Magnetic Fields in the Dental Surgery

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Summary

In this study magnetic fields in dental surgeries were measured by means of a specially constructed device with a Hall's probe. The purpose was to measure the mean square distance of the magnetic field in relation to the position of dental apparatus in the area. The data obtained were analysed by the method of simple statistical regression.

The study showed that the force of the magnetic field of the majority of the examined apparatus is harmless to man. The force decreases with increasing distance from the source of radiation. Older apparatus radiates stronger than newer products.

Key words: *magnetic fields, dental apparatus.*

Acta Stomat Croat
2001;

ORIGINAL SCIENTIFIC PAPER
Received: February 1, 2001

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Introduction

We live in an environment permanently surrounded by numerous electromagnets and their fields, and the planet earth is a large magnet with a strong magnetic field. It is, therefore, no surprise that the desire of man has always been to learn of the effects of magnets and magnetic fields in order to be able to use and adapt them for his needs. The diversity of data on measurements, values and application of magnets in biomedicine demonstrates the many uncertainties, which need to be solved. The present study is the result of one such attempt.

Throughout history magnets and magnetic fields have been the source of many discoveries which have contributed to knowledge of the earth's magnetism and explanation of many natural occurrences, and also to the development of navigation, numerous scientific disciplines and even studies of the electromagnetic field in biomedicine, particularly dental medicine. Such studies showed the desired and also undesired effects of magnetic fields (1-6).

Artificial sources of direct fields mainly consist of permanent magnets used for the retention of prostheses, electromagnets from different apparatuses, and remnant magnetism u tools. The force of these fields rapidly decreases with decreasing distance, and thus their amount in the area is practically immeasurable (7, 8).

The aim of this study was to determine and describe sources of magnetic fields in dental surgeries. Direct and alternating magnetic fields were recorded and measurements taken up to the level of microtesle (μT) only beside the surface of the objects which contained remnant magnetism. Dur-

ing the measuring process the effect of the earth's magnetic field (- 10 μT), which is direct and all pervasive, must be isolated. Oscillations of the earth's field depend on the season, solar activity and disturbances in outer space, and they range from 0.1 to 1 μT.

In order to realise our objective we constructed a device which accurately measures alternating magnetic fields in the dental surgery, excluding the direct component of the earth's magnetic field. The purpose of the device was to measure mean square values of the field (RMS) depending on the position of the investigated apparatus in the room.

Material and methods

In order to measure the magnetic field we constructed a device which works on the principle of Hall's effect. The device measures the magnetic field by means of a Hall's sensor which is charged with 5 - 10 volts and which, together with the preamplifier is incorporated into one system. Exit from the sensor is differential (Q1-Q2) and proportional to the values of the measured magnetic induction B. Because the values of the alternating fields in dental surgeries are small it is necessary to increase the voltage by approximately 100 times, from differential exit (Q1-Q2), by means of an amplifier A_1. Direct error of the amplifier must be compensated in the resistance by selecting voltage between V+ and V- by means of a suitable Rz potentiometer.

Because the least direct earth's magnetic field of induction of around - 10 μT is continually present in the room it is necessary for this field and other possible direct fields to be excluded from the measurement of the alternating field. This is achieved by means of an A_2 amplifier, which has the function of a filter. Filtration of direct signals is performed by means of a Ro-Co circle on the inverted access of the amplifier. When the direct field is measured, the S switch bridges the condensator Co.

On leaving the A_2 amplifier the signal is still alternate and unsuitable for measuring. Consequently, integration of the signal is done in an A_3 amplifier by resistance of R_4 and Rx-Cx direct feedback connection in the A_3 amplifier. In order to stabilise the signal it is further modified by means of a D diode on a C_1 condensator. The device is charged from a network 220 V through a rectifier which gives +10 at the exit (Fig. 1).

