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Effect of henna (mehndi) on pulse oximetry reading

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Abstract

Introduction: Pulse oximetry is a frequently used and a non-invasive method for monitoring oxygen saturation in blood. It estimates arterial hemoglobin saturation by measuring the light absorbance of pulsating vascular tissue at two wavelengths which can be altered by various factors. Numerous factors could lead to inaccuracy or ambiguous information about oxygen saturation and might result in unwanted procedures. In many cultures, women decorate their fingernails and feet with henna. The purpose of this study was to determine the effect of henna on the measurement of oxygen saturation.

Methods: 100 healthy females with a mean age of 19±1.0 years with normal oxygen saturation at room air were included into the study. Individuals with cardiovascular disorders like congenital heart disease, heart failure, any respiratory diseases were excluded from the study. Henna was applied to all the participants on the distal phalanx of left index finger (test) of the individuals and kept for 2 hours whereas right index finger was left empty as control. After 2 hours of application, henna was scrapped off from left finger. Oxygen saturation in addition to radial pulse was determined on both tested and control finger. Similarly, oxygen saturation and radial pulse was again determined on 2nd day as well as on the 7th day of application of henna on both tested and control finger and were statistically compared.

Results: Our results revealed no alteration in radial pulse after henna application even after 07th day (p value more than 0.05 in all the cases). However, a change in oxygen saturation was observed after 2 hours of application of henna till 07th day. Nonetheless, it must be emphasized that an increase of saturation of this minor magnitude (average 0.67%) does not translate into a clinically important change.

Conclusion: Application of natural henna does not cause any major error in measurement of oxygen saturation in young healthy individuals.

Keywords: Oxygen saturation, Pulse oximetry, Henna, Monitoring, Errors

Introduction

Pulse oximeter was first developed in the early 1970s by Takuo Aoyagi from the Nihon Kohden Corporation by 1987, it became the standard of care for the administration of a general anesthetic in the U.S. From the operating room, the use of pulse oximetry rapidly spread throughout the hospital, first to the recovery room, and then into the various intensive care units and emergency medical resuscitation of critically ill patients[1,2].

The pulse oximeter has transformed modern medicine with its ability to continuously and trans-cutaneously monitor the functional oxygen saturation of hemoglobin in arterial blood (SpO2). Pulse oximetry is so widely prevalent in medical care that it is often regarded as a fifth vital sign[3,4].

The ability of pulse oximetry to detect SpO2 of only arterial blood is based on the principle that the amount of red and infrared (IR) light absorbed fluctuates with the cardiac cycle, as the arterial blood volume increases during systole and decreases during diastole; in contrast, the blood volume in the veins and capillaries as well as the volumes of skin, fat, bone, etc., remain relatively constant. A portion of the light that passes through tissues without being absorbed strikes the probe's photo detector and, accordingly, creates signals with a relatively stable and non-pulsatile "direct current" (DC) component and a pulsatile "alternating current" (AC) component[5].

Pulse oximetry has now become a reliable tool for indirectly assessing the oxygen saturation in patients during critical care, anesthesia, surgery and particularly in patients who suffer from hypoxemia and hypoxia. Although it gives a reliable reading of oxygen saturation, it is also influenced by certain factors like complexion of skin, color or dye applied to skin, nail polish, etc[6,7].

Henna is a cosmetic dye that is made from special leaves (Lawsoniainermis), which grow in hot climates (North Africa, Asia and Middle East). It is very popular in Saudi Arabia, the Middle East, and Indian subcontinent and is used in dying the skin and hair. In India, henna is a traditionally used dye by women for decorating their hands. It is also used by some men for tattooing. Whole, unbroken henna leaves will not stain the skin. Henna will not stain skin until the laws one molecules are made available (released) from the henna leaf. Dried henna leaves will stain the skin if they are mashed into a paste. The laws one will gradually migrate from the henna paste into the outer layer of the skin and bind to the proteins in it, creating a fast stain. Henna stains are orange when the paste is first

removed, but darkens over the following three days to deep reddish brown.

