Effects of henna dye on oxygen saturation reading using pulse oximetry

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Pulse oximetry is a non-invasive method that uses the spectrophotometric principle to monitor oxygen saturation in the blood. It produces a plethysmographic wave from which oxygen saturation is obtained.[1] It is has become increasingly used in outpatient clinics and emergency rooms in addition to its use in critically ill patients and during anesthesia.[1] Although it is an accurate method in reflecting oxygen level in the blood, its reading can be influenced by several conditions, including poor peripheral perfusion, carboxyhemoglobinemia, methemoglobinemia, and anemia. Henna is a cosmetic dye that is made from special leaves (Lawsonia inermis), 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. Recently, it has been sold in the west as a form of transient tattoo. It is particularly used in dying the skin of the hands and feet. The natural henna when used to dye the skin gives an orange-red color. However, when combined with synthetic dye it produces a black color. Studies have shown changing the color of the skin in hyperbilirubinemia,[2] and hyper-pigmentation[3] may influence the reading of pulse oximetry. Similarly, White and Boyle[4] demonstrated that applying nail polish to the nails can affect the accuracy of pulse oximetry readings. Therefore, it is possible that dying the fingers and toes with henna can give an erroneous pulse oximetry reading. However, we found only one study in the literature examining the effect of henna on pulse oximetry.[5] In this prospective study we have addressed this issue, and studied the effect of natural henna on the reading of pulse oximetry.

We recruited 104 healthy individuals (mean age 32.93; 16% male and 84% female) with normal oxygen saturation at room air. In addition, 14 patients (mean age 42.5; 6 male and 8 female) with hypoxemia on room air were enrolled. The study was explained to all subjects and consent was obtained. For the purpose of this study, hypoxemia was arbitrarily defined as oxygen saturation less or equal to 91%. The study was approved by the ethical committee of our institution (King Khalid National Guard Hospital), where the study was conducted. The study was explained to all subjects and consent was obtained. The henna paste was made from the same powdered leaves and in the same way for all patients. No synthetic dye was added to the henna. A professional traditional Saudi beautician used the same henna type commonly used in Saudi Arabia constituted henna paste. The henna was applied to the index finger of the right hand for all individuals, while the index of the left hand was not stained and used as control. The paste was applied to the finger for 2 hours in all patients. The same oximeter (Ohmeda Blox 37000) was used for all subjects enrolled in the study. All measurements were performed under room temperature on room air. The oximeter probe was applied to the nail bed of each index finger (test and control) perpendicular to its anterior-posterior diameter and the values obtained were recorded after stable reading was attained. Results were expressed as median and range. Wilcoxon signed-rank test for paired data was used to compare continuous non-parametric variables obtained with and without henna applications. Although oxygen saturation was slightly higher with henna (median 98%, range 96-100%) compared with the control (median 97% range 95-100%), the difference was not statistically significant ($p>0.05$). Measurement of oxygen saturation in patients with cardio-respiratory disease and hypoxemia showed significant difference ($p<0.01$) between the test (median 82, range 65-91%) and control (median 79, range 55-89%) (**Figure 1**).

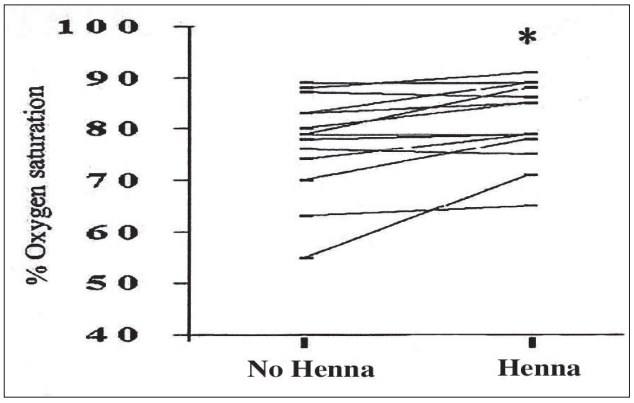

Figure 1 - The effect of henna on oxygen saturation in hypoxic patients measured by oximetry. Results expressed as median; *stand for $p<0.01$.

