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MR SCANNING, TATTOOS AND REPORTED SKIN BURN - FACT OR MYTH?

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Background

- Magnetic resonance imaging (MRI) is commonly used for diagnostic evaluation of internal disease
- Adverse events have become a relevant concern when tattooed persons are examined with MRI; iron oxide pigments suggested to cause problem
- MRI and tattoo associated problems are expected to increase parallel to the tattoo trend



Background, Medical Literature

- The literature on MRI burn is scarce
- Case reports indicate adverse events related to MRI on tattoos are unusual, in one study estimate to 1.5% [1]
- The majority of reports are on sensation of “burn” directly in the tattoo, more frequent in cosmetic tattoos [2]
- Reports with MRI and redness and edema of the tattoo rate this as skin burn grade I or II [1,2,3,4]

Neck tattoo with redness and oedema after MRI [2]

Same patient, elbow region [2]
Courtesy of Dr. Kolnes, Volda Skjukehus

[1] Tope, WD and Shellock FG; J Magn Reson Imaging (2002):15:180-84.

[2] Kolnes, K.; Tidsskr.Nor Laegeforen. 132.16 (2012): 1873.

[3] Ross, JR and Matava, MJ; Sports Health (2011):3431-34.

[4] Kreidstein; Plast Reconstr Surg (1997):99:1717-20.

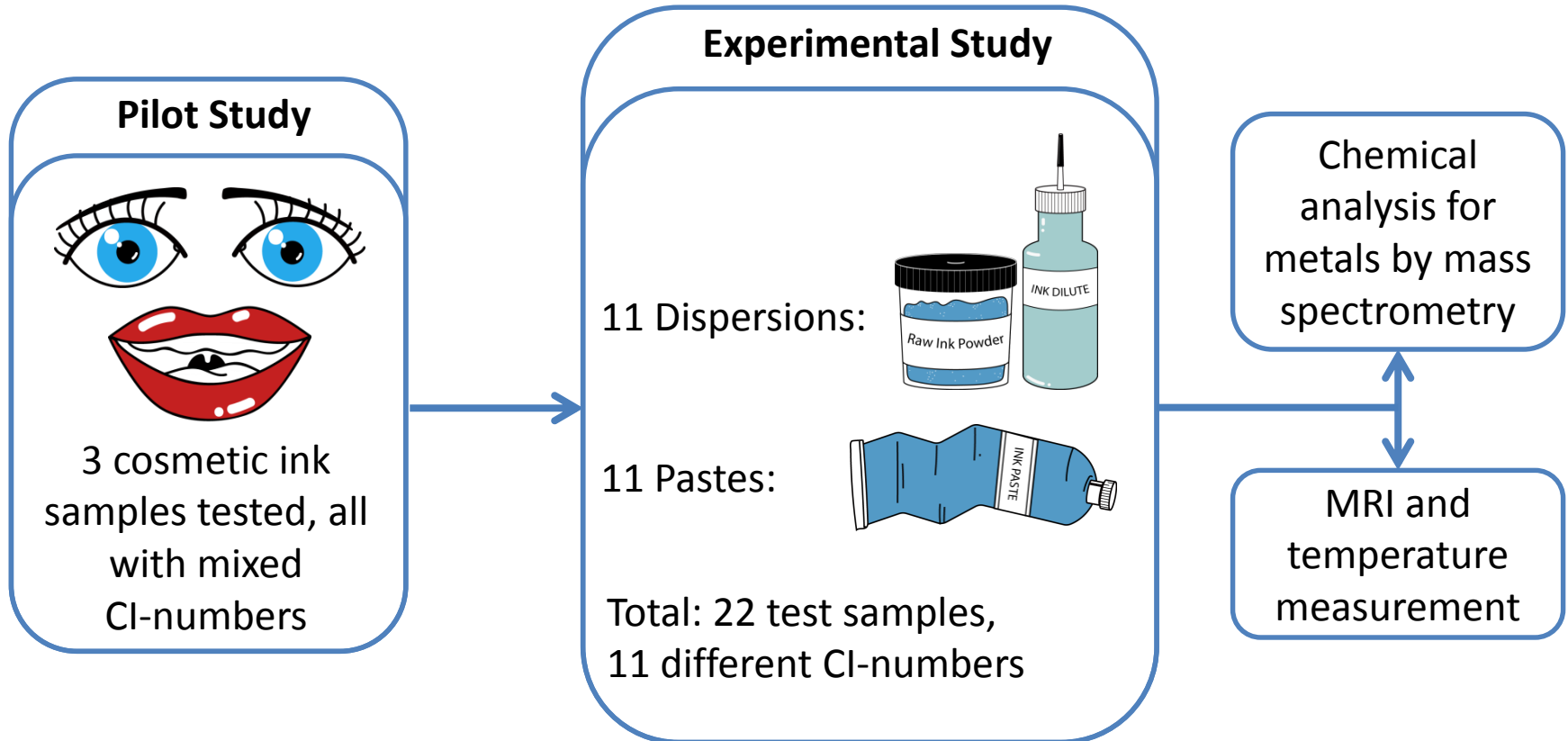


Aim of the Study

To study thermal changes of tattoo inks exposed to MRI, referenced to type of pigment and chemical composition



