Dermatology Reports

*Dermatology Reports 2026; 18:10306*
*doi:10.4081/dr.2025.10306*

©Copyright: the Author(s), 2025
*Licensee PAGEPress, Italy*

# Microinfusion of medications into the skin as a drug delivery technique: a narrative review

Khalid Nabil Nagshabandi,[1] Raed Alojayri,[2] Abdulaziz Alghufaili,[3] Mona Alkallabi[1]

[1]Department of Dermatology, College of Medicine, King Saud University Medical City, Riyadh; [2]Department of Dermatology, King Fahad Medical City, Riyadh; [3]College of Medicine, King Saud University, Riyadh, Saudi Arabia

## Abstract

Microinfusion of medications into the skin (MMP®) is an innovative method that employs tattoo devices to administer pharmaceuticals transdermally. This technique facilitates the formation of microchannels in the skin, allowing for localized drug deposition with minimal systemic absorption and fewer adverse effects. A literature search was conducted using PubMed and Google Scholar to identify studies discussing the application of MMP as a transdermal drug delivery method, covering publications up to October 2025. All studies identified through the literature search were summarized in chronological order from the earliest (2013) to the most recent (2025). This arrangement was chosen to illustrate the progressive evolution of the MMP technique and its expanding clinical applications over time. Our research found 14 studies that evaluated the effectiveness of the tattoo machine for transdermal drug administration. Eight studies focused on MMP for alopecia treatments, demonstrating notable improvements in androgenetic alopecia, alopecia areata, and frontal fibrosing alopecia, with minimal adverse reactions reported. Six studies investigated its role in treating scars and striae, showing significant lesion improvement. One study examined its use with bleomycin in basal cell carcinoma treatment, and another assessed its impact on psoriasis vulgaris with cyclosporine A and methotrexate (MTX). MMP represents a promising, minimally invasive transdermal delivery system with a growing body of evidence supporting its application in alopecia, oncologic dermatology, and pigmentary disorders. The ability to uniformly distribute medications at targeted skin depths, combined with its favorable safety profile, highlights its potential as a valuable alternative to conventional delivery methods. Furthermore, the microneedling effect of the tattoo device itself may confer therapeutic benefits independent of pharmaceutical administration.

**Key words:** microinfusion of medications; transdermal drug delivery; tattoo machine drug delivery; MMP® technique; dermatological drug administration.

*Correspondence: Khalid Nabil Nagshabandi, Department of Dermatology, College of Medicine, King Saud University Medical City, PJ7C+89Q, 12372 Riyadh, Saudi Arabia. E-mail: khaloed23@gmail.com*

## Introduction

The outermost layer of the skin, the stratum corneum, serves as a protective barrier that impedes drug penetration. Despite various transdermal drug delivery techniques being available, achieving effective absorption remains a challenge. Traditional methods, such as intralesional injections, offer direct drug administration into affected areas but pose challenges, including inconsistent diffusion into deeper layers, difficulty in microdosing large regions, and pain associated with the procedure.[1,2] Microinfusion of medications into the skin (MMP®) was initially introduced for administering bleomycin in keloid treatment.[1] Since then, numerous studies have explored its applicability in conditions such as alopecia, scars, skin cancers, and psoriasis. This review aims to compile evidence on MMP indications, drug compatibility, advantages, and safety considerations.

### MMP® overview

MMP (the Portuguese acronym for microinfusion of drugs into the skin), first described in 2013, is a potential drug delivery method that uses a tattoo machine to deliver medications.[1-17] The complete set of equipment consists of the tattoo machine (body), disposable tips, and needles, all of which are suitable for use in an outpatient setting. Many models are available; one has the Brazilian National Health Agency (ANVISA) certification for use in medical practice (Cheyenne®, Berlin, Germany). The machine has basic on- and off-operation buttons powered by a single energy source, has an adjustable operation velocity, and contains a set of solid needles in a sterile cartridge. The cartridge is filled with the medication by the dermatologist and initiates drug delivery. The drug is actively delivered through needling regardless of the chemical nature of the medication. During each cycle, the medication is drawn through needles, and the skin is then punctured to reach the desired depth. The friction caused by the rapid penetration into the desired level creates shear stress and a turbulent swirl of the medication, which increases its diffusion in the desired level.[1-5] However, even when no medication is infused, the microchannels created by MMP can induce an outcome like other microneedle devices.[7]