In this study, we have demonstrated that in normal subjects there was no significant difference in oxygen saturation recorded in the finger dyed with henna 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% in most cases (13 out of 14 patients).

These findings suggest that henna dye gives a falsely higher reading when using pulse oximetry in patients with low oxygen saturation. Al-Majed and Harakat[5] studied the effect of natural henna and black henna (natural henna mixed with synthetic dye) on oximetry reading of normal individuals. These authors found that the oximetry reading was substantially limited by black henna. In contrast, they found there was no significant difference between the values from the fingers dyed with natural henna compared with control. However, these authors studied only normal subjects with normal oxygen saturation, and therefore the propensity of the henna to increase the reading was not detected. This study has an important clinical implication, especially in the Middle East, Asia and Africa, where staining of the fingers with henna is a common cosmetic practice. This is particularly relevant in patients with cardiopulmonary disease who seem keen to use henna as a cosmetic dye to mask the bluish discoloration in the fingers due to cyanosis. Although henna does not change significantly the oxygen saturation measurement in normal subjects using oximetry, in the setting of hypoxemia, there is significant difference in oximetry reading with henna compared with control. This can be of great clinical importance, especially in patients with compromised saturation where a difference of 1-3% in oxygen saturation could count. Therefore, we recommend the use of the ear lobe for oxygen monitoring in patients applying henna to their hands.

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Random 2 dimensional ultrasonic evaluation of uterine cervix in pregnancy

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A competent uterine cervix is the bedrock of normal pregnancy. Although there is no anatomical sphincter, the isthmus and internal cervical os of the uterus, have a containing function. A failure of this containing function, with subsequent lack of support for the fore waters, is said to explain the condition of cervical incompetence in pregnancy. The start of incompetence of cervix in pregnancy, most of the time is silent as it goes with painless effacement of the cervix, thinning of the wall and dilatation of the cervical os. This occurs mostly between 16-28 weeks gestation, and affects 10% of pregnant women. Since this condition is not induced by start of labor, it is rather due to structural weakness of the cervix. This weakness of the cervix is mostly idiopathic, but can result from the following conditions; injury to the cervix such as dilatation and curettage, cone biopsy, deep cervical laceration, diethylstilbestrol exposure, and can also occur from inherited physical conditions of the cervix. The final effect of incompetence of the uterine cervix is abortion or premature labor. The most common outcome is death of a viable fetus. This usually causes devastating psychological trauma to the patient, and most especially in recurrent effects of incompetence cervix. The most common course of management is the use of cervical cerclage, bed rest and relaxation drug therapy, and this is a common practice among obstetricians in Nigeria. Besides, diagnosis of cervical dystocia in labor is a very unreliable diagnostic decision, as in our environment the diagnosis is subject to the experience of the attending obstetrician, based on only finger palpation of the cervix. This may affect early intervention by cesarean section and can lead to the following complications, ruptured uterus, intrauterine fetal death, cervical laceration, and possible death of the mother. The reason for the study of random ultrasonic sampling evaluation of uterine cervix in pregnancy is to introduce, a non painful, non invasive, evidence based picture, and reproducible reliable method of determining the possible start of uterine cervical competence in pregnancy from routine ultrasonic assessment in our environment. This will be useful

