Effect of MRI on Vital Signs of Patients

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Abstract

Introduction: In medicine, the magnetic field is used in diagnostic tools such as MRI and in some therapeutic cases. This study evaluates the effect of MRI on vital signs of patients.

Materials and Methods: This was an analytical study carried out at a MRI center in Gonabad, Iran. Eighty-nine patients aged 20-60 years old with at least one previous MRI history for at least ten to thirty minutes were recruited and vital signs including body temperature, pulse, blood pressure and respiration were measured before and after MRI. MRI was done by 0.35 T magnetic field Newsoft device, China. Data was analyzed by using SPSS software, version 14.5, by using paired samples t-test ($p<0.05$).

Results: There was a significant difference between systolic, diastolic, mean arterial pressure, heart rate, respiratory rate before and after MRI ($P<0.001$). Systolic pressure was 127.9 ± 15.50 mmHg and 121.61 ± 14.02 mmHg before and after MRI, respectively. Diastolic pressure was 80.08 ± 9.85 mmHg and 76.42 ± 9.43 mmHg before and after MRI, respectively. Mean arterial pressure was 96.02 ± 0.66 mmHg and 91.48 ± 0.36 mmHg, before and after MRI, respectively. Heart rate was 80.63 ± 10.41 per minute and 71.58 ± 10.22 per minute before and after MRI, respectively; respiratory rate was 18.08 ± 11.31 per minute and 14.50 ± 1.05 per minute before and after MRI, respectively. In addition, body temperature was 36.98 ± 0.08 °C and 36.33 ± 2.19 °C before and after MRI, respectively. This difference was not statistically significant ($p = 0.30$).

Conclusion: The results showed that 0.35 T magnetic MRI could decrease systolic, diastolic and mean arterial blood pressure, heart rate and respiratory rate; however, it did not influence body temperature index. Therefore, measurements of these variables are recommended before and after MRI. MRI device is calibrated periodically in accordance with standards to ensure function of the device.

Key words: Magnetic field, blood pressure, heart rate, respiratory rate, body temperature

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Introduction

Health status is reflected in vital signs; it is a part of nursing care to maintain the hemostatic status of body, cause vital signs to fall into normal range, and evaluate them [1]. Vital signs have been important for care providers in the past; currently, the most important measurable physiological criteria are vital signs which include temperature, pulse, blood pressure and respiratory rate [2].

When a nurse learns about the effect of physiological variables on vital signs and recognizes the relevance of changes in vital signs to other physical findings, the nurse can determine health problems of the patient. Vital signs and other basic physiological scales are used for solving clinical problems; examining vital signs is an essential factor in nurse-physician collaboration to determine the health status of the patient. The study of vital signs is an effective and rapid way to control the patient's condition or determine problems and to assess the patient's response to various actions and provide basic information about the general health of the patient [3].

Magnetic resonance imaging (MRI) is currently considered as one of the most important and most effective medical imaging techniques based on the magnetic field. This imaging technique provides very accurate and clear images of the organs in the body. In fact, this technique produces images with complete details of tissues and organs of the body without using X-rays; this advantage distinguishes it from other techniques [4]. Magnetic resonance imaging has become a common medical technique [5]; it is a daily challenge to maintain a safe environment for MRI for healthcare professionals, particularly considering the increasing number of clinical applications [6]. MRI, as a clinical diagnostic method since its emergence in the early 1980s, has seen more than 100 million diagnostic tests performed worldwide [7].

MRI devices, telecommunication and radar devices, wireless transmitters, cell phones, wireless telephones, microwave ovens, video devices and computer monitors are sources of electromagnetic fields [8]. Research shows that the generated electromagnetic fields can cause biological disturbances [9]. Electromagnetic fields have physiological effects such as increased body metabolism, vasodilatation, hyper pigmentation, effects on sensory nerves (relaxing effect), effect on muscle tissue, cellular and tissue destruction, general increase in body temperature, decreased blood pressure and ultimately increased activity of eccrine sweat on the human body [10]. There are also numerous epidemiological and laboratory reports on the effects of each of these fields on biological systems. Studies have shown that electromagnetic fields affect many vital phenomena such as cell growth and differentiation, ion transfers, free radicals production, apoptosis, enzyme activity, changes in hormones, changes in some membrane and intracellular proteins, angiotensin II, chromosome damage , nitric oxide levels, and immune system [10[. It is a daily challenge to maintain a safe environment for MRI for healthcare professionals, particularly considering the increasing number of clinical applications [8]. Therefore, this study was conducted to determine the effect of 0.35 T magnetic field MRI on vital signs of patients referring to a MRI center.

