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Does Henna Affect Pulse Oximetry Reading? – A Study

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Abstract

Introduction: Pulse oximetry is a simple, non-invasive, continuous, bedside method of measuring blood oxygen saturation of patients in emergency departments. The accuracy of measurement in patient have been questioned due to its limitations when henna is applied in previous studies. *Objective:* Our study was done to determine whether pulse oximeter showed appropriate readings when henna has been applied. *Material and Methods*: 100 normal healthy individuals with ages between 20 & 40 years of both sexes were included into the study. In all participants red and black henna was applied to right thumb and index finger, this was the test finger. Uncoloured left thumb was used as control. Oxygen saturation was measured in all participants, both in day or night and at constant room temperature. Arterial blood gas analysis was also done on each individual to see the accuracy of pulse oximeter with partial pressure oxygen. *Results*: Red henna causes statistically significant difference as it showed there is mild change in reading of oxygen saturation to that of control finger whereas black henna when applied caused potential error in all pulse oximetry reading. *Conclusions*: Red henna is not likely to drastically change the accuracy of oxygen saturation measured by pulse oximeter whereas black henna does not show any reading.

Keywords: Henna; Pulse Oximetry.

Introduction

Pulse oximetry is a simple, relatively cheap and non-invasive technique to monitor arterial oxygenation. After its discovery by Takuo Aoyagi in 1972 [1] it has become increasingly used in outpatient clinics, wards, emergency rooms and operation theatres to monitor continuously patient's oxygen saturation (Spo2). Although an accurate method in reflecting oxygen level in the blood, but it has its own limitations in measuring Spo2. Pulse oximetry cannot differentiate between different forms of haemoglobin. Carboxyhemoglobin is registered as 90% oxygenated haemoglobin and 10% desaturated haemoglobin, thereby causing an overestimation of true saturation levels. Methemoglobinemia and sulfhemoglobinemia can cause false low or high SPO2. Significant venous pulsation such as occurs in tricuspid incompetence and venous congestion can cause falsely low SPO2. Poor perfusion [13] due to a number of causes, e.g., hypovolemia, hypotension, arrhythmias and vasoconstriction etc are other causes that may lead to falsely low signal. Environmental interference such as vibration at 0.5-3.5 Hz, excessive movement and perhaps high level of ambient light, including infrared heat lamps can interfere with recording. Opaque Nail polish and henna [14] cause interference and can lead to false readings. Intravascular dyes, such as methylthioninium chloride, methyleneblue, indocyanine green may also temporarily falsely reduce saturation readings. Adequate scientific evidence to prove or disprove that henna interferes with pulse oximetry readings are lacking. Our study aims to see whether henna alter oximetry readings significantly to cause change of patient management in emergency.

Materials and Methods

The study is designed as a prospective observational study which was done in the Department of Emergency Medicine at Peerless Hospital, Kolkata between June 2015 to May 2016. The study includes one hundred apparently healthy adult female and male volunteers between 20-40 years of age at the hospital. The study was explained to all subjects and written consent was obtained from all participants in their vernacular language regarding both invasive & non invasive procedures in a consent form. Health screening of the healthy volunteers was done by obtaining proper history and physical examination including axillary temperature, heart rate, respiratory rate and blood pressure. Capillary blood sugar was also recorded. Prior to the data collection for the actual study, SpO2 of all the fingers of each of the volunteers were checked without heena to make sure that there was no difference in SpO2 readings using pulse oximeters (model OxiMax N-560; NELLCOR) with a clip-type sensor. All pulse oximeter readings were taken during either daytime or night time at constant room temperature. Same pulse oximeter was used for each volunteer after taking all precautions to rule out factors that can adversely affect the accuracy of pulse oximeters, like transducer movement, peripheral vasoconstriction, a nonpulsating vascular bed, hypotension, anaemia or hypothermia.