Extra - Study Flow Chart



MRI of commercial inks, pastes and dispersions

PROCEDURES

Samples were placed in a clinical 3T scanner

- in the iso-center (max. RF radiation)
- 30 cm away from (off) the iso center (max. gradient variations inducing currents)
- Surface temperature of samples was measured before (PRE) and after (POST) MRI, by infrared thermography

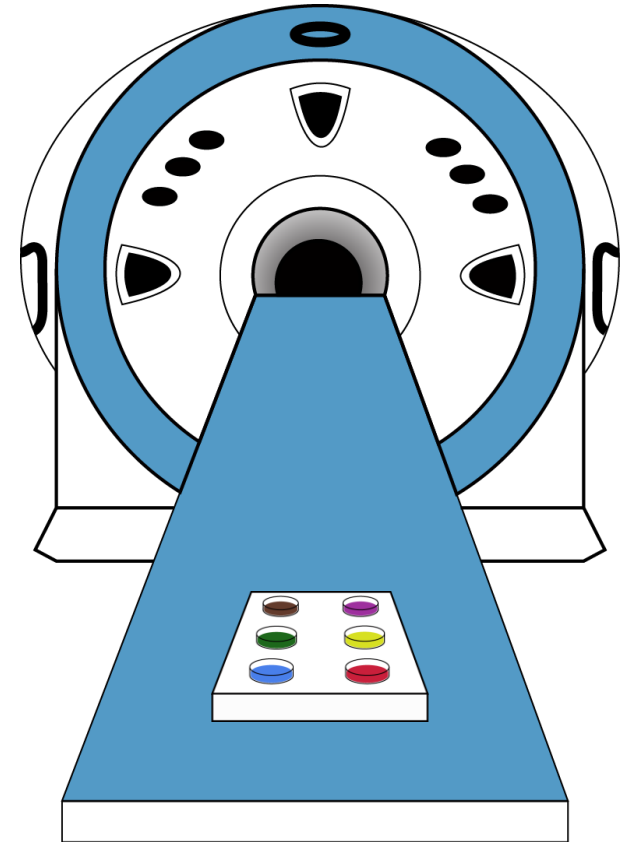
SAMPLES

Pilot Study:

- 3 commercial ink stock products

Experimental Study:

- 11 dispersions (pigment/diluent 1/1)
- 11 pastes (realistic formulations for tattooing)



Results, Study of Three Commercial Ink Stock Products

Table 1A: Measurement of ink temperature (°C) before (Pre) and after (Post) MRI.

| Sample no. | Product Name | CI-Number | Pre, in iso* | Post, in iso* | Pre, off iso* | Post, off iso* | Magnet Test ** |
|------------|----------------|-------------------------------|--------------|---------------|---------------|----------------|----------------|
| 1 | Olive Light | 77288 77491 77492 77499 77891 | 22.0 | 22.1 | 21.6 | 22.1 | + |
| 2 | Brownish Black | 77491 77492 77499 | 21.8 | 22.1 | 21.6 | 21.8 | +++ |
| 3 | Dark Chocogold | 77491 77499 | 22.0 | 21.9 | 21.5 | 21.6 | ++ |

* Samples were studied in the iso center (iso) and off the center (off)

** Magnet Test: indicates visual movement of product tested with an NdFeB magnet, expressed in three grades (little, medium, major).

Table 1B: Chemical analysis of metals in ink stock products (mg/kg).

| Sample no. | Product Name | Cd | Cr | Cu | Ni | Pb | Zn | Hg | Fe |
|------------|----------------|----|----|----|----|----|----|----|--------|
| 1 | Olive Light | - | 52 | - | 9 | - | - | - | 52000 |
| 2 | Brownish Black | - | - | - | 52 | - | - | - | 290000 |
| 3 | Dark Chocogold | - | - | - | 20 | - | - | - | 240000 |



Results, 11 Dispersions, MRI and Delta Temperature (°C)

| | Mean (temp/°C) | Standard deviation [range] | Paired t-test, p 95% CI[range] |
|------------------------|-------------------|-------------------------------|-----------------------------------|
| Pre, in iso center | 22.5 | 0.2 [22.3, 22.8] | - |
| Post, in iso center | 22.8 | 0.1 [22.6, 22.8] | - |
| In iso, difference | 0.26 | 0.2 [-0.2, 0.4] | p<0.01 [-0.4, -0.12] |
| Pre, off center | 22.6 | 0.3 [22.3, 22.9] | - |
| Post, off center | 22.4 | 0.3 [22.1, 22.7] | - |
| Off center, difference | - 0.2 | 0.3 [-0.3, 0.3] | p< 0.08 [-0.02,0.35] |