Materials and Methods

This analytical study was conducted at the MRI Center of the 22nd Bahman Hospital of Gonabad, Iran. To determine sample size, a pilot study was conducted for the main variables including heart rate, respiration rate, body temperature and systolic, diastolic and mean arterial pressure. Based on the formula for comparing the mean of two dependent populations, taking into account 0.95 confidence coefficient and 80% test power, sample size was calculated for all the above variables. Considering that more samples were obtained for diastolic blood pressure, 84 subjects were considered for the study considering the probability of a 10% drop in sample.

Samples were selected randomly from non-contrasting MRI patients by convenient non-probability method. In order to eliminate confounding factors, inclusion criteria were: the willingness to participate in the study, 10-30 min MRI, at least one previous MRI to have less anxiety, the age of 20-60 years, non-pregnancy, not taking drugs such as beta-blockers which may alter vital signs, absence of known psychological disorders and severe anxiety, absence of a history of underlying illness, mild or non-existent anxiety range in the Beck anxiety test before or after MRI, no comment by MRI personnel about the result. Exclusion criteria included: the patient's unwillingness to continue participating in the study and discontinued MRI imaging for any reason.

Once the project was approved by the Ethics Committee of the Gonabad University of Medical Sciences (GMU. REC.1393.90), the researcher selected the eligible patients referred to the MRI center. Objectives of the study were explained and written consent was obtained. Beck anxiety test was done. Before and after entry to the imaging room, temperature, blood pressure, respiratory rate and heart rate were examined. Prior to the above procedures, patients should have been present at least 15 minutes in a temperature range of 25-30°C and a relative humidity of 40-50% in order to prevent changes in temperature [10]. Procedures were performed for all patients in the supine position. Before entering the imaging room, the patients should be at least 5 minutes in a supine position; after leaving the imaging room, anxiety test and procedures were done immediately. If the anxiety test after MRI was moderate and severe, they were excluded from the study. The MRI device was a 0.35 T magnetic Newsoft, China, available in the 22nd Bahman Hospital of Gonabad. Blood pressure was measured using the Erkameter 3000 mercury barometric device, Germany. Body temperature was measured by the AMARELL mercury thermometer, Germany. Heart rate was measured by radial pulse per minute; respiratory rate was measured by observing chest for one minute by the researcher. Pulse and respiration were counted by using a clockwise full minute. To assess

reliability of the researcher responsible for measuring vital signs, they first controlled vital signs of the patients; within a minute, without changing the cuff of the barometer and the medical device and one of the nursing colleagues again controlled the vital signs. In order to determine scientific reliability of the data sheet, simultaneous observation was used by the researcher and the colleague; if there was a difference, it was again controlled by two people. Blood pressure was measured by the left hand according to nursing standards. Temperature was also sub-lingual according to nursing standards; it was recorded within three minutes after the thermometer was inserted.

Data was collected and inserted in SPSS software version 14.5. Mean and standard deviation were used for normally distributed quantitative variables; absolute and relative frequencies were used for qualitative variables. Kolmogorov-Smirnov test was used to determine normality of data. Pairwise t-test was used to compare the mean of normally distributed quantitative variables including temperature, systolic, diastolic and mean arterial pressures, heart rate and respiratory rate per minute before and after MRI ($P<0.05$).

Results

Eighty four patients participated in this study (45.2% male and 54.8% female). The average age of participants was 40.29 years; 56.2% had elementary education and 39.9% were housewives. In 73.8% of cases, MRI was done on the spinal cord and average time of MRI was 18.2 minutes.

