

Research Article

Adverse reactions to tattoos: a study from the hilly region in northern India

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ABSTRACT

Background: Body art in the form of ornamental tattoos has been prevalent since ages and is followed with increased popularity in modern times. Tattoo prevalence ranges from 8.5% to 24%, higher among younger ages. Two third of such people who ever had a tattoo reported of being regretted of having a tattoo itself while 2% have adverse reactions. The aim was to study the adverse reaction to tattoos and histological variants in the chronic tattoos.

Methods: An observational prospective study was conducted on patients presented with adverse reactions to tattoos in the out-patient department of dermatology, venereology and leprosy, Indira Gandhi Medical College, Shimla, Himachal Pradesh, India from July 2012 to June 2013. Relevant clinical profile of the patient was studied and histopathological examination with a 5 mm punch biopsy was done in chronic cases.

Results: A total of thirty-three cases (19 male and 14 females) with complications to tattoos were registered over the period of one year. Thirty patients had their tattoo from an amateur while only three had from a professional tattooist. Twenty one (63.6%) had acute complications and twelve (36.3%) had chronic complications. Histopathological examination (HPE) was done in ten of these cases and two refused biopsy. The findings were suggestive of lupus vulgaris (LV) and foreign body granuloma (FBG) in three each; chronic granulomatous changes in two, and spongiotic dermatitis (SD), and lichen planus hypertrophicus (LPH) in one case each.

Conclusions: Tattooing being largely unregulated has led to variability in contents of tattoo solution and inadequate sterilization during the procedure. This combined with lack of awareness, increases the chances of various adverse reactions. So it is extremely important to strictly regularize the tattoo practice and to increase awareness about tattoo complications among consumers, tattoo artists and dermatologists.

Keywords: Tattoo, Adverse reaction, Tattoo pigments, Tattoo granuloma

INTRODUCTION

Tattoo is a form of art and identity and is a permanent mark or design made on the skin by a process of pricking and ingraining an indelible pigment or by raising scars. Word “tattoo” originated from polynesian ‘tatau’ meaning ‘to mark’.¹ Practice is known to be prevalent since 2000 BC. Estimates of prevalence of tattoos in current population ranges from 8.5% to 24% and 2% of them have adverse reactions.² Tattoo regret has been seen in large number of people who get their tattoo done for

fashion without adequate psychological preparation. Various adverse inflammatory reactions to tattoo pigments have been reported and described like infections, allergic reactions, malignancies and others like flaring of existing dermatosis. Acute reactions are described which occur within three weeks while chronic inflammatory changes develop later. Chronic reactions present in varied histopathological patterns like lichenoid, sarcoidal, spongiotic, granulomatous, sclerodermatous, sarcoidal, pseudoepitheliomatous, or rarely granuloma annulare type.³

Tattoos are of five types, traumatic, amateur, professional, cosmetic, and medical tattoos. Traumatic tattoo results from accidental insertion of foreign materials like, coal dust, graphite and amalgam, into the dermis. Amateur and professional tattoos are done for cosmetic reasons. Tattoos are also utilized medically in vitiligo, to localize the site for repeat radiotherapy, convey blood group of the wearer and in cosmetic surgery.

After initial injection, pigment is dispersed throughout a homogenized damaged layer down through the epidermis and upper dermis, in both of which the presence of foreign material activates the immune system's phagocytes to engulf the pigment particles. As healing proceeds, the damaged epidermis flakes away (eliminating surface pigment) while deeper in the skin granulation tissue forms, which is later converted to connective tissue by collagen growth. This mends the upper dermis, where pigment remains trapped within fibroblasts, ultimately concentrating in a layer just below the dermis/epidermis boundary. Its presence there is stable, but in the long term (decades) the pigment tends to migrate deeper into the dermis, accounting for the degraded detail of old tattoos

Tattoos in sophisticated centers are made by electric tattoo machine, which inserts ink into the skin via a single needle or a group of needles that are soldered onto a bar, which is attached to an oscillating unit. The unit rapidly and repeatedly drives the needles in and out of the skin, usually 80 to 150 times a second. Older methods of making tattoo include cutting designs into the skin and rubbing the resulting wound with ink, ashes or other agents, by hand-tapping the ink into the skin using sharpened sticks or animal bones (made like needles) with clay formed disks or, needles.