For the red heena we used natural heena powder without additives and for black heena we used heena powder with additives and dye that were available in the market . Adult normal male and female volunteers had their right thumb and index finger coloured with red henna and black henna respectively used as test fingers. The uncoloured left thumb was used as a control. Henna paste was made by dissolving 1 gram henna powder in 10 CC water and applied to the distal phalanx of right thumb & index (test) of the individuals and kept for 2 hours (in order to have uniformity and direct supervision) whereas left thumb finger was left empty as control. After 2 hours the henna was scrapped off from right fingers and oxygen saturation was measured on both tested and control fingers. Arterial blood gas analysis was done in all participants to obtain standard P02 value in room air. All the data were noted down in a specified data collection form.

The study included apparently healthy adult females & males in the age groups 20 to 40 years with normal vitals and apparently healthy fingers. Adult females and males not falling under the above mentioned age groups and individuals with diseases like skin diseases, soft tissue disease, hemoglobinopathy, peripheral vascular disease, cardio-vascular disease, and pulmonary diseases were excluded from the study. Also individuals with conditions like jaundice, hypotension, hypothermia, pigmented skin, chills and rigor were excluded.

Statistical Analysis

A total of 100 subjects were enrolled into this study. There were 100 subjects of those left thumb has been used as a control (without using application of Henna) and right thumb has been considered as experimental finger with application of red henna. Also black henna has been applied in the right hand index finger which has been considered as another experimental finger. All data of the individuals has been entered into XL sheet and validated through logical checks. Finally data has been transferred into statistical Software package (SPSS ver. 19.0) and statistical analyses were done. For comparison of oxygen saturation between control finger and application of red henna finger, we used both parametric test (paired-t test) and non-parametric test (Wilcoxon signed rank test- for paired data) for statistical significant difference. The statistical significance level was considered at 5% level. We failed to compare oxygen saturation measurements between control finger and black henna finger, as 95% of the cases; reading of pulse oximeter did not show any value in black henna fingers.

Results

A total of 100 subjects were enrolled for participation in this study

Table 1: Age distribution of the participants

Age group	Frequency	Percent
20-25 years	18	18.0
26-30 years	40	40.0
31-35 years	33	33.0
36-40 years	9	9.0
Total	100	100.0

