

Complications arising from artistic body tattoos: our experience

Marta Patricia La Forgia¹, Myriam Alperovich², María Cristina Kien³, Daniel Batistonit⁴, Graciela Pellerano⁵

Abstract

Background. Tattooing is an art known since ancient times, popularized as from the 1990s and not without adverse reactions.

Objectives. To classify tattooing complications in patients consulting for adverse reactions to tattoos. To identify clinical and histological patterns, and frequency distribution, as well as the patch test (PT) and component chemical analysis results.

Design. Retrospective and prospective, observational, carried out at the Dermatology Unit of Hospital General de Agudos "Dr. Cosme Argerich" from March 1, 1998 to November 30, 2006.

Methods. Methodology was carried out through review of medical records, to gather information about: 1) physical examination, 2) laboratory tests, 3) histopathological exams, 4) patch test, and 5) chemical analysis of the dye.

Results. In the above mentioned period, 21 patients were treated for tattoo complications: 80.8 percent were reactions to decorative dyes, 9.6 percent to an adverse effect of removal, 4.8 percent to inflammatory reactions due to injection injury, and 4.8 percent coincidence with skin disease location.

Conclusions. Most tattooing complications in our experience were accounted for by dye reactions, which could be related either to the presence of the exogenous component, to individual predisposition, or to a combination of both factors. Tattooing complications may be deemed infrequent, but they alter the results of a procedure with esthetic purposes (Dermatol Argent 2008;14(1):46-55).

Key words: tattoo, complications.

ABBREVIATIONS

CNEA	Comisión Nacional de Energía Atómica
CI	Confidence interval
IPL	Intense pulsed light
PT	Patch test
VDRL	Venereal disease research laboratory test

Ye shall not make any cuttings in your flesh for the dead, nor print any marks upon you: I am the LORD.

Leviticus 19:28. Old Testament

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1. Assistant Staff Physician. Head of Dermatoallergies consulting office.
2. Attending Physician, 2nd year of Superior Course for Specialists in Dermatology.
3. Dermatopatologist.
4. Head of the Chemical Activity Unit. CNEA.
5. Head of Dermatology Unit.

Dermatology Unit. Hospital General de Agudos "Dr. Cosme Argerich". Pi and Margall 750, (1155) Autonomous City of Buenos Aires. Argentine Republic.
Centro Atómico Constituyentes. CNEA. Av. General Paz 1499, (1650) San Martín. Province of Buenos Aires. Argentine Republic.
Centro de Investigaciones Dermatológicas. Uriburu 1590, (1114) Autonomous City of Buenos Aires, Argentine Republic.

Correspondence

Marta Patricia La Forgia: Cochabamba 774 1° A - (1150) Autonomous City of Buenos Aires – Argentine Republic.
E-mail: martalaforgia@gmail.com

Introduction

The term tattoo comes from the Polynesian *tau-tau*, reminding of the sound produced by the hammers striking on the bones used by Tahitians when they drew decorative figures on the skin.¹ Tattooing implies introducing substances into the dermis, and sometimes even the hypodermis, with the purpose of creating permanent marks.

Tattoos may be accidental (abrasion injuries), repairing/cosmetic (areola reconstruction), iatrogenic (use of Monsel solution or ferric perchloride) or decorative, which constitute an art recognized since ancient times (Egyptian mummies) and popularized since the 1990s. However, the procedure is not without adverse reactions, which may be related to physical tissue inju-

TABLE 1. CHARACTERISTICS OF THE POPULATION.

