

Position Paper

Skin markings methods and guidelines: A reality in image guidance radiotherapy era

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Abstract

Preparation of site of radiation delivery is an important process in radiation treatment planning and plays a crucial role during a course of radiotherapy to achieve reproducibility of set-up and accuracy of treatment delivery. The preparation of treatment area is done by markings of field center, field edge or other reference point of planned field. Both non-invasive (marker pen, henna) and invasive methods (tattoo) are available for marking with limitations of each. Tattoo with a needle pricked at angle of 30° to 1-2 mm depth to create tattoo 2-3 mm diameter in size is an ideal procedure. Visibility, permanent nature, social-religious belief, and mobility of skin are one of the main concerns about tattoo. Tattoo removal can be done performed if desirable by patients by various modern ways, which will be esthetically available. Dermabrasion, cryotherapy, surgery, QSRL (Q-switched ruby laser) are common methods of tattoo removal. Esthetic dissatisfaction, allergy, dermatoses, keloids, infection, fanning/fading of tattoo are associated problems. In IMRT and IGRT treatment, delivery dependence on tattoo is reduced and use of surrogate markers including particularly for bony set-up and implanted markers (e.g. gold seeds) for tumor localization and treatment verification is increasing. However, these are complex procedures and require an expertise. Ease of set-up and less time required for tattooing are one of the main advantages of tattoo as compared to external or internal marker set-up. Tattoo still remains a crucial method of positioning, especially in developing countries and in palliative treatment settings.

Key words: Radiation oncology, skin marking methods, tattoo

Introduction

In the modern era of image-guided radiotherapy, preliminary marking of site of radiation delivery is an important step in radiation treatment planning,^[1] and these plays a crucial role during a course of radiotherapy to achieve reproducibility of treatment set-up and accuracy of treatment delivery.^[2] Skin markings are done either on isocenter or at margins of planned field. Skin marking protocols varies with an institution.^[3] An accurate and reliable marking is only gateway for desired radiation delivery.

In IMRT and IGRT treatment, delivery dependence on

tattoo in reduced and use of surrogate markers including particularly for bony set-up and implanted markers (e.g. gold seeds) for tumor localization and treatment verification is increasing.^[4] However, these are complex procedures and require an expertise. However, tattoo is easy procedure requires less time and still an important skin marking method.

Method

Marker pen, henna, and tattoo are 3 commonly used methods for the skin markings.^[5] Marker pens and henna are non-invasive techniques^[6-8], whereas 3rd is an invasive technique that involves using needles or commercially available tattooing needles with non-toxic ink.^[9] Comparison of marking methods is shown in Table 1.

Tattoo

Worldwide permanent tattooing is the most popular method for skin markings.^[10] In this method, a non-toxic ink is injected in the epidermis of the skin using a disposable needle to make a 1-2 mm permanent tattoo. Tattoo provides a permanent reference mark on the skin. If tattoos are used, the point being marked needs to be considered (e.g. field center, field edge or other reference point). As cosmetics is a major end point, the use of multiple tattoos is not desirable. Potential hazards are needle prick injury and

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Table 1: Comparison of skin marking methods

Method	Advantages	Dis-advantage
Temporary marker pens	Easy Painless	Patient discomfort as washing / bathing not allowed Oncologist dissatisfaction and increased workload as requires repetitions of marking during course of treatment
Henna	Cost-effective More durable and requires a less number of repetitions	Repeated markings may prolong the treatment time Prolonged drying period of henna keeps the simulator room and attending radiographers busy, thus time consuming
Permanent tattoos	Washing and showering are allowed during the treatment Permanent mark with a small spot of 1-2 mm size Re-markings not required Showering and bathing allowed Patients' comfort and oncologist satisfaction	Not a suitable method at places with heavy work load Allergic reactions in some patients and oncologist Mild to moderately painful Potential hazard for needle prick injury to radiographers

tattoo allergy although the latter is very rare.^[3]

Mechanism

Superficial pricking deposits pigments into epidermis and superficial dermal layers, especially papillary and reticular dermis. This causes superficial dermal capillary damage and blood droplet covers skin. Pierced skin reacts by getting red and inflamed (erythematosus) followed by swollen (edematous). This reaction subsides within few hours.

