Measurement of the Magnetic Field in Dental Laboratories

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Summary

While efforts are being made by science to discover all aspects of the effects of the magnetic field on man, data on the use of magnets in dental medicine are few. Thus, the aim of this study was to measure the magnetic field in dental laboratories, and at the same time to exclude the direct component of the Earth's magnetic field. A specially constructed device was used for measurement, consisting of two amplifiers and a low frequency filter, by which the mean square of the value of the field was measured, depending on the position of the object in the area. The results of the study show that the magnetic field decreases with distance from the source of radiation, and that newer apparatus emits a weaker magnetic field than older apparatus.

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Introduction

Soft and hard magnetic alloys are used in dental medicine. Soft magnetic alloy is used for the production of dental equipment (electromagnets, apparatus for measuring the magnetic circuit of electric apparatus etc.). Hard magnetic alloy is used during the production of permanent magnets for so-called dental use (1-5).

Alloys with identical magnetic characteristics in all directions are used for the production of permanent magnets, i.e. isotropic type. As these alloys have comparatively weak magnetic characteristics it was necessary to discover non-isotropic alloys with better magnetic characteristics, such as samarium and cobalt, and more recently iron, neodymium and borax with even better characteristics (6-10). The magnetic field spreads isotropically through the area, and its values at any point in the area can be calculated by means of regression equation, based on the results obtained by measuring. In this way 95% of the data can be explained.

Normal daily variations of the magnetic field amount to 0.1-0.3 mG.

The object of the study was to measure magnetic fields in dental laboratories, for which a device was specially constructed which measures the alternating magnetic field in the laboratory and at the same time excludes the direct component of the Earth's magnetic field. The device enables measurement of the mean square values of the field (RMS) depending on the position of the object in the area. The study included measurement of direct fields, beside the surface of objects which contain permanent magnetism.

Material and methods

A device was constructed to measure the force of the magnetic field in dental laboratories, which works on the principle of Hall's effect. A conductor is placed in magnetic field B, through which current of a determined force is released, so that the conductor is vertical to the direction of the magnetic field, and electric field develops on the edges of the conductor. The device is called Hall's voltage, which is equal to Vh=cBI, the sum of the constant c of magnetic induction B and current I which flows through the conductor. The sensitivity of the measuring device is 0.0001 mT.

The device measures the magnetic field by means of a Hall sensor, located on a special aluminium holder, so that it can be moved close to inconveniently located objects. It is integrated in one chip together with the amplifier. As the values of the alternating field in the laboratory are small, the obtained current must be increased 100 times by means of the amplifier. It is also necessary to exclude the Earth's magnetic field, and other magnetic fields, from the measurement of the alternating field, which is achieved by means of the amplifier, which acts as a filter.

The samples for this study were certain apparatus in dental laboratories, which are known to be very strong sources of electromagnetic radiation. For example, the apparatus used for casting alloy. Apart from smelting and casting the high frequency system enables the simultaneous mixing of components during smelting, without the use of special mixers. Simultaneous mixing and smelting, without direct contact of the mass and object are the basic advantage of high frequency heat. Each metal has Hall's coefficient, as shown in Table 1.

The apparatus consists of a high frequency generator, charged by a magnetic coil and simultaneously water-cooled. The components for smelting and mixing are situated in a small graphite container, which, like the components, conducts electric current, which is essential for the heating process. The high frequency field in the components induces so-called vortical (Foucault) current, which heats the material through the electric resistance of the material. As the electromagnetic field is of great force, more than five kW, radiation in the area is intense. The device for measuring the magnetic field was calibrated prior to the measuring, by nullifying the Earth's magnetic field and also the magnetic field induced by various conductors. The point where the force of the magnetic field was greatest was determined, and this was then taken as the initial point for measuring the force of the magnetic field of a particular apparatus. After which the device for measuring the magnetic field was moved by approximately 5 cm from the initial position and measurement repeated until zero value of the force of the magnetic field of a particular apparatus was reached.

Results and discussion

The aforementioned device was used in dental laboratories to measure the distance of the examined objects from the source of magnetic radiation and the force of the magnetic field for the following apparatus: circular (TEH 1), vibrator (TEH 2), trimmer (THE 3), polisher (THE 4), caster (THE 5), rotational caster (THE 6) and vacuum compressive caster (THE 7). The data obtained were analysed by the method of simple statistical regression. By calculating probability error, occurring as a result of adjustment of the data by the statistical regression model, very slight deviation was determined. Thus the chosen regression model adequately describes the examined data. By this method it was therefore possible to explain more than 95% of the obtained data (Tables 2 & 3).

The apparatus tested were grouped according to the force of the magnetic field and its spreading in the surroundings. Table 4 shows the order of the tested apparatus, depending on the initial radiation and the spreading of that radiation. The mean value (arithmetic mean) of the equation regression can be calculated from the above table, determining the average amount of radiation to which the technician is exposed in the dental laboratory.

The equation regression in the dental laboratory is:

Coefficient A	Coefficient B	Variance	Standard deviation
2,993971	0,7300823	0,146290	0,280167

The equation:

$$y = 2.993971 - 0.730823\ x$$

The above data show certain conformity. The force of the magnetic field for each apparatus decreased with distance from the place/point of the initial measurement. It can be concluded that the magnetic field spreads isotropically through the area. The highest measured values of magnetic radiation of the examined laboratory apparatus were slightly higher than 40 G, and the highest frequency around 100 kHz. The effect of the magnetic field of the majority of the apparatus invested is negligible for anyone in their vicinity. The reason being that the effect of the magnetic field decreases with distance, and that the environment in which we live is continually under the effect of magnetic field.

By comparing the effects and force of the magnetic field in the dental surgery and the dental-technical laboratory it was concluded that the effects of the magnetic field in the dental surgery are of slightly less magnitude and radius compared with the dental-technical laboratory (10). On the other hand, staff in the dental-technical laboratory are further away from the apparatus creating the magnetic field than staff in the dental surgery.