Patient	Gender	Age	1st consultation	Professional tattoo	Colors	Term	TLA (months)	Personal history
1	M	32	10-02-98	Yes	R-G-B	48	4	n/p
2	M	26	09-12-99	Yes	(1) R-B-BI (2) R-B	12	2	n/p
3	F	27	05-09-02	Yes	B	12	<1	n/p
4	M	22	03-02-04	No	R-B	72	1	Asthma
5	M	24	08-03-04	Yes	R-B	36	24	n/p
6	M	20	29-06-04	Yes	R-B-W-G	8	3	n/p
7	M	23	27-07-04	Yes	R-BI-Y	9	6	n/p
8	M	26	26-11-04	Yes	R-B	6	<1	Seizures
9	M	22	06-01-05	No	R-B	12	4	n/p
10	F	19	25-02-05	Yes	R-B-Y-G	24	3	n/p
11	F	28	25-02-05	No	R-B	36	<1	Chronic anemia
12	M	35	24-05-05	Yes	R-B	18	4	n/p
13	M	24	01-11-05	Yes	R-B	8	<1	Hepatitis A
14	M	24	09-05-06	No	B	72	6	n/p
15	M	19	16-06-06	No	R-B	6	2	n/p
16	F	21	07-08-06	No	R-B	24	2	n/p
17	M	15	10-08-06	Yes	R-B-Y	1	1	Psoriasis
18	F	36	22-08-06	No	R-B-G	9	2	n/p
19	F	32	05-09-06	Yes	R-B-BI	48	<1	n/p
20	M	25	21-09-06	Yes	R-B	1	<1	n/p
21	M	46	19-10-06	No	B	264	1	Psoriasis

TLA: time of lesion appearance. R: red. B: black. W: white. G: green. BI: blue. Y: yellow. n/p: no particulars.

ries or with the substance remaining in the skin. Complications of decorative tattoos may be classified as follows:

- Regret or social stigmatization (its permanent quality is not always taken into account at the time of performance).
- Infection transmission (through dye or application method).
- Inflammatory reactions of the injection injury.
- Reactions to decorative dyes.
- Location of skin disease (coincidental or koebnerization-mediated).
- Adverse effects of dye removal.

Like piercing, it is an invasive procedure not subjected to health authority regulation: tattoo drawers do not follow anatomic or anti-infective prophylaxis studies, and dyes are not subjected to health approval. Commonly used dyes contain a variety of non-soluble colored pigments, among them: mercury sulfide for red; cobalt aluminate for light blue; chrome sesquioxide for green; cadmium sulfate for yellow; ferric oxide for brown; carbon for dark blue.

Objectives

1. To identify common clinical and histological patterns among patients consulting for adverse reactions to their tattoos.
2. To establish the frequency distribution of patch test (PT) and component chemical analysis results in those patients where the used dye could be obtained.

3. To establish the frequency distribution of various types of complications, according to the above classification.
4. To establish the frequency distribution of the various treatments applied.

Materials and methods

This is a retrospective and prospective, observational study based on medical records of the Dermatology Unit of Hospital General de Agudos "Dr. Cosme Argerich" from March 1, 1998 to November 30, 2006.

Cases were considered according to the following criteria:

Inclusion criteria

- Patients of both genders and any age group with 1 or more colored permanent tattoos at any location, with adverse reaction attributable to: 1) performance of the tattoo, 2) removal treatment, or 3) underlying disease lesions at the tattooed site, appearing after the tattoo was drawn (coincidental or secondary to koebnerization).

Exclusion criteria

- Patients with permanent tattoo and without reaction, consulting for removal.
- Lesions of the tattooed site differing from those stated in the inclusion criteria.

Study methodology was carried out according to our rulings for assessment of patients with tattooing complications: 1) physical examination, 2) application of laboratory tests

(complete blood count, glycemia, urea, creatinine, hepatogram, lipidogram, and serological tests for B and C hepatitis, HIV and VDRL), 3) biopsy for histopathological testing, 4) patch test, and 5) chemical analysis of the used dye.

The Chemotechnique (Malmö, Sweden) standard battery was used for the patch test, plus the dye provided by the patient, pure and diluted according to the standard application and reading methodology. The chemical study was done by 1) electron microscopy - energy-dispersive X-ray spectrometry, 2) total reflection X-ray fluorescence to qualitatively determine components, at the Chemical Activity Unit of Centro Atómico Constituyentes, San Martín, Province of Buenos Aires, Argentina.

Different therapeutic options used in each patient were taken from the follow up.

When treatment with intense pulsed light (IPL) was required, a Photo Derm Vasculight TM Plus, Model P/N, Israel, equipment was used; and for CO₂ laser treatment, a Sharplan1030 (Laser Industries Ltd, Israel) equipment was used.

Reactions were defined as follows:

- a. *Injury reactions*, those of early onset, involving all the tattooed surface, independent of the colors used.
- b. *Dye reactions*, processes localized in the area of a particular dye, independent of the time of appearance.