### MMP® advantages

MMP, besides its low cost and little complexity, is well tolerated by most patients. Although pain is an unwanted adverse effect of microneedling, it can be managed with topical anesthesia. It has also proved to be quite safe. Compared with intralesional injections, MMP needs a scanty amount of volume that can be infused



OPEN ACCESS

uniformly into the desired depth of the dermis, thus enhancing medication delivery to the intended level and minimizing local adverse effects.[8] MMP addresses several challenges commonly encountered with other drug delivery methods. The sterile medication is drawn by capillarity and is naturally diffused when the skin is deeply perforated by shear force. Unlike other techniques, post-procedure massaging is unnecessary, minimizing the risk of contamination from external organisms. Furthermore, the ability to regulate the speed and length of needling (from 0.1 mm to 2 mm) allows for a more uniform delivery to the desired level. The small size of the needle cartridges makes MMP perfect for reaching areas that are challenging to reach by larger techniques, such as derma rollers.[6] Alternative techniques, including fractional lasers, fractional radio frequency, and certain microneedling techniques, are available for transdermal drug delivery. However, these techniques lack MMP effectiveness and sterility. The delicate perforation process, along with the potential to use it on small lesion areas, makes MMP unique. Additionally, this technique has not been shown to cause shaft breakage, which is seen with other techniques. Fractional lasers, despite being expansive, induce a thermal effect on the perforation's walls, which impedes the absorption of medication. Thus, fractional radiofrequency involves the addition of ultrasound to enhance medication diffusion.[1,8]

## Safety of the technique

Following drug delivery by the tattoo machine, the administered active pharmaceutical ingredient would be absorbed and subsequently eliminated over a variable period. However, when assessing the pharmacokinetics of medications delivered through any transdermal drug delivery method, systemic absorption of the medication upon administration is undeniable. Although variations in systemic absorption, whether through the lymphatic system or the bloodstream, must be considered, other factors, such as the chemical composition, molecular weight, and dose of the medication administered, also play a crucial role. A fundamental criterion for transdermal drug delivery is whether the drug or its vehicle is already approved for systemic administration or whether safety studies have been conducted for intradermal administration.[1,2,5]

Arbache *et al.* conducted an experimental study to assess the safety of MMP by measuring the medication delivered through weighing human skin samples before and after MMP sessions. They utilized a Cheyenne® tattoo machine along with cartridges containing 27 needles, each with a diameter of 0.3 mm and a tip length of 5.5 mm. The needle depth was fixed at 300 microns, while the frequency was set at 120 Hz. A small quantity of medication (1,175 μg/cm$^2$) was diffusely scattered in the superficial dermis without causing an expansive effect. Modifying drug delivery depth led to an improvement in the safety of this technique.[2,8]

# Materials and Methods

A comprehensive literature search was conducted using PubMed and Google Scholar databases to identify all publications discussing MMP as a transdermal drug delivery technique. The search included all studies published up to October 2025, using the following key words and Boolean combinations: "microinfusion of medicines" OR "microinfusion of drugs" OR "MMP technique" OR "tattoo machine drug delivery" OR "tattoo-assisted drug delivery" OR "dermal microinfusion" OR "transdermal drug delivery" OR "microneedling for drug delivery". All studies identified through the literature search were summarized in *Supplementary Table 1*, which presents the included publications in chronological order from the earliest (2013) to the most recent (2025). Additional filters were not applied for language or study type to ensure comprehensive coverage. No time restrictions were used and animal clinical trials were excluded. Reference lists of included articles were also screened to identify relevant studies not captured through database search.

