VSTech 2005 *The First International Symposium on Advanced Technology of Vibration and Sound*
June 1-3, 2005, Miyajima, Hiroshima, JAPAN

110 Vibration measurement of MRI device

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Keywords: MRI, Vibration acceleration level

ABSTRACT

The MRI inspection is a necessary, indispensable inspection on the medical treatment site of today. A small, piezo-electric obstruction was made to stick to the surface of the device to acquire the vibration characteristic the MRI device's operating and the vibration acceleration was measured. The size and the frequency response of the vibration acceleration generated while operating the MRI device were obtained.

The vibration acceleration Z axially reached a value that was larger than Y axially in the center part of the gantry and the opening. The value that rises 100dB in the high frequency element is indicated though the frequency response is a low frequency weighted acceleration level for whole body vibration in the low frequency element. The vibration acceleration the MRI device's operating showed the peak up to the frequency from 500 to 2000Hz.

The vibration generation under the inspection cannot be disregarded because of making of the MRI device in recent years high magnetic. It is thought that it wants to reflect it in the control of the device vibration in consideration of the characteristic of the vibration acceleration in the future.

1 ・INTRODUCTION

MRI(Magnetic Resonance Imaging) equipment is the diagnostic-imaging of the medical care, which used a Nuclear Magnetic Resonance phenomenon. The MRI inspection gives a tendency magnetic field to the human body in the magnetic field. After that, it irradiates RF pulse, and it collects a signal from the inside the body and it composes an image. The MRI equipment becomes popular nationwide and becomes the necessary and indispensable inspection about the field of the diagnosis and the treatment today.

It is well known that the MRI equipment makes big noise. However, we know little report, which was written about vibration in detail. For the human being, the low frequency vibration is sensitive. However, when the device vibrates, the high frequency ingredient (that the person is not sensitive) is important. Their vibration may become the factor, which injures health unconsciously. Therefore, it is necessary to grasp beforehand about the occurring vibration. In future, it thinks that the vibration can be ignored and that it passes away by the superior performance, making a high magnetic field. Therefore, to acquire the size and the periodicity of the vibration, when the MRI device operates, it did measurement and an analysis in the vibration acceleration level and the frequency response.

2 ・The principle of the vibration occurrence

The vibration of the gradient-coil becomes the source of the vibration of the device. The evolution-method of the inclination magnetic field is that passes an electric current to the gradient-coil. And there happen the electromagnetic induction phenomenon, so it makes a magnetic field occur. When the electric current flows through the conductor in the magneto static field, the conductor receives power from the magneto static field. With this power, the gradient-coil conflicts with the installed sill and the vibration occur during imaging. So, if the inclination magnetic field is strong, it accompanies to that and the vibration occurrence, too, becomes big.

This inclination magnetic field is the cause of the vibration occurrence. Besides, there is an influence of the vibration of the refrigerating-machine and the switching of the RF coil, too. However, it is much smaller than the inclination magnetic field vibrates.

3 ・The method and the implement

3 — 1 The measuring position

It measured in the condition by which the cover of the gantry was unbuckled.

1. It divided equally in the 30 degree interval from yen center about the gantry aperture area and it measured a vibration acceleration level.

2. In the 270 ° side surface of the gantry, it measured a vibration acceleration level in the 20 cm interval in the transverse. The standard of the height was 110 cm and it measured 70 cm, 110 cm, and 150 cm.

3. In the 90 ° side surface of the gantry, it measured a vibration acceleration level in the 20 cm interval in the transverse. As for the height, it measured only 110 cm.

