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Working Paper

on

Health effects and risks from tattoos, body piercing and of related practices

by

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to be peer-reviewed by the

*“JRC – virtual Regulatory and Scientific/Technical Tattoo/piercing expert network”
“JRC-TattooNet”*

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Foreword

The present preliminary version of this working paper is a step in a series of actions of the Institute for Health and Consumer Protection (IHCP)/Physical and Chemical Exposure Unit (PCE) aiming at supporting the work of DG SANCO, European Commission in the field of “Technical/scientific and regulatory issues on the safety of tattoos, body piercing and of related practices”.

A Technical Working Group (TWG) of experts from Member States was established to carry out the action plan of the project. This action plan and the minutes of the meetings of the TWG will be available at the project website currently under construction.

The members of TWG are currently developing in collaboration with other experts and organisations, the following working papers:

- ?? **Regulatory Review** (JRC)
- ?? **Chemicals used in tattoos/piercings** (Norwegian Food Control Authority & CHEMTOX A/S & University Regensburg)
- ?? **Review of health effects and risks** (JRC & University Regensburg & WHO)
- ?? **Policy options:**
 - ?? **Positive & negative list** (Norwegian Food Control Authority)
 - ?? **Risk Assessment** (Dutch Inspectorate for Health Protection)
 - ?? **Authorisation & Registration** (Danish EPA & CHEMTOX A/S)
 - ?? **Education & Skills** (National Consumer Agency, Finland)
 - ?? **Hygiene Practices** (Dutch Inspectorate for Health Protection & GC&GD Amsterdam)
- ?? **Status Report on the current situation, nature and size of the problem in the EU** (JRC)

The draft versions of these working papers will be peer-reviewed by the members of the “**JRC – virtual Regulatory and Scientific/Technical Tattoo/piercing expert network**” and the final texts will be published following their presentation and discussion in a **workshop in 6-7 May 2003 at the premises of the JRC in Ispra, Italy**.

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1. Project Description

Regarding the safety of tattoos and body piercing there are recent concerns expressed by Member States and the European Parliament, in particular because of the health risks involved and the absence of a clear legislative background in the EU and at world scale. In this light, the JRC has been requested by DG SANCO to undertake action with the overall aim to collect and assess all necessary information for establishing a common knowledge basis for the conception of a future legislation at EU level. The main axes are:

- ? ? Take stock of the actual situation in the EU on tattooing and body piercing activities in terms of prevalence
- ? ? Review the regulatory situation on tattooing/body piercing in the EU and elsewhere
- ? ? Review the safety data, epidemiology, of tattooing dyes and pigments, piercing, tattooing/body piercing practices
- ? ? Review the professional aspects (training, requirements, hygiene standards, etc)

The end of the day goal is to assess the need of, and, if appropriate, come up with regulatory proposals to harmonise these activities across the EU. In this undertaking, the JRC and DG SANCO are working together with the Council of Europe, which is preparing a resolution on “permanent make-up and tattooing colours”.

As a first step, a technical working group from experts active in Member States in the above areas was established. The working group is assisting the JRC in the planning of the work, the information exchange/assessment and the review of the deliverables. Two meetings have been held at the JRC, Ispra on December 16th 2002 and in Brussels on January 28th 2003.

In these meetings the members of the TWG reviewed the currently available information and agreed that the currently available policy options are the following:

- provisions on authorisation/registration of the activity
- provisions on skills/education of the practitioners
- provisions on the equipment/space
- provisions on hygienic practices
- provisions on sterility of products/equipment/practices
- request for risk assessment
- introduction of a negative list of substances
- introduction of a positive list of substances

On this basis the JRC is organising a **workshop on “Technical/scientific and regulatory issues on the safety of tattoos, body piercing and of related practices” in Ispra on 6-7 May 2003**. The workshop will have two daily sessions:

- technical/scientific issues on health effects and risks
- regulatory issues and roundtable discussion

Agenda, list of participants and official invitations will be sent by the end of March 2003. For the time being the JRC is inviting experts to express interest in participating in this event.

2. Scope of the present survey

In line with the above overall project objectives, the focus of the present draft working paper is to review the current knowledge on health effects and risks. To this end, we present in this paper the results of our preliminary survey of the existing publications on this subject. Being aware that our current information basis is very limited, we are kindly inviting the recipients of this survey to

- ? ? verify that the information concerning their own publications or activities is interpreted and integrated in the text appropriately**
- ? ? communicate to us detailed scientific information on their current activities**
- ? ? communicate to us about regulatory information and activities by using the attached questionnaire on the regulatory review**
- ? ? communicate to us any missing information whose inclusion in this working paper is important**
- ? ? feel free to comment on any area independent from their own.**

We would appreciate receiving feedback by Friday March 21st 2003 at the latest.

On the basis, the information collection will be completed and JRC will be able to send the **final draft version of the working paper by the end of April 2003 to all experts participating in the “JRC-TattooNet”**. Finally the working paper will be presented in the May workshop and published following the conclusions of this workshop.