Earlier reports of pulse oximeters noted that fingernail polish, particularly black, blue, and green color, can lower SpO2 by up to 10%[8]. More recent studies with newer models of pulse oximeters found that fingernail polish has only a minor effect on SpO2 readings; i.e., black and brown fingernail polish displayed the greatest reduction in the SpO2 reading but by an average decrease of 2%.[9-11]. Skin pigmentation has been shown to influence variability in readings by as much as 4%.

In critical care units where important interventional and therapeutic decisions hinge routinely upon oxygen desaturation, it is important to recognize this variability to prevent over-investigation, unwarranted invasive tests (such as arterial blood gas analyses) or increase in oxygen delivery which may predispose individuals to the risk of oxygen toxicity[12]. There is paucity of literature on effects of henna, especially the variety used in India which is usually natural henna, on oxygen saturation. The aim of this study was to determine the effect of Henna on pulse oximetry reading and also to assess whether there is any significant variation in the pulse oximetry reading due to application of henna and how accurately we can rely on the pulse oximetry reading in patients who has applied henna.

Material and Methods

100 healthy females with no complaints or known disease were included in the study. Individuals with cardiovascular disorders like congenital heart disease, heart failure, respiratory diseases were excluded. This study was approved by the ethics committee of our institution. Informed consent was obtained from all the participants prior to commencement of the study.

All the measurements were done under room temperature, and the same pulse oximeter was used in the study group to determine oxygen saturation in both transverse and conventional direction. Natural Henna powder without any additives was made into a paste (with water), and later it was applied to the distal phalanx of left index finger (test) of the individuals and kept for 2 hours (in order to have uniformity and direct supervision) whereas right index finger was left empty as control. After 2 hours the henna was scrapped off from left finger and oxygen saturation and radial pulse was determined on both tested and control finger.

Similarly, oxygen saturation and radial pulse was again determined on 2nd day as well as on the 7th day of application of henna on both tested and control finger. Results were compared with the distal phalanx of right index finger (control) and also compared with the readings before and after application of henna.

Statistical Analysis: Student's t-test was used to compare mean values at baseline among the tested and control group. Data were expressed as mean ± SD. Significance was defined as *p* value of <0.05. All statistical tests were performed with the uses of SPSS version-18 and ORIGIN Pro8.0 software's.

Results

Table 1 shows oxygen saturation in both tested and control finger after application of henna on the above mention protocol. We observed a change in the oxygen saturation before and after application of henna. The mean ± SD of SpO_2 levels before application of henna was 97.71±0.95, after 2 hours of application 97.83±0.98 and after two days of application it was observed to be 98.06±0.76 respectively.

Table 2 describes the radial pulse in both tested and control finger. We found that there was no change in the radial pulse after henna application from 2 hours till 07 days(p value more than 0.05 in all the cases).

Table 1: SpO_2 levels in tested and control finger

Description		Mean	Variance	t-value	p value
Right	Before	97.76±0.76	0.616		
Left (Transverse)		97.71±0.95	0.911	0.63	0.52
Left (Conventional)		97.75±1.06	0.137	0.15	0.87
Right	After 2hr	97.42±1.07	1.14		
Left (Transverse)		97.83±0.98	0.96	3.4	0.67
Left(Conventional)		97.84±1.25	1.58	2.76	0.51
Right	After 02 days	97.58±1.04	1.09		
Left (Transverse)		98.06±0.76	0.58	4.9	0.33
Left (Conventional)		97.98±0.87	1.47	3.06	0.28
Right	After 07 days	97.48±1.17	1.38		
Left (Transverse)		97.77±0.83	0.69	2.86	0.58
Left (Conventional)		97.81±0.75	0.57	2.60	0.81

Table 2: Radial pulse in tested and control finger

Description		Mean	Variance	t-value	p value
Right	Before	83.61±12.79	163.81		
Left (Transverse)		83.99±14.05	197.48	0.199	0.85
Left (Conventional)		85.18±13.6	184.97	0.84	0.41
Right	After 2 hr	85.28±14.96	224.01		
Left (Transverse)		84.48±14.5	211.06	0.24	0.81
Left (Conventional)		84.33±13.56	184.04	0.44	0.66
Right	After 02 days	84.68±11.8	140.30		
Left (Transverse)		84.59±12.3	147.35	0.32	0.74
Left (Conventional)		84,42±12.1	144.15	0.85	0.39
Right	After 07 days	84.24±10.66	113.69		
Left (Transverse)		83.65±10.7	114.75	0.41	0.68
Left (Conventional)		84.04±11.74	137.85	1.53	0.128