METHODS

The observational prospective study was conducted on patients presented with adverse reactions to tattoos in the out-patient department of dermatology, venereology and leprosy, Indira Gandhi Medical College, Shimla, Himachal Pradesh, India from July 2012 to June 2013. Relevant clinical profile of the patient was studied and histopathological examination with a 5 mm punch biopsy was done in chronic cases.

RESULTS

A total of thirty-three cases (19 male and 14 females) with complications to tattoos were registered over the period of one year, with age ranging from 16 years to 45 years. Thirty had (90.9%) their tattoo from an amateur while only three (9%) had from a professional tattooist. Twenty one (63.6%) had acute complications which occurred within three weeks while twelve (36.3%) had chronic inflammatory lesions. None of the cases were informed about the risks involved in tattooing.

Composition of ink was not disclosed to any case. Standard safety precautions and proper sterilization was not followed during tattooing. Clinical details are summarized in Table 1, 2.

Table 1: Pattern of acute complications in tattoo (n=21).

Type of complication	Number of cases
Pain	22
Itching	12
Tenderness	14
Acute inflammation	12
Furunculosis	3
Cellulitis	1
Tattoo regret	22

Table 2: Pattern of chronic complications in tattoo (n=10).

Type of complication	Number of cases
Lupus vulgaris (LV)	3
Foreign body granuloma (FBG)	3
Chronic granulomatous changes	2
Spongiotic dermatitis (SD)	1
Lichen planus hypertrophicus (LPH)	1



Figure 1: Images of a hypertrophied tattoo over the left forearm; a- Clinical image, b-Scanner HPE, c- 40X image.

There is keratinizing stratified squamous epithelium revealing focal follicular plugging and presence of black pigment throughout the infiltrate suggestive of foreign body granulomatous inflammatory reaction to tattoo (Figure 1).

Figure 2 shows small nodular tuberculoid granulomatous infiltrate made up of lymphocytes, plasma cells, histiocytes and epithelioid cells. Overlying epidermis shows marked spongiotic psoriasiform change. Underlying dermis shows fibroplasia and extensive

lymphoplasmocytic infiltrate suggestive of *Lupus vulgaris*.

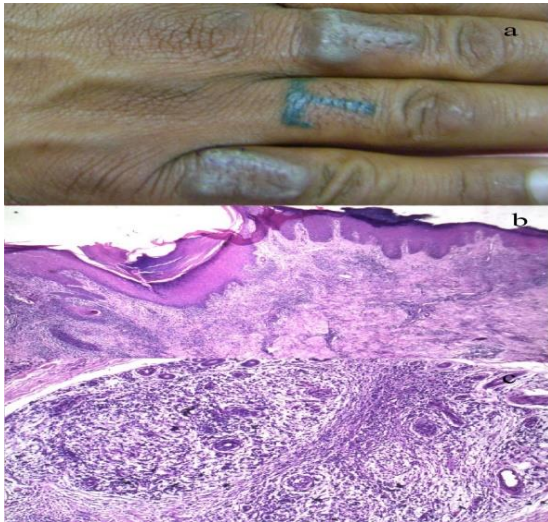


Figure 2: Images of hypertrophied tattoo over dorsa of left hand fingers; a- Clinical image, b-Scanner HPE, c- 40X image.

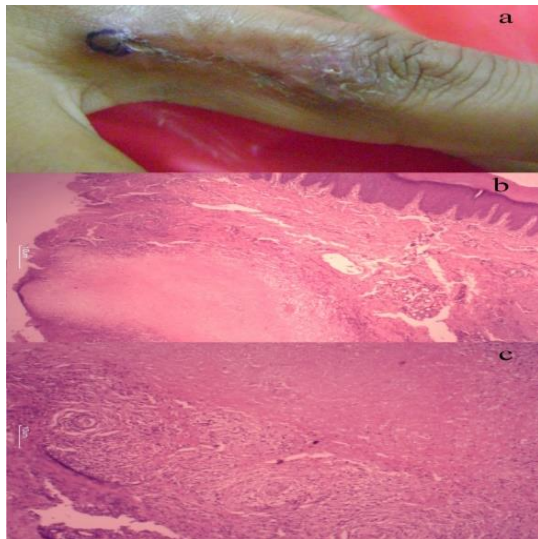


Figure 3: Images of inflamed tattoo in dorsa of left middle finger; a-Clinical image, b-Scanner HPE, c-40X image.

