

Significance of micronuclei in buccal smears of mobile phone users: A comparative study

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Abstract

Aims and Objectives: The present study was designed to evaluate the frequency of micronuclei (MN) in the buccal exfoliated cells of mobile phone users. In addition, comparison of MN frequency between high and low mobile phone users was also done.

Materials and Methods: A total of 30 male and 30 female participants between the age group of 20–28 years were selected from the Outpatient Department of Navodaya Dental College and Hospital, Raichur, Karnataka. The participants were divided into two groups: Group A – low mobile phone users and Group B – high mobile phone users. Cell sampling and preparation was done on the slide. All the slides were observed for a total of 1000 cells for the presence and number of MN in each cell.

Results: There was a significant increase in the mean MN count in Group B in comparison to the Group A. There was highly significant difference in the mean MN count of participants using (code division multiple access) CDMA than (global system for mobiles) GSM mobile phones. The MN mean count was found to be significantly increased in nonheadphone users in comparison to headphone users. In Group B, the MN count on the side of mobile phone use was found to be statistically significantly elevated in comparison to the opposite side.

Conclusion: Mobile phone radiation even in the permissible range when used for longer duration can cause significant genotoxicity. The genotoxicity accentuates when mobile phones are frequently used on the same side which may be due to more amount of radiation and increase in the temperature. Headphone usage reduces the genotoxicity of mobile phone radiation to some extent.

Keywords: Cell, micronuclei, mobile phone, Papanicolaou, radiation

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INTRODUCTION

The mobile phone radiates an average power of 0.2–0.6 W, 40% of which is absorbed in the hand and the head. It may be regarded as a quite “powerful radio transmitter.” Its emission is 10,000 times stronger than that reaching

the head of a user standing within 30 m range of relay transponder.^[1]

The natural terrestrial electromagnetic environment does not significantly comprise radiofrequency (RF)

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(30 kHz–300 MHz) or microwave fields (300–3000 MHz). However, the artificial RF/microwave fields emanate from wireless communication technology with average intensities around 1 iW/cm² (4 V/m).^[2]

Radiation has a specific frequency and wavelength, which decide the identity of the waveform. The electromagnetic energy absorbed by a unit of tissue is known as the specific absorption rate (SAR, W/Kg or mW/g). The identified whole-body threshold level of exposure in terms of SAR is 4 W/Kg. The WHO has classified mobile phone radiation on the International Agency for Research on Cancer scale as Group 2B – “possibly carcinogenic by increased risk of glioma formation.”^[1]

Schüz *et al.* found an association with gliomas with 10-year exposure criteria. Hepworth *et al.* found that glioma occurrence was associated with ipsilateral mobile phone usage. Gandhi and Singh and Yadav and Sharma confirmed the genotoxicity of mobile radiation on oral mucosa. However, others have apparently denied the genotoxic effect. Considering all these disagreements, re-evaluation of the effect of mobile radiation on oral epithelium is needed.^[3-6]

Thomas *et al.*, in 2009, conducted a study to evaluate the mobile phone radiation effect using the micronuclei (MN) index in the buccal exfoliated cells.^[7] Thus, the present study was designed to evaluate the frequency of MN in the buccal exfoliated cells of mobile phone users. In addition, comparison of MN frequency between high and low mobile phone users was also done.

MATERIALS AND METHODS

The study protocol was approved by the Institutional Ethical Committee. A total of 30 male and 30 female participants between the age group of 20 and 28 years were selected from the Outpatient Department of Navodaya Dental College and Hospital, Raichur, Karnataka.

The participants were divided into two groups:

- Group A – Low mobile phone users, used since or <5 years and <4–5 h a week
- Group B – High mobile phone users, used more than 5 years and more than 10 h a week.

Inclusion criteria

The inclusion criteria of this study were as follows:

- Healthy individuals in the age limit of 20–28 years
- Receiving and making calls were considered
- Minimum range of 4 h or above was considered.

Exclusion criteria

The exclusion criteria of this study were as follows:

- Participants having any deleterious habits
- Participants having any oral lesions.

Cell sampling and preparation

Exfoliated oral mucosa cells were collected from all participants. Before cell collection, the mouth was rinsed with 1% glacial acetic acid to remove saliva, food particles and any other debris. A moistened wooden spatula was used to collect the exfoliated cells from the buccal mucosa and was fixed using cytofixative, and the slides were stained with Papanicolaou nuclear staining solution. Two cytological smears were collected from each participant (right and left cheek, respectively).