## Review of the indications

### *Alopecia*

Neri *et al.* (2023) reported substantial improvement in the clinical condition of the patient with frontal fibrosing alopecia (FFA) treated with botulinum toxin type A using MMP, characterized by inhibition of the inflammatory process, increased follicular density and growth of new hairs.[4]

Pitlovanciv *et al.* (2022) found significant reductions in frontal-glabella and frontal temporo-parietal measurements in the infused area with MTX microinfusion, in contrast to the untreated areas where the FFA increased.[13]

Barletta *et al.* (2020) examined the effects of MMP sessions with triamcinolone acetonide in two patients with alopecia areata. A male patient with previous use of oral and intralesional corticosteroids and vitamins showed variable outcomes and reappearance of alopecia patches. But with MMP 4-monthly sessions, significant hair regrowth in frontal and parietal regions and partial regrowth of the temporo-occipital areas was observed. The female patient was using 5% topical minoxidil and a daily dose of biotin (10 mg) for 4 weeks with no changes in clinical condition. Topical minoxidil and 4-monthly tattoo machine sessions with triamcinolone acetonide resulted in complete hair regrowth in the frontal and parieto-occipital regions.[11]

Nogueira *et al.* (2023) reported a 37-year-old female diagnosed with systemic lupus erythematosus and ophiasis pattern alopecia areata. After failure of topical treatment and intolerability of systemic treatment with MTX due to hepatotoxicity, the author used a single session tattoo machine with 20 mg of MTX in the affected areas, which was stopped due to transient elevation of aspartate transaminase and glutamate transaminase and subsided 2 weeks after stopping the treatment.[9]

Contin *et al.* (2016) evaluated MMP with and without minoxidil in two male patients with androgenetic alopecia who did not tolerate finasteride. Results showed cosmetically satisfactory partial response in both cases but no superiority of MMP with drug delivery.[12]

Ragi *et al.* (2023) examined MMP with minoxidil and dutasteride in individuals with androgenetic alopecia with no improvement with topical minoxidil and oral 5-α-reductase inhibitors for a period exceeding 6 months. After 3-month tattoo machine sessions, 15 male patients experienced successful regrowth of 25% of the upper scalp area.[14]

In recent research, there has been growing focus on female pattern hair loss (FPHL). Corrêa *et al.* (2024) conducted a split-scalp, self-controlled pilot study comparing the efficacy of minoxidil 0.5% administered *via* MMP microinfusion with the standard topical minoxidil 5% solution for treating FPHL. Sixteen women with trichoscopy-confirmed FPHL, who had received no prior treatment for at least 6 months, underwent 4 monthly MMP sessions on the right frontal-parietal-vertex areas, while continuing topical 5% minoxidil once daily to both sides of the scalp beginning 72 hours post-procedure. Trichoscopic reassessment 6 weeks after the final session demonstrated that both interventions were effective overall, with comparable global improvement between sides.[18]

Building upon prior androgenetic alopecia studies, Gasques *et al.* (2025) conducted a pilot randomized controlled trial evaluating the efficacy and safety of dutasteride infusion *via* MMP in men with androgenetic alopecia. Eight participants underwent 3 monthly sessions of MMP using dutasteride 0.05% on one half of the scalp and saline on the other. Although blinded dermatologic assessments did not reveal a statistically significant difference between sides, patients reported subjective improvement at the vertex in the dutasteride-treated areas. Importantly, no sexual or systemic adverse effects were observed, suggesting that scalp-level delivery of dutasteride *via* MMP may represent a safe, localized therapeutic approach for male pattern hair loss pending confirmation in larger trials.[19]

### Scars and striae

Arbache *et al.* (2019) examined the tattoo machine with 5-fluorouracil (5-FU), in a patient who had 18 laser tattoo removal sessions, which resulted in achromic scars. After five monthly MMP sessions, the scars were completely repigmented for more than 2 years.[15] Arbache *et al.* (2021) evaluated the effect of MMP sessions using 5-FU and/or bleomycin in 11 patients with hypochromic lesions. Among the patients, five received treatment with 5-FU, with three showing satisfactory results after one session, while the remaining patients did not see improvement until they received bleomycin in subsequent sessions. On the other hand, six patients were exclusively treated with bleomycin, and three of them experienced temporary hyperpigmentation. However, all patients demonstrated a significant improvement (>75%) in their lesions compared to baseline, and none of the 11 patients experienced any adverse effects.[16]