Results, 11 Pastes, MRI and Delta Temperature (°C)

| | Mean (temp/°C) | Standard deviation [range] | Paired t-test, p 95% CI[range] |
|------------------------|-------------------|-------------------------------|-----------------------------------|
| Pre, in iso center | 21.7 | 0.3 [21.2, 22.0] | - |
| Post, in iso center | 21.9 | 0.3 [21.2, 22.2] | - |
| In iso, difference | 0.14 | 0.1 [0.0, 0.3] | p<0.01 [0.08, 0.19] |
| Pre, off center | 21.6 | 0.4 [21.0, 22.0] | - |
| Post, off center | 21.8 | 0.3 [21.3, 22.1] | - |
| Off center, difference | 0.21 | 0.2 [- 0.1, 0.6] | p < 0.01 [0.08,0.34] |



Chemical Analysis, Pastes and Dispersions; ranked according to CI-number. Iron oxide pigments in red frame.

| Sample no. | CI-number | Formulations | Cd | Cr | Cu | Ni | Pb | Zn | Hg | Fe* |
|------------|-----------|----------------------------------|----|-----|-------|-----|----|----|------|--------|
| 4 | 51345 | Violet Paste 24% | - | - | - | - | - | - | - | 14 |
| 5 | 51345 | Violet Dispersion 50% | - | - | - | - | - | - | - | 41 |
| 6 | 56110 | Red Paste 33% | - | - | - | - | - | - | - | 15 |
| 7 | 56110 | Red Dispersion 50% | - | - | - | - | - | - | - | |
| 8 | 56300 | Yellow Paste 35% | - | - | - | - | - | - | - | 28 |
| 9 | 56300 | Yellow Dispersion 50% | - | - | - | - | - | - | - | 91 |
| 10 | 74160 | Blue Paste 28% | - | - | 21300 | - | - | - | - | 20 |
| 11 | 74160 | Blue Dispersion 50% | - | - | 92300 | - | - | - | - | 29 |
| 12 | 74265 | Green Paste 34% | - | - | 2190 | - | - | - | - | 29 |
| 13 | 74265 | Green Dispersion 50% | - | - | 29700 | 5.7 | - | - | - | 34 |
| 14 | 77266 | Carbon Black 1 Paste 20% | - | - | - | - | - | - | - | 26 |
| 15 | 77266 | Carbon Black 1 Dispersion 50% | - | - | - | - | - | - | 0.12 | |
| 16 | 77266 | Carbon Black 2 Paste 10% | - | - | - | - | - | - | - | 18 |
| 17 | 77266 | Carbon black 2 Dispersion 50% | - | - | - | - | - | - | - | 37 |
| 18 | 77491 | Iron Oxide Brown Paste 30% | - | 6.3 | - | 40 | - | - | - | 246424 |
| 19 | 77491 | Iron Oxide Brown Dispersion 50% | - | 17 | 8.5 | 110 | - | - | - | 647000 |
| 20 | 77491 | Iron Oxide Red Paste 30% | - | 7.7 | - | 23 | - | - | - | 184000 |
| 21 | 77491 | Iron Oxide Red Dispersion 50% | - | 26 | 13 | 77 | - | - | - | 523000 |
| 22 | 77492 | Iron Oxide Yellow Paste 30% | - | 21 | 8.3 | 25 | - | - | - | 456000 |
| 23 | 77492 | Iron Oxide Yellow Dispersion 50% | - | 5.0 | - | 6.6 | - | - | - | 116000 |
| 24 | 561170 | Orange Paste 29% | - | - | - | - | - | - | - | 15 |
| 25 | 561170 | Orange Dispersion 50% | - | - | - | - | - | - | - | 12 |



Conclusion

- Minute but statistically significant temperature increase was observed in both iron oxide and non-iron oxide pigments
- **Delta temperature (0.14, 0.21,0.26,-0.2 °C) after MRI is far below what could ever cause thermal skin burn**



It is a **myth** that magnetic resonance imaging causes thermal burn, as noted in the medical literature

Individual's report of burn during MRI shall be seen as the feel of burning sensation, for instance a neuro-sensory stimulus mimicking "burn"

Various kinds of stimuli other than MRI can elicit burning sensation, stinging, smarting, pain, itch and discomfort, mediated by c-fibre neurons and occasionally associated with mild inflammatory reaction due to release of neuromediators

