REVIEW ARTICLE



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Non-laser treatment for tattoo removal

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Abstract

Tattoos are increasingly gathering attention in the young population, especially in second to fourth decade of life. With such trends, rate of its removal also has been on the rise. Treatment options for tattoo removal besides lasers are surgery, radiofrequency, infrared light, cryotherapy, dermabrasion and salabrasion. Unfortunately, none of these procedures are associated with satisfactory cosmetic results due to adverse effects such as scarring and dyspigmentation. Although laser treatment has become the gold standard for tattoo removal, it is also associated with some limitations. Some tattoo inks are resistant to laser, and multiple sessions and multiple wavelengths may be required for its complete removal. Considering these limitations, other treatment modalities for tattoo removal must be explored. This article highlights the non-laser treatment options for tattoo removal. We reviewed all published literature identified from electronic databases (MEDLINE and PubMed) till August 2021 to highlight the non-laser treatment options for tattoo removal.

KEYWORDS laser, tattoo removal, treatment

1 | INTRODUCTION

Tattooing has been trending in recent times.¹ It has been symbol of style and beauty, especially among younger populations.² Prevalence of tattooing is about 10%–20%, depending on the population, country and time of the studies.³ According to the Harris Poll

conducted in 2015, the prevalence of tattooing in the United States was 29%.⁴ It is more common in young people especially in second to forth decade of life. The practice of tattooing is seen in people across all classes. The prevalence of tattooing in general population is increasing because of several reasons.³ It may be due to peer pressure, social stigma, impressing the opposite sex or sometimes under

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the influence of alcohol and substance abuse.⁵ Some follow the trend of fashion from stars, soccer, and basketball players. According to the Harris Poll, 23% people regretted getting a tattoo.⁴ Many people wanted tattoos to be removed later in life and some within a few months. Around 10% of the patient with tattoo undergone a removal.⁶ Methods employed for tattoo removal include surgeries like simple excisions or excisions with skin grafting, chemicals, radio frequency, infrared coagulator, cryotherapy, and cutaneous abrasion by dermabrasion or salabrasion.⁷ Removal of tattoo can be very complicated with multiple options, and outcomes may be disappointing cosmetically due to scarring and hypo/hyperpigmentation.⁸ Factors like the color of the tattoo, type of the tattoo, pigment of the tattoo, and duration of the tattoo play an important role in outcome of tattoo removal. Lasers with nano- or picosecond technology have become the gold standard for removing tattoo.⁹⁻¹² However. sometimes, tattoos are incompletely removed or recalcitrant to laser. Multiple sessions (ten or even more) are usually required with prolonged treatment duration. Considering these limitations of laser therapy, non-laser treatments must be investigated.

2 | SURGICAL TECHNIQUES

Surgical procedures are preferable for small sized tattoos over larger tattoos due to difficulty in closure.¹³ Several surgical techniques like punch excision, simple excision, excision with grafting, and flaps are employed for tattoo removal.^{14,15} Punch excision and closure could be used for very small tattoos, post-traumatic tattoos and those for radiotherapy tracking.¹⁶ Smaller tattoos are mostly treated by simple excision and closure method along relaxed skin tension lines.¹⁷ Flap surgeries like rotation flaps can be considered for elongated tattoos and O to Z flaps used for round/ovoid tattoos.¹⁸ Blepharoplasty is helpful for small tattoos over eyelids. Serial split thickness excision is reserved for larger tattoos on limbs and the trunk.¹⁸ Main complications of surgery are hypertrophic scar, keloid, and scar dehiscence. Surgery always leaves scars while laser therapy usually does not. Surgical excision can also be considered in cases of contraindication for Q-switched laser therapy like allergic reactions to tattoo pigment after laser.

3 | DERMABRASION

Dermabrasion is a skin resurfacing procedure where epidermis is scraped off by means of a rapidly rotating device such as wire brush or diamond fraises attached to a motorized handle. It removes the epidermis and upper dermis consisting of tattoo. This procedure is preferred for tattoos that are too large to be excised.

Initially with dermabrasion, the surface used to be abraded till total removal of pigment, but this is associated with excess scarring. In subsequent years, it was observed that dermabrasion results in an inflammatory response, which prompts the shifting of pigment-laden macrophages to the surface.¹⁹ Considering this, only superficial

dermabrasion is preferred for removal of tattoos. Clabaugh has reported 5-year experience of using superficial dermabrasion for tattoo removal. This observation suggests that the procedure results in good pigment removal without or with little scar formation. Overall, this procedure can be performed quickly with not much risk to the patient.²⁰

The procedure involves shaving of the area, which is then cleaned with isopropyl alcohol. The area is anesthetized with infiltration using lidocaine (2%). It is carried out until pinpoint bleeding is seen. This causes little or no scar. A dressing applied is changed every day, and oral antibiotic is given. Often, repeated procedures may be required because of incomplete removal of pigment. There is formation of crust after around 2 weeks followed by complete healing after 4–6 weeks. A second procedure can be planned after 6–8 weeks. Regular dermabrasion usually provides good outcome with effective clearance of pigments and good satisfaction rate. The shape of the tattoo following dermabrasion persists despite having no pigments, called "ghost of tattoo".