Percentage, average, standard deviation, and their respective confidence intervals were used as statistical measures, as indicated and where thus obtained values had clinical projection. Where necessary, significance of ratio differences was calculated by the Chi Square test. Alpha level used was 0.05.

Results

During the assessed period of time, 21 patients were seen at the Dermatology Unit of Hospital General de Agudos “Dr Cosme Argerich” for adverse reactions to tattoos; 6 females (28.5 percent), and 15 males (71.5 percent).

Annual average attendance at the general dermatology consulting office counted 11,349 patients during the period 1998-2006 (this figure does not include patients seen in specialized consulting offices): 59 percent females and 41 percent males. Out of 5,867 annual first consultations between 1998 and 2003, 3 came for tattoo complication consultation (0.0082 percent); while between 2004 and 2006,



Figure 1. Patient with history of psoriasis (case 17), where initially a Köebner phenomenon was suspected, and the biopsy evidenced epidermal hyperplasia and lichenification.



Figure 2. The tattoo on the son (case 9, right) produced foreign body-type granulomatous reaction on the red area; his mother was tattooed the same day with the same dye (left) and showed no reaction.

they increased to 18 (0.11 percent), coinciding with the spread of the use of this “ornament” among the general population.

The ages of our patients oscillated from 15 to 46 years, with an average of 26 years (**Table 1**).

The only relevant personal history was psoriasis (**Figure 1**) en 2 cases, equivalent to 9.5 percent of our population.

Patients 9 and 16 claimed to have been tattooed at the same date and place as a related person (mother and friend, respectively), and with the same dyes, including red. Absence of reaction in said persons was verified. Most tattoos in our group were located in exposed areas, predominantly on arms (10 of 21 cases, that is, 47.6 percent).

In the cases of dye presence complications, at the time of consultation the tattoo had been done between 6 months and 6 years before, with an average of 20.5 months.

The color of the tattoo was single (black) in 3 (13.6 percent); the remain-

ing 19 (86.4 percent) showed more than one color, and all including red.

Dye reactions were located in the red tattooed area in 17 cases (89 percent of all red tattoos); in the black area in 3 cases (14 percent of all black tattoos), and in the green area in 1 case (25 percent of all green tattoos) (**Table 2**).

Performance of the tattoos was deemed professional in most cases (58.5 percent), and amateur in 41.5 percent of the cases.

The clinical examination of reactions showed:

- Plaques (infiltrates, erythematous, scaling, and/or ulcerate) en 16 patients (76 percent; 95 percent CI: 52.8-91.8 percent).
- Papuloid lesions in 2 patients (9.5 percent; 95 percent CI: 1.2-30.1 percent).
- Atrophy in 2 patients (9.5 percent).
- Discreet scaling in the red area of the tattoo and target lesions surrounding the tattoo in 1 patient (4.8 percent; 95 percent CI: 0.1-23.8 percent).

Itching was the main symptom referred to (81.2 percent; 95 percent CI: 58.1-94.6 percent); in 3 cases exacerbated by sun exposure, in 2 cases associated with pain, and in 1 case associated with discomfort. Pain was mentioned in 4.8 percent of the cases as the sole symptom, and the remaining 14.4 percent was asymptomatic.

In our experience, dye reactions had started within a period of few days to 2 years after having the tattoo. In the 2 cases with removal treatment complications, the reaction started immediately after the procedure; the same occurred with the injury reaction case.

In the psoriasis patient case, the disease location (coincidental) on part of the tattoo (black) occurred 2 years after it was drawn.

Serologic tests were requested in 14 patients. Ten cases (71.4 percent; 95 percent CI: 41.9-91.6 percent) resulted negative; the remaining 4 are pending. Routine findings were not relevant.

Histopathologic tests of the skin lesion were done in 20 patients (95.5 percent), and one of them (4.8 percent) refused it. In case 2, with dye complications in tattoos on the back of trunk and forearm, biopsies of both lesions were obtained.