3 − 2 The setting of an axis

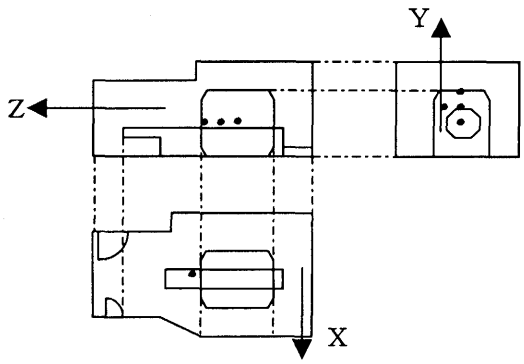

Figure 1 The axiation of the MRI device

3 − 3 The use equipment

The MRI equipment is SIGNA HORIZON LX, which is made by the GE INC, and it used 1.5 T. In case of imaging, it used the head Phantom and the head coil, and measured vibration acceleration level.

The vibration acceleration-measuring machine used the piezo-electric type acceleration device PV-90B that is made by the RION Inc. This is the non-magnetism, which is made from titanium alloy to use in the magnetic field of the MRI equipment. It is said that the characteristic of this device is small and lightweight, the measuring range is wide, highly reliable. It fixed a vibration acceleration measuring machine simply with the double-stick tape.

It used 2 channel charge amplifier UV-06 A. The output-signal for the proofreading is 80Hz± 5%, 1Vpeak±2%.

It used ONO SOKKI CF-5200 MULTI-PURPOSE FFT ANALYZER and "spwave-0.6.8."in analyzing.

3 − 4 Imaging sequence

It used T2WI of the fast spin echo law (Table 1).

The FSE law repeats a 180 ° pulse and impresses the phase encoding inclination magnetic field which is different to each echo signal. It gets for the scan to be fast more than usual SE law with this.

But, in the FSE, it forms a 1 corner image with the echo signal of different TE.

Therefore, the spatial-resolution of the image declines.

Table 1 Each parameter of T2WI

TE [ms]	102
TR [ms]	4000
Freq FOV	256
Phase FOV	192
BAND Width	31.25

3 − 5 The analysis method

It used spwave-0.6.8 for the analysis of Over All(20kHz). It uses Haming filter. It made a Fourier transform 24bit/sample and it made a sampling frequency 48000 Hz.

4 ・The result and the considering

4 − 1 The confirmation of the vibration occurrence

Figure 2 shows the 80 Hz frequency response of the vibration acceleration level in the gantry opening upper part. The auxiliary scale is 4.75 Hz. It is possible to read that the peak occurs in the 4.75 Hz interval in the figure.

So, that an inclination magnetic field is switched becomes approximately 210 ms in the 4.75 Hz reciprocal. In other words, it is repeated about five times by 1 second. TE of imaging sequence that was used this time is 102 ms. Theoretically, the period of the inclination magnetic field is 4.90 Hz, which are a 204 ms reciprocal. Therefore, the difference with the theoretical value and the measure appeared as 3 %.