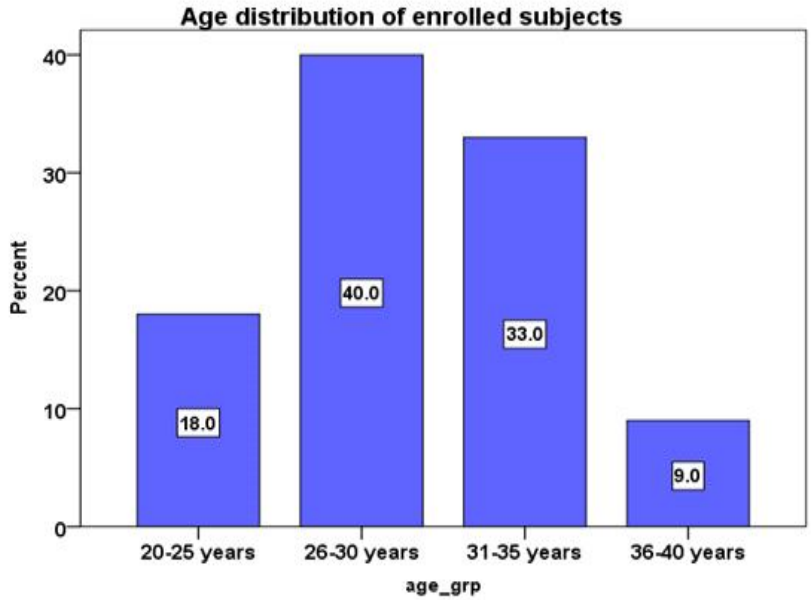

Fig. 1: Age distribution of the participants

Table 2: Sex distribution of enrolled patient

Sex	Frequency	Percent
Female	56	56.0
Male	44	44.0
Total	**100**	**100.0**

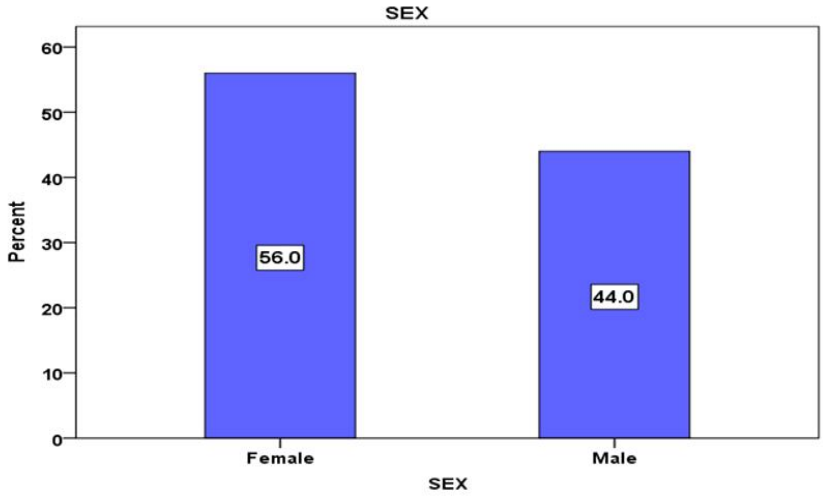

Fig. 2: Among the enrolled subjects, sex distribution was almost similar

Table 3: Age group wise sex distribution of enrolled subjects

Age Group	Sex		Total
	Female	Male	
20-25 years	14	4	18
	77.8%	22.2%	100.0%
26-30 years	21	19	40
	52.5%	47.5%	100.0%
31-35 years	18	15	33
	54.5%	45.5%	100.0%
36-40 years	3	6	9
	33.3%	66.7%	100.0%
Overall	56	44	100
	56.0%	44.0%	100.0%

Table 4: Distribution of PO2 (mm of Hg)

PO2 group	Frequency	Percent	Valid Percent	Cumulative Percent
80 - 85	2	2.0	2.0	2.0
86 - 90	23	23.0	23.0	25.0
91 - 95	13	13.0	13.0	38.0
> 95	62	62.0	62.0	100.0
Total	100	100.0	100.0	