3. Review of Health Effects & Risks

3.1. Introduction

Since tattoo compounds in comparison to cosmetics are not officially controlled, the origin and chemical structure of these colouring agents are hardly known, even the tattoo manufacturers do not know which substances are punctured into the skin. There is no disclosure of the ingredients of these colouring agents. A variety of tattoo pigments has been analysed recently^{1, 2, 3}. The results show that pigments are mainly industrial organic pigments with high microbiological and impurities load.

Risk assessment studies for these substances for the intended use of tattooing and piercing are totally missing. The resulting health effects are numerous and to some extent documented as single case reports.

The review of the literature shows that a systematic observation and registration of these effects is widely missing. On the basis of the case reports collected in the literature we organised the present review along the axes:

? ? Infectious Risks

? ? Non-Infectious Risks

Peer review of the information presented and more systematic networking of the scientific society involved will possibly provide the clues for future ways of effectively monitoring the health effects and to adequately support regulatory action.

¹ H.R. Reus; R.D. van Buuren, Inspectorate for Health Protection North, Ministry of Health: Tattoo and Permanent Make-up Colorants. An exploratory examination of: -Chemical and microbiological composition; - Legislation, Report no ND COS 012, November 2001

² Lundsgaard J: Chemtox A/S: Investigation of pigments in tattoo colours, Survey no 2 – 2002, on behalf of the Danish EPA

³ Baeumler W; Eibler ET; Hohenleutner U; Sens B; Saeur J; Landthaler M: Q-switch laser and tattoo pigments: first results of the chemical and photophysical analysis of 41 compounds, *Lasers Surg Med.* 2000;26(1):13-21

3.2. Infectious Risks

3.2.1. Viral infections

Evidence about TTDs (Transfusion-Transmitted-Diseases) that can be transmitted by tattooing has been recently reviewed systematically⁴. According to available studies, there is strong evidence for the transmission of hepatitis B virus (HBV) infection, hepatitis C virus (HCV) infection, and syphilis by tattooing. Tattooing may also transmit the human immunodeficiency virus (HIV). Epidemiological studies to date have shown a large variation in odds ratio estimates of the association between tattooing and HBV, HCV, and HIV infections^{5,6}.

Clinically apparent hepatitis C virus (HCV) infection developed in a prison inmate after two tattooing episodes within the recognised incubation period for HCV infection. Seroconversion and HCV viraemia with subsequent resolution of hepatitis and loss of plasma viraemia were also documented⁷.

A report about the situation in the city of Frankfurt am Main, Germany is covering the period 1995-1999⁸. Studios for tattoos or piercing were informed about hygiene rules and annually controlled from 1995-1999, using a special checklist on cleanliness in the studios, disinfection and sterilisation procedures etc. For permission of tattoo and piercing exhibitions special hygiene orders were made mandatory. During 1995-1997 the absolute number of complaints decreased from 20 to 9, in spite of the increasing number of tattoo studios in Frankfurt am Main (from 6 to 10). This was true also of the tattoo and piercing exhibitions. After 1 year without control visits however, an increase of complaints was to be seen in 1999. A report on the prevention of infectious diseases by the Public Health office of the city of Bremen⁹ has also been published.

Viral transmission (hepatitis B, hepatitis C, hepatitis delta, HIV) is another risk considered by the French study group, which reports that a few cases of fatal fulminant hepatitis have been described immediately after piercing.

⁴ Nishioka Sde A; Gyorkos TW: Tattoos as risk factors for transfusion-transmitted diseases, *Int J Infect Dis* 2001;5(1):27-34

⁵ Nishioka Sde A; Gyorkos TW; Joseph L; Collet JP; Maclean JD: Tattooing and risk for transfusion-transmitted diseases: the role of the type, number and design of the tattoos, and the conditions in which they were performed, *Epidemiol Infect* 2002 Feb;128(1):63-71

⁶ Franz R: Tattooing a major route of hepatitis C infection, *Dermatol Nurs* 2001 Aug;13(4):307-8

⁷ Post JJ; Dolan KA; Whybin LR; Carter IW; Haber PS; Lloyd AR: Acute hepatitis C virus infection in an Australian prison inmate: tattooing as a possible transmission route, *Med J Aust* 2001 Feb 19;174(4):183-4

⁸ Heudorf U; Kutzke G; Seng U: Tattooing and body piercing--experiences from public health infection surveillance by a public health office [Tatowieren und Piercing--Erfahrungen aus der infektionshygienischen Überwachung eines Gesundheitsamtes.] *Gesundheitswesen* 2000 Apr;62(4):219-24

⁹ Zolondek U; Stelling R; Hohmann H: Development of public health regulations for tattooing and piercing and their realization][Entwicklung von Hygieneregeln für das Tatowieren und Piercing und ihre Umsetzung.] *Gesundheitswesen* 1998 Mar;60(3):170-2