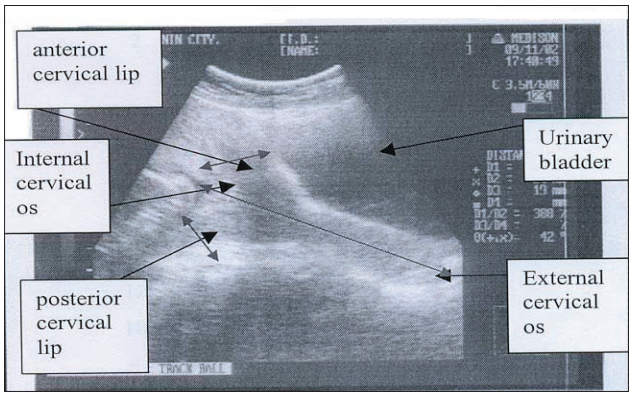

Figure 1 - Ultrasonogram showing cervix (second trimester preganancy). Internal cervical os was closed, cervix length was 93mm, anterior lip of uterine internal cervical os diameter was 24mm and the lower lip of uterine internal cervical os diameter was 19mm.

Table 1 - Frequency of occurrence of cervical dimensions.

Measurements (cm)	Cervical length	ICOP	ALICOD	PLCOD
0 - 0.4	-	66	1	1
0.5 - 0.9	-	1	13	8
1 - 1.4	-	4	29	21
1.5 - 1.9	-	-	13	21
2.0 - 2.4	-	2	11	10
2.5 - 2.9	2	-	1	5
3.0 -3.4	-	-	1	3
3.5 - 3.9	3	-	1	4
4.0 - 4.4	6	-	1	-
4.5 - 4.9	7	-	2	-
5.0 - 5.4	6	-	-	-
5.5 - 5.9	12	-	-	-
6.0 - 6.4	12	-	-	-
6.5 - 6.9	10	-	-	-
7.0 - 7.4	4	-	-	-
7.5 - 7.9	2	-	-	-
8.0 - 8.4	3	-	-	-
8.5 - 8.9	6	-	-	-
9.0 - 9.4	-	-	-	-
9.5 - 9.9	-	-	-	-

ICOP - uterine internal cervical os patency,
ALICOD - anterior lip of uterine internal cervical os diameter
PLICOD - lower lip of uterine internal cervical os diameter

in comparative follow up evaluation to determine incompetence and dystocia in labor, as ultrasound evaluation with present day knowledge has no adverse side effect. Some studies show a different funnel shape form of the cervical canal opening and protrusion of amniotic membrane into it in pregnancy, such as T, Y, V and U.[1-3] In this study, it was taken into consideration, and has not affected the measurements, as our measurement were taken from the lower limits of the amniotic fore water.

A random ultrasonic assessment of the uterine cervix in pregnancy during the routine ultrasonographic evaluation, of pregnant women, attending antenatal care was carried out (**Figure 1**). The examinations were carried out in the following centers, University of Benin Teaching Hospital, Benin Nigeria and NNPC Medical Center Warri, Nigeria. Seventy-three pregnant women were assessed within the period from January to October 2002. The patients were informed of the research intention and consent was obtained from each patient. There was no special attention paid to any particular period of gestation age, hence assessment were carried out in random from 6 weeks gestation to 40 weeks gestation. Each patient was scanned with either Medison sonace or Siemen ultrasound scanning machines; a B-mode real-time scans with gray scale imaging. Patients were scanned in the supine position with a 3.5 MHz curvilinear array transducer. The scanning was carried out supra-pubically through an inert aqueous gel for good skin contact and a full urinary bladder as ultrasonic window. The following parameters were evaluated; 1. Maximum length of uterine cervix, starting from the inferior wall of the gestation sac as it deepens into the internal cervical os to external cervical os. 2. Opening and width of dilatation of uterine internal cervical os. 3. Maximum diameter of the anterior lip of uterine internal cervical os. and 4. Maximum diameter of the posterior lip of uterine internal cervical os. The gestation age using Hadlock et al[6] biparietal diameter measurement, has an statistical mean value of 6.75 cm, median value of 7.8 cm, and standard deviation (SD) of 2.51 cm, hence in most of the pregnant women the gestation age statistically fell within 21 week + 6 days ± 14 days and 42 weeks ± 24 days. Specifically, 8 of the women's' pregnancies were at the first trimester, hence, Hadlock biparietal diameter measurement was not applicable to them, however, they were assessed based on crown rump length. The uterine cervical length has a range of 2.5-8.9 cm, with a mean value of 6 cm, median value of 5.97 cm and SD of 1.38 cm (**Table 1**). Hence, normal range statistically can be assessed as 5.97 ± 1.38 (median ± SD) which is equal to 4.89-7.35 cm. The maximum diameter of the anterior lip and posterior lip of the uterine internal cervical os, has a respective range of 0-4.9 cm, and 0-4.4 cm. The anterior lip of the uterine internal cervical os diameter has a mean value of 1.56 cm, median value of 1.34 cm and SD of 0.876 cm. Hence, the statistical normal range is 0.464-2.216 cm. The posterior lip of the uterine internal cervical os diameter has a mean value of 1.73 cm, median value of 1.6 cm and SD of 0.769 cm. Hence, the statistical normal range is 0.804-2.396 cm. The internal cervical

