

Original Article

The comparison between the impacts of henna and nail polish on pulse oximetry among healthy women

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ABSTRACT

Background & Aim: Pulse oximetry is a frequently used and standard non-invasive method for monitoring oxygen (O₂)-saturation in blood. Many factors including dark skin and pigmentation may effect on rate of saturation of the blood oxygen absorbed by pulse oximetry. The effect of nail polish and/or henna color on blood oxygen has not been yet identified and the present study has been carried out by aiming at the review on impact of henna and nail polish on results of pulse oximetry.

Methods & Materials: In the current investigation, clinical trial was studied on 60 resident young women at ages 20-40 by means of purposeful sampling method. Initially, 20 g of Iranian original henna was solved in 30 ml water and put on forefinger of non-dominant hand of the subjects. The other fingers of the same hand were stained by red, black, and white nail polish, respectively. The middle finger of the same hand was considered as the control variable. Then, blood O₂-saturation was measured by two calibrated pulse oximetry devices simultaneously.

Results: The results indicated that henna (P = 0.020), red nail polish (P ≤ 0.001), and white nail polish (P = 0.020) have increased significantly the rate of O₂-saturation absorbed by pulse oximetry. The impact of black nail polish (P = 0.100) on O₂-saturation was not significant, but it has changed the mean rate of O₂-saturation. Test result of ANOVA with iterative values of $f = 10.385$ and $P \leq 0.001$ showed the significant statistical difference among mean values of O₂-saturation (henna, red, black, white, and control nail polish).

Conclusion: Henna and nail polish may effect on percent of O₂-saturation that showed by pulse oximetry and this may lead to error in monitoring of the patient. As a result, it is recommended to use other areas of the hand to put pulse oximetry sensor if henna is utilized and nail polish to be removed before installing the given sensor.

Introduction

Pulse oximetry device is usually used for

monitoring of patients (1-3). Pulse oximeter is a non-invasive and standard tool to approximate the rate oxygen (O₂)-saturation in patient's blood (3), particularly it is employed in those patients who may suffer from possible hypoxemia and reduction of oxygen level in blood (4). Pulse oximetry has provided this possibility to evaluate constantly respiratory performance in

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acute patients (5). After the invention of pulse oximetry device (1980), many changes have been exerted to improve the performance and to reduce measurement error of blood O₂-saturation, which have led to higher trustable tools of this kind (4, 6). Pulse oximetry and arterial blood gases are two different techniques for determination of blood O₂-saturation that contribute to evaluation of pulmonary performance by a respiratory physician, nurse, and therapist. The perfect and accurate coordination have been demonstrated between O₂-saturation of sample arterial blood with pulse oximetry in the previous studies (7). Monitoring of O₂-saturation in clinical environments is widely considered as an advanced and important tool to survey the patients (8).

Recently, it has been suggested to add nutritional status, smoking, spirometry, and pulse oximetry to four vital signs (temperature, respiratory rate, blood pressure, and heart rate) while pulse oximetry is the most prevalent added parameter to vital signs (9). Pulse oximeter consists of a sensor (probe) and survey part (data analysis site). This sensor guides the light in two wavelengths (infrared and ultraviolet) through a pulsating venous platform, including finger, forehead, and earlobe. Each of wavelengths is absorbed differently. Oxyhemoglobin absorbs infrared ray further. Survey site compares the rate of the absorbed red and infrared lights in order to calculate the existing oxyhemoglobin percentage (10). Although, this tool is an accurate technique for reflection of blood O₂-saturation level, the indicated figure may be affected by several conditions including poor peripheral blood transfer (11-13), hypoxemia (14, 15), carboxyhemoglobinemia (16), methemoglobinemia, and acute anemia (4, 17), nail polishing, dark skin, high level of bilirubin in patients with hepatitis, and using radiographic contrast agents, hypothermia, chills, hypotension, vasoconstrictive drugs and cardiac dysrhythmia such as atrial fibrillation (5). The studies have shown that increase in quantity of skin pigments as well as rising blood bilirubin may cause changing skin color. This change may influence in the rate of O₂-saturation that was absorbed by pulse oximetry (18). The study

done by Feiner et al. (2007) suggests that pulse oximetry may approximate the rate of saturation in arterial blood among people with dark skin further (19). Also in some essays, nail polish has been introduced as a factor, which leads to change in rate O₂-saturation by pulse oximetry (20, 21). The first reports have been found about the impact of nail polish on pulse oximetry at middle and end of 1980, which the results of these reports were controversial (22, 23). However, it still serves as an equivocal issue (1). Likewise, so far no study has been conducted on henna color and its impact on rate of O₂-saturation measured by pulse oximetry in Iran and results of studies in other countries about henna were contradictory.

Henna is a popular and widely use material among the oriental people, including Saudi Arabia and India, and it is used for staining hand and foot skin and hair (18). And also henna is commonly used among different Iranian tribes and ethnicities, while it has acquired special position in Islamic religion. Given this point that researchers have been exposed for several times to patients who had stained their fingers with henna and at the same time they needed to pulse oximetry for various reasons so with respect to the contradicted results of the impact of nail polish and henna on pulse oximetric results in other countries and lack of any research regarding the relationship of henna effect on pulse oximetric results in Iran and different application and type of henna in Iran from Arabic countries, the present study was carried out in order to examine the impact of henna paint and nail polish on pulse oximetric results.