In a recent study¹⁰ in the United States risk factors for blood-borne infection were assessed by physician's interview of 626 consecutive patients undergoing medical evaluation for spinal problems in 1991 and 1992 while unaware of their HCV status. Later all were screened for HCV infection with enzyme-linked immunosorbent assay (EIA-1 and EIA-2), and positives were confirmed with second-generation recombinant immunoblot assay (RIBA). Forty-three patients were seropositive for HCV. Logistic regression analysis identified 4 independent risk factors for HCV infection: injection-drug use, ancillary hospital jobs held by men, tattoos from commercial tattoo parlors, and drinking. If causal, these 4 risk factors account for 91% of HCV infections, with tattooing explaining 41%, heavy beer drinking 23%, injection-drug use 17%, and ancillary health care jobs for men 8%. Unlikely to be explained by confounding or incomplete disclosure of other risk factors, tattooing in commercial tattoo parlors may have been responsible for more HCV infections than injection-drug use. In contrast to that, other studies do not provide evidence to support the observation that tattoos serve as a risk factor for chronic viral hepatitis¹¹, and most particularly regarding HCV¹². Moreover, one has to take into mind that the class of population – involved in tattoos – changed within the last five years. Nowadays, not only people with abuse of drugs and alcohol have tattoos. Obviously, there is a need of new studies regarding the infection with hepatitis, in particular in view of new types of hepatitis.

The relationship of viral hepatitis and body piercing has been investigated in twelve research studies published between 1974 and 1997. Eight of them identified¹³ percutaneous exposure, including body piercing and ear piercing, as a risk factor for viral hepatitis. Six studies found⁴ that hepatitis seropositivity was significantly associated with ear piercing.

¹⁰ Haley RW; Fischer RP: Commercial tattooing as a potentially important source of hepatitis C infection. *Clinical epidemiology of 626 consecutive patients unaware of their hepatitis C serologic status*, *Medicine (Baltimore)* 2001;80(2):134-51

¹¹ Silverman AL; Sekhon JS; Saginaw SJ; Wiedbrauk D; Balasubramaniam M; Gordon SC: Tattoo application is not associated with an increased risk for chronic viral Hepatitis, *Am J Gastroenterol* 2000 May;95(5):1312-5

¹² Thompson SC; Goudey RE; Breschkin AM; Carnie J; Catton M: Exposure to hepatitis B and C of tattooists in Victoria in 1984, *J Viral Hepat* 1997 Mar;4(2):135-8

¹³ Hayes MO; Harkness GA: Body piercing as a risk factor for viral hepatitis: an integrative research review, *Am J Infect Control* 2001 Aug;29(4):271-4

3.2.2. Bacterial infections

In France between 10% and 20% of all piercings are reported to lead to a local infection¹⁴. This seems to be consistent with results obtained in the USA¹⁵. The most commonly found causal agents are *Staphylococcus aureus*, group A *Streptococcus* and *Pseudomonas* spp. These germs may eventually cause severe life-threatening complications even in common localizations (earlobe).

Piercing the upper ear can cause infection. Its devastating chondritis leads to collapse of the ear. Five cases referred for autogenous-tissue ear reconstruction are reported¹⁶. In four of them, the destroyed segments of ear cartilage were replaced with a carved costal-cartilage framework. In another study, a man patient, who underwent chest augmentation and nipple piercing, developed chronic nipple infection, which led to unnecessary invasive diagnostic procedures, serious implant infection, and eventually urgent explanation. The study¹⁷ recommends avoiding nipple piercing in men with chest implants. Another study reported¹⁸ three adolescents who developed infections due to anaerobes at pierced body sites: the nipple, the umbilicus and the nasal septum. Anaerobes (*Prevotella intermedia* and *Peptostreptococcus anaerobius*) were recovered from pure culture of specimens obtained from one patient with nipple infection and were mixed with aerobic bacteria in cultures of specimens obtained from two patients (*Streptococcus aureus*, *Peptostreptococcus micros* and *Prevotella melaninogenica* were recovered from a patient with nasal septum infection and *Bacteroides fragilis* and *Enterococcus faecalis* were recovered from a patient with umbilical infection). The infection resolved in all patients after removal of the ornaments and use of antimicrobial drug treatment.

Reported infectious cases related to tattooing are of endocarditis caused by repeated tattooing in an individual with known valvar heart disease¹⁹, candida endophthalmitis after tattooing in an asplenic patient²⁰.

Piercing has also been correlated with endocarditis. The case of a 24-year-old man in whom coarctation of the aorta had been corrected 15 years earlier has been reported²¹.

¹⁴ Guiard-Schmid JB; Picard H; Slama L; Maslo C; Amiel C; Pialoux G; Lebrette MG; Rozenbaum W: [Piercing and its infectious complications. A public health issue in France] [Le piercing et ses complications infectieuses. Un enjeu de sante publique en France.] *Presse Med* 2000 Nov 18;29(35):1948-56

¹⁵ Braithwaite R.L. et al.: Risks associated with tattooing and body piercing, *J. Public Health Policy*, 1999; 20: 459-70

¹⁶ Cicchetti S; Skillman J; Gault DT: Piercing the upper ear: a simple infection, a difficult reconstruction, *Br J Plast Surg* 2002 Apr;55(3):194-7

