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# Tattoo and vaccination sites: Possible nest for opportunistic infections, tumors, and dysimmune reactions

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**Abstract** Tattoos have gained worldwide popularity in recent years, and vaccinations are universal preventive measures designed to minimize morbidity associated with specific pathogens. Both dermal tattoos and vaccine injections may alter local immune responses, creating an immunocompromised district on or near the site of placement. This can lead to the development of opportunistic infections, benign and malignant tumors, and local dysimmune reactions.

With regard to tattoos, a predominance of warts among a variety of opportunistic infections has been reported. These warts appear to result from a local immune dysregulation rather than from direct inoculation or coincidence. A variety of tumors including basal and squamous cell carcinomas, keratoacanthomas, and malignant melanoma also have been reported in association with tattoos. Granulomatous, lichenoid, and pseudolymphomatous reactions represent the most common dysimmune reactions.

Vaccination sites similarly provide a setting for both benign and malignant tumors. Frequent reports of dermatofibrosarcoma protuberans would be unlikely to result from coincidence. Granuloma annulare and pseudolymphomatous reactions are relatively common dysimmune reactions.


## Introduction

The injection of foreign material under the skin has become ubiquitous. Tattoos are increasingly popular in recent years, especially among young people.[1] Vaccinations are universal measures that provide protection by stimulating the immune system to develop adaptive immunity to a particular pathogen. In both circumstances, local destabilization of immune control associated with tattoo pigment or the vaccine can produce an immunocompromised district associated with localized cutaneous disease.[2,3] These conditions include opportunistic infections, benign and malignant skin tumors, and local dysimmune reactions. Although these cutaneous reactions from tattoos and vaccinations are not common, they provide important clues about immune function.

## Tattoos

Traditionally, tattoo inks were composed of both salts and inorganic heavy metals such as mercury (cinnabar), cobalt, cadmium, or manganese.[4–6] More recently, tattoo inks that contain azo and polycyclic pigments are more widely used. None of these products has been adequately studied to determine whether they are safe for use in humans.[5] A group of organic red inks, Naphthol-AS pigments, contain azo pigments and were most commonly reported to cause

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cutaneous complications; however, recent studies suggest that most cutaneous complaints are associated with black amorphous carbon pigments, followed by red pigments.[1,6]

Tattoo pigments residing in the dermis can initiate an altered immune response at the site of tattoo, which may produce an immunocompromised district. The presence of decomposed pigments from tattoos within lymph nodes may explain the occurrence of immunocompromised districts proximal to tattoo sites.[5]

## Opportunistic infections

### Verruca

The earliest case of verruca vulgaris on tattooed skin was described in 1884.[7] Since then, a number of cases of verruca vulgaris and verruca plana have been reported within the outlines of both permanent and semipermanent tattoos.[5,7–10] A healthy 39-year-old woman experienced development of verruca plana on areas of semipermanent tattoo located on her eyebrow and eyeline 2 years after tattoo placement.[10] Similarly, a 33-year-old man presented with a 2-year history of 120 skin-colored, acuminate warts localized within the 15 × 12-cm area of his lion tattoo (Figure 1). Most of the papules were present in black dye, not in areas of red dye or surrounding normal skin.[8]

It is unlikely the ink injected into the dermis would lead to human papillomavirus (HPV) infection in the epidermis. In addition, the long latency period before manifestation of flat warts suggests that the HPV was not inoculated at the time the tattoo was placed. More likely, the HPV contracted incidentally grew preferentially within the immunocompromised district where local immunity was suppressed by carbon pigment.

**Fig. 1** Pinpoint to 1-mm diameter skin-colored, acuminate papules localized within 15 × 12-cm area on lion tattoo. (Reprinted from Figure 1 in Miller and Brodell[8] with permission from Journal of the American Medical Association.).

## Other infections

A review of the literature pertaining to skin infections on or around tattoos from 1991-2011 revealed 151 total cases, including viral warts, community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA), leprosy, Molluscum contagiosum, superficial fungus infections, and nontuberculous mycobacteria.[5] Many of these infections likely result from direct inoculation of the infectious agent because tattoo dyes are often contaminated. Many tattoos are placed by amateurs who may not abide by sterile technique.

Like the HPV cases reviewed earlier, Molluscum contagiosum and superficial fungus infections cannot survive in the dermis where tattoo dye is injected. It is more likely that these infections occur at the sites of tattoos as a result of local immune dysregulation rather than direct inoculation or coincidence.[5,7,11,12]

## Tumors

The majority of cases with tumor development arising on tattoos have been malignant because common benign tumors are rarely reported.[5] A literature search from 1991-2011 for malignant tumors on tattoos yielded 33 total cases, including malignant melanoma (MM), basal cell carcinoma (BCC), and squamous cell carcinoma (SCC), among others.[5] The first case of MM on a tattoo was described in 1969, and an additional eight cases have been reported from 1991-2011.[5,7,13] BCC within a tattoo has been reported in skin not exposed to the sun or radiation therapy.[7] In another case, a 58-year-old man experienced development of periungual BCC on the thumb at the site of repeated trauma and exposure to azo pigment from fishing bait colorant.[14] It was postulated that azo pigment decomposed to carcinogenic products when exposed to light. Finally, a case of eruptive keratoacanthomas (KA) arising in a permanent tattoo has been reported.[15] Histopathologic examination showed tattoo pigment in association with the KA in the superficial dermis.[15] The KAs were located only within this tattoo with an absence of lesions elsewhere.

The causative basis for these occurrences could be related to the initial trauma of the tattoo producing a chronic scar. Chronic scars whether associated with burns, lichen planus, discoid lupus erythematosus, or trauma can be etiologically related to skin cancers by producing an immunocompromised district within the scar itself.[16–19] Most tattoos, however, are associated with no visible scarring. The tattoo pigment itself could represent a carcinogen leading to tumor initiation or could chronically suppress immune reactions within an immunocompromised district.[7]

## Dysimmune reactions

The degree to which tattoo dyes can cause dysimmune reactions is highlighted by cinnabar or red dye tattoo allergies. For instance, the red dye in a spider web tattoo became inflamed