Scoring method

All the slides were observed under light microscope using low magnification (×10) for screening and high magnification for counting the MN. The most commonly used method was zig-zag method for screening of the slide. Cells with intact nuclei and cell boundaries were counted. A total of 1000 cells were counted in the smear from the right and left mucosa of each participant for the presence and number of MN in each cell.

The following criteria for designating an extranuclear body as micronucleus were given by Tolbert *et al.*:

- Rounded smooth perimeter suggestive of a membrane
- Less than a third the diameter of the associated nucleus but large enough to discern shape and color
- Staining intensity similar to that of the nucleus
- Texture similar to that of nucleus
- Same focal plane as nucleus
- Absence of overlap with, or bridge to, the nucleus.^[8]

Statistical analysis

The percentage frequency of MN was recorded. The comparative evaluations were done using unpaired *t*-test. The values were represented in mean ± standard deviation. *P* < 0.05 was considered to be statistically significant.

RESULTS

There was a significant increase in the mean MN count in Group B (1.58 ± 0.57) in comparison to the Group A (1.26 ± 0.28) [Table 1 and Figure 1]. There was highly significant difference in the mean MN count of participants using CDMA (1.84 ± 0.32) than GSM (1.25 ± 0.41) mobile phones [Table 2 and Figure 2].

The MN mean count was found to be significantly increased in nonheadphone users (1.78 ± 0.18) in comparison to

headphone users (1.22 ± 0.61) [Table 3 and Figure 3]. In Group B, the MN count on the side of mobile

Table 1: Comparison of mean micronucleus count between low and high mobile phone users

Group	n	Mean MN±SD	df	t	P	Result
Group B (high mobile users)	30	1.58±0.57	58	2.28	0.0258	S
Group A (low mobile users)	30	1.26±0.28				

MN: Micronucleus count, SD: Standard deviation, S: Significant

Table 2: Comparison of mean micronucleus count between CDMA and GSM mobile phone users

Group	n	Mean MN±SD	df	t	P	Result
CDMA users	9	1.84±0.32	28	3.79	0.0007	HS
GSM users	21	1.25±0.41				

MN: Micronucleus count, SD: Standard deviation, HS: High significant, CDMA: Code Division Multiple Access, GSM: Global System for Mobiles

Table 3: Comparison of mean micronucleus count between headphone and nonheadphone users

Group	n	Mean MN±SD	df	t	P	Result
Nonheadphone users	23	1.78±0.18	28	3.981	0.0004	HS
Headphone users	7	1.22±0.61				

MN: Micronucleus count, SD: Standard deviation, HS: High significant

Table 4: Comparison of mean micronucleus count between same side and opposite side of mobile phone use

	n	Mean MN±SD	df	t	P	Result
Frequently used side	30	1.69±0.23	58	5.197	<0.0001	HS
Other side	30	1.14±0.54				

MN: Micronucleus count, SD: Standard deviation, HS: High significant

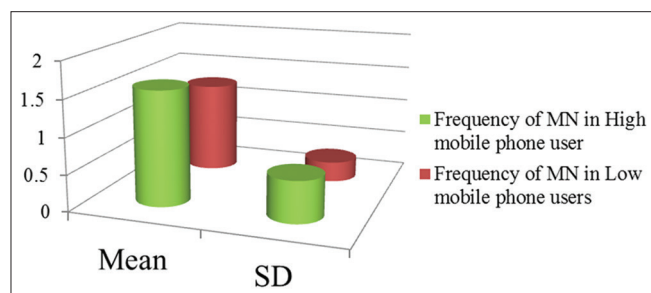


Figure 1: Frequency of mean micronucleus count in low and high mobile phone users

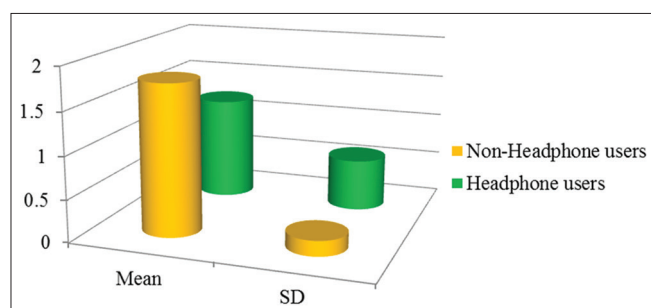


Figure 3: Frequency of mean micronucleus count in headphone and nonheadphone users

phone use was found to be statistically significantly elevated (1.69 ± 0.23) in comparison to the opposite side (1.14 ± 0.54) [Table 4 and Figure 4].