¹⁷ de Kleer N; Cohen M; Semple J; Simor A; Antonyshyn, O: Nipple piercing may be contraindicated in male patients with chest implants, *Ann Plast Surg* 2001 Aug;47(2):188-90

¹⁸ Brook I: Recovery of anaerobic bacteria from 3 patients with infection at a pierced body site, *Clin Infect Dis* 2001 Jul 1;33(1):e12-3

¹⁹ Satchithananda DK; Walsh J; Schofield PM: Bacterial endocarditis following repeated tattooing, *Heart* 2001 Jan;85(1):11-2

²⁰ Alexandridou A; Reginald AY; Stavrou P; Kirkby GR: Candida endophthalmitis after tattooing in an asplenic patient, *Arch Ophthalmol* 2002 Apr;120(4):518-9

Two months after piercing his left nipple without antibiotic prophylaxis, he developed a local mastitis, followed by bacterial endocarditis that required replacement of the aortic valve. Another case study²² of a 25 years old man with congenital heart disease suggests that *H. aphrophilus* endocarditis was possibly caused by tongue piercing.

²¹ Ochsenfahrt C; Friedl R; Hannekum A; Schumacher BA: Endocarditis after nipple piercing in a patient with a bicuspid aortic valve, *Ann Thorac Surg* 2001 Apr;71(4):1365-6

²² Akhondi H; Rahindi AR: *Haemophilus aphrophilus* Endocarditis after Tongue piercing, *Emerging Infectious Diseases* [serial online] August 2002, www.cdc.gov/ncidod/EID/vol8no8/01-0458.htm

3.3. Non-Infectious Risks

A recent review²³ of the English literature provides a quick reference to tattoo reactions. Generally, the pigments used for tattooing seem to be well tolerated by the skin. Nevertheless, adverse reactions have been published in the literature, which might be arranged in three main classes of tattoo-associated dermatoses: allergic/ granulomatous /lichenoid, inoculation/infection, and coincidental lesions. However, it is very likely, that a great number of skin reactions on tattoos is not reported.

3.3.1. Allergic Reactions

There are several cases reported in the literature regarding tattoo and allergy, which state that cutaneous allergic reactions to pigments in tattoos are not infrequent.

A) A case of an allergic reaction to India ink in a black tattoo is described²⁴.

B) A case of urticaria in a tattooed patient due to hypersensitivity to the cobalt chloride contained in the blue ink used for tattoo has been reported. The patch test with the series of International Contact Dermatitis Research Group was positive only for cobalt chloride. Cobalt chloride is believed to be responsible for contact urticaria through a non-immunological mechanism²⁵.

C) A 42-year-old man presented with an allergic reaction in the red parts of his tattoos. Histologically a chronic granulomatous, partly fibrous inflammation with transfollicular elimination of pigment granules was found. Spontaneous regression in a part of the inflammatory reaction was observed, simultaneously with depigmentation and scarring of the overlying skin. The pigment used for tattooing was found to be an aromatic azo derivative. In addition to a positive cutaneous reaction to the dye, the patient also showed a positive patch test to Naphthol AS, used for the coupling of different dyes in the textile industry²⁶.

An investigation²⁷ on nickel allergy from piercing was carried out in Denmark between March 1999 and March 2000 involving 427 girls in public schools (mean age 12.4 years, range 10-14) and 534 girls in high schools (mean age 18.8 years, range 17-22). They all filled out a questionnaire concerning ear piercing, use of oral braces and former patch testing for nickel sensitivity. 305 girls (71.4%) in public schools and 275 girls (51.5%) in high schools/production schools were patch tested. 17.1% of girls in high schools

²³ Jacob CI: Tattoo-associated dermatoses: a case report and review of the literature, *Dermatol Surg* 2002 Oct;28(10):962-5

²⁴ Gallo R; Parodi A; Cozzani E; Guarrera M: Allergic reaction to India ink in a black tattoo, *Contact Dermatitis* 1998 Jun;38(6):346-7

²⁵ Bagnato GF; De Pasquale R; Giacobbe O; Chirico G; Ricciardi L; Gangemi S; Purello d'Ambrosio F: Urticaria in a tattooed patient, *Allergol Immunopathol (Madr)* 1999 Jan-Feb;27(1):32-3

²⁶ Waldmann I; Vakilzadeh F: Delayed type allergic reaction to red azo dye in tattooing, *Hautarzt*. 1997 Sep;48(9):666-70

²⁷ Jensen CS; Lisby S; Baadsgaard O; Volund A; Menne T: Decrease in nickel sensitisation in a Danish schoolgirl population where ears pierced after implementation of a nickel-exposure regulatin, *Br J Dermatol* 2002 Apr;146(4):636-42

demonstrated a positive patch test reaction to nickel. In contrast, the prevalence of nickel sensitization in the public schools was only 3.9%. Comparing girls with and without pierced ears, the prevalence of nickel sensitization was significantly higher in girls with ears pierced before, but not after 1992 (odds ratio 3.34 and 1.20 respectively). The study concluded that implementation of the nickel-exposure regulation in 1992 in Denmark protected the female population from becoming allergic to nickel.