Reticular dermis shows multiple epitheloid cell granulomas with langhans type of giant cells one of granuloma showed caseous necrosis suggestive of *Lupus vulgaris* Figure 3.

Figure 4 shows keratinizing stratified squamous epithelium revealing acanthosis, papillomatosis, hypergranulosis and compact orthokeratosis with presence of civate bodies and basal cell vacuolation. Lichenoid infiltrate consisting of mononuclear inflammatory cell infiltrate at dermoepidermal junction suggestive of lichen planus hypertrophicus.

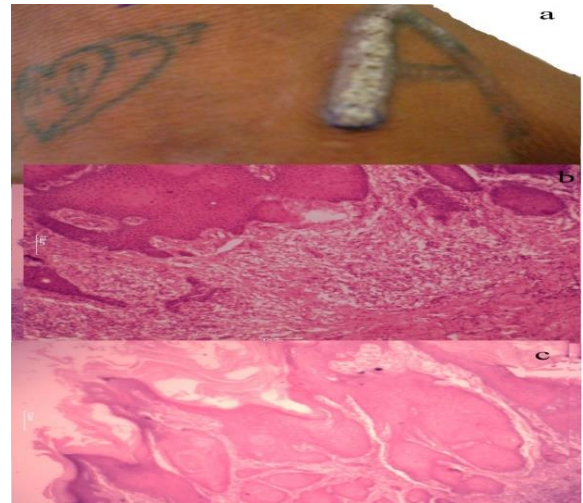


Figure 4: Images of inflamed tattoo in back of right hand; a-Clinical image, b-Scanner HPE, c-40X image.

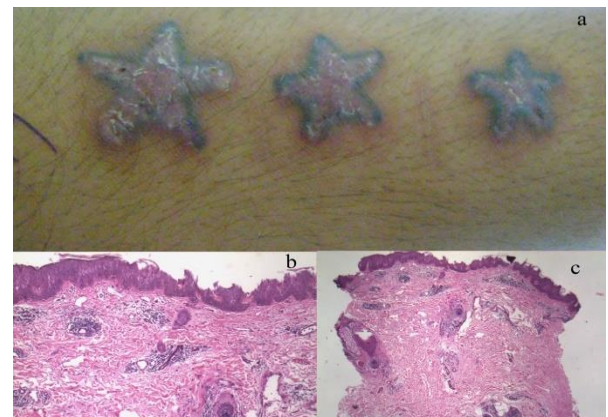


Figure 5: Images of inflamed tattoo in left forearm. a-Clinical image, b-Scanner HPE, c-40X image.

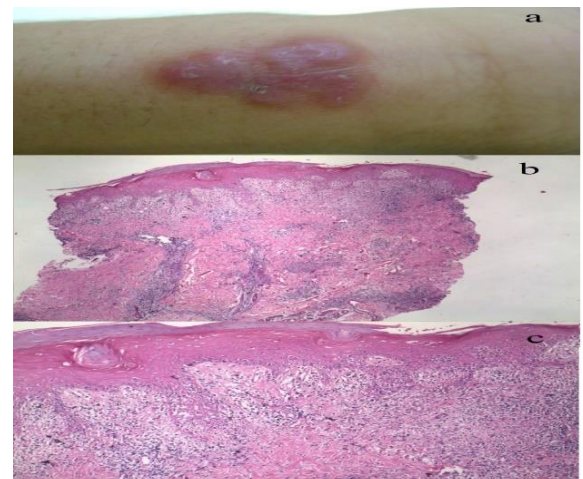


Figure 6: Images of inflamed tattoo over the front of right wrist; a-Clinical image, b-Scanner HPE, c-40X image.

Figure 5 shows sparse superficial perivascular lymphohistiocytic infiltrate with moderate epidermal

hyperplasia and mild focal spongiosis. Stratum granulosum is slightly thickened. Stratum corneum shows compact orthokeratosis. Impressions of persistent spongiotic dermatitis are suggestive of contact dermatitis.

Figure 6 shows patchy nodular tuberculoid granulomatous infiltrate made up of lymphocytes, plasma cells, histiocytes and epithelioid cells with occasional langhan's giant cells. Overlying epidermis shows moderate spongiotic psoriasiform change. Underlying dermis shows fibroplasia. PAS stain is negative for fungi, suggestive of *Lupus vulgaris*.