The Hall's sensor is placed on a special holder of aluminium in order to facilitate moving closer to the objects to be measured. The earth's field and other possible direct fields were excluded from the measurement of the alternating field.

The sample investigated consisted of different apparatus in dental surgeries. Lamps, such as halogen lamps, are a powerful source of electromagnetic radiation, which reach the transformer via the path by which the bulb is charged. The transformers transform the voltage to the level of 115 V and radiate as a strong ac field. The lamp itself is a powerful source of radiation because of the strong pulsating currents in the area of the discharge. The main part of the mixer for amalgam is a synchronised motor with an adjustable number of revolutions, which is a regular powerful source of electromagnetic radiation. It should be noted here that modern mixers have solved the problem of radiation. The speed of the revolutions changes similar to the frequency of radiation from 3000 to 4000 revolutions a minute.

The source of the magnetic fields of the micromotors is the electromagnets which turn them. Electromagnets are a source of a relatively small magnetic field and act at small distances. Consequently while working they affect the professional personnel by their maximal field. For this reason we tested them separately.

The greatest source of radiation in the dental chair was determined at the point of connection to the electrical network, where silencers, transformers and old types of fuses may be located. It is important to note that modern dental chairs do not emit electromagnetic radiation, which could be detected on older dental chairs by a sensitive gaussmeter.

The device for measuring magnetic field was calibrated by annulling the earth's magnetic field and magnetic fields caused by different conductors. The point at which the force of the magnetic field was greatest was determined and this point was taken as the starting point for measuring the force of the magnetic field of a particular apparatus. The device for measuring the magnetic field was then moved by approximately 5 cm from the starting

point and measuring was repeated until zero value of the force of the magnet field of a particular apparatus.

Results

By using the specially constructed device and the above measuring methods, relations of the force of the magnetic fields were obtained, depending on the distance between the examined objects (micromotors, dental chairs, halogen lamps, dental lights and mixers for amalgam).

The relations of the force of the magnetic fields, expressed in gausses in relation to the distance from the source of radiation were investigated in four types of micromotors and results are presented in Fig. 2, and also in four types of dental chairs (Table 1).

The relations of the forces of the magnetic fields and the distances between five types of heliolamps were determined; and also dental lamps and mixers for amalgam. The obtained data were analysed by the method of simple statistical regression. For the analysis data were transformed from exponential into a linear model by taking square root of data.

Regression equation is a statistical term by which it is possible to calculate the value of the magnetic field at any point in the area, on the basis of the obtained measurements. Deviations were calculated by means of variance and standard deviations, i.e. possible error occurring during adaptation of data to the statistical regression model. Such deviations were extremely small. By means of coefficient determination it was possible to determine how the regression model (Table 2) expressed much of the obtained data. The Table shows that in almost all cases 95% and more of the obtained data were expressed by regressive equation.

Discussion and conclusions

In all biomechanical investigations there is a need for a longitudinal study of the investigated variables. Although in some biometric methods there is the problem of impossibility or less accuracy in defining the measured variables. However, in spite of the above difficulties we most frequently obtained the relevant data.

By application of suitable methods and a device, together with computer analysis, a qualitative and quantitative study of the investigated variables was achieved, enabling conclusion of the magnetic fields in dental surgeries.

The above data show a certain pattern:

- The force of the magnetic field of each of the measured apparatus decreased in proportion with the distance from the initial measuring point and indicated the isotropic manner of the diffusion of the magnetic field in the room.
- The force of the magnetic field in the immediate vicinity of the majority of the measured apparatus is harmless for persons in the area. The reason for this is probably the decreasing force of the magnetic field in relation to the distance from the source of radiation.
- When comparing apparatus of the same function but different manufacturer and year of manufacture, we concluded that newer apparatus affects the environment with weaker magnetic radiation, and at smaller distances.
- An important conclusion of this study was the knowledge that the apparatus on which we work every day is not dangerous to our health, because the amount of radiation is generally within permitted limits.