3.3.2. Granulomatous/lichenoid reactions

In most cases the reactions are reported to be caused by different red pigments. While in the past these reactions have been ascribed to mercury salts (cinnabar) and cadmium sulphide, now synthetic inorganic azo dyes have also been found to be responsible for such reactions.

A) A case on a potential etiologic role of nickel was published²⁸.

B) On the effects of azo dyes a case report²⁹ describes allergic reactions in the red parts of tattoos of a 42-year-old male. Histologically a chronic granulomatous, partly fibrous inflammation with transfollicular elimination of pigment granules was found. Spontaneous regression in a part of the inflammatory reaction was observed, simultaneously with depigmentation and scarring of the overlying skin. The pigment used for tattooing was found to be an aromatic azo derivative. In addition to a positive cutaneous reaction to the dye, the patient also showed a positive patch test to Naphthol AS, used for the coupling of different dyes in the textile industry.

3.3.3. PseudoLymphomas

In a review article³⁰ in the Journal of the American Society of Dermatology the generation of pseudolymphomas by tattoos is listed as tattoo-induced lymphocytoma cutis. Additionally, there are several case reports:

A) Three cases with pseudolymphomatous hypersensitivity reaction to tattoo pigment are described³¹. One of the cases showed histological features of Spiegler-Fendt pseudolymphoma. Awareness of this type of reaction to tattoo pigment can help prevent erroneous diagnosis of lymphoma. Several published reports are cited in which pseudolymphomatous reaction to tattoo pigment was erroneously diagnosed as lymphoma.

B) A 35-year-old patient developed swellings in the red colored areas of his tattoo indicating a lichenoid pseudolymphomatous tattooing reaction³². Histological examination revealed a lichenoid, pseudolymphomatous infiltrative pattern that could be distinguished

²⁸ Corazza M; Zampino MR; Montanari A; Pagnoni A; Virgili A: Lichenoid reaction from a permanent red tattoo: has nickel a possible aetiologic role?, *Contact Dermatitis* 2002 Feb;46(2):114-5

²⁹ Waldmann I; Vakilzadeh F: [Delayed type allergic reaction to red azo dye in tattooing] [Allergische Spätreaktion auf roten Azofarbstoff in Tätowierungen.], *Hautarzt* 1997 Sep;48(9):666-70

³⁰ Ploysangam T; Breneman DL; Mutasim DF: Cutaneous pseudolymphomas, *J Am Acad Dermatol* 1998 Jun;38(6 Pt 1):877-95; quiz 896-7. Review

³¹ Blumental G; Okun MR; Ponitch JA: Pseudolymphomatous reaction to tattoos. Report of three cases, *J Am Acad Dermatol* 1982 Apr;6(4 Pt 1):485-8

³² Amann U; Luger TA; Metze D: Lichenoid pseudolymphomatous tattooing reaction, *Hautarzt* 1997 Jun;48(6):410-3

from frank lymphoma by means of electron microscopy, immunohistochemistry and molecular biology. The presence of dermal dendritic cells suggests a dermal-allergic pathogenesis of non-granulomatous tattoo reactions. Therapy of choice is an excision of the inflamed areas.

3.3.4. Lymphadenopathy

The case of a left inguinal lymph node enlargement in a young man has been reported. A tattoo was present in close proximity to the lymph node and had preceded its enlargement by several years. The lymph node was removed surgically, and pathologic examination showed it to contain dark pigment material characteristic of a tattoo. The clinical significance of this finding was analysed, and the relationship of tattoo lymphadenopathy to inflammatory skin reactions and to dermatopathic lymphadenopathy was considered³³.

3.3.5. Sarcoidosis

Sarcoidosis is an idiopathic granulomatous disease with many cutaneous manifestations and a known predilection for scars and areas of previous trauma. Immune alterations involving heightened T-helper-1 responses have been proposed to play a major role in the pathogenesis of sarcoidosis. In the literature there are several cases reported which were caused by tattoos.

A) A patient with sarcoidosis who presented with a granulomatous tattoo reaction is described. Although tattoo granulomata usually represent a local hypersensitivity reaction to tattoo pigments, they can be a manifestation of systemic sarcoidosis. In this case the lesions were confined to the red areas of tattoos suggesting that tattoo sarcoid may be more than just an example of the Koebner response³⁴.

B) A first case of systemic sarcoidosis presenting in only the black dye of a tattoo is reported. The skin manifestations of sarcoidosis and the histological differential diagnosis of granulomas are reviewed³⁵.

C) A 42-year-old white female with hepatitis C, who developed systemic sarcoidosis shortly after therapy with IFN-alpha2b. The disease was heralded by the appearance of a cutaneous sarcoid/ foreign body granulomatous reaction at the site of an old tattoo. The sarcoidosis responded to a short course of oral prednisone therapy. We also reviewed the other reported cases and discussed the possible immunological mechanisms involved³⁶.

