Analysis of average glandular dose for mammography in 2011 questionnaire

Y. Asada* [1], S. Suzuki [1], T.Otsuka[1]

[1]Faculty of Radiological Technology, Fujita Health University, School of Health Sciences,

1-98 Dengakugakubo Kutsukake-cho Toyoake, Aichi, 470-1192, Japan

Abstract. We were obtained from a 2011 questionnaire carried out nationwide in Japan was investigated. The breast entrance skin dose was estimated from the dose of 468 institutes in 2011, which was calculated from data measured at 92 mammographic X-ray equipments in Japan. Then, patient exposure dose for mammography was estimated from exposure condition obtained 2011 questionnaire. The dose estimated about 1.6mGy in 2011 was approximately equivalent to that in 2007 survey.

Keywords: average glandular dose, mammography, digital equipments

1.Introduction

Recently, the patient exposure dose in mammography has varied because of great progress in digital mammography. Patient exposure dose (average glandular dose) as obtained from a 2011 questionnaire carried out nationwide in Japan was therefore investigated. Average glandular dose in 2011 was also compared with doses in 1993, 1998, 2001, 2003 and 2007 [1-4].

2.Materials&Methods

The questionnaire was sent to 3,000 institutes, with responses from 741 (24.7%). Of these 741 institutes, average absorbed dose could be calculated for 468 institutes. The theoretical average absorbed dose (Dg) in the mammary gland can, for the purposes of mammography, be calculated from the equation Dg = DgN·Xa, where DgN is the average absorbed dose in the mammary gland resulting from an incident exposure in air of 2.58×10^{-4} C/kg and Xa is the incident exposure in air, for X-ray tubes with a combination of targets and filters (molybdenum (Mo)-target and Mo-filter, Mo-target and rhodium (Rh)-filter, or tungsten (W)-target and Rh-filter) operating at radiation quality (half-value layer and tube voltage, etc.) and a tissue composition of 50% adipose tissue and 50% gland and for breast thickness of 4.2cm. DgN is expressed in mGy per 2.58×10^{-4} C/kg. In this study, Dg was estimated from clinical exposure conditions (tube voltage and mAs value) of 468 institutions participating in the 2011 questionnaire, based on the average absorbed dose per

mAs value (mGy/mAs) of every tube voltage measured in 92 systems from the Tokai and Hokuriku areas and other areas in Japan [5], containing the DgN was used published table [6] of tissue composition of 50% adipose tissue and 50% gland and a breast thickness of 4.2 cm corresponding to every tube voltages, as shown in Table 1. Furthermore, data from the 2011 questionnaire were compared with findings from the 1993, 1998, 2001, 2003 and 2007 questionnaires[1-4].

Table1: Average absorbed dose per mAs value of every tube voltages

Target/filter	Tube Voltage	Average absorbed dose per mAs value
Mo/Mo	**20kV**	**0.0069mGy/mAs**
	24kV	**0.0130mGy/mAs**
	25kV	**0.0152mGy/mAs**
	26kV	**0.0177mGy/mAs**
	27kV	**0.0206mGy/mAs**
	28kV	**0.0239mGy/mAs**
	29kV	**0.0276mGy/mAs**
	30kV	**0.0319mGy/mAs**
	31kV	**0.0368mGy/mAs**
Mo/Rh	**27kV**	**0.0184mGy/mAs**
	28kV	**0.0210mGy/mAs**
W/Rh	**28kV**	**0.0119mGy/mAs**

3.Result

The average glandular dose in 2011 was estimated as 1.58 mGy and the 75% dose was 1.91 mGy. The largest class for average glandular dose was 1.5-2.0 mGy (Fig. 1). In terms of image receptors, digital systems (Computed Radiography(CR) + Flat Panel Detector(FPD)) were about 97% and analog systems (Film/Screen) were about 3% (Fig. 2). Average glandular doses for CR, FPD and F/S image receptors were 1.59 mGy, 1.58 mGy, and 1.26 mGy, respectively. The class of 1.5-2.0 mGy in the digital system was strikingly large (Fig. 3). Digital systems outnumbered

F/S systems in 2007, reflected the trend in 2011 (Fig. 4). Average glandular doses as found in each survey are shown in Table 2. Dose in 2011 was approximately equivalent to that in 2007. Table 3 shows the average glandular dose for digital systems in each year. The dose in 2011 was approximately equivalent to that in 2007.