Figure 7: Clinical image of other tattoo with complications. a- right forearm, b- left shoulder.

Figure 7 shows few other cases with bumps and swellings.

DISCUSSION

Tattooing has become a common procedure in the Indian subcontinent, no longer restricted to Western World. Although tattoo craze is more common among youngster and young adults, but there seems to be no age bar and sex differentiation. Unsterilized instruments, improper methodology and inks itself can lead to variety of complications and adverse effects. Tattooing and its removal had become a business; with more expensive and less successful tattoo removal.⁴

In the present study 63.6% patients were presented with acute adverse reactions and 36.3% patients with chronic adverse reactions. The most common acute adverse reaction was pain (66.6%) and *Lupus vulgaris*, foreign body granulomas was seen in chronic cases.

There has been more than 150 adverse reactions to permanent make up procedure were reported to FDA in 2003 and 2004. The FDA and centers for disease control and prevention (CDC) identified 101 of these cases as having adverse reactions. The most common acute

adverse reactions were tenderness and itching associated with allergic reactions and bumps secondary to granulomatous reactions.⁵

The different types of adverse reactions are as enumerated.

Infections

Tattoos can lead to bacterial (staphylococcal, clostridium sp, *Mycobacterium leprae*, *T. pallidum* etc.), viral (hepatitis C and B, herpes simplex virus, HPV, HIV), superficial and deep fungal infections (sporotrichosis) and tuberculosis including atypical mycobacterial infections.⁶ There can be potentially life-threatening cellulitis, and necrotizing fasciitis or cutaneous vasculitis.⁷

Atypical mycobacterial infections in particular are increasingly reported; special stains for mycobacteria should be performed and cultures recommended particularly when dense, mixed or granulomatous infiltrates are present.

Allergic reactions

Allergic reactions to tattoo can occur due to latex in gloves of the tattoo artist, metals in the ink and carriers. Reactions can be triggered by exposure to sunlight.

Acute inflammatory reactions

Acute inflammatory reactions are an expected adverse effect of the tattooing which occurs within few days of tattoo application. It is due to the inks and carrier molecules and usually recedes without consequence within 2-3 weeks and process.

Eczematous hypersensitivity reactions

Eczematous hypersensitivity reactions are the most frequent reaction observed with tattoos. They occur most commonly to red tattoo pigments which contain mercury sulfide. Patch testing may be positive for mercuric chloride but is not reliable for cinnabar. Histopathologic evaluation of involved skin may reveal a spongiotic, granulomatous, or lichenoid type of tattoo reaction.

Most often, hypersensitivity reactions to a tattoo pigment are contact dermatitis and photoallergic dermatitis. These conditions may manifest clinically as localized eczematous eruptions or, rarely, as an exfoliative dermatitis. Histopathologic findings include acanthosis, spongiosis and a lymphocytic perivascular infiltrate.

Organic vegetable dyes and temporary henna tattoo also have been associated with eczematous reactions. Organic dyes are insoluble so little penetration into the epidermis occurs; therefore, a negative patch test result occurs.⁸

Photo-aggravated reactions

Photo-aggravated reactions are most commonly caused by yellow tattoo pigment containing cadmium sulfide. It is thought to be due to phototoxic mechanism. Red tattoos which have cadmium added to brighten the pigment also associated with photo-aggravated tattoo reactions. Chromium in green tattoo pigment is associated with localized eczematous reactions at the site of the pigment, eczema of the hands and generalized eczematous reactions. Patch testing to 0.5% potassium dichromate is often positive. Previously quiescent green-colored tattoos may become inflamed during patch testing in potassium dichromate-sensitive individuals.⁹

Blue tattoos that contain cobalt have been linked to localized hypersensitivity reactions and (rarely) spontaneous development of uveitis. Rarely allergic reactions to black tattoo pigment have also been reported.

Granulomatous reactions

Granulomatous reactions may take two forms. Foreign body reaction to pigment can produce numerous pigment-filled giant cells. This reaction may be viewed as the counterpart to an irritant contact dermatitis. An immunologic granulomatous reaction is characterized by aggregates of epithelioid cells, a ring of lymphocytes, and a few giant cells. They may be indistinguishable from granuloma in sarcoidosis.

Red pigments containing mercury is most commonly associated with a granulomatous tattoo reaction followed by chromium (green pigment) and cobalt (blue pigment) and rarely to manganese (purple) aluminum (violet) have also been reported. Patch test is negative.