³³ Zirkin HJ; Avinoach I; Edelwitz P: A tattoo and localized lymphadenopathy: a case report, *Cutis* 2001 Jun;67(6):471-2

³⁴ Sowden JM; Cartwright PH; Smith AG; Hiley C; Slater DN: Sarcoidosis presenting with a granulomatous reaction confined to red tattoos, *Clin. Exp. Dermatol.* 1992; 17:446-448

³⁵ Jones MS; Maloney ME; Helm KF: Systemic sarcoidosis presenting in the black dye of a tattoo, *Cutis* 1997; 59:113-115

³⁶ Nawras A; Alsolaiman MM; Mehboob S; Bartholomew C; Maliakkal B: Systemic sarcoidosis presenting as a granulomatous tattoo reaction secondary to interferon-alpha treatment for chronic hepatitis C and review of the literature, *Dig Dis Sci* 2002 Jul;47(7):1627-31

D) A patient presenting with nodules in his tattoos was referred for laser treatment, following which there was a diagnosis of cutaneous and pulmonary sarcoidosis. Nodular change involving several different tattoo colours is characteristic of sarcoidosis³⁷.

E) A 29-year-old Caucasian man who developed cutaneous sarcoidosis manifesting itself as a tumour at the left outer canthus clinically mimicking a basal cell carcinoma and nine tattoo granulomas was described. Subsequent investigation revealed that the patient was also suffering from systemic sarcoidosis³⁸.

3.3.6. Malignant Lesions

Several malignant lesions have occurred in tattoos, possibly coincidental, including basal cell carcinomas, squamous cell carcinomas and malignant melanomas.

3.3.6.1. Melanoma

Malignant melanoma has been reported to occur in vaccination scars, in tattoos and in tattoo sites used for radiotherapy fields marking.

A) Mercury-cadmium pigment used in tattooing has been suggested to give a photo-allergic reaction due to the red pigment and to be a factor in the development of melanoma³⁹.

B) According to a 1997 study⁴⁰ seven documented cases of malignant melanoma occurring in tattoos were previously reported in the English literature.

C) Another study describes the eighth case of a patient with malignant melanoma in a tattoo⁴¹. One, a 47-year male, had a four-year history of a “mole” in a multicoloured tattoo in his abdomen. This lesion had appeared 16 years after the placement of the tattoo and had doubled in size in the last 2 years. The tumour was classified as a Clark’s level III superficial spreading malignant melanoma with a Breslow thickness of 0.75 mm.

D) Another study describing a case of patient with malignant melanoma in a tattoo was published in 1997⁴². The colours of the tattoo in the forearm of a 44-year-old male were dark blue and black. The patient had not been aware of any lesion on his forearm prior to the tattoo and only noticed 25 years later a change when the tumour started to ulcerate and extend outside the tattoo boundaries. Histology confirmed a Breslow thickness of 0.9 mm malignant melanoma.

³⁷ Tran D; Ashton RE; Cotterill JA: Sarcoidosis presenting as tattoo granuloma inadvertently treated with laser therapy, *J Cutan Laser Ther* 2000 Mar;2(1):41-3

³⁸ Papageorgiou PP; Hongcharu W; Chu AC: Systemic sarcoidosis presenting with multiple tattoo granulomas and an extra-tattoo cutaneous granuloma, *J Eur Acad Dermatol Venereol* 1999 Jan;12(1):51-3

³⁹ Wolfort et al.: Superficial Melanoma in a tattoo, *Br. J. Plast Surg.* 1974, 27: 303-4

⁴⁰ Soroush V; Gurevitch AW; Peng SK: Malignant melanoma in a tattoo: case report and review of the literature, *Cutis* 1997 Mar;59(3):111-2

⁴¹ Soroush V; Gurevitch AW; Peng SK: Malignant melanoma in a tattoo: case report and review of the literature, *Cutis* 1997 Mar;59(3):111-2

⁴² Khan IU; Moiemmen NS; Firth J; Frame JD: Malignant melanoma disguised by a tattoo, *Br J Plast Surg* 1999 Oct;52(7):598

E) Several reports describe cases of tattoo pigment masquerading as secondary malignant melanoma^{43,44,45}. In all these cases tattoo pigments migration through lymphatic drainage was initially considered as evidence of metastatic tumours.

3.3.6.2. *Non melanoma skin cancer*

A) Basal cell carcinomas arising in tattoos have been reported previously in four patients. The fifth reported case of a basal cell carcinoma arising in a tattoo that was at a site not frequently exposed to ultraviolet radiation and briefly review malignancy in tattoos⁴⁶.

B) Another case is reported about a Squamous-cell carcinoma arising in a tattoo⁴⁷.

3.3.7. **Other skin diseases**

3.3.7.1. *Psoriasis*

Case reports provide indication of tattoo reactions on disorders, such psoriasis, which are known to exhibit the Koebner response^{48,49}.

3.3.8. **Transport of tattoo pigments and admixtures in the body**

It is known that part of the colouring agents and its admixtures is transported into the body, at least to the lymph nodes. Since blood vessels are harmed during the tattoo process, part of the colouring agents can also be distributed in the human body by blood vessel system. Unfortunately, to what extent other organs are involved, is still unknown.