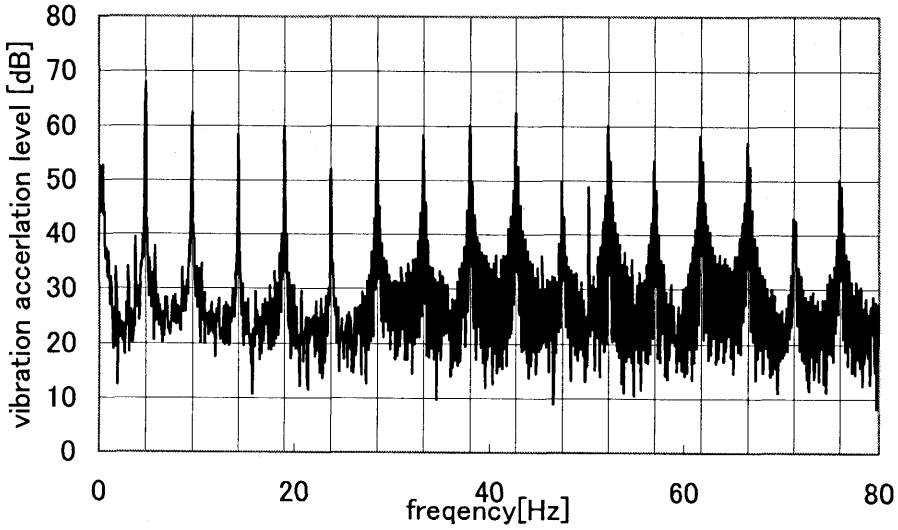

Figure 2 The frequency response under 80Hz

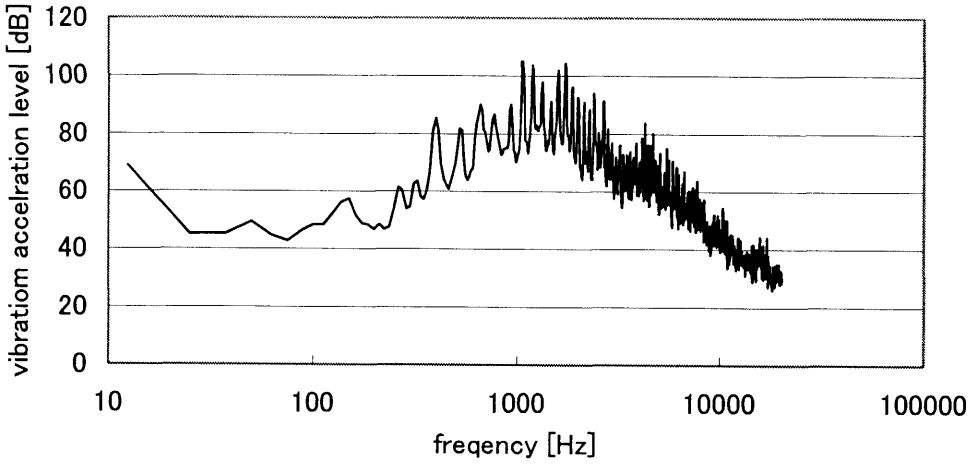

Figure 3 The frequency response of Over All

However, the noise increases when becoming a high frequency range from figure 3.And the conspicuous characteristic is seen and is passing away.

When the inclination magnetic field depends, the vibration cause. Also, it knows that it is necessary to separate in the low-frequency-component and Over All when analyzing vibration.

4 — 2 The distribution of the vibration by the gantry aperture area

The vibration acceleration level of the gantry aperture area is shown in figure 4. The axial vibration of Z as it surrounds a gantry center is taking a close value each other. In the 80 Hz low-frequency-component, it was about 90 dB but the vibration acceleration level of Over All, which included a high frequency range, too, became the big value, which exceeds 130 dB.

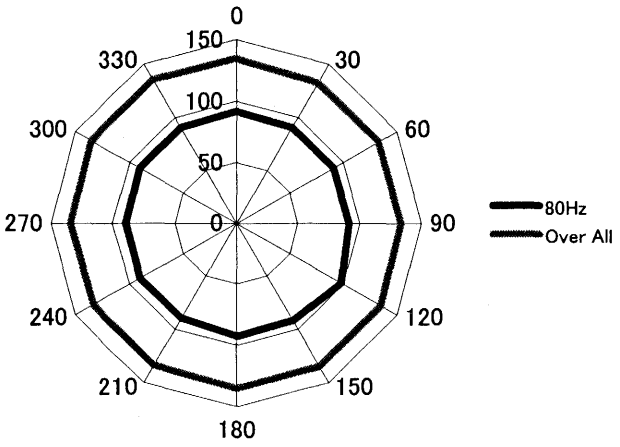

Figure 4 The vibration acceleration level of the gantry aperture area

angle＼distance	20cm	105cm	190cm
250°	132.86	134.07	133.41
270°	132.67	133.54	133.33
290°	133.31	134.16	133.55
310°	131.79		
330°	131.57		

Table 2 The vibration acceleration level in the gantry side

In the gantry aperture area, it is possible to say that Z's axial vibration is vibrating uniformly. Also, the vibration acceleration level of Over All catches the value, which is about 45 dB bigger than that in the low frequency area.