Lichenoid reactions

Lichenoid reaction is an expression of delayed hypersensitivity to a lymphocytic T-cell infiltrate, which may simulate the graft-versus-host response. It occurs most commonly to mercury and present as warty papules or plaques typical of hyperkeratotic lichen planus are usually confined to the red portion of the tattoo. Rarely can it be generalized.

Histopathologically, the pattern of inflammation is consistent with that of lichen planus, including a band like infiltrate at the dermo-epidermal junction, liquefaction degeneration, hyaline bodies, and sawtooth rete ridges. Similar to granulomatous tattoo reactions, lichenoid reactions are associated with negative patch test results.¹⁰

Pseudolymphomatous reactions

Tattoo-induced pseudolymphoma occurs primarily within red portions of the tattoo. Clinically, most reactions are characterized by flesh-to-plum or plum-red indurated

nodules and plaques. Pseudolymphoma may be distinguished from cutaneous lymphoma at histologic examination.

Important features of a pseudolymphoma include germinal centers, a mixed cell infiltrate, prominent vasculature, and predominant involvement of the upper dermis compared with the lower dermis. Immunohistochemical studies may provide additional information.¹¹

Carcinogenicity and teratogenicity

Tattoo ink may contain harmful lead which has been linked to birth defects, cancer, and other reproductive harm. Aromatic amine may be present in tattoo ink which is carcinogenic. Azo-type pigments used in tattoos tend to cleave through enzymatic catalysis of redox reactions, resulting in highly electrophilic aromatic amine by-products capable of covalently binding with DNA.

Naphthol and Azos break down in sunlight exposure into toxic and/or carcinogenic aromatic amines. As with heavy metals, these by-products of the pigments' decomposition accumulate in the lymphatic system. Other documented conditions caused by tattoo pigments have been carcinoma, hyperplasia, squamous and basal cell carcinoma, keratoacanthoma and melanoma.^{12,13} sixteen cases of malignant melanoma developing in tattoos.¹⁴

MRI and Laser complications

Black ink commonly contains iron oxide which heat up either by inducing an electrical current or hysteresis by the MRI scanner and may lead to burns. Non-ferrous pigments have also been known to cause burns during an MRI.¹⁵ Burn can occur to IPL on tattoo.¹⁶

Dermal reactions

In addition to various histological patterns secondary to above described reactions scleroderma or morphea-like, sarcoidal, pseudoepitheliomatous hyperplasia and rarely a perforating granulomatous reaction can occur.^{17,18,19} Other conditions noted have been collagen deposits, discoid lupus erythematosus, hyperkeratosis and parakeratosis, and keloids. Lichen planus, psoriasis, sarcoidosis, and lupus erythematosus have been associated with localization to the site of a tattoo.

Delayed reactions

Delayed abrupt chronic reactions, such as eczematous dermatitis, are known to manifest themselves from months to as many as twenty years after the patient received his or her most recent tattoo. Plastic-based inks (e.g., glow-in-the-dark ink) are known to lead to

polymerisation under the skin, where the tattoo pigment particles converge into one solid plastic piece under the skin.

Lymphatic and vascular system

Pigment particles migrating to lymph nodes, may mimic metastasis in mammography and lead to chronic lymphadenitis.²⁰ Damage to blood vessel during the tattooing may lead to a haematoma which generally heal within one week but may appear as halos around a tattoo.

Tattoos on melanocytic nevi which later develop melanoma may cause interference with melanoma diagnosis.

Chemical composition

Manufacturers of inks and pigments are not required to reveal the contents and information is proprietary and tattoo professionals are often secretive, so exact composition is uncertain most of the time. Most tattoo inks are basically pigments that are suspended in a carrier solution. Pigments are mostly metal salts but plastics and vegetable dyes are also used. Various carriers used are, ethyl alcohol, propylene glycol, distilled water and glycerine (Table 3).

The plastic-based pigments are very intensely colored, but have increased potential of adverse reactions so are pigments that glow in the dark which may be radioactive.

Table 3: Composition of tattoo ink.

