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Comparison between digital hematocrit reader and standard centrifugation based hematocrit measuring instrument.

مقارنة بين قراءة نسبة الدم بالجهاز الرقمي والجهاز القياسي المعتمد على الطرد المركزي.

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Abstract:

The study is designed to determine the differences between readings of hematocrit by the digital hematocrit reader and the standard centrifugation based hematocrit measuring instrument.75 individuals (25 healthy individuals, 25 anemic individuals and 25 polycythemic individuals), 38 males and 37 females with age range of 18-51 years, were studied after their consent. For each patient, 2 ml of venous blood sample was obtained for hematocrit measurement by the two different devices for comparison. Results showed that the digital hematocrit measures are less than that of the standard centrifugation based instrument in 69 out of 75 individuals i.e 92% which requires special attention during diagnosis or treatment and follow up.

الخلاصة :

تمت دراسة نسبة الدم باستخدام الجهاز الرقمي والجهاز القياسي المعتمد على الطرد المركزي للمقرنة بين القراءات لدى 75 شخصا (25 شخصا طبيعيا, 25 شخصا مصابا بفقر الدم و 25 شخصا مصابا بزيادة في نسبة الدم)وتم سحب 2 ملي لتر من الدم الوريدي بعد اخذ الموافقة منهم لقياس نسبة الدم بجهازين مختلفين. أظهرت النتائج بان نسبة الدم باستخدام الجهاز الرقمي اقل منها في الجهاز القياسي لدى 69 من مجموع 75 شخصا اي بنسبة 92% من الحالات وهذا يحتاج الى الانتباه الخاص عند تشخيص او متابعة علاج المريض ومعرفة او تحديد نوع الجهاز المستخدم لقياس نسبة الدم.

Introduction:

Hematocrit (Hct) or packed cell volume (PCV) measure is one of the very important daily required measures for many individuals including healthy[1] (e.g for routine checking), anemic[2] and polycythemic[3] individuals. Not only the first measure is important, but the subsequent follow up measures are also important to determine the improvement or worsening of the patient state. The normal adult male hematocrit value is 40-50% while the normal value for adult females is 36-46% i.e. there is a sexual variation in hematocrit values with higher values in males[1].

Hematocrit value is affected by plasma volume and the state of hemoconcentration can lead to high hematocrit measure while hemodilution gives low hematocrit measure as seen in normal pregnancy in which the activity of erythropoiesis is usually increased with an increase in plasma volume with an end result of low hematocrit measure[4&5].

The value of hematocrit is 2-4% lower than normal when blood is collected from the arm in atrial level (i.e elevated arm)[6]. Hematocrit value is also affected by posture being transiently decreased (5-10%) when blood is collected after change in posture from walking to lying down. This fall is transient (lasts for 20 minutes) due to changes in plasma volume and stabilized after 20 minutes[7&8]. A study showed that there is a significant increase in hematocrit value when there is a change in posture from lying to sitting[9]. Race differences in hematocrit values is shown in Godsland's study which showed that healthy Indians who live in United kingdom (UK) had lower hematocrit values than UK peoples regardless nutritional status[10]. There is a slight higher morning hematocrit values than evening values (i.e there is a diurnal rhythm in hematocrit values)[11]. The standard centrifugation based instrument requires special capillary tubes designed for the instrument, electrical current (220-240 volt), and a special measurement scale to read the result after capillary centrifugation at 12000 rounds/minute for 3-5 minutes. Results by the centrifugation

device require up to 5 minutes[12] while the digital hematocrit reader is a portable small instrument supplied with small battery which gives the result within few seconds after adding 10µl of blood to a special application strip. The digital instrument is designed for both hemoglobin and hematocrit measures and its main principle is the hemolysis of red cells, followed by conversion of hemoglobin to methemoglobin with subsequent measurement of methemoglobin concentration as reflected by its colour to give the result of methemoglobin concentration which corresponds to hemoglobin concentration and by multiplying this resuly by the number 3, measurement of hematocrit is obtained. Hematocrit test by the digital reader is a bed side simple test which does not require laboratory or difficult handling[13].

