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Unavoidable Health Menaces of Tattoo Inks

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Abstract:

A tattoo is a permanent mark or design made on your skin with pigments inserted through pricks into the skin's top layer. Typically, the tattoo artist uses a hand-held machine that acts much like a sewing machine, with one or more needles piercing the skin repeatedly. With every puncture, the needles insert tiny ink droplets. The process — which is done without anesthetics — causes a small amount of bleeding and slight to potentially significant pain.

Tattoos breach the skin, which means that skin infections and other complications are possible, including:

- **Allergic reactions.** Tattoo dyes — especially red, green, yellow and blue dyes — can cause allergic skin reactions, such as an itchy rash at the tattoo site. This can occur even years after you get the tattoo.
- **Skin infections.** A skin infection is possible after tattooing.
- **Other skin problems.** Sometimes an area of inflammation called a granuloma can form around tattoo ink. Tattooing also can lead to keloids — raised areas caused by an overgrowth of scar tissue.
- **Bloodborne diseases.** If the equipment used to create your tattoo is contaminated with infected blood, you can contract various bloodborne diseases — including methicillin-resistant Staphylococcus aureus (MRSA), hepatitis B and hepatitis C.
- **MRI complications.** Rarely, tattoos or permanent makeup might cause swelling or burning in the affected areas during magnetic resonance imaging (MRI) exams. In some cases, tattoo pigments can interfere with the quality of the image.

Medication or other treatment might be needed if you experience an allergic reaction to the tattoo ink or you develop an infection or other skin problem near a tattoo.

Keywords: Pigments, Allergic reaction, Skin infection, Bloodborne disease.

Introduction:

From elaborate designs and sports team badges to the names of loved ones, tattoos come in all shapes and sizes. Their popularity has increased in the past 20 years. In recent decades, large parts of the Western world have undergone a broad change, and attitudes towards tattoos have become notably more pronounced. Initiators of this trend are particularly persons with tattoos who are in the public eye, such as actors, musicians, and sports personalities/athletes. In recent years tattooing has become popular in almost every country among every race of people. Tattoo inks contain generally one or more colorants (pigments) as well as co-formulants such as, e.g. binders (usually barium sulphate), additives substances loosely bound to the pigment in order to enhance the colors and properties of the pigment, and solvents (usually ethanol and isopropanol). In addition, the finished tattoo inks may also contain chemical impurities. [1]. As widely used tattoo inks formulations contain different chemicals which are hazardous and toxic when penetrates into the body. In 2011, in a study in *The British Journalof Dermatology,* investigators reported the discovery that nanoparticles are found in tattoo inks.[2] Nanoparticles are ultramicroscopic, making them able to penetrate through skin layers into underlying blood vessels and then travel with the bloodstream. Evidence suggests that some of these nanoparticles might induce toxic effects in the brain and cause nerve damage. Some of these nanoparticles might also be carcinogenic.

As skin allergies and mild reactions are very common with tattoos but still the chronic toxicological and hazardous effects of the substances penetrating the skin need more concern because in most of the countries there are no government regulations and recommendations have been set for the composition of tattoo inks. Sometimes most of the tattoo inks are manufactured locally by the tattoo artists and safety measures are usually avoided. Therefore the main objective of the study is to create cognizance about common effects of tattooing on health and toxic nature of chemical substances being used in the inks [3].

Jungmann et al. [2] described a severe systemic reaction that occurred some 5 hours after a tattoo had been applied. It started with a swelling in the area of the tattoo and ended with the patient admitted to the emergency room with systemic grade 3 anaphylaxis. Such severe disease courses have been described in the specialist medical literature in very rare instances. Notably more common, and equally as impairing, are local reactions in the area of the tattoo, which may also trigger scattered reactions, especially in areas where red tattoo inks were used. Therapy of such localized reactions can be tedious and, in some cases, excision is the only option [4].

Chemical Composition of Tattoo Inks:

A very rare data is available about the detail chemical composition of tattoo ink. As chromophore in tattoo inks consist of organic colorants and a wide range of metal salts. There are different colours of tattoo inks with different chemical composition of which the few have described below (Table 1).