os, in the majority of the cases were closed, but had the mean of value 0.32 cm, median value of 0 and SD of 0.395 cm. Hence, statistically the normal range is from 0-0.395 cm. This study has shown the possibility of the use of ultrasound to determine the size of the cervix in pregnancy. With the assessment of average length of uterine cervix, maximum diameter of the anterior and posterior lip of the uterine internal cervical os and the opening of the uterine internal cervical os, it may be possible to determine cervical effacement or cervical dystocia in labor. This may need further confirmatory test in follow up on a suspicious patient. The following assessment criteria are elicited in the study; 1. Cervical length between 4.89-7.35 cm was considered as acceptable range. 2. Internal cervical os acceptable range of dilatation was between 0-0.395 cm. 3. The anterior and posterior lip of uterine internal cervical os, acceptable range of normal were between 0.464-2.216 cm and 0.804-2.396 cm.

Our primary target for this study was to determine a baseline size to monitor cervical effacement in pregnancy. The study shows that 11% of women evaluated, were in the first trimester of pregnancy, 31.5% at the 2nd trimester of pregnancy and 57.5% at the 3rd trimester of pregnancy. The random evaluation allowed the entire variable in uterine cervical effacement to be considered in this study. Hence, the study is suggesting that upper range of the normal measurements were for the 2nd trimester of pregnancy while the lower range of the normal measurements were for the 3rd trimester of pregnancy. This is based on the statistical analysis which showed that the pregnant women fell within the range of 21 week + 6 days ± 14 days and 42 week gestation ± 24 weeks. Hence, at the lower limit of the normal range of measurements at 2nd trimester may suggest start of premature effacement of the cervix, which may mean start of incompetence cervix. The upper limit of the normal range of measurement at late 3rd trimester pregnancy, especially during labor, may suggest cervical dystocia in labor. This study may have been able to bring to the fore, better, reliable, reproducible with pictorial documentary evidence of assessing the uterine cervix. This will reduce to the barest minimum, the use of vaginal finger examination of uterine cervix in such assessment. The uses of finger examination of uterine cervix have the disadvantage that most pregnant women would rather avoid vaginal examination. It can be a source of introducing infection and may exacerbate premature effacement of uterine cervix. This type of examination is strongly dependent on the experience of the examiner; hence, it is highly subjective and carries the risk of ante-partum hemorrhage in patients with placenta previa.

In conclusion, this study has shown effectiveness in use of ultrasound to determine, uterine cervical length, internal cervical os dilatation, upper and lower lip of uterine internal cervical os maximum diameter. We therefore suggest the use of these ultrasonographic measurements in determining the condition of the cervix in pregnancy, and can be used as a reliable evidence based method in determination of management choice in incompetence cervix, and cervical dystocia. Even though work is in progress for confirmation of the deduction on patients with a history of cervical incompetence or dystocia in labor, it is also a very good reproducible method for follow up comparable assessment of cervix.

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