The histological variants found (**Table 3**) include: 7 granulomatous reactions (35 percent; 95 percent CI: 15.4-59.2 percent), 2 lichenoid reactions (9.5 percent; 95 percent CI: 1.2-31.7 percent), 6 lymphoid hyperplasia (30 percent; 95 percent CI: 11.9-54.3 percent), 4 pseudo-epitheliomatous hyperplasia (20 percent; 95 percent CI: 5.7-43.7 percent), 6 non-specific in-

flammatory reactions, 1 erythema-multiforme-type lichenoid infiltrate, and histologic changes compatible with psoriasis in 1 case. In 14 tattoos (70 percent; 95 percent CI: 45.7-88.1 percent) only one reaction pattern was seen, and the rest (7 tattoos) had more than one. When the clinical and the histological variants were compared, we found that: the atrophy clinic corresponded to epidermal thinning and dermal fibrosis (2/2), the papuloid lesions with strange body granuloma (as sole or associate pattern) (2/2), and the target reactions with erythema-multiforme-type reaction (1/1). Clinical variants appearing as plaques (16 tattoos [80 percent; 95 percent CI: 56.3-94.3 percent]) showed more than one related histopathological pattern.

Although initially we intended to establish the composition of the dyes causing altered tattooed skin reactivity and analyze the causes through a patch test, we found it difficult to obtain dyes due to: 1) the long period of time occurring between the tattooing and the appearance of reaction, leading to loss of contact; 2) the tattooist's refusal to provide the product, or 3) differences between products used by the tattooist now and at the time the tattoo was done. However, in cases 2, 6, and 10, some of these tests were carried out.

The PT was done in 3 patients with standard battery and the provided dyes (red). Case 2 obtained 2 dyes from the tattoo artist, identified as A and B, and diluted 1/2; the response was positive (+) for nickel sulfate and for both diluted dyes (++) (**Figure 3**). In case 6, PT was done with the red dye provided by the patient in 1/1000, 1/100, 1/10, 1/2 dilutions and pure, and the response was construed as irritating. In case 10, the test carried out likewise resulted negative.

Chemical analysis of two of the used dyes was done by several methods. In case



Figure 3. Reading of PT (positive) on case 2 with dyes A and B diluted 1/2; the patient showed lymphoid hyperplasia and foreign body-type giant cell reaction due to the presence of pigment in the dermis.

TABLE 2.

Tattoo color	Total	With reaction	Without reaction
Red	19	17	2
Green	4	1	3
Black	21	3	18
Yellow	2	0	2
Blue	3	0	3
White	1	0	1

6, total reflection X-ray fluorescence gave the following result: main elements (tenths in percentage): chlorine, calcium, copper, zinc; minor elements (units in percentage): sulfur, chrome, potassium, titanium, iron, bromine, nickel, lead; and traces (millionth part): mercury. In case 10, 1) electron microscopy - energy-dispersive X-ray spectrometry, and 2) total reflection X-ray fluorescence were performed. In this case, the first method identified Cl and Si as main elements; the second identified Ca and Fe as minor elements and Cr, Cu, Mn, P, Ti, and Zn as traces.

Frequency distribution according to the type of complication was: A) reactions to decorative dyes (80.8 percent; 95 percent CI: 58.1-94.6 percent), B) adverse effect of removal (9.6 percent; 95 percent CI: 1.2-30.4 percent), C) injection injury inflammatory reactions (4.8 percent; 95 percent CI: 1-23.8 percent) and D) location of coincidental skin disease (4.8 percent). Case 20 showing erythema multiforme-type lesions located only in the tattooed (red and black) lower limb, but away from the tattoo, and with positive temporal relationship (2 weeks after the tattooing), was included as dye reaction due to the co-existing scaling in the red area of the tattoo (not histopathologically verified); this decision may be controversial. All reactions were treated with combinations of local, occlusive, or intralesional moderately to highly potent corticoids, which improved symptoms in 14 cases (66.7 percent; 95 percent CI: 43.0-85.4 percent). Adverse reactions to this treatment were irritation in 1 patient and atrophy in other 2. Topic tacrolimus was used (0.03 percent) in 3 cases (14.4 percent; 95 percent CI: 3.0-36.3 percent), with a similar response to corticoids. In one case (4.8 percent), intense pulsed light spot test, and in another (4.8 percent) CO₂ laser test, were applied, but the treatment was not completed. Non-sedative antihistamines (loratadine, cetirizine) were used symptomatically for a limited period of time, alone or associated with corticoids, but no conclusion was possible due to scarce adherence to treatment. Total follow up time of all the assessed patients fluctuated between 1 and 10 months, because they lost from consultation.