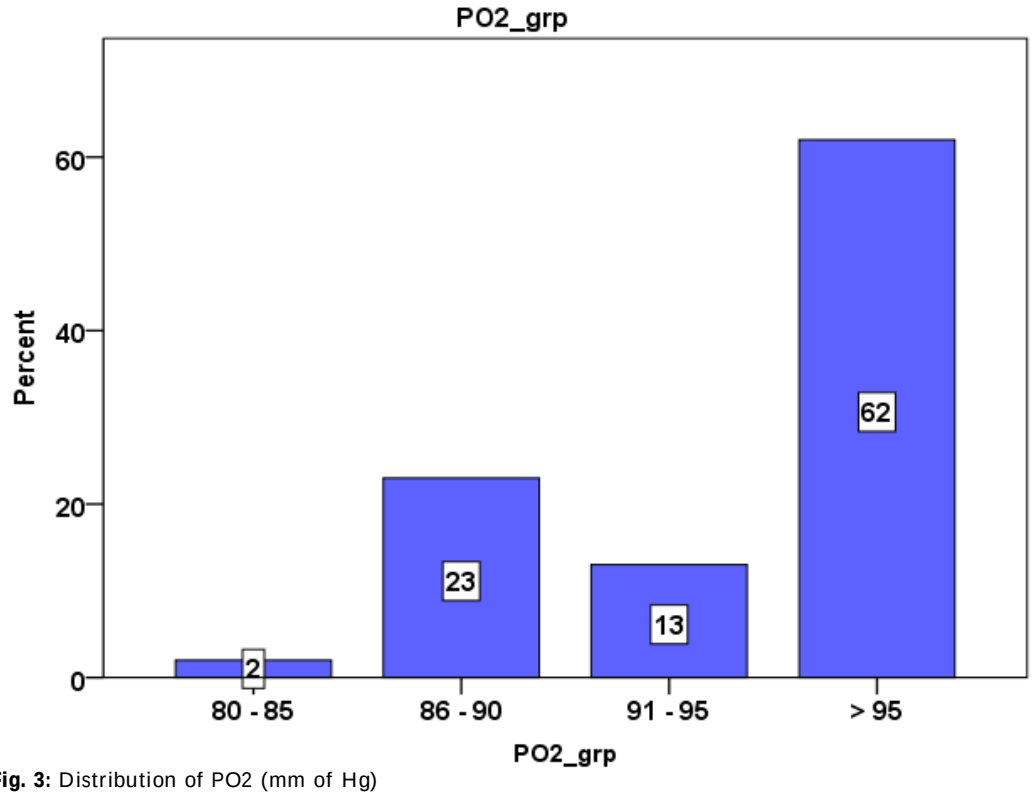

Fig. 3: Distribution of PO2 (mm of Hg)

Table 5: Distribution of SPO2(mm of Hg)

SPO2group	Frequency	Percent
97 - 98 %	12	12.0
99 - 100 %	88	88.0
Total	**100**	**100.0**

Table 6: Oxygen saturation label of the control finger without any henna application

Oxygen Saturation	Frequency	Percent
95 - 96 %	2	2.0
97 - 98 %	42	42.0
99 - 100 %	56	56.0
Total	100	100.0

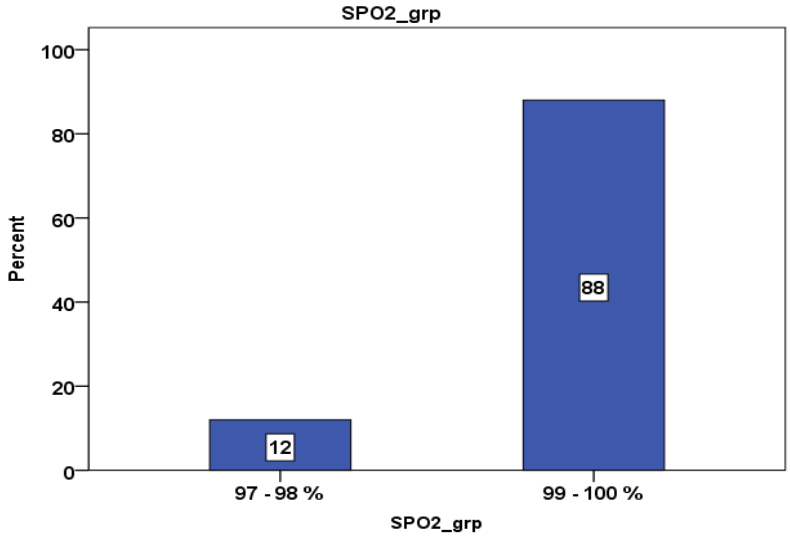

Fig. 4: Distribution of SPO2(mm of Hg)