Color	Materials
Black	Iron oxide, carbon, logwood
Brown	Ochre (iron oxides mixed with clay)
Red	Cinnabar, cadmium red
Orange	disazodiarylide and/or disazopyrazolone, cadmium seleno-sulfide
Flesh	Ochres (iron oxides mixed with clay)
Yellow	Cadmium yellow, ochres, curcuma yellow, chrome yellow (PbCrO ₄ , often mixed with Pbs), disazodiarylide
Green	Chromium oxide, malachite (Cu ₂ (CO ₃)(OH) ₂), ferrocyanides and ferricyanides, lead chromate, monoazo pigment, Cu/Al phthalocyanine, Cu phthalocyanine
Blue	Azure blue, cobalt blue, Cu-phthalocyanine
Violet	Manganese violet (manganese ammonium pyrophosphate), various aluminum salts, quinacridone, dioxazine/carbazole
White	Lead white (lead carbonate), titanium dioxide (TiO ₂), barium sulfate (BaSO ₄), zinc oxide

To add to the complexities a tattooist can add anything as a pigment or carrier which may have adverse effects of its own. Alcohol used as a carrier can cause burns, makes skin more permeable and works synergistically with other carcinogens. An increase in consumer complaints has prompted FDA investigation into tattoo inks and their safety. It is important that further complications be reported to promote regulation of cosmetic tattoo inks.²¹

Treatment and management

Black inks can be removed more completely than inks of other colors. Older tattoo removal methods included dermabrasion, cryosurgery, carbon dioxide lasers, and cold steel surgical excision and excision - skin grafts for larger tattoos. Acute allergic reaction resolves with topical or intralesional steroids, but permanent removal may be necessary.

Q-switched ruby laser was first described by Goldman et al, laser tattoo removal often requires multiple treatments, and complete resolution of color may not be achieved in all cases.²² Lasers that can target specific pigment-

containing structures in the skin have been developed using the theory of selective photothermolysis. The Q-switched ruby (694 nm), Q-switched Nd: YAG (1064 nm), Q-switched alexandrite (755 nm), Q-switched frequency-doubled Nd: YAG (532 nm), and the pigmented lesion pulsed dye (510 nm) lasers are used to remove various tattoo pigments.

The mechanism involved in removing tattoo pigment is not understood completely, but it most likely involves the release of ink particles into the extracellular space with subsequent lymphatic drainage and re-phagocytosis of smaller residual ink particles.

Laser treatment infrequently may cause a localized tattoo reaction to become generalized. Pigment released into the extracellular space after laser treatment may be viewed as foreign by the immune system, causing a hypersensitivity response.

Laser-induced photochemical changes can occur in tattoo inks resulting in irreversible immediate darkening of the tattoo. Pigments, including red, brown, and white, used

for cosmetic tattoos are at highest risk for this type of reaction. The immediate whitening of the tattoo is likely caused by the formation of gas bubbles that intensely scatter light.

Most cosmetic tattoos contain iron (or titanium) oxide inks that, on QS laser irradiation, are reduced from ferric oxide to the ferrous oxide form; the latter being black and insoluble. Although this reaction pattern can usually be improved with continued pigment-specific QS laser treatments or vaporization with a carbon dioxide laser, the darkened color may be permanent.

QS lasers can effectively and safely remove different types of unwanted tattoos.²³ Motivations for laser tattoo removal were mainly considering the tattoo as youthful folly (29%), esthetic reasons (28%) and 6% indicated medical problems. One third of participants were unsatisfied with the result of laser tattoo removal, and a complete removal of the tattoo pigment was obtained in 38% only. Local transient side effects occurred in nearly all participants, but an important rate of slightly visible scars (24%) or even important scarring (8%) was reported. Every fourth participant described mild or intense tan when the laser treatment was performed, and the same number of people indicated UV exposure following laser therapy, which should normally be avoided in these circumstances. As reported in the literature, nearly half of the participants experienced hypopigmentation in the treated area. Our results show that from the patients' point of view there is an important rate of side effects occurring after laser tattoo removal. Appropriate pretreatment counseling with regard to realistic expectations, possible side effects and the application of test spots is mandatory to ensure patient satisfaction. Laser treatment should be performed by appropriately trained personnel only.²⁴

CONCLUSION

Tattooing being largely unregulated has led to variability in contents of tattoo solution and inadequate sterilization during the procedure. This combined with lack of awareness, increases the chances of various adverse reactions. So it is extremely important to strictly regularize the tattoo practice and to increase awareness about tattoo complications among consumers, tattoo artists and dermatologists.

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