Now with advent of new layered dermabrasion technique, it is possible to remove tattoo pigments in one session with somewhat fading of original shape.²¹ Layered dermabrasion are novel techniques where tattooed area is abraded till pinpoint bleeding, then further abraded deeply till most of the pigment is disposed of.^{22,23} In addition, the surrounding normal (non-tattooed) skin is then superficially abraded to merge into the normal skin around it. After few weeks, final shape of the healed tattooed skin is obscured with minimal residual scar. This procedure offers an advantage over regular dermabrasion in terms of cosmetic appearance. Shape of tattoo is hardly visible after the procedure and healed scar left behind by deep dermabrasion of tattoo area get better merged with superficially dermabraded surrounding normal skin.²⁴

Side effects of dermabrasion include pigment alteration like hypo- or hyperpigmentation, scars, keloids, persistent erythema, or infections (bacterial or herpes simplex activation).

4 | SALABRASION

Technique of salabrasion was first introduced by Manchester for the removal of tattoos.²⁵ In this unique procedure, home used salt is used to abrade the upper layer of skin followed by delivering across to the dermis.²⁶ There are many postulations behind its mechanism of action. According to a theory, inflammatory reaction to salt dermabrasion leads to increased disposal of the pigment through lymphatics and macrophages.²⁷ Another theory postulates that dermabrasion by salt augments the phagocytosis power of macrophages. There is increased mobility of pigment-laden macrophages and shifting to the surface which is subsequently disposed of.^{19,28}

The treatment area is cleaned with spirit, and infiltration anesthesia (lidocaine 2%) is given. A dampened sterile gauze swab dipped in salt is then used for rubbing the tattoo area. Initial faint erythema within minutes is followed by shearing of epidermis. Rubbing is ^{6 |} ──WILEY─

continued until appearance of deep red color followed by pinpoint bleeding. Swab is changed with loss of abrasive nature. After the endpoint, it is covered with dry glaze swab with bandage, course of antibiotics, and daily change of dressing. There is similar formation of crust as dermabrasion followed by complete healing after 4–6 weeks. Gradual loss of pigment occurs with subsequent sessions, which can be done a month apart. In a study by Koerber and Price et al.²⁹ salt was left for few hours to a day during salt abrasion on tattoo. Immediate removal of salt after salt abrasion provided better results than continued contact, which led to bad cosmetic results.

The procedure is very simple and inexpensive. No technical equipment and expertise are required. Patients not willing for surgery are eligible for salabrasion. Tattoos which are relatively pale and areas other than hand are suitable for the procedure. In addition, sometimes there is unbearable pain associated with rubbing of salt on unanesthetized wound, which limits its use. Proper counseling must be done regarding incomplete removal of tattoo in some cases and change in skin texture if there is complete removal. Comparative incidence of scar formation has not been formally estimated with salabrasion versus laser therapy, a popular method due to its better results with very less risk of scar formation.

Similar in a study by Manchester et al.³⁰ results were somewhat similar (total 37 patients) with similar proportions having good (10)/ excellent (10)/ fair (11)/ poor (6) response. Overall, laser removal is a much better option than salabrasion.

5 | CHEMICAL TATTOO REMOVAL

In this method, chemicals like phenol, trichloroacetic acid, silver nitrate, tannic acid, sulphuric acid, nitric acid, salicylic acid, and lactic acid are used either alone or in combination with other techniques. They act by causing inflammation in the form of erythema followed by crusting on the surface and more severe in the form of full thickness burn in subsequent sittings.³¹As a result, tattoo pigments are disposed off along with crusts as it falls off. However, these methods are usually associated with scarring, textural changes which are main disadvantages cosmetically.^{32–36} The German Federal Institute for Risk Assessment warns against this method.

Recently, 0.1% ingenol mebutate used for treating actinic keratoses has been helpful in tattoo removal as proven in animal studies. It activates protein kinase C which starts the inflammatory process resulting in necrosis and peeling of epidermis followed by crust formation which then falls off to initiate repithelialization.^{37,38} Like ingenol mebutate, imiquimod 5% has similar effects likeinducing inflammation in form of epidermal and dermal necrosis, neutrophil infiltration and eschar formation which helps in tattoos removal in a guinea pig studies. It induces production of TNF- α and IFN- γ thus activating innate and cell mediated immunity.

A study conducted by Solis et al.³⁹ evaluated either tretinoin, imiquimod, or both for tattoo removal in guinea pig model. Imiquimod cream alone was found to be the more effective than tretinoin or both used together but additional human studies are needed.

Some of these may cause severe scarring in patients when used for tattoo removal. There have been increased incidence of skin cancers like squamous cell carcinoma after treatment with ingenol mebutate.⁴⁰ Considering the safety, chemical tattoo removal method should be strongly discouraged.