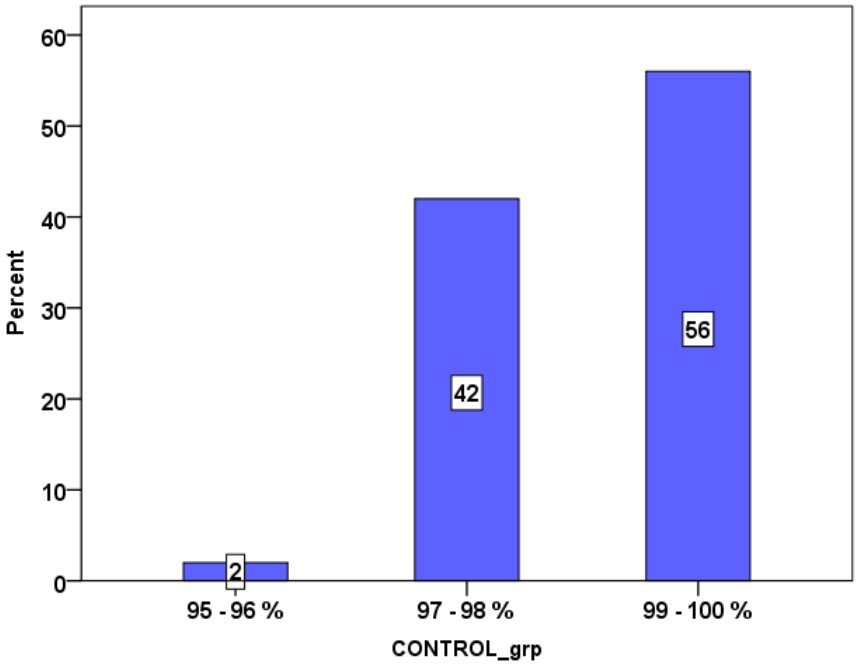

Fig. 5 Oxygen saturation label of the control finger without any henna application

Table 7: Oxygen saturation label of the finger with red henna application

	Oxygen saturation	Frequency	Percent
Valid	95 - 96 %	6	6.0
	97 - 98 %	81	81.0
	99 - 100 %	13	13.0
	Total	100	100.0

Table 6 Oxygen saturation label have been categorised into 3 groups (95-96%, 97-98% and more than 99%). The reading of oxygen saturation label in control finger (Left thumb without henna application) are presented in Table 7 and it was observed that only 2% had lower oxygen saturation label i.e. in between 95-96%

If we consider the oxygen saturated measurements continuous parametric variable, the reading in right thumb with application of red henna was slightly lower (mean ±sd: 97.6 ± 0.90) than that of application without henna in left thumb (mean ±sd: 98.6 ± 0.89) and this difference is not so high but it was statically significant by paired t-test ($p<0.001$) which is presented in Table 8. We also examined the data by considering as a continuous non-parametric variable and the results were presented as median value (minimum, maximum value). it was observed that oxygen saturation label was slightly lower with red henna application [median (min, max): 98% (95%,

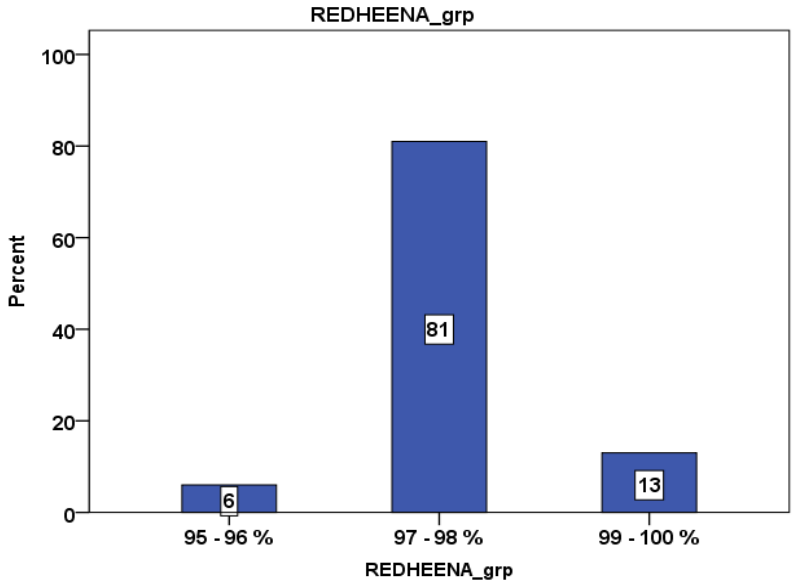

Fig. 6: Oxygen saturation label with application of red henna in right thumb was lower compared to control finger reading

Table 8: Comparison of Pulse Oximetry Reading (%) between control Left thumb and Right thumb with application of red henna

Group	N	Mean ± SD	Median (Min, Max)
Control (Left Thumb)	100	98.6 ± 0.89	99 (96, 100)
Right Thumb(with Red Henna)	100	97.6 ± 0.90	98 (95, 100)

		Paired Samples t-Test							
		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	control_fing - red_henna	.95	1.18	.12	.72	1.18	8.025	99	**.001**

