REVIEW ARTICLE

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Does mobile phone impair blood cells?

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Abstract

Background: Electromagnetic waves (EW) of mobile phones are incriminated to be a risk factor of many health disorders and in tumor development. Actually, effects of EW on blood cells are not well known, the objective of this study was to search eventual structural changes of blood cells after an exposure to EW emitted by a mobile phone. **Material and methods:** 30 healthy volunteers were sampled for a complete blood count (CBC) on ADVIA 2120i. Each sample was placed in direct contact with a smartphone during a call for 60 min. likewise, each volunteer emitted a call with a smartphone placed near ear for 60 min. CBC of the first sample was redone and volunteers were sampled for a second CBC and compared to the first results before exposure to EW. **Results:** Acute exposure to EW was responsible for a decrease of neutrophil count with a rise of myeloperoxidase activity explicated by an activation and destruction of neutrophils followed by the release of immature granulocytes. For red cells, an isolated decrease of mean cell volume (MCV) was observed without modification of hemoglobin rate. Theses modifications were more important in blood samples than in human volunteers. **Conclusion:** Acute exposure to EW seems to alter neutrophils and red cells physiology. Potential clinical impact of mobile phone in hematology needs to be more considered.

Keywords: Electromagnetic waves, Complete blood count, Mobile phone, Hematology.

INTRODUCTION

EW emitted by are suspected to be a risk factor of many health disorders. In 2005, the world health organization (WHO) defined the electro sensitivity as an idiopathic environmental intolerance secondary to electromagnetic expositions including redness, tingling, burning sensation, dizziness and cardiac palpitations. This manifestations concern 10% of all population in developed countries [1]. In a new report in 2011, WHO described chronic exposition to electromagnetic waves as responsible for oxidative stress, disturbance of immune system, genotoxicity and even carcinogen especially for cerebral tumors after chronic exposure to EW of mobile phone [2] and thereby, the WHO classed the EW in the group 2B as possible carcinogen [3]. Many authors studied the effects of exposure to EW in humans and animals and several observations were made. It is estimated that a long exposure to EW of a mobile is responsible for increasing brain temperature, an accumulation of intracellular calcium in pituitary gland, an accumulation of free radicals in brain and also DNA damages responsible for tumor development [4, 5].

In hematology, the impact of EW of a mobile was also described in some parameters of complete blood count (CBC) after an exposure of 30 to 60 minutes of a sample. Some modifications were found particularly in polynuclear neutrophils structure and EW were considered as a potential source of preanalytical error [6-11].

Actually, hematological impact of exposure to EW of a mobile on human body remains little known. In this work, we tried to check the effects of exposure to EW on blood cells as revealed by CBC. We studied separately the direct impact on blood samples and in a second time effects on CBC of healthy mobile users.

MATERIALS & METHODS

This analytic study was done in the laboratory of hemobiology of the 1st November hospital of Oran. 30 healthy volunteers (age ranging from 18 to 40 years old) were enrolled from students and personal of the laboratory. Volunteers were free from any chronic disease and did not use their mobile 12 hours before participating in the study. All participants were informed about the objectives and the course of the study.

To evaluate effects of EW of a mobile phone on hematological parameters of a whole blood sample and on human body we

used a mobile using 3G network (1800Mhz) with a disabled WIFI connection. Hematological parameters were determined on analyzer ADVIA 2120i (SIEMENS healthcare). Routine and research parameters were studied and are listed below.

Erythroid parameters: red cells rate (RBC), hemoglobin (HB), MCV, mean concentration of hemoglobin (MCH), red cells distribution width (RDW) and percentage of macrocytic (MACRO) and hypochromic (HYPO) red cells.

Parameters of leucocytes: leucocytes rate (WBC) with differential (NEUT, EOS, BASO, LYMPH and MONO), myeloperoxidase index of neutrophils (IMPX), percentage of myeloperoxidase saturated neutrophils (HPX), the d/D valley of BASO cytogram (reflecting the area of low segmented granulocytes) and index of segmentation of polynuclear cells (PMNX).

Platelet parameters: platelet rates (PLT), mean platelet volume (MPV), platelet distribution width (PDW), mean platelet concentration (MPC), mean platelet mass (MPM) and platelet aggregates count (PAC).

Organization of the study

Specific steps of blood sampling were the same for all subjects. Whole blood specimens were collected on evacuated plastic tube containing K3EDTA from an antecubital vein of the arm and mixed 10 times to avoid clot formation.

First, a CBC was performed to determine the basal status of each participant and was designated T0. Then, the whole blood sample was placed in direct contact with a smartphone receiving a call for exactly 60 minutes. Immediately at the end of the call, a second CBC was done for the sample and appointed T1vitro.

In the same time, each volunteer made a phone call of 60 minutes with a smartphone close to ears. The mobile used have the same specifications then the mobile used in the first step. After this, the volunteer was sampled for a second CBC and appointed T1vivo.