Methods

This investigation is a clinical trial study. The statistical population of this survey includes all young women (20-40 years), who resided in dormitories of Tehran University of Medical Sciences at academic year 2011. The criteria for initialization of this study comprises of lack of suffering from anemia, having hemoglobin level within the range 12-15 g/dL, body temperature about 36.8-37.4° C, and rate of blood O₂-saturation within range 95-99%. Sixty partici-

pants were approximated as the number of the sample group for this study. The individuals were chosen and studied by means of purposeful sampling technique. To gather information, a form of data collection with several parts (demographic information, disease background, drug use, recorded hemoglobin rate, body temperature, and O₂-saturation rate in blood of control finger and the intervening fingers) was utilized.

After receiving permission from Medical Research Ethics Committee of the Tehran University of Medical Sciences and taking recommendation letter for the research environment, goal and the way of conducting this study were explained for the qualified participants. Then, the informed consent letter was taken from persons, who intended to participate in this research. A complete blood count sample was taken from all participants before any intervention and hemoglobin level was evaluated in these participants by calibrated cell-counter. Similarly, body temperature was measured by means of thermometer in axillary area. The persons who had hemoglobin level within the range of 12-15 g/dL with body temperature limit 36.8-37.4° C participated in this study. At first, demographic data and the relevant information about possible diseases were collected. Afterwards, the rate blood O₂-saturation was measured in all fingers of the qualified participants' hands at room temperature by the calibrated pulse oximetry. If the acquired figure was the same in all studied fingers and in normal range 95-99% then 20 g of Iranian original red henna was solved in 30 ml water and put on the forefinger of the non-dominant hand for 1 h. The consumed henna was the same for all studied participants and no synthetic color and substance was added to it. The other fingers of the same hand were stained by red, black, and white nail polishes, respectively. As a result, the little finger (pinky) was stained by black nail polish, ring finger was stained by red polish, and thumb was painted by white polish. The middle finger of the same hand (without nail polish or henna) was considered as a control group. Two calibrated pulse oximetric devices were adapted for measuring blood O₂-saturation rate. The rate of blood O₂-saturation was simultaneously measured from two stained fingers respectively

by henna, red, black, and white nail polishes with the control finger in the same hand. All samplings have been done at the same room temperature for all the participants and the indicated figure was recorded simultaneously by both devices after 10 min. Data were collected, and SPSS 16.0 statistical package (SPSS Inc., Chicago, IL, USA) was used for data analysis. In order to classify and summarize findings, descriptive statistics were adapted, including table of distribution of absolute and relative frequency, distribution of central tendencies, dispersion, and relative distribution charts and inferential statistics was utilized plus statistical pair t-test.

Results

Sixty participants were qualified to enter in this study. Age range of participants was determined by mean and standard deviation as 32.6 ± 12.3 years. All samples were students. Mean value of standard deviation of hemoglobin level was 13.2 ± 0.8 for the samples, while mean value and standard deviation was 36.9 ± 0.2 for their body temperature. Mean value of standard deviation of the absorbed O₂-saturation rate by pulse oximetry was 96.7 ± 3.1 at room temperature and were measured before intervention. None of the studied participants smoked. Pair t-test was adapted for comparison of the rate of O₂-saturation in control finger by staining with henna, red, black, and white nail polishes and impact of each of them was separately examined (Table 1). Findings showed that henna, red, black, and white nail polishes caused changing in the rate of the O₂-saturation absorbed by pulse oximetry comparison to control finger that is indicated in figure 1. According to statistical pair t-test, rate of O₂-saturation in control finger showed a significant difference from the finger(s) stained by henna (P = 0.020), red nail polish (P = 0.001), and white nail polish (P = 0.020). ANOVA test was utilized to compare mean values. The result of ANOVA test along with iterative values $f = 10.385$ and $P \leq 0.001$ indicated statistical significant difference from mean rates of O₂-saturation (henna, red, black, and white nail polishes, and control finger). Similarly, Bonferroni pair-to-pair com-

parison test was carried out. The results of test signify that rate of O₂-saturation in the stained finger by red nail polish significantly differ from other fingers, and the stained fingers have statistically significant difference from control finger.

Discussion

Today, pulse oximetry has been converted into a standard monitoring technique during anesthesia, medical care in intensive care units and emergency unit. Many factors may affect on rate of O₂-saturation absorbed by pulse oximetric device. In this study, the effect of henna color and nail polish on pulse oximetric results was examined among 60 healthy female adults. Results of this investigation showed that henna has affected on O₂-saturation measured by pulse

oximetry. The investigation which was done by Samman et al. (2006) on impact of henna color on pulse oximetry among 104 healthy people with mean average 32.93 (16 males and 84 females) and 14 hypoxemic patients, indicates that henna does not affect on pulse oximetric results among the healthy people and no statistical significant difference was seen between both groups of control and intervening in healthy people (P > 0.050). However, in hypoxemic patients, this may increase the rate O₂-saturation rate absorbed by pulse oximetry (P < 0.010) (18). Similarly, the results of studies done by al-Majed and Harakati (1994) suggest that red henna is not a barrier against measurement of O₂-saturation by pulse oximetry and creates no significant difference statistically. However, black henna may reduce the rate of O₂-saturation by pulse oximetry (23).