Subjects and methods

From May 2013 to November 2013, 75 individuals (25 healthy individuals, 25 anemic individuals and 25 polycythemic individuals), 38 males and 37 females with age range of 18-51 years, were studied in Karbala special private laboratory for hematological investigations after their consent. For each patient, 2 ml of venous blood sample was withdrawn from unelevated arm (i.e dependent, or arm at rest) at evening (about 6:00 PM) for hematocrit measurement by the two different devices (the hematocrit centrifuge; model: KHT-410E, Cannic, inc, USA and the digital device, mission trade mark, Acon laboratories, 10125 Mesa Rim Road, San Diego, CA 92121, USA). Blood samples are collected in EDTA tubes with appropriate shaking and measurement of hematocrit is done for each sample using both devices as follow:

Using the ordinary hematocrit capillary tube, ¾ of capillary tube is filled with blood, sealed at the other end by wax and centrifuged by the standard hematocrit centrifugation based instrument for 4 minutes[16]. At the same time 10 µl of blood is withdrawn by micropipette (instrument instructions suggest the use of drop of blood directly or from the capillary tube or micropipette for accurate procedure) and transferred to a special application site in an already inserted strip. The digital hematocrit reader will give the result (hemoglobin and hematocrit) after few seconds. Statistical analysis was done using paired t-test and the difference is considered to be statistically significant when $p \leq 0.05$. For each group (healthy, anemic and polycythemic groups), the mean value of hematocrit by both devices is calculated together with the mean difference and the standard deviation of difference to find t-value and p value for each group.

Results

Results showed that 69 out of 75 individuals (92%) have less hematocrit value (the mean of hematocrit by digital instrument is 38.833% and by centrifugation instrument is 41.333% i. e 2.5% less than that of the standard centrifugation based device with no statistically significant differences, $P>0.05$) while 6 out of 75 individuals (8%) have exactly similar readings and there is no observed digital hematocrit value which is higher than that of the standard centrifugation based device. Individuals who have lower digital hematocrit measures than the standard device are 69/75 (20 from the 25 healthy group i.e 29%, 24 from the 25 anemic group i.e 34.8%, and 25 from the 25 polycythemic group i.e 36.2%). P value was more than 0.05 for each group.

Table1. Mean hematocrit values (PCV) which are measured by digital and centrifugation devices.

	Digital device	Centrifugation device	P value
Mean PCV of 75 individuals	38.833%	41.333%	P > 0.05 (not significant).
Mean PCV of healthy group (n=25)	41±1	43.6±1.2	P > 0.05 (not significant).
Mean PCV of anemic group (n=25)	21±1.2	23.5±1.1	P > 0.05 (not significant).
Mean PCV of polycythemic group (n=25)	54.5±1.02	56.8±1.04	P > 0.05 (not significant).

Discussion

The study showed that 69/75 (92%) had different hematocrit measurement (the digital device measurements are less than that of the centrifugation device); however, there is no statistically significant difference between the two measurements. Follow up of patients by different instruments may cause misleading results which cannot be explained by the physician. On the other hand 6/75 (8%) had similar measurements by both devices. The standard centrifugation device is well known to be accurate; however, there are few cases of false high or false low hematocrit measurement e.g in case of hemoconcentration or hemodilution[12]. Few private side laboratories (minor laboratories) depend on digital device without the presence of centrifugation device. Physicians should ask about the type of device for hematocrit or ask for result of both hematocrit and hemoglobin for better interpretation and explanation of results. The main laboratories are usually depending on the centrifugation device alone or the centrifugation and digital devices together for each result to be more accurate.

The digital hematocrit device is important for quick hemoglobin estimation together with hematocrit estimation with no need for special voltage regulator and can be used as a simple bed side test[13]. In case of low voltage supply to the standard centrifugation device (less than 180 volt), there will be inadequate centrifugation characteristically less than 12000 rounds per minute leading to false high hematocrit measurement. This situation is frequently encountered in Iraq because of low voltage supply of city generators; however, there are instruments which can be used to regulate or elevate the voltage (auto voltage regulators) and supply the needed voltage for centrifugation devices to give accurate results[8].

Conclusion:

The study showed that the digital hematocrit measurements are less than that of the standard centrifugation based device in 92% of individuals with no statistically significant differences; however, results of diagnosis or follow up of patients might be misinterpreted because of the use of different devices for hematocrit measurement which need special attention.

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