Discussion

Given the popularity of tattoos nowadays,² adverse reactions may be deemed relatively rare. Based on statistical data provided by a study group of the University of Chicago, 24 percent of 500 persons between 18 and 50 years had tattoos.³ In our experience, consultation ground “adverse reaction to tattoo” also proves



Figure 4. Case 7 shows a combined histologic pattern due to the presence of red pruriginous dye, which is exacerbated by sun exposure (photo-aggravated).

TABLE 3. HISTOPATHOLOGY.

Patient	Histopathological patterns
1	Lymphoid hyperplasia
2	Back: cutaneous lymphoid hyperplasia. Focal foreign-body giant cell reaction Forearm: foreign body-type giant cell granuloma
3	Lichenification lesions with presence of exogenous pigment
4	Epidermal thinning, dermis fibrosis, exogenous pigment in dermis
5	Histiocyte granuloma with central hyalinization areas
6	Pseudoepitheliomatous epidermal hyperplasia Non-specific acute and chronic inflammatory reaction Presence of abundant exogenous pigment at dermal and hypodermal level
7	Lymphoid hyperplasia with exogenous pigment Foreign body granuloma Pseudoepitheliomatous hyperplasia
8	Pseudoepitheliomatous epidermal hyperplasia Non-specific acute and chronic inflammatory reaction
9	Necrobiotic granuloma with histiocyte reaction and presence of exogenous material related to tattoo
10	Interface dermatitis with presence of exogenous pigment at the papillar and reticular dermis
11	Cutaneous lymphoid hyperplasia against exogenous pigment Foreign-body giant cell reaction
12	Cutaneous lymphoid hyperplasia
13	Lymphoid hyperplasia Lichenoid reaction
14	Not done
15	Chronic inflammatory (lympho-histiocyte) reaction to exogenous pigment
16	Lympho-histiocyte granuloma with collagen necrosis area and presence of exogenous pigment
17	Epidermal hyperplasia. Lichenification. Exogenous pigment in dermis
18	Pseudoepitheliomatous hyperplasia Chronic inflammatory reaction
19	Dermal fibrosis
20	Tattoo: dermal exogenous pigment related to tattoo Surrounding the tattoo: polymorph erythema
21	Psoriasis. Exogenous pigment related to tattoo

rare (0.0082-0.11 percent). Thus, and given its low frequency, tattoos seemingly do not represent a serious general health risk. Although prevalence of tattooing according to this study appears equally

in both sexes,³ in our experience men consulted in a greater ratio (71.5 percent), in contrast with the total consultations of our department, with clear female dominance (59 percent).

In today's society, it may be deemed that the practice of "body art", principally in juvenile strata with a context of less religious and political involvement, would be related to the desire to experience a sense of belonging to a group, and may be explained as an aspect of the development of identity.

As regards tattoo location, although most communications inform of predominance of covered areas, for them to be hidden due to their permanent quality, our patients were tattooed on exposed and easily seen areas, such as hands, malleoli and forearms (10 of 21 patients).

According to our experience, red tattoos have been the most frequently affected areas, which coincides with the scientific literature reviewed.^{4,5,6}

Reactions to red dyes may be caused by various pigments,⁷ especially mercury sulfide (vermillion), and the use of alternative red dyes (non-metal organic substances)⁸⁻¹¹ caused little frequency reduction. They may appear early or months after of the tattooing.^{12,13}

Yellow or red dyes have been related to photosensitivity due to their possible content of cadmium sulfide,¹⁴ by an unclear mechanism, but assumed phototoxic. Cadmium sulfide is the photosensitive material in photoelectric cells. In patients 7 (Figure 4), 9, and 16 we suspected that this substance may be involved, due to the photoaggravation of the affected area of the tattoo, although we could not perform the chemical determination study.

As regards histological variants, the granulomatous reactions, most frequent, may generally appear as:^{12,15-17}

- Tuberculoid granuloma
- Foreign body-type granuloma, with numerous giant cells filled with pigment.
- Sarcoidal granuloma, characterized by aggregation of epithelioid cells and scarce giant cells (granulomatous hypersensitivity type IV) without lymphocyte crown. This second type is indistinguishable from the involvement of the tattoo area as a Koëbner phenomenon in sarcoidosis,¹⁸ thus a clinical evaluation must be done to rule it out.

