isolated (Fig. 4b1, 4b2).

None of the patients had atrophy in the treated area. They reported mild burning sensation during the procedure.

DISCUSSION

A number of treatments can induce hair growth in alopecia areata, and has been reported in literature, such as topical, systemic and intralesional corticosteroid injections, topical immunotherapy, photochemotherapy (PUVA), minoxidil and dithranol. The use of fractioned resurfacing to create micro-channels in the epidermis to improve drug delivery into skin is a new concept of treatment called transepidermal drug delivery (TED) and have been reported in literature. Gómez et al. reported that Erbium laser ablation of stratum corneum enhances transepidermal delivery of 5-fluorouracil. Another paper published by Haerdersdal et al. evaluated drug delivery by CO$_2$ laser ablative fractional resurfacing using methyl 5-aminolevulinate. A new study about PDT after fractional ablative RF associated with impact US was reported in literature with good clinical results in actinic keratosis treatment even with methyl aminolevulinate incubation time reduced to one hour. In 2012, the use of ablative fractional RF and acoustic pressure US associated with retinoic acid 0.05% cream was described as a safe and effective method for alba-type SD treatment. More recently, we reported some cases of transepidermal triamcinolone acetonide delivery using the same technique in hypertrophic scars treatment as a new possibility of treatment with high efficacy and low side effects.

In this study we used two different technologies to promote ablative fractional skin resurfacing, ablative fractional RF and ablative fractional CO$_2$ both of them were associated with an acoustic pressure wave (impact US) which acted as a hammer to push the triamcinolone into the epidermis through the micro-channels pre-formed by RF and by CO$_2$ with the aim at increasing triamcinolone acetonide permeability in areata alopecia patches.
It seems that with this new technique triamcinolone is applied more homogeneously on the skin comparing to needle injection, facilitating the treatment. Our lesions control showed the importance of the complete procedure, using an ablative method + triamcinolone + impact US.

CONCLUSION

TED using ablative fractional RF and CO₂ in association with high pressure acoustic wave US to deliver triamcinolone acetonide promoted an excellent clinical result in few sessions with low side effects in AA treatment. This new method of TED was effective and avoided the pain and skin atrophy caused by needle intradermal injection of triamcinolone.

References


Figure Legends

Figure 1. TED procedure with fractional ablative CO2. First step, applying the CO2 roller tip; Second step, dropping triamcinolone acetonide on the perforated skin; Third step, applying the acoustic pressure US in areata alopecia patchy.

Figure 2. Gradual Improvement in the patchy of areata alopecia before, after 2 and after 3 sessions of RF + triamcinolone + US, and after 12 months of treatment.
Figure 3. Before, 3 weeks, 3 months and 12 months after treatment, one session of CO2 + triamcinolone + US.
Figure 4. 4 a1, 4 a2: Occipital area: before and 3 months after CO2 laser + triamcinolone without US.

4 b1, 4 b2: Retro-auricular area: before and 3 months after CO2 laser isolated without triamcinolone or US.