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ORIGINAL ARTICLE

Effect of quality-switched laser exposure in patients with history of edible gold consumption

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Abstract

Injectable gold is known to deposit in the dermis for life, and such patients are at risk of developing chrysiasis post-laser exposure. It is unknown if patients with history of edible gold consumption would develop a similar reaction after quality-switched laser exposure. Our aim is to assess if patients with history of edible gold consumption develop chrysiasis after quality-switched laser exposure. This is a proof of concept pilot study conducted between September 2017 and September 2018 at two dermatology clinics in Riyadh, Saudi Arabia. Adult patients who have history of edible gold consumption were recruited to receive a spot test with different quality-switched lasers in a hidden, non-sun-exposed skin site. The test area was photographed before, immediately after, and 10 min after laser exposure. The test area was examined by two independent investigators for the development of chrysiasis. A total of 10 patients (five male and five female) were enrolled. The mean age was 31.7 years. Forty percent of subjects consumed edible gold more than once, and the duration of last intake ranged from 3 weeks to 3 months. Chocolate was the main source of edible gold. All participants had no chrysiasis reaction post-quality-switched laser exposure. Contrary to our hypothesis, all participants with history of short-term edible gold consumption did not develop chrysiasis after quality-switched laser exposure. Further controlled studies including more patients with longer duration and higher frequency of edible gold consumption are needed.

Keywords Edible · Gold · Chrysiasis · Laser

Introduction

Chrysiasis is a condition characterized by blue-gray discoloration of sun-exposed skin caused by deposition of gold particles in the skin. Historically, the source of exposure to gold was mainly in the treatment of rheumatoid arthritis [1]. Gold particles from gold therapy are known to deposit in dermis for life. Furthermore, chrysiasis might occur after laser skin treatment. Such patients are at risk of developing chrysiasis post-laser exposure used for the treatment of a wide variety of skin conditions [2, 3]. The mechanism of chrysiasis is not fully understood. Trotter et al. [4] and Yun et al. [5] proposed that quality-switched (QS) laser can alter the mechanical or chemical properties of gold deposits resulting in photo-induced cutaneous pigmentation. Chrysiasis is diagnosed clinically given the characteristic blue-gray skin discoloration and history of gold exposure. However, in suspected cases, a re-challenge test with QS laser in a hidden site can be done to induce a localized chrysiasis [6]. Typical histopathological findings of chrysiasis include oval black granules that are irregular in size and located around blood vessels and in dermal macrophages [7]. Gold was used in the past by medical practitioners for the treatment of a wide-range of pathological conditions. However, the effectiveness of new therapeutic options has resulted in a significant decline of gold therapy [8]. But, the potential hazard of gold continues in a different form. In 1975, elemental gold (E 175) has been authorized as a food additive for decoration of sweets and in some drinks [9]. In contrast to gold therapy where the toxicity profile is well-documented [10–12], data on the toxicity of edible gold is still

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too limited [9]. It has been reported that edible gold could induce allergic reactions and lichen planus [13–15]. We hypothesize that edible gold might lead to chrysiasis after QS laser treatment. Treatment of chrysiasis is very challenging; therefore, prevention of this reaction is crucial. Evidence on the effect of QS laser exposure in patients with history of edible gold consumption is lacking. The aim of our study is to examine if patients consuming gold containing products would develop chrysiasis after QS laser exposure.

Methods

This is a proof of concept pilot study conducted between September 2017 and September 2018. All participants were informed about the nature of the study including the procedure risks and benefits, and an informed written consent was obtained from all participants. The study was reviewed and approved by King Abdullah International Medical Research Center committee, and participants were recruited from dermatology clinics at King Abdulaziz Medical City and Derma Clinics. All adult patients attending the dermatology clinic for pigment laser therapy for any cause and have history of edible gold consumption in the past were candidate to be enrolled in the study. They were screened through a self-administered questionnaire for previous history of gold therapy, gold implants, and details of edible gold consumption. Exclusion criteria were individuals known to have gold implants (such as dental implants and cosmetic gold threads) and history of gold therapy. Each participant received a spot test with either QS 755–nm laser (Accolade, Cynosure, Westford, MA, USA) or QS 532–nm laser (Medlite C6, HOYA ConBio, Fremont, CA, USA) in a hidden, non-sun-exposed skin site (such as inner thigh or inner arm), prior to performing the main laser therapy for which they are attending the clinic. The size of the test spot was approximately 1 cm in diameter. The type of laser and laser parameters for the test spot were chosen based on the treatment indication. The test area was photographed before, immediately after, and 10 min after laser exposure under the same condition (site, light source, room, camera). The photographs then were evaluated by two independent board-certified dermatologists (Alissa A and AlJasser M) for the development of any blue-gray discoloration. Each dermatologist was asked to grade the degree of pigmentation (if present). Other documented data included type of laser, test site, and laser parameters. Participants who develop blue-gray discoloration (chrysiasis) in the laser test spot will not receive further laser treatment for the indication they were referred for. Other therapeutic strategies will be discussed with them instead. Data from the self-administered questionnaire was transferred into a Microsoft Excel worksheet and imported to Predictive Analysis Software version 18.0 (SPSS Inc., IBM, Chicago, IL, USA) for analysis.