All granulomatous reactions in our experience caused by red dye were related to the foreign body-type.

Lichenoid reactions¹⁹⁻²¹ were described as caused



Figure 5. Pseudoepitheliomatous hyperplasia attributable to red dye (case 6).



Figure 6. Erythema-multiforme-type eruption surrounding the tattoo (case 20).

by mercury (red). They may be construed as an expression of delayed hypersensitivity to a T-lymphocyte infiltrate mimicking a graft-versus-host response. For our experience, the 2 lichenoid reactions were also caused by red dye.

The importance of histological diagnosis of lymphoid hyperplasia²²⁻²⁴ resides in preventing confusion with malignant lesions. Causes include red, blue, and green pigments of tattoos. All our cases stated as lymphoid hyperplasia appeared in the red areas.

Although the literature describes a case of massive pseudoepitheliomatous hyperplasia^{25,26} appearing as wart-like plaques, in a description almost identical to case 6 (Figure 5), the same pattern was verified in patients 7, 8, and 18, with a much less florid clinic.

Erythema-multiforme-like eruption following an allergic contact dermatitis was described in a patient with a temporary tattoo,²⁷ but no communication of this type related to permanent tattoos was found, as in case 20 (Figure 6).

Psoriasis is a dermatosis which may be localized in tattoos both as a Koebner phenomenon and coincidentally; such as case 21. However, most cases about coincidental lesions communicated in the literature refer to malignant lesions.²⁸

No atrophic lesions descriptions as tattoo complications were found; such as case 4, with long-term lesions and without symptoms. Atrophy, confirmed by biopsy, may correspond to a final stage of some of the previously described reactions.

The described reaction variants have not been related to a metallic element or a particular dye. Seven of our patients showed more than one reaction pattern in the same tattoo and with the same dye. Although lichenoid reactions are the most frequently communicated as tattoo complications, in our population the most frequent were granulomatous reactions (7 of 16 patients with dye reactions; 44 percent).

The chemical composition of the dyes commonly used for tattooing is very diverse. Some of their compounds have potentially toxic properties. These may be found in the order of parts per million (ppm) to parts per billion (ppb). Determination²⁹ of these concentration levels requires the use of light spectrometry of X-ray fluorescence techniques, which may be useful to establish the composition, since the formulation of commercial dyes is unknown. The analysis carried out in 2 of our cases revealed different metal components, among them mercury, in one of the cases, probably responsible for the observed reaction.

On the other hand, the patch test (PT) does not produce conclusive results either in these patients.^{29,30} The cases where we used it are proof of this.

Our therapeutic suggestions are similar to those reviewed in the scientific literature³¹⁻³⁷ and are not devoid of adverse effects. For those treated with IPL and CO₂ laser, the small number of sessions does not allow for outcome reports.

Conclusions

We present our own experience in adverse reactions to tattoos, their clinical patterns and histological relationship, as well as a complication frequency distribution. Our contribution reviews numerous complication variants, mostly attributable to dyes, whose immunopathologic mechanism remains yet unknown.

In such cases, complications may relate to:

- The presence of an **exogenous component**, capable of provoking and maintaining the reaction, especially in the red dyes, as detected in most of our patients (17 of 19 cases tattooed with red color).
- An **individual predisposition**, given the low frequency of these reactions (0.0082-0.11 percent of the annual consultations at the Dermatology Department).
- A combination of **both factors**, as occurred in the cases of other persons being tattooed with the same dye on the same day, without having any type of complication (2/2).

Although our experience does not reflect microbiological involvement, we believe that the person who performs an invasive procedure such as tattooing should, as part of the informed consent, detail the possibility of dye reactions on the most frequently found. Even though they may be deemed rare, they alter the outcome of a procedure with esthetic purposes.

Tattoo-addicts will probably benefit more from the use of safe, sterile, non-toxic dyes, designed for removal, than from recommendation about possible adverse effects.

Although all activities related to body art deserve to be regulated, we keep the hope of reducing to a minimum this type of complications in our population, once Law No. 1.897 of the Autonomous City of Buenos Aires becomes effective.³⁸

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