6 | CRYOTHERAPY

Cryotherapy is one of the oldest procedures for tattoo removal. It is cheap, quick, and easy technique. However, now a days, availability is a significant issue. In this procedure, release of cryogen (liquid nitrogen) causes freezing of the area.⁴¹ As a result, blister formation results in split between epidermis from the dermis. There is transelimination of epidermal pigmentation via the blister fluid and also due to disruption in dermo-epidermal junction. Multiple sessions are required for significant improvement in tattoo. Shuster et al.⁴² reported a case of successful treatment of Monsel solution tattoo with 4 sessions of cryotherapy.

In one study, Dvir and Hirshowitz et al.⁴³ used liquid nitrogen cryoprobe for tattoo removal. In this study, improvement was observed in 75% of patients. In another study with liquid nitrogen spray, nearly similar results (73%) were observed.⁴⁴

The effect of cryotherapy is difficult to control and is often associated with side effects. Due to this, it should not be considered in darker skin types.

7 | INFRARED COAGULATOR

It is a simple, guick, and cheap method of tattoo removal first reported in 1975 and approved by the US FDA in 1991 for tattoo removal.^{45,46} A comparative study between infrared coagulator and the CO₂ laser showed advantages of better healing time with similar cosmetic result with former method. On the contrary, CO₂ laser had an advantage of total pigment removal in a single treatment. With infrared coagulator procedure, often residual pigment was left.⁴⁶ It works on principle of non-coherent radiation leading to nonspecific thermal effects. It consists of a bulb, which emits light ranging between 400-2700 nm and hand piece with 6mm contact tip. There is also a reflector that guides the radiation toward light guide in contact with skin via sapphire cap and an electronic timer with pulse duration between 0 and 1.5 s, which can be chosen by the operator.⁴⁷ Small tattoos are best suited to this form of modality. It results in satisfactory removal of tattoo with almost all pigment discarded except a few flecks remaining in some cases. Mostly, it is complete with one sitting. Rarely, second and third sessions are required at monthly intervals for removal of residual pigments. It results in nonspecific thermal damage, thus resulting in scarring although cosmetically acceptable.

8 | RADIOSURGERY

This technique works on a principle of utilization of electromagnetic waves for creating vibration of molecules at the site of touch, thus causing coagulation of tattoo area with minimal or no effect on nearby normal area.²⁴ The ball-shaped electrode is used with prior application of local anesthetic cream.⁴⁸ There is formation of scab over treated area which falls off within a week. It usually heals with post-inflammatory hypopigmentation or hyperpigmentation and scarring in some cases. Repeated sessions may be required for complete tattoo removal.

9 | COSMETIC CAMOUFLAGES

In these methods, powders, creams, and liquids are used for covering the tattoo. They have higher percentage of pigments and thicker in comparison with regular cosmetic makeup. Complement color theory should be applied in tattoos for satisfactory results.⁴⁸

10 | OVERTATTOOING AND TATTOO SUPPLEMENTATION

Overtattooing means tattooing over the existing tattoo, thus changing the appearance completely or making it less prominent by lighter color application.⁴⁹ Tattoo supplementation is similar modification of existing tattoo, but applying different tattoo over only objectionable part of the existing tattoo.⁵⁰ In Germany, there is a prohibited list of tattoo components, but no list of harmless ingredients. From the medical point of view, over-tattooing should not be an option considering the risk of side effects and long-term adverse effects to the skin or health.

11 | HOME REMEDIES

Natural agents like lemon, honey, yoghurt, and aloe vera have been used as home regimens in tattoo removal especially for fresh, tiny, and light tattoos but has not been validated by studies. There are DIY tattoo removal kits with creams available in market but not approved by FDA for tattoo removal.⁵¹ Unfortunately, it has been practiced in various beauty parlor by non-medical personnel leading to many side effects. There are not any stringent regulation/laws regarding this.

12 | CONCLUSION

Tattoo removal is a challenging procedure. Although there are multiple modalities for removal of tattoo, Q-switched lasers remains the treatment of choice. Laser tattoo removal typically requires multiple sessions for complete removal. The lack of response to certain tattoo inks and the high cost of Q-switch lasers have prompted a search for better non-laser options. All of the aforementioned procedures do not specifically target tattoo ink but rather all tissue in which the ink resides. Q-switched lasers remain the only technology that specifically target tattoo inks.

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CONFLICT OF INTEREST

AUTHOR CONTRIBUTIONS

Gaurav Dash involved in writing and revising the manuscript. Anant Patil, Martin Kassir, Mitchel P Goldman, Stephan Große-Büning Maurice Adatto, Stephan Grabbe, and Michael H. Gold involved in review and revising the manuscript. Mohamad Goldust involved in conception, writing, review, and revising the manuscript.

DISCLAIMER

"We confirm that the manuscript has been read and approved by all the authors, that the requirements for authorship as stated earlier in this document have been met and that each author believes that the manuscript represents honest work".

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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