Data collection and statistical analysis

Data was collected from all results and statistical analysis was conducted using SPSS 20 software (IBM®). CBC of basal sample (T0) was considered as reference and compared to CBC done after 1 hour (after exposure of the sample to EW and after exposure of volunteer to EW). t test of student was used to compare results and to evaluate changes of each parameter: T0 vs T1vivo and T0 vs T1vitro. Statistical significance was defined as $P<0.05$.

RESULTS

Results of comparisons are resumed in the tables below. Difference of means of each parameter before and after exposure to EW are précised with the statistical signification of the deviation.

Leucocyte parameters are listed in table 1, in blood samples there was a decrease of neutrophil rate especially neutrophils with high peroxidase activity probably after their destruction. For volunteers, there was no changes in neutrophil rate but just a significant decrease of segmentation of granulocytes.

Table 1: Modifications of leucocytes parameters, evaluation of the difference before and after exposure to EW of blood sample and human users (significant differences are marked with an asterisk)

Parameters	Difference of means	Standard deviation	P
WBC T0 vs WBC T1vivo (G/l)	-0.026	0.129	0.842
WBC T0 vs WBC T1vitro (G/l)	0.043	0.048	0.373
NEUT T0 vs NEUT T1vivo (G/l)	0.106	0.122	0.392
NEUT T0 vs NEUT T1vitro (G/l)	0.277	0.122	0.031*
LYMPH T0 vs LYMPH T1vivo (G/l)	-0.066	0.116	0.576
LYMPH T0 vs LYMPH T1vitro (G/l)	-0.005	0.020	0.812
MONO T0 vs MONO T1vivo (G/l)	0.349	0.223	0.130
MONO T0 vs MONO T1vitro (G/l)	0.29	0.225	0.210
EOS T0 vs EOS T1vivo (G/l)	0.228	0.163	0.172
EOS T0 vs EOS T1vitro (G/l)	0.232	0.164	0.170
BASO T0 vs BASO T1vivo (G/l)	0.055	0.036	0.144
BASO T0 vs BASO T1vitro (G/l)	0.061	0.036	0.100
NEUTX T0 vs NEUTX T1vivo	-0.864	0.824	0.304
NEUTX T0 vs NEUTX T1vitro	-3.903	0.715	<0.001*
HPX T0 vs HPX T1vivo (%)	-0.708	0.381	0.074
HPX T0 vs HPX T1vitro (%)	0.581	0.208	0.009*
PMNX T0 vs PMNX T1vivo	1.746	0.392	<0.001*
PMNX T0 vs PMNX T1vitro	0.792	0.395	0.055
IMPX T0 vs IMPX T1vivo	-2.457	0.937	0.014*
IMPX T0 vs IMPX T1vitro	-7.553	2.397	0.004*
d/D T0 vs d/D T1vivo	0.071	0.029	0.025*
d/D T0 vs d/D T1vitro	-0.071	0.025	0.012*

Platelet parameters are summarized in table 2. The only change observed was an increase of platelet rate in blood sample. Table 3 concerns red cells parameters. The decrease of MCV was significant also in blood samples and with human volunteers. It is clear that red cells become smaller after exposure to EW without anemia development.

Table 2: Modifications of platelets parameters, evaluation of the difference before and after exposure to EW of blood sample and human users (significant differences are marked with an asterisk)

Parameters	Difference of means	Standard deviation	P
PLT T0 vs PLT T1vivo (G/l)	-3.285	5.343	0.544
PLT T0 vs PLT T1vitro (G/l)	-9.214	2.538	<0.001*
MPV T0 vs MPV T1vivo (fl)	0.117	0.109	0.293
MPV T0 vs MPV T1vitro (fl)	-0.203	0.109	0.074
PDW T0 vs PDW T1vivo (%)	-0.021	0.649	0.974
PDW T0 vs PDW T1vitro (%)	0.414	0.729	0.575
MPC T0 vs MPC T1vivo (g/dl)	-0.132	0.284	0.646
MPC T0 vs MPC T1vitro (g/dl)	0.053	0.736	0.943
MPM T0 vs MPM T1vivo (pg)	0.002	0.007	0.791
MPM T0 vs MPM T1vitro (pg)	-0.004	0.008	0.617
PAC T0 vs PAC T1vivo	-12.321	19.261	0.528
PAC T0 vs PAC T1vitro	-8.964	9.858	0.371

Table 2: Modifications of red cells parameters, evaluation of the difference before and after exposure to EW of blood sample and human users (significant differences are marked with an asterisk)