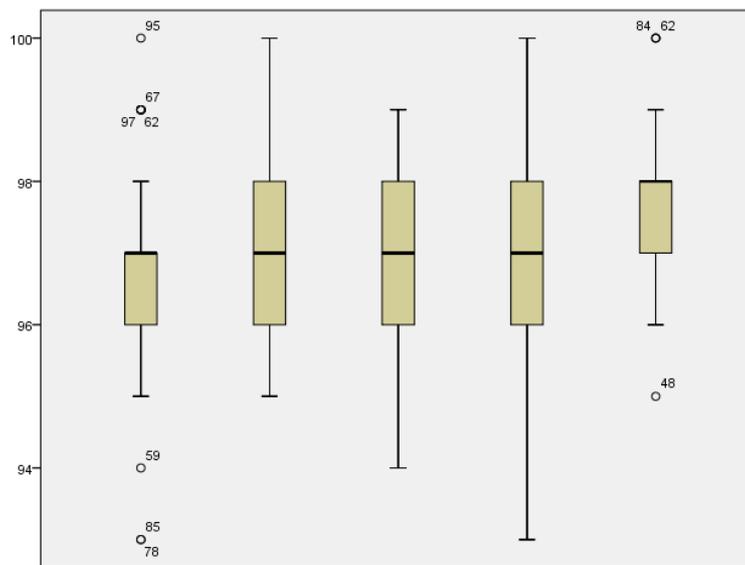


Figure 1. Comparison of the mean value of the oxygen-saturation absorbed by pulse oximetry in control finger, finger stained by henna, red, black, and white nail polishes

Table 1. Comparison of rate of the oxygen-saturation absorbed by pulse oximetry in control finger, finger stained by henna, red, black, and white nail polishes and results of analysis of variance test with iterative values

Finger	SPO ₂ (standard deviation ± mean)	Results
		ANOVA test with iterative values
Control	96/7 ± (1/3)	F = 14.78, P-value < 0.001
Henna	97/1 ± (1/1)	
White nail polish	97/1 ± (1/2)	
Black nail polish	96/9 ± (1/2)	
Red nail polish	97/7 ± (1/1)	

Unlike these two studies, the given results from the present investigation showed that the rate of O₂-saturation indicated in the stained finger with henna is greater than control finger and a significant difference was observed among rate of O₂-saturation in control finger and intervening fingers that may be due to the difference in the consumed henna. Type of henna which is used in Iran and it is commonly consumed here may differ from the henna in Saudi Arabia in terms of type and compounds. As a result, the created color by henna will differ so this may effect on rate of the O₂-saturation measured by pulse oximetry. At the same time, in both of these aforesaid studies the samples were males and females, while in our study only female adults have participated. Consequently, it is suggested to conduct this study on both genders and in a larger sample size.

With respect to the results of study, white and red nail polishes showed the statistical significant difference. Despite of insignificant statistical test, black nail polish also indicated great variance in the rate of O₂-saturation, which was created by pulse oximetry.

Hence, in many participants reduced rate of O₂-saturation (<92%) was observed, while in other persons the increase in O₂-saturation than control finger was seen. With respect to these results, it is recommended to study on impact of black nail polish effect in the larger sample size. Thus, results of this study reflected that nail polish might intervene in results of pulse oximetry that were contradicted to study results from Kataria and Lapkins. No remarkable error was seen in 15 volunteer participants who used nail polish in this investigation and nail polish had no effect on pulse oximetric results (24). In a study done by Cote et al., reported that blue, green, black, brown, and red nail polishes intervene in pulse oximetric results. These colors may cause reducing indication of O₂-saturation rate (more than 6%) (21). However, in the present study, in some cases nail polish causes reducing O₂-saturation and/or in the majority of circumstances, it leads to increase O₂-saturation so that such a difference may be due to different compounds used to produce nail polishes and recognizing its cause requires further investigation.

In the current survey, rate of reduced hemoglobin saturation from oxygen was not clinically significant, and it was not placed in hypoxemic range. But with respect to the importance of monitoring on rate of blood O₂-saturation among, especially cardiac and respiratory patients, it is suggested that an investigation to be conducted on patients in this regard. Similarly, with respect to the given statistical results, henna and nail polish effect on rate of O₂-saturation indicated by pulse oximetry and it may lead to error in monitoring of patient. Thus, if henna exists, it is better to use other areas, including earlobe, nose tip, and forehead to install pulse oximetric sensor for this purpose and nail polish to be remove from these areas before placing sensor. Results of this study could be used as important clinical application in the Eastern countries, Asia and Africa, and Iran where henna is used as cosmetic colorful polish for fingers.

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