Table 8a: A Non-parametric test: Wilcoxon Signed Ranks Test

Ranks				
		N	Mean Rank	Sum of Ranks
control_fing - red_henna	Negative Ranks	11[a]	28.95	318.50
	Positive Ranks	67[b]	41.23	2762.50
	Ties	22[c]		
	Total	100		

a. control_fing<red_henna : b. control_fing>red_henna : c. control_fing = red_henna

Table 8 b: Test Statistics

Test Statistics[b]	
	control_fing - red_henna
Z	-6.259[a]
Asymp. Sig. (2-tailed)	**.001**

a. Based on negative ranks. : b. Wilcoxon S

100%)] compared to that of control finger without use of henna ([median (min, max): 99% (96%, 100%)] but this difference also showed statistical significant difference (p=0.001) by Wilcoxon signed rank non-parametric test (Table 8b).

Discussion

Pulse oximetry has been regarded as fifth vital sign due to its ability to monitor continuously patient's oxygen saturation [18]. It is extensively used as monitoring tool in operation theatres, icu and emergency departments. It works on the basis of transmission and absorption of two wavelengths of light between emmitor and photodetector. Any interference in the transmission is likely to affect oxygen saturation. Monitoring of oxygen saturation is very critical in patient's initial management and safety in emergency.

Table 9: Comparison of Pulse Oximetry Reading (%) between control Left index finger and Right index finger with application of black henna

Group	N	Mean ± SD	Median (Min, Max)
Control (Left Index)	100	98.6 ± 0.89	99 (96, 100)
Right Index(with Black Henna)	100	No reading	No reading

Many circumstances may lead to fasely high or low oxygen saturation recording. 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 [3]. Henna is a dye commonly used in India as a cosmetic to decorate hands and feet in various rituals. This study recruited 100 normal healthy volunteers with normal oxygen saturation to evaluate the effect of heena dye on measurement of oxygen saturation by pulse oximetry. Results showed that there is slightly lower but statistical significant difference (p<0.001) in oxygen saturation in red henna group as compared to controlgroup. Though the difference obtained with red henna is statistically significant but the clinical values remained within the range of acceptability (from 95% to 100%), which is clinically insignificant. With black henna 95% cases showed no reading by pulse oximetry. A study Yaseen S. et al (2006) [19] showed there was no significant difference in oxygen saturation recorded in the finger dyed with henna in normal subjects as compared with the control, however, in hypoxic patients there was an increase in oxygen saturation in the henna-dyed fingers compared with control by 3%.

This study included hypoxic patient also and not specified colour of henna. Al-Majedet al (1994) [20] showed in 50 normal volunteers that red henna causes no significant difference in SPO2 measurement however black henna causes potential error in measurement by pulse oximetry. Finding of this study is similar to our study for black henna and red henna but sample size was less. Contradictory result obtained by Mitra Zolfaghariet al (2014) [21] who showed that oxygen saturation measured by pulse oximetry with red henna group is statistically significant (p=0.020) greater than control group. They concluded that this difference is due to Iranian henna which is different in terms and types of compound from henna of Saudi Arabia. More recent Iranian study (in 2014) [22] by the same group showed that Henna does not change the accuracy of oxygen saturation measured by pulse oximeter. Both this study only used red henna. A recent Indian study by NaziaUzmaet al (2016) [23] found application of natural henna does not cause any major error in measurement of oxygen saturation in young healthy individuals .This study closely match with our finding for red henna but they also not used black henna.

Conclusion

Pulse oximetry has become a quick and easy assessment process to measure the oxygen saturation of the patient in medical institutions. Because of its simplicity and portability it became a dependent tool in emergency scenario. Since the reading of pulse oximeter may help us in the initial management of a

patient, it is important to know its accuracy and factors that can affect. Among the many factors, henna is one (black and red henna) which effect its accuracy. In our study we found that red henna does affect the reading on pulse oximetry compared to that of control group by a very marginal number which may not be of clinical significant. But black henna causes potential error in reading. Hence we would like to suggest that black henna has to be removed before taking pulse oximetry reading or ear lobe to be used for SPO2 measurement.

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