Table 1: Composition of Tattoo Pigments

Composition of Tattoo Pigments			
Color	**Material**	**Comment**	**Adverse Effects**
Black	Iron Oxide (FeO)Carbon	Natural black pigment is made from magnetite crystals, powdered jet, wustite, bone black, and amorphous carbon from combustion (soot). Black pigment is commonly made into India ink	discoloration of the eyes, siderosis, and pneumoconiosis
Brown	Ochre	Ochre is composed of iron (ferric) oxides mixed with clay. Raw ochre is yellowish. When dehydrated through heating, ochre changes to a reddish color.	risk of lung cancer
Red	Cadmium Red (CdSe)Iron Oxide (Fe2O3)Napthol-	Iron oxide is also known as common rust. cadmium pigments are highly toxic. Napthol reds are	kidney and liver afflictions, respiratory problems

	AS pigment	synthesized from Naptha. Fewer reactions have been reported with naphthol red than the other pigments, but all reds carry risks of allergic or other reactions.	
Yellow	Cadmium Yellow (CdS, CdZnS)Curcuma YellowChrome Yellow (PbCrO4, often mixed with PbS)	Curcuma is derived from plants of the ginger family; aka tumeric or curcurmin. Reactions are commonly associated with yellow pigments, in part because more pigment is needed to achieve a bright color.	Risk of skin cancer, irritation, redness, and swelling

Source: (Athar & Sameena,2019)

How Tattoo Ink Penetrates Skin:

Solid needles are used to deposit ink into the deep layer of the skin. The body recognizes tattoo pigments as foreign particles and tries to clear them from the skin, but the chemistry of the ink used in tattoos makes this process quite difficult for the body. Hence, most of the color stays in the skin. The tattoo needle punctures the skin around 100 times per second, with the aim of depositing the ink in a region of 1.5 to 2 millimeters below the surface of the skin. The reason for this depth of penetration is to bypass the outer layer of the skin, or the epidermis. This part of the skin constantly renews itself. Every day, thousands of epidermal cells are shed from the skin and replaced with new cells. Ink injected into the superficial skin layer simply comes off within 3 weeks. In order to give the ink a permanent home into the body, the tattoo needle must travel through the epidermis into the deeper layer, or the dermis. Nerves and blood vessels are located here, which is why getting a tattoo hurts and skin tends to bleed. The bleeding is part of the skin's natural defense against injury. The result is an influx of immune cells to the site of injury. Macrophages are specialized immune cells, whose job it is to engulf foreign particles and clear them from the tissue, but this process is only partially successful when it comes to tattoo ink.

Some macrophages loaded with ink particles remain in the dermis, while other pigment particles are taken up by the main dermal residents, which are called fibroblasts. Clumps of pigment particles have also been found to stick between the dense collagen fibers of the dermis. Some macrophages loaded with ink particles remain in the dermis, while other pigment particles are taken up by the main dermal residents, which are called fibroblasts. Clumps of pigment particles have also been found to stick between the dense collagen fibers of the dermis. Although every new tattoo will display some pigment loss, the majority of the ink will stay in the skin. A study in mice reported that 42 days after tattooing, 68 percent of the dye was still located at the injection site. In most cases, macrophages carry the ink particles to the lymph nodes closest to the site of the tattoo. Because the cells cannot break down the particles, they become lodged there. The side effect is that the lymph nodes take on the same color as your tattoo. [11]

Mild Reactions and Allergies after Tattooing:

Jungmann et al. [2] described a severe systemic reaction that occurred some 5 hours after a tattoo had been applied. It started with a swelling in the area of the tattoo and ended with the patient admitted to the emergency room with systemic grade 3 anaphylaxis. Such severe disease courses have been described in the specialist medical literature in very rare instances. Notably more common, and equally as impairing, are local reactions in the area of the tattoo, which may also trigger scattered reactions, especially in areas where red tattoo inks were used. Therapy of such localized reactions can be tedious and, in some cases, excision is the only option [3] Tattoo dyes — especially red, green, yellow and blue dyes — can cause allergic skin reactions, such as an itchy rash at the tattoo site. This can occur even years after you get the tattoo. A skin infection is possible after tattooing. Sometimes an area of inflammation called a granuloma can form around tattoo ink. Tattooing also can lead to keloids — raised areas caused by an overgrowth of scar tissue. If the equipment used to create your tattoo is contaminated with infected blood, you can contract various blood borne diseases — including methicillin-resistant Staphylococcus aureus (MRSA), hepatitis B and hepatitis C.Rarely, tattoos or permanent makeup might cause swelling or burning in the affected areas during magnetic resonance imaging (MRI) exams. In some cases, tattoo pigments can interfere with the quality of the image. Medication or other treatment might be needed if you experience an allergic reaction to the tattoo ink or you develop an infection or other skin problem near a tattoo.[5]

Probable Chronic Effects:

In 2011, in a study in *The British Journalof Dermatology,* investigators reportedthe discovery that nanoparticles are found in tattoo inks.20 Nanoparticles are ultramicroscopic, making them able to penetrate through skin layers into underlying blood vessels and then travel with the bloodstream. Evidence suggests that some of these nanoparticles might induce toxic effects in the brain and cause nerve damage [6]. Some of these nanoparticles might also be carcinogenic. And according to the results of a study from the University of Bradford,nanoparticles from tattoo ink were found around blood vessels elsewhere in the body and could possibly enter organs and other tissues. Black ink is the color most often linked with high concentrations of such nanoparticles. Some studies have found that red tattoo ink often contains azo-based hues. [7] Azo dyes are organic compounds that are of great concern due to their potential toxicity and carcinogenic properties. Red ink appears to be connected to chronic and allergic skin reactions caused by tattoos.[8]

There is much to learn regarding how specific pigments interact with the metabolism of the human body. For example, studies by the National Center for Toxicological Research21 report that yellow ink is broken down by enzymes and metabolized by the body. This pigment also breaks down in sunlight, often turning colorless. The chemically altered remnants of these pigments, however, remain in the skin layer, and it is still unknown if they are toxic or not. We do know that small amounts of ink particles always pass into the lymphatic system and accumulate in lymph nodes. [9,10].

Despite the heterogeneous and often unknown components of older tattoo inks, until now, no studies have shown a clear connection between tattoos and skin cancer. According to some findings however, tattoos can make it more difficult to diagnose skin cancer or can cause false identifications of cancer in lymph nodes[11].

Discussion:

Chemical irritation from the pigment and/or chemical substances in the tattoo ink of an unspecified character causing a chronical inflammatory condition. The irritation might originate from too much colour being tattooed into the skin. The irritation can vary from light to severe and can possibly manifest itself as a lichenoid reaction.

As described in the table byAthar and Sameena,2019 [1] different colors of tattoo inks have different formulations with number of chemical substances which have potential adverse effects. The most common adverse health outcomes induced by iron oxide include permanent discoloration of the eyes, siderosis, and pneumoconiosis. [4,5]. National Center for Toxicological Research21 report that yellow ink is broken down by enzymes and metabolized by the body. This pigment also breaks down in sunlight, often turning colorless.According to a report published by health department of New Jersey, lead chromate is toxic substance and prolonged contact with skin can cause blisters and deep ulcers [6].

Conclusion:

While tattoos aren't completely risk-free, knowing the potential effects ahead of time can reduce your chances of side effects. Despite the improved safety of tattoos, even when to work with an experienced tattoo artist at a reputable shop to reduce your risk of side effects. Proper aftercare on your part is also important to reduce scarring and other risks. As tattoos can be great form for personal expression and have been in trends for centuries but it is important to consider all the health risks that are associated with tattooing specially the chemical compounds that are used as tattoo inks. A deep research and concern is required to understand the possible health concerns. Remember, tattoos are more than just a trend; they are a permanent modification to your body that carries possible health risks.

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