Pairwise t-test showed a significant difference between systolic and diastolic blood pressure and mean arterial blood pressure, heart rate and respiratory rate before and after MRI; systolic and diastolic blood pressure and mean arterial pressure, heart rate and respiratory rate decreased after MRI ($P<0.001$). Moreover, t-test showed no significant difference between body temperature before and after MRI ($P = 0.30$) (Table 1).

Discussion

In this study, vital signs were measured and compared before and after MRI. The results showed that 0.35 T magnetic field MRI could decrease systolic, diastolic and mean arterial blood pressure, decrease heart rate and respiratory rate; however, it did not affect body temperature index. Chakeres' findings on ordinary people under 8 T magnetic field showed no significant change in the central temperature which was measured through the outer ear and sublingual temperature with the optical fiber core; this is consistent with the current study [11]. A study on physiological responses to magnetic imaging process with a specific absorption rate of 0.6 W/kg showed a significant increase in temperature of tympanum and skin of the chest and abdomen, above the arm, hands and blood flow in the skin, which is not consistent with current findings [12]. Findings of Whittington on acute effects of 50 Hz magnetic field on cardiovascular system revealed no significant changes in blood pressure, which is not consistent with current findings [13]. Chakeres' findings on ordinary people under 8 T magnetic field showed that the only significant effect in the study of vital signs was the increase in systolic blood pressure, which is not consistent with current findings [11]. Chakeres' results on ordinary people under 8 T magnetic field, findings of Kim on adolescents and adults under 60 Hz magnetic field and findings of Sait on the effect of 50 Hz magnetic field on human heart rate showed no significant changes in heart rate, which is not consistent with current findings [11, 14, 15]. Yang's findings on subjects under 8 T magnetic field MRI and Scherlag's findings on magnetism and arrhythmia of dogs showed that heart rate significantly decreased, which is consistent with current findings [16, 17]. Chakeres' results on ordinary people under 8 T magnetic field and results of Kim on adolescents and adults under 60 Hz magnetic field showed no significant changes in respiration, which is not consistent with current findings [11, 14]. Yang's results on subjects under 8 T magnetic field MRI showed significant changes with increasing respiratory rate in the patient group, which is not consistent with current results [16]. The results of Kianmehr et al. on the effect of 0.35 T magnetic field on ECG showed that the heart rate decreased, which is consistent with current findings [18]. This difference in findings may be due to strength of magnetic field used and the method or subjects studied. Electromagnetic fields can affect the functioning of sympathetic-parasympathetic system. People who are in temporary contact with magnetic fields experience a decrease in sympathetic activity and an increase in parasympathetic activity, which can explain these findings. This change is due to addition of electrical potential, which is generated by flow of arterial blood in the presence of a magnetic field. One of the most important limitations of this study is the lack of control group due to ethical issues. In order to control this limitation, patients who were referred to the imaging center for the second time were selected and patients were exposed to identical conditions to eliminate severe and moderate anxiety before imaging.

Table 1: Comparison of mean of vital signs in patients before and after MRI

Variable	Before MRI	After MRI	p-value
Systolic blood pressure (mmHg)	127.90 ± 15.5	121.61 ± 14.02	<0.001
Diastolic blood pressure (mmHg)	80.08 ± 9.85	76.42 ± 9.43	<0.001
Mean arterial pressure (mmHg)	96.02 ± 10.66	91.48 ± 10.36	<0.001
Heart rate per minute	80.63 ± 10.41	71.58 ± 10.22	<0.001
Respiratory rate per minute	18.08 ± 1.31	14.50 ± 1.05	<0.001
Temperature (°C)	36.98 ± 0.08	36.73 ± 2.19	0.30

Conclusion

Findings showed that 3.5 T magnetic field MRI could reduce systolic, diastolic and mean arterial blood pressure, heart rate and respiratory rate; however, it did not affect body temperature index. Therefore, measurements of these indices are recommended before and after MRI. Studies have shown that international standards on magnetic field MRI are more focused on effect of the field on metal bodies inside the body or around the patient, while it is essential to control vital signs of the patients because of potential effects of magnetic field of MRI devices on health (for example, a decrease in aortic blood flow, increased or decreased blood pressure, cardiac arrhythmia, and effects on brain functions).

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