The fact, which takes more than 130 dB value even if it is difficult to feel a person, must be admitted.

4 − 3 The distribution of the vibration of the surface of 270 ° of gantries

The vibration acceleration level in the gantry side catches a big value at Center 105 cm (Table 2).

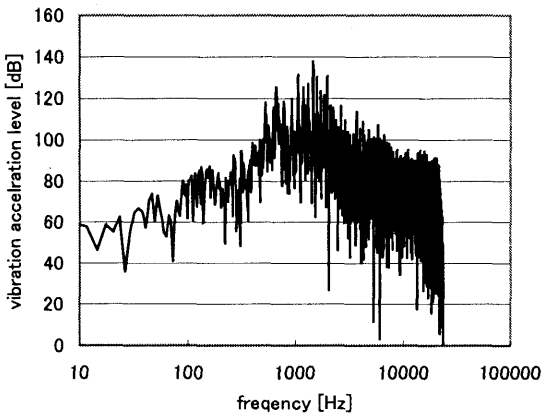

Figure 5 The gantry side 270 degrees of 105cm

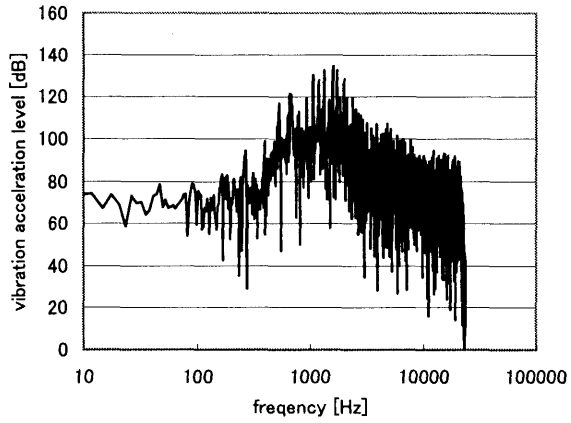

Figure 6 The gantry side 90 degrees of 105cm

Also, it becomes the value, which is bigger than the others at 290 degrees.

But, at 150 cm, it is vibration of X-axis purely. It includes an ingredient of the direction of the Y-axis as the height changes from this standard.

As for the vibration acceleration level by the Over All level, the value is the same compared with 4-2 approximately in the gantry aperture area direction of the Z-axis and the direction of the X-axis in the gantry side.

4 — 4 The symmetry

Figure 5 and figure 6 show the frequency response of Over All in the gantry symmetricalness position.

The low frequency ingredient is low and the peak appears in the 1 kHz neighborhood. Then, it attenuates when the frequency becomes higher. As for this, the high frequency ingredient is because it is the ingredient of the side wave for which it is easy to attenuate.

The vibration acceleration level by Over All is 125.70 dB in figure 5 and 125.80dB in figure 6. The difference is 0.1 dB and there is not laterality in the X-axial vibration of the gantry. The whole gantry is vibrating uniformly therefore.

5 conclusion

In this time, the size, periodicity and the frequency response with vibration acceleration became the clarifying while the MRI device operates. The 80 Hz vibration acceleration level that the person is easy to sense showed an equal to or more than 90 dB value, in Over All, it became equal to or more than 130 dB. Size with the vibration acceleration was proved.

While the inspection time of the MRI device, it needed from 20 to 40 minutes. If the inspection is long it need more than 60 minutes. To be continuing to catch these vibrations during the inspection is very cruel environment.

It thinks that it is effective when restraining the vibration of " the low-frequency-component " and " from 1 kHz " to " 2 kHz ".

It is necessary to increase a measuring position in the future and to do the specifying and the modal-analysis of the vibration source and to analyze further vibration.

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