Parameters	Difference of means	Standard deviation	P
RBC T0 vs RBC T1vivo (T/l)	0.03	0.126	0.813
RBC T0 vs RBC T1vitro (T/l)	-0.012	0.022	0.591
HB T0 vs HB T1vivo (g/dl)	-0.01	0.132	0.936
HB T0 vs HB T1vitro (g/dl)	0.11	0.768	0.137
MCV T0 vs MCV T1vivo (fl)	0.55	0.183	0.006*
MCV T0 vs MCV T1vitro (fl)	0.707	0.127	<0.001*
MCH T0 vs MCH T1vivo (g/l)	0.457	0.419	0.285
MCH T0 vs MCH T1vitro (g/l)	0.303	0.409	0.465
RDW T0 vs RDW T1vivo (%)	0.042	0.027	0.130
RDW T0 vs RDW T1vitro (%)	-0.6	0.645	0.361
HYPO T0 vs HYPO T1vivo (%)	0.692	0.430	0.119
HYPO T0 vs HYPO T1vitro (%)	1.171	0.289	<0.001*
MACRO T0 vs MACRO T1vivo (%)	0.096	0.035	0.011*
MACRO T0 vs MACRO T1vitro (%)	0.078	0.031	0.017*

DISCUSSION

In this work, we tried to evaluate eventual effects of an exposure to EW of a mobile phone on blood cells. For this, we compared results of CBC before and after 60 minutes of exposure to EW of a mobile call. So, the study has focused on direct effects on a blood sample and on healthy humans.

Many studies reported that approximately 70% of EW are absorbed by organs and tissues of the body and transformed in heat and can also cause cellular damages, modification of arterial pressure and cardiac frequency, development of neurological symptoms and even inflammation [8]. Almost all studies and experimentations about biological effects of EW concerned animals' models. For humans, pathogenicity of EW was studied retrospectively to follow up tumor development and also for neurological symptoms. However, hematological implication of EW was done only in blood samples.

In the present study, platelet rate raised significantly in blood sample after exposure of EW. This constatation can be induced by a fragmentation of other cells that can be counted as platelet. this modification has not been observed in human volunteers for which platelet rate remains unchanged as in the studies of Ahmed and Lippi after a chronic exposure to EW of a group of students [7, 12]. However, an increase of platelet rate in rats after chronic exposure to EW was also described by many authors and explained it by a stimulation of megakaryopoiesis [13-17].

In blood sample, a raise of MPV was also found by Lippi who explained it by a probable platelet activation [7] while in our study, no change of MPV and other extended platelet parameters was found in in vivo and in vitro tests.

Concerning leucocytes with differential count, no change was found excepting for neutrophil rate in in vitro test. A significative decrease of neutrophils was found in blood sample related probably to a neutrophil destruction. Moreover, the myeloperoxidase activity in neutrophils increased significantly in blood sample as revealed by the IMPX, HPX and NEUTX but in opposite, Lippi found a decrease of myeloperoxidase activity in blood sample after 30 minutes of exposure to EW [6]. This discordance is probably in relation with the difference in exposure time with the present study (60 minutes). For volunteers, after 60 minutes of a mobile call just a raise of IMPX was observed suggesting a minor effect of EW in circulating neutrophils. Stimulation of inflammation by EW was postulated by Lu who described an activation of immunological cells with secretion of some mediators (Interleukin 1β, Interleukin 6 and TNFα) after exposure to EW [18].

Following these observations, it is clear that exposure to EW of a mobile call activate neutrophils and entail their destruction. For human body, this effect is less important but the apparition of immature granulocytes less segmented as revealed by the decrease of the d/D valley and PMNX suggest an acute mobilization of cells after an eventual activation or destruction.

For red cells, a significant decrease of MCV and macrocytic red cells was observed in in vivo and in vitro tests. Diminution of MCV was also described in rats in many studies with a reduction of hemoglobin rate [14, 15, 19]. These authors supposed that EW impair erythroid membrane and cytoskeleton leading to a leak of hemoglobin [15, 19]. Though, in our study, statistically, no significant modification of hemoglobin rate was found but only a raise of the percentage of hypochromic red cells in blood samples.

CONCLUSION

In this study we supposed that CBC of humans is stable for several hours and the only cause of the observed changes remains the exposure to EW. Finally, despite the small sample size, mobile phone seems to have an impact on blood cells especially neutrophils and red cells. These modifications were more important in blood sample but effects on human body may be underestimated by the dilution effect. Clinical and biological consequences have to be clarified by other studies and compared to chronic exposure to EW.

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Authors' contributions

Mohammed Nazim Bennaoum (MNB) is the principal investigator of this manuscript. MNB conceptualized the study and wrote the manuscript. Amira Benabbou (AB) and Djouher Belbachir (DB) participated in the execution of the study. Noujoum Zmouli (NZ) and Mohamed Chekkal (MC) reviewed and revised the manuscript.

Ethics approval and consent to participate

We conducted the research following the Declaration of Helsinki Ethical approval was obtained from the ethical committee of the DGRST (direction génerale de la recherche scientifique et technologique N° 09 on 03 February 2021). Informed consent was also obtained from volunteers.

Consent for publication

Not applicable.

Competing interest

The authors declare that they have no competing interests.

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