Results

A total of 10 patients (five male and five female) were enrolled. Age ranged from 26 to 38 years (mean 31.7 years). Forty percent of subjects consumed edible gold more than once, and the duration of last intake ranged from 3 weeks to 3 months. Chocolate was the main source of edible gold. All participants consumed edible gold within the Kingdom of Saudi Arabia. The main indication for which they were attending the clinic for laser therapy was melanocytic nevi (junctional and compound). Every participant received a test spot with QS laser (755 nm or 532 nm) in the inner arm prior to performing main laser therapy using the same parameters (Table 1). Independent photograph evaluation of all participants did not reveal any pigmentary changes immediately after or 10 min after laser exposure (Fig. 1).

Discussion

Elemental gold is considered an inert metal with very low solubility and systemic availability; thus, systemic effects would not be expected [9]. Nonetheless, the high serum gold levels detected in patients with dental gold implant [16] and coronary gold stent [17] suggests otherwise. Edible gold has no nutritional benefits, and when ingested, it is expected to pass through the gastrointestinal tract without systemic absorption [18]. However, small particles may stay in the digestive system and possible delayed reaction cannot be ruled out [18]. Furthermore, it has been proposed that metallic gold has the ability to be slowly ionized and eventually absorbed [19]. Subsequently, allowing the explanation of systemic effects related to gold depositions in different organs and tissues [20]. None of the participants in our study with history of edible gold consumption showed chrysiasis following QS laser exposure, which is contrary to our hypothesis. Chrysiasis is known to develop after many years of gold exposure [21] and is directly correlated with the cumulative dose [22, 23]. The absence of chrysiasis in our study population could be explained by the relatively short duration ($\leq$3 months) of edible gold consumption and low frequency of edible gold intake (once or twice). Our study has several limitations. First, edible gold was consumed over a relatively short period of time in our study population. Second, most patients had edible gold only a few times which might not be associated with a significant rise in serum gold level. Third, we had a small sample size which was mainly due to the difficulty finding patients who had consumed gold. Fourth, no confirmatory tests were performed (such as serum gold level or skin biopsy). Fifth, since it is not a controlled study, we were not able to quantify the amount of gold present in chocolate previously consumed by participants. In conclusion, we have shown that

Table 1 Characteristics of patients with history of edible gold consumption

PARTICIPANTS	1	2	3	4	5	6
Age (years)	32	38	26	29	33	33
Gender	M	M	F	F	M	F
Last time since gold intake (weeks)	3	4	6	5	8	3
Number of times gold was consumed	Twice	Once	Once	Once	Twice	Once
Type of food containing gold	Cake and chocolate	Chocolate	Chocolate	Chocolate	Cake and chocolate	Chocolate
Laser type	QS 755 nm	QS 755 nm	QS 755 nm	QS 755 nm	QS 532 nm	QS 755 nm
Laser parameters*	2 mm, 12 J/cm^2 1.7×10^{12} mw/cm^2	2 mm, 12 J/cm^2 1.7×10^{12} mw/cm^2	2 mm, 14 J/cm^2 2×10^{12} mw/cm^2	2 mm, 14 J/cm^2 2×10^{12} mw/cm^2	2 mm, 2.6 J/cm^2 5.2×10^{11}mw/cm^2	2 mm, 14 J/cm^2 2×10^{12} mw/cm^2
Degree of pigmentation (immediately)	None	None	None	None	None	None
Degree of pigmentation (after 10 min)	None	None	None	None	None	None

PARTICIPANTS	7	8	9	10
Age (years)	34	33	31	28
Gender	M	F	F	M
Last time since gold intake (weeks)	4	12	12	8
Number of times gold was consumed	Once	Twice	Once	Twice
Type of food containing gold	Chocolate	Ice cream and chocolate	Chocolate	Chocolate
Laser type	QS 532 nm	QS 755 nm	QS 755 nm	QS 532 nm
Laser parameters*	2 mm, 2.5 J/cm^2 5×10^{11}mw/cm^2	2 mm, 14 J/cm^2 2×10^{12} mw/cm^2	2 mm, 12 J/cm^2 1.7×10^{12} mw/cm^2	3 mm, 3 J/cm^2 6×10^{11}mw/cm^2
Degree of pigmentation (immediately)	None	None	None	None
Degree of pigmentation (after 10 min)	None	None	None	None

*Pulse duration is fixed QS 755 nm (70 ns) QS 532 nm (5 ns)

M, male; *F*, female; *QS*, quality-switched; *NM*, nanometer

Fig. 1 Skin changes after Q-switched laser test spot in patients with history of edible gold consumption. Baseline (top). Immediately, post-laser shows immediate physiological whitening endpoint (middle). Ten minutes post-laser (bottom)

individuals with history of short-term edible gold consumption did not develop chrysiasis after QS laser exposure. To the best of our knowledge, our study might be the first to evaluate the effect of QS laser in patients who had consumed gold in the past. Further controlled studies including more patients with longer duration and higher frequency of edible gold consumption are needed.

Compliance with ethical standards

IRB approval status: Reviewed and approved by King Abdullah International Medical Research Center IRB, approval no. RC17-186-R.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest The authors declared that they have no conflict of interest.

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