Arbache *et al.* (2023) evaluated the effectiveness and safety of administering 5-FU through MMP in one limb and compared it with saline in the contralateral limb to repigment idiopathic guttate hypomelanosis (IGH) lesions in 29 patients. It demonstrates a substantial reduction in achromic lesions compared to saline-treated limbs in patients with IGH.[3]

De Souza *et al.* (2023) studied eight patients who had mature atrophic and achromic scars located in various anatomical areas such as the face, thighs, abdomen, knee, and breast. The findings indicated a significant enhancement in scar pigmentation and texture following 2 to 3 monthly MMP sessions. After 6 months, six out of eight patients expressed the highest level of satisfaction, rating the results as "very satisfied" on the Likert scale, while the remaining two patients rated their outcome as "satisfied". Additionally, one patient experienced temporary post-inflammatory hyperpigmentation, which was completely resolved after the application of topical 4% hydroquinone cream.[17]

Arbache *et al.* (2013) evaluated the use of MMP with saline and bleomycin to treat keloids in two separate cases. In the first case, the keloid lesion was divided into three segments: bleomycin was infused on the left side, no treatment was given to the center, and 0.9% NaCl was infused on the right side. Two infusions were administered with a 30-day interval between each. The lesion in the second case was divided into two parts, with bleomycin infused on the right side and 0.9% NaCl on the left side. A single infusion was carried out. The study reported a significant reduction in keloid thickness and improvement in consistency in the bleomycin treated keloids in contrast to those treated with 0.9% NaCl, as confirmed microscopically.[1]

Gasques *et al.* (2023) investigated the effects of MMP treatment on stretch marks in 10 females with striae alba, focusing on various body areas such as the buttocks, thighs, abdomen, and breasts. The participants received 3-monthly sessions using a sterile product containing elastin, chondroitin, ascorbic acid, and hyaluronic acid. Following the treatment, patients evaluated their satisfaction using a visual analogue scale. The feedback provided by all patients fell within the range of moderate to good.[6]

### Skin cancer

In the oncologic setting, Pacola *et al.* (2023) provided the largest prospective study to date investigating bleomycin delivery *via* MMP for the treatment of basal cell carcinoma. The study included 98 lesions treated with bleomycin microinfusion, yielding an impressive 6-month cure rate of 96.9%, with only expected, manageable local reactions such as transient erythema, edema, and crusting. The authors highlighted the precision of drug delivery across tumor margins and the practicality of treating multiple lesions within a single session, underscoring MMP's potential as a minimally invasive alternative for patients unfit for surgery or those with multiple low-risk lesions. Nevertheless, long-term follow-up remains necessary to evaluate recurrence rates and define ideal candidates for this modality.[5]

### Psoriasis vulgaris

Okita *et al.* (2018) reviewed MMP sessions using cyclosporine or MTX in four psoriasis cases (two cases for each drug). The paper evaluated patients who had moderate to severe psoriasis and lesions that proved refractory to previous treatment. The findings indicated favorable tolerability among the participants, rapid response, lack of adverse effect with no methotrexate or cyclosporine serum levels detected.[10]

## Discussion

Physicians are increasingly turning to transdermal drug delivery techniques as a method to bypass the stratum corneum that impedes the absorption of topical medications. MMP is characterized by the advantage of creating micropunctures through needling, in addition to the spontaneous delivery of a small amount of medication actively to its site of action with fewer local side effects. Tattoo machines penetrate the dermis through needling and induce micropunctures with columns of superficial bleeding, initiating a controlled inflammatory reaction that results in the release of various growth factors such as transforming growth factor-alpha, transforming growth factor-beta, platelet-derived and vascular endothelium-derived growth factor, ultimately resulting in angiogenesis, neocollagenesis, and elastin synthesis. The extent to which retrograde blood flow is actively expelled through the micropunctures created by other needling methods that impede the passive penetration of drugs remains unknown. This shows the advantage of MMP, as it delivers the drug actively to its site of action.[6,7] The literature describes the use of MMP to treat various dermatological conditions such as alopecia areata, frontal fibrosing alopecia, androgenetic alopecia, psoriasis vulgaris, basal cell carcinoma, hypochromic scars, idiopathic guttate hypomelanosis, linear scars, keloid lesions and striae alba with promising results and no severe side effects reported. However, Nogueira *et al.* (2022) reported a transient elevation in transaminase levels 1 week after a single session of tattooing with a tattoo machine and MTX in a patient with ophiasis-pattern alopecia areata associated with systemic lupus erythematosus. This was observed after excluding lupus-related alopecia and other potential confounding factors, in a patient with a prior history of hepatotoxicity due to systemic MTX