DISCUSSION

Mobile phones, sometimes called cellular phone, are now an integral part of modern life. The mobile phone handsets are low-powered RF transmitters. Mobile phones are being used extensively throughout the world. For the year 2018, the number of mobile phone users is 4.93 billion and will reach 5 billion mark by 2019.^[9]

The reported adverse effects include physiological, behavioral and cognitive changes as well as tumor formation and genetic damage. MN count in the exfoliated cells can be used as a marker for an abnormal cell cycle as results of aberrant mitosis when the whole chromosome or chromatid fragment fails to reach the spindle pole.^[8]

It is one of the best indicators of mitotic interference and chromosomal mutations or breakage. The MN index is preferable for mass screening as it is rapid, simple, sensitive and cost-effective.^[8] Thus, in the present study, MN index was used to analyze the genotoxicity caused by mobile phone usage.

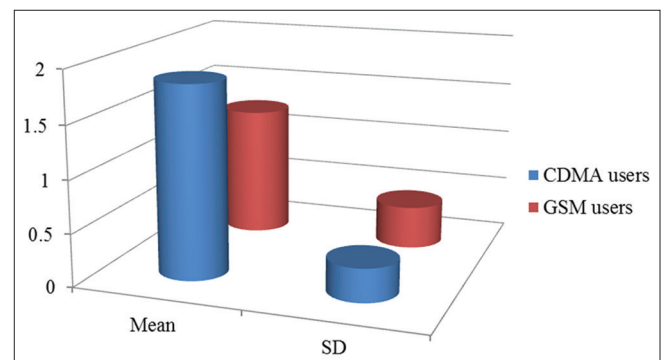


Figure 2: Frequency of mean micronucleus count in CDMA and GSM mobile phone users

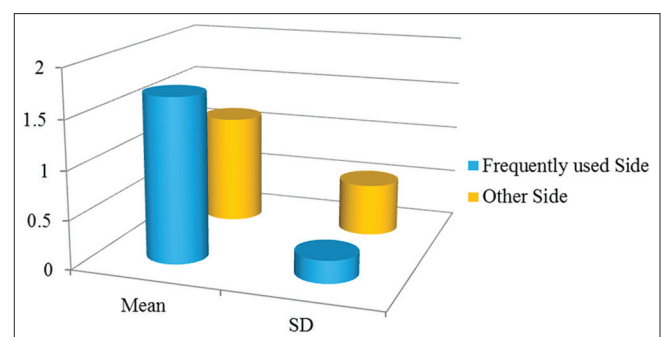


Figure 4: Frequency of mean micronucleus count between the same side and opposite side of mobile phone use

MN count was found to be significantly higher in Group B (high mobile users) in comparison to Group A (low mobile phone users). Our findings were similar to the study conducted by Banerjee *et al.* conducted in the year 2016.^[9] In this study, the higher mobile phone users were also evaluated by the type of mobile phone used, i.e., CDMA or GSM. CDMA phones work under higher electromagnetic frequency (1800 MHz) in comparison to GSM mobiles (900 MHz). Thus, in our study, there was a significant increase in MN count of CDMA phone users when compared to GSM users.

All the mobile phone users were questioned for usage of wired headphones. There was a significant decrease in MN count in headphone users when compared to nonheadphone users. When headphones were used with mobile phones, it helps to keep the mobile phone away from the body, and there is no direct contact of the RF receiver with the body. This also reduces the local temperature which arises around the ear.

In the present study, higher frequency of MN was observed in habitually used side of mobile phone users when compared to other side of mobile phone used. Long-term use of mobile phone on one side leads to excess heat production due to battery of the phone or as a result of the long press of the mobile phone against the cheek. This heat provides a synergistic effect on genotoxic damage.^[10]

Precautions

- Keeping the mobile phone away from the body while connecting
- Use a Bluetooth/headset
- Turn your phone off at night
- Use an electromotive force (EMF) shielding device.

This may help us to reduce the deleterious effects of mobile phone radiation.^[10]

CONCLUSION

Mobile phone radiation even in the permissible range when used for longer duration can cause significant genotoxicity. The genotoxicity accentuates when mobile phones are frequently used on the same side which may be due to more amount of radiation and increase in the temperature. Headphone usage reduces the genotoxicity of mobile phone radiation to some extent.

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Conflicts of interest

There are no conflicts of interest.

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