Over the next few days, superficial and regenerative basal layer of epidermis will peel off until only pigment in dermis remains. Superficial layer will regenerate and pigment will be seen in dermis through overlying epidermis.

Complete regeneration of epidermis will be complete within 2 weeks, but body will react to pigment as foreign body. Dermal macrophage will engulf pigment particle and will carry them into dermal lymphatic. Some macrophage will travel only short, and this will cause blurring and spreading of tattoo.^[11]

Material

Ink used can be visible under normal or ultra-violet light. India ink is most commonly used for visible tattoo worldwide. Recently, sterile pigment inks are available commercially.^[12]

Ideal methodology

Single drop of ink should be applied over the site. A 21 gauge needle should be pricked at angle of 30° to 1-2 mm but not deeper.^[11] Ideal tattoo is 2-3 mm diameter in size.

Drawbacks of tattoo

- India ink tattoo are not visible on all skin type (e.g. Dark-colored or heavily freckled skin); Hair follicles, moles, and tattoos may be similar in appearance, leading to possible set-up error

- Permanent and visible nature of tattoo can be detrimental to patient and constant reminder of cancer
- Some religious beliefs oppose any kind of skin tattoo
- Social stereotype
- Mobility of tattoo in elderly and obese patients, the skin tends to be looser; accuracy is lost because the external tattoo set-up points are not necessarily consistent with internal structures

Tattoo removal

Various tattoo removal strategies are being explored since 1960.^[12]

- Dermabrasion: Epidermis overlying tattoo is sanded black, and chemicals like tannic acid and silver nitrate are applied to pigment-containing region to enhance fading of tattoo. This technique leaves behind significant scar and is not very popular.
- Cryotherapy: Liquid nitrogen, applied to pigmented skin, causes necrosis of skin and eventually falls away. However, it is more useful for smaller tattoo.
- Surgery: Complete surgical excision is available modality but is associated with scarring.
- QSRL (Q switched ruby laser): This emits nano-second domain pulses of light, which are absorbed by tattoo pigment, especially blue-black pigment as India ink. This results in heating of pigments granule containing cells and destroys them. Post-destruction inflammatory process clears the tattoo. Due to extremely short pulses (40-nanosecond), this doesn't affect deeper normal tissue.

Drawback of tattoo removal

These tattoo acts as history of previous treatment and mark the site. This, in turn, prevents an overlap of radiation fields and avoids over-irradiation. Though care may be taken by taking clinical photograph or by maintaining medical records, change in anatomy by weight gain or loss can blur boundaries. Permanent tattoo is valuable in this scenario.

Table 2: Complications of tattoo

Patient related	Esthetic dissatisfaction	Infection
	Allergy	Fanning / fading of tattoo
	Dermatoses	
	Keloids	
Clinician related	Needle prick injury	

Complications of tattoo are summarized in Table 2.^[13,14]

Relevance of tattoo in IMRT/IGRT

For image-guided treatments, patients are often aligned to external markers, either placed on the head cast or positioned at patient tattoo position. External marker positions are usually defined at CT simulation time, whereby external fiducial markers are placed with reference to isocenter. Unfortunately, there is internal organ mobility; therefore, external markers can at best only guide the initial treatment set-up. While some structures such as the pelvic lymph nodes may follow the bony anatomy quite nicely, other organs such as the prostate undergo significant motion with respect to the bony anatomy.

Ease of set-up and less time required for tattooing are one of the main advantages of tattoo as compared to an external or internal marker set-up. Tattoo still remains a crucial method of positioning, especially in developing countries and in palliative treatment settings.

Conclusion

Permanent tattoo with India ink remains most-widely used and cost-effective way of skin marking in radiotherapy. Optimal tattoo is the one performed on relatively stable skin, preferably not on visible body parts to avoid cosmetic issue, away from moles/hairy region, done with 21 gauge needle at 30° angulations, measuring 2-3 mm diameter in size. In patients with sense of cosmetic issue, tattoo

removal can be addressed. Tattoo still remains an important method of skin marking, especially in palliative settings.

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