OPEN ACCESS

treatment. On the other hand, Okita *et al.* (2018) used the same intervention and reported favorable tolerability, absence of adverse events and quick response among psoriasis patients who were unable to tolerate systemic therapy.

In general, there are potential benefits of this technique, including a potent local effect, minimized toxicity through bypassing the hepatic first-pass metabolism, and the ability to administer lower drug dosages due to efficient dermal permeation and reaching the systemic circulation at a minimal and unnoticeable level.[9,10]

Recent evidence has further validated the versatility of the MMP technique across distinct dermatologic conditions. In androgenetic alopecia, a pilot randomized trial using dutasteride MMP demonstrated favorable patient-reported improvement with excellent tolerability, highlighting its potential as a localized alternative to systemic 5-α-reductase inhibitors. Likewise, a split-scalp study using MMP-delivered minoxidil showed efficacy comparable to topical 5% minoxidil, with superior response in vertex and parietal areas, suggesting enhanced drug bioavailability in less advanced disease.[18] In the oncologic field, bleomycin microinfusion achieved a 96.9% 6-month cure rate for basal cell carcinoma, confirming the method's capacity for uniform and effective intradermal chemotherapeutic delivery.[5] Collectively, these data reinforce the safety and clinical potential of MMP as a versatile transdermal platform applicable to both inflammatory and neoplastic skin conditions.

When it comes to the safety of the MMP technique, the main issue is the amount of drug infused. Although there are discrepancies in various studies, Arbache *et al.* (2019) determined the mean value to be 1.175 μg/cm$^2$. Highlighting the advantage of the procedure, as it allows such a small amount of medication to be injected onto a surface of 1 cm$^2$ compared to using syringes.[2] However, no studies further describe the depth of application needed, the frequency of sessions, the optimal time gap between sessions necessary for initial results to be perceived, elimination of drugs, potential contraindications and complications associated with the procedure.

## Conclusions

MMP is a simple, cost-effective, and well-tolerated technique that allows precise intradermal drug delivery with minimal systemic absorption. Recent studies using dutasteride and minoxidil for alopecia and bleomycin for basal cell carcinoma highlight its expanding therapeutic potential. Even without medication, the microneedling effect contributes to clinical improvement. Overall, MMP offers a promising, minimally invasive transdermal delivery method, warranting further research to standardize protocols and confirm long-term efficacy.