So far, there are some reports on tattoo pigments in lymph nodes.

A) A 42-year-old man with metastasizing melanoma from an unknown primary is presented. Initially a subcutaneous metastasis in the scapular region and a single lung metastasis were resected. Thorough examinations did not show any evidence of a primary tumour. From the site of the metastasis on the right scapular region, lymphoscintigraphy with axillary sentinel lymph node biopsy was performed. One axillary lymph node could be identified intra-operatively with the gamma probe as sentinel node. The sentinel node and 4 adjacent lymph nodes clinically showed black pigmentation. However, histopathological examination of the lymph nodes did not detect micrometastases. The pigmentation of the lymph nodes was due to decorative tattoos of the scapular skin⁵⁰.

⁴³ Hannah H; Falder S; Steele PR; Dhital SK: Tattoo pigment masquerading as secondary malignant melanoma, Br J Plast Surg 2000 Jun;53(4):359

⁴⁴ Moehrle M; Blaheta HJ; Ruck P: Tattoo pigment mimics positive sentinel lymph node in melanoma, Dermatology 2001;203(4):342-4

⁴⁵ Anderson LL; Cardone JS; McCollough ML; Grabski WJ: Tattoo pigment mimicking metastatic malignant melanoma, Dermatol Surg 1996 Jan;22(1):92-4

⁴⁶ Wiener DA; Scher RK: Basal cell carcinoma arising in a tattoo, Cutis 1987 Feb;39(2):125-6

⁴⁷ McQuarrie DG: Squamous-cell carcinoma arising in a tattoo, Minn. Med. 1966 49,799-801

⁴⁸ Jacob CI: Tattoo-associated dermatoses: a case report and review of the literature, Dermatol Surg 2002 Oct;28(10):962-5

⁴⁹ Punzi L; Rizzi E; Pianon M; Rossini P; Gambari PF: Tattooing-induced psoriasis and psoriatic arthritis, Br J Rheumatol 1997 Oct;36(10):1133-4

⁵⁰ Moehrle M; Blaheta HJ; Ruck P: Tattoo pigment mimics positive sentinel lymph node in melanoma, Dermatology 2001;203(4):342-4.

B) The benefits of elective lymph node dissection (ELND) in the treatment of melanoma remain controversial, however, it may be beneficial in some patients. Tattoo pigment from decorative tattoos may migrate to the regional lymph nodes. In patients who develop malignant melanoma and who have been tattooed, this pigment may clinically mimic metastatic disease. ELND for malignant melanoma, in a patient with a history of decorative tattoos that had been removed by dermabrasion, was performed in a recent study⁵¹. Black lymph nodes that clinically resembled metastatic disease were identified. Subsequent histological examination revealed normal lymph node architecture with a heavy collection of black pigment. Mass spectrophotometry showed this pigment to be consistent with tattoo dye. A patient who had undergone dermabrasion for removal of decorative tattoos developed malignant melanoma in the same extremity. Clinically suspicious black lymph nodes were identified during ELND. Histological examination did not reveal metastatic disease. Additional therapy was not considered intra- or postoperatively even though the clinical suspicion of metastatic disease was high. The patient was not subjected to any unnecessary emotional or physical distress pending histological confirmation. Tattoo pigment in the lymph nodes may clinically mimic metastatic melanoma. Histological confirmation of metastatic disease should always be obtained before additional therapy is considered.

3.3.9. Risks of the laser treatment of tattoos

The absorption of the light pulses in the tattoo pigments is the first and important step to tattoo removal using Q-switched lasers. The absorbed energy is converted to heat (photothermal effect) or breaks chemical bonds inside the pigment (photochemical effects). After the ultrashort heating of the pigment surface shock wave are induced leading to a mechanical destruction of the pigments. As a response, a multitude of mechanisms may occur at the same time. Large aggregates and agglomerates break down into smaller crystals. Particles pulverize and form a solution of pigment molecules. Molecules can break up, resulting in decomposition products or molecular structure change. Due to fragmentation of the tattoo pigments, small pigment particles, unknown decomposition products and newly generated chemical compounds may be then removed from the skin via blood vessels or the lymphatic system. On the other hand, the pigments remaining in the skin may exhibit different chemical characteristics as compared to non-irradiated pigments. Thus, there might be again a reaction of the immune system. Moreover, it was shown that cancerogenic amines are generated by a laser-induced cleavage of azo-dyes⁵².

3.3.9.1. Allergy

As described above the laser treatment induce old/new chemical compounds in the skin leading to allergic reactions.

⁵¹ Anderson LL; Cardone JS; McCollough ML; Grabski WJ: Tattoo pigment mimicking metastatic malignant melanoma, *Dermatol Surg.* 1996 Jan;22(1):92-4

⁵² Baeumler et al.: *Lasers in Surgery and Medicine*, Volume 30, Issue S14, 2002

A) Cinnabar (mercuric sulfide) is the most common cause of allergic reactions in tattoos and is probably related to a cell-mediated (delayed) hypersensitivity reaction. The purpose of these case presentations is to describe a previously unreported complication of tattoo removal with two Q-switched lasers. Two patients without prior histories of skin disease experienced localized as well as widespread allergic reactions after treatment of their tattoos with two Q-switched lasers. The Q-switched ruby and neodymium:yttrium-aluminum-garnet lasers target intracellular tattoo pigment, causing rapid thermal expansion that fragments pigment-containing cells and causes the pigment to become extracellular. This extracellular pigment is then recognized by the immune system as foreign⁵³.