Discussion

In the early 1970s, significant progress was made in the development of reliable, relatively portable and affordable equipment, which made non-invasive monitoring of oxygen saturation possible in a variety of clinical settings. Pulse oximetry was quickly and widely accepted. A myriad of uses have been described in a wide variety of clinical settings. The value of pulse oximetry in patient care has been so great that pulse oximetry has been referred to as the ''fifth vital sign'' and ''arguably the greatest advance in patient monitoring since electrocardiography''[13,14].

A pulse oximeter functions by evaluating the transmission of light at two wavelengths. Any interference in the transmission of light is likely to affect the oxygen saturation readings Continuous pulse oximetry is the standard of care in monitoring of patients in the ICU. During patient monitoring early detection of untoward events using pulse oximeter is most important, as it may contribute to the prevention of hypoxic insults and therefore improve patient safety.

It must be noted however, that circumstances exist in which the pulse oximeter may give inaccurate or misleading information about arterial oxygen saturation. Until now, many factors have been described which can lead to erroneous results in measurement of oxygen saturation by pulse oximetry. One of these factors is the use of nail polish. Blue, green, and black coloured nail polish is considered especially to result in inaccurate measurements[15].

Skin pigmentation is one factor that may affect the accuracy of pulse oximetry. In critically ill patients, readings that were more than 4% different from actual measured SpO2 were found in 27% of black patients compared with only 11% of white patients[16]. Intravenous dyes such as methylene blue, indocyanine green, and indigo carmine can cause falsely low SpO2 readings for up to 20 minutes after administration. Henna (*Lawsoniainermis*) is a member of the family Lythracae, and is a commonly used dye. Henna, when newly applied, causes a black discolouration of the skin. During this initial phase, it absorbs all wavelengths of visible light, allowing only infrared rays to pass through. This results in the failure to monitor oxygen saturation using pulse oximeters[12]. Unlike other colorants, henna penetrates the superficial layers of the skin and cannot be removed immediately by solvents[17].

A study conducted by Majed SA et al have reported the effect of henna on the accuracy of pulse oximetry and revealed that black henna caused errors in oxygen saturation readings whereas red henna did not[9]. Another previous study screened that the style of the henna stain can influence the readings of the pulse oximeter. Patients who had henna paste applied to the thumbnails only showed an insignificant effect on oximetry but those in whom the entire digit was stained were at significantly higher risk for inaccurate readings when red henna was used[18]. In the present study there was no significant change in the oxygen saturation as measured by pulse oximeter after the application of henna which is in consistent with the other finding by Zolfaghari M et al in 2015[19].

In the present study, the radial pulse was not changed after henna application even after 07 days (p value more than 0.05 in all the cases). However, the oxygen saturation was changed from 2 hours of henna application till 07th day. Nevertheless it must be emphasized that a change of saturation of this minor magnitude (average 0.67%) does not translate into a clinically important change. In general, in clinical statistics a change in oxygen saturation of >3% is considered significant.On the basis of this study, application of natural henna does not cause an error in the measurement of oxygen saturation by pulse oximetry.

Conclusion

Patient monitoring is an essential part of critical care which has contributed to the greatly decreased levels of morbidity and mortality. During patient intensive care using pulse oximeter is most important tool as it may contribute to the prevention of hypoxic insults and therefore improves patient safety. One of the factors which may interfere with pulse oximeter

readings is the dark skin pigmentation caused by certain skin dyes. Our study illustrates that, application of natural henna does not causes any major error in the measurement of oxygen saturation by pulse oximetry however the darker shade of henna or black henna cause error in oxygen saturation we therefore suggest the patients not to apply any henna paste who are schedule for any interventions or surgery.

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