## References


1. Arbache S, Godoy C. Microinfusion of drugs into the skin with tattoo equipment. Surg Cosmet Dermatol 2013;5:70-4.
2. Arbache S, Mattos EDC, Diniz MF, et al. How much medication is delivered in a novel drug delivery technique that uses a tattoo machine? Int J Dermatol 2019;58:750-5.
3. Arbache S, Hirata SH. Efficacy and Safety of 5-Fluorouracil Tattooing to Repigment Idiopathic Guttate Hypomelanosis: A Split-Body Randomized Trial. Dermatol Surg 2023;49:603-8.
4. Neri SRNG, De Oliveira Domingos M, Michalany NS, et al. Botulinum Toxin A Delivery via MMP Technique: An Emerging Therapeutic Approach for Frontal Fibrosing Alopecia. Braz J Case Rep 2023;4:3-7.
5. Pacola PR, Rostey RRL, Rizzo FFA. Chemotherapeutical treatment of basal cell carcinoma with bleomycin via microinfusion of the drug into the skin (MMP®). An Bras Dermatol 2023;98:587-94.
6. Gasques L, Okita A, Giraldelli G, et al. Management of striae alba with Infusion of drugs using MMP technique. J Dermatol Cosmetol 2023;7:41-4.
7. Müller Ramos P, Melo DF, Radwanski H, et al. Female-pattern hair loss: therapeutic update. An Bras Dermatol 2023;98:506-19.
8. Cortez de Almeida RF, Melo DF, Tosti A. Scalp Microinfusion: A Novel Drug Delivery Technique for Hair Loss Treatment. Skin Appendage Disord 2023;9:81-3.
9. Nogueira BL, Bonamigo RR, Heck R. Elevation of transaminases after MMP® session with methotrexate for alopecia areata treatment - how much do we know about the risks of systemic absorption of the technique? An Bras Dermatol 2023;98:390-1.
10. Okita AL, Arbache S, Roth DMP, et al. Tratamento de psoríase vulgar pela microinfusão de medicamentos na pele (MMP®) usando ciclosporina e metotrexato. Surg Cosmet Dermatol 2018;10.
11. Barletta M, Gasques L. Successful Treatment of Alopecia Areata Patches with Triamcinolone Acetonide Using MMP®: Report of 2 Cases. Skin Appendage Disord 2020;6:229-34.
12. Contin LA. Male androgenetic alopecia treated with microneedling alone or associated with injectable minoxidil by microinfusion of drugs into the skin. Surg Cosmet Dermatol 2016;8.
13. Pitlovanciv TES, Skare TL, Medeiros KB, Fabri AB. Efficacy of Methotrexate Microinfusion in Scalp Lesions of Patients with Frontal Fibrosing Alopecia: A Prospective Controlled Trial. Skin Appendage Disord 2025;11:151-8.
14. Ragi SD, Ghanian S, Rogers N, et al. Evaluation of hair regrowth after minoxidil and dutasteride tattooing in men with androgenetic alopecia. JAAD Int 2023;12:103-4.
15. Arbache S, Roth D, Arbache ST, Hirata SH. Original Method to Repigment Achromic Laser Tattoo Removal Scars. Case Rep Dermatol 2019;11:140-4.
16. Arbache S, Arbache ST, Hirata SH. Is it possible to repigment iatrogenic and traumatic hypochromic lesions? A case series using the MMP® drug delivery technique with 5□fluorouracil and bleomycin. Int J Dermatol 2021;61:71-83.
17. De Souza LG, Gold MH, Steiner D, et al. A simple drug-delivery microneedling technique modality successfully improves linear atrophic scars. J Cosmet Dermatol 2024;23:857-61.
18. Corrêa AC, Machado CJ, Carneiro SCS. Split-scalp pilot study to evaluate effectiveness of Minoxidil 0,5% MMP® versus Topical Minoxidil 5% in the treatment of Female Pattern Hair Loss. Arch Dermatol Res 2024;316:313.
19. Gasques L, Lima A, Lima M, et al. Dutasteride Infusion in Male Androgenetic Alopecia Using a Novel Drug Delivery Technique: MMP®. Skin Appendage Disord 2025.

*Online supplementary material:*
*Supplementary Table 1. Review of studies reporting the use of MMP® for delivering drugs (chronological order).*

Received: 19 February 2025; Accepted: 23 October 2025.

Contributions: Khalid Nabil Nagshabandi, Raed Alojayri, Abdulaziz Alghufaili: data collection and analysis; Mona Alkallabi, Khalid Nabil Nagshabandi: supervision; Khalid Nabil Nagshabandi, Raed Alojayri, Abdulaziz Alghufaili, Mona Alkallabi: writing – original draft, design. All authors have read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Conflict of interest: the authors have no conflict of interest to declare.

Ethics approval and consent to participate: not required.

Availability of data and materials: the data that support the findings of this study are available from the corresponding author upon reasonable request.

*Publisher's note: all claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article or claim that may be made by its manufacturer is not guaranteed or endorsed by the publisher.*

*This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0).*



OPEN ACCESS