B) A first reported case of an immediate cutaneous reaction to Q-switched laser tattoo removal was published recently⁵⁴. A 26-year-old female presented with two 6-year-old tattoos placed at different times. These were of different colours and had remained entirely asymptomatic since placement. There was a Mardi Gras mask on her thigh and a Tasmanian devil on her chest. With laser treatment of the Tasmanian devil, she experienced no untoward effects. However, with treatment of the Mardi Gras mask tattoo, she developed an extensive urticarial and indurated reaction 30 minutes posttreatment. The identical reaction occurred twice with subsequent laser treatments. Dermatology consulted allergy to provide prophylaxis against possible systemic reaction with subsequent Nd:YAG laser therapy. The patient was treated with 3 days of prednisone, cetirizine, and ranitidine before subsequent laser treatments.

3.3.9.2. Transport

It is obvious, that after laser treatment the transport of pigment particles through the body is newly started. Moreover, chemically altered molecules (e.g. cancerogenic amines) are transported through the body. Comparable to the situation before laser treatment, there are no investigations on this issue.

3.3.9.3. Others

A) According to a recent study in the USA⁵⁵ computer simulations carried out in this study suggest that the breakup of tattoo particles is photoacoustic. Tissue surrounding the tattoo particles can be damaged by cavitation bubbles.

B) According to a UK study⁵⁶ the Nd:YAG laser effectively removes or lightens amateur and professional tattoos. This study examined biopsies obtained from 35 amateur and professional tattoos (including coloured tattoos), treated on three or more occasions with

⁵³ Ashinoff R; Levine VJ; Soter NA: Allergic reactions to tattoo pigment after laser treatment, *Dermatol Surg* 1995 Apr;21(4):291-4

⁵⁴ England RW; Vogel P; Hagan L: Immediate cutaneous hypersensitivity after treatment of tattoo with Nd:YAG laser: a case report and review of the literature, *Ann Allergy Asthma Immunol* 2002 Aug;89(2):215-7

⁵⁵ Ho DD; London R; Zimmerman GB; Young DA: Laser-tattoo removal--a study of the mechanism and the optimal treatment strategy via computer simulations, *Lasers Surg Med* 2002;30(5):389-97

⁵⁶ Ferguson JE; Andrew SM; Jones CJ; August PJ: The Q-switched neodymium:YAG laser and tattoos: a microscopic analysis of laser-tattoo interactions, *Br J Dermatol* 1997 Sep;137(3):405-10

the Nd:YAG laser. Biopsies taken immediately after laser treatment showed vacuolation with complete clearance of tattoo particles in the most superficial layers of the dermis, as assessed by light and electron microscopy. The study proposes that the 'disappearance' of the tattoo particle arises from the formation of atomic species and gaseous products, which are rapidly dissolved in the extracellular fluid. Residual fragmented particles that are commonly found in the mid- and lower dermis are rephagocytosed. The interaction between the Nd:YAG laser and black tattoo particles at 1064 nm, and red tattoo particles at 532 nm, appears to be specific, as there was little evidence of thermal damage to adjacent cells or stromal collagen.

C) Particulate matter incorporated into the skin of former miners was compared to ornamental tattoos with regard to composition and cutaneous reaction pattern. The specimens were examined histologically and immunohistochemically followed by scanning electron microscopy and element analysis. In the skin biopsies containing dirt particles, silicon and aluminium were regularly found and the particles were positively birefringent under the light microscope. Even years after the initial foreign particle incorporation strong reactions against quartz-containing substances deposited perivascularly and perifollicularly continued to take place. Reactions ranged from strong macrophage activation to pre-granulomatous changes. Anthracotic pigment was demonstrated in all layers of the dermis depending on the degree of traumatic insult and the colour pigments of the ornamental tattoos showed variable spectra of elements depending on the type of dye used. Fibrous reactions were only discrete, however, strong macrophage activation and sometimes capillary proliferation as well as non-specific lymphocytic infiltration could still be confirmed even decades after the initial incorporation. In conclusion, the cutaneous incorporation of ornamental tattoo dyes and accidental dirt particles is not an inert process. Even years later, non-specific macrophage activation as well as discrete inflammatory changes in an attempt to degrade the foreign material can still be documented. A clear correlation between subcutaneous incorporated quartz particles and progressive systemic sclerosis was not found in this study⁵⁷.

4. Conclusions

Text to be written after the 21st of March, taking into account the feedback and recommendations of the "JRC-TattooNet"

⁵⁷ Muller KM; Schmitz I; Hupe-Norenberg L: Reaction patterns to cutaneous particulate and ornamental tattoos, Pathologie 2002 Jan;23(1):46-53