Fig1: Distribution of average glandular dose

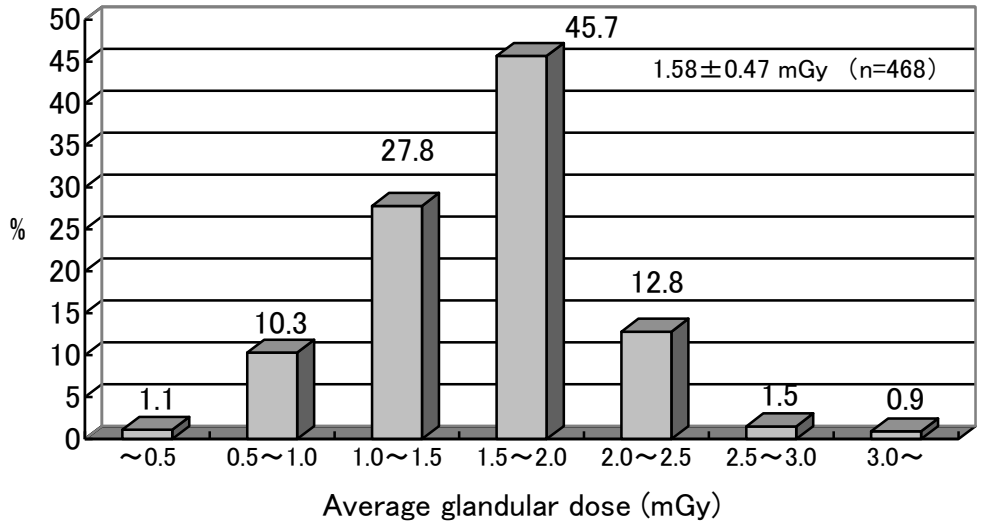

Fig2: The ratio of every image receptor

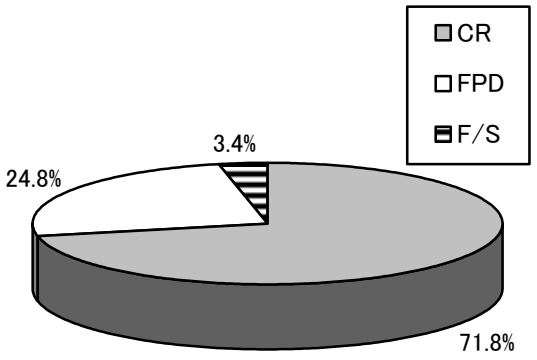

Fig3: Distribution of average glandular dose per every image receptor

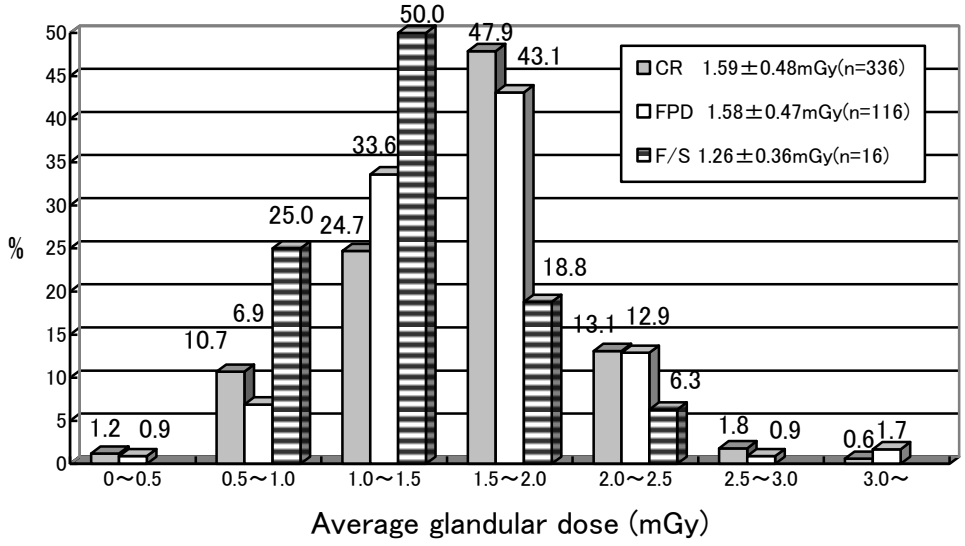

Fig4: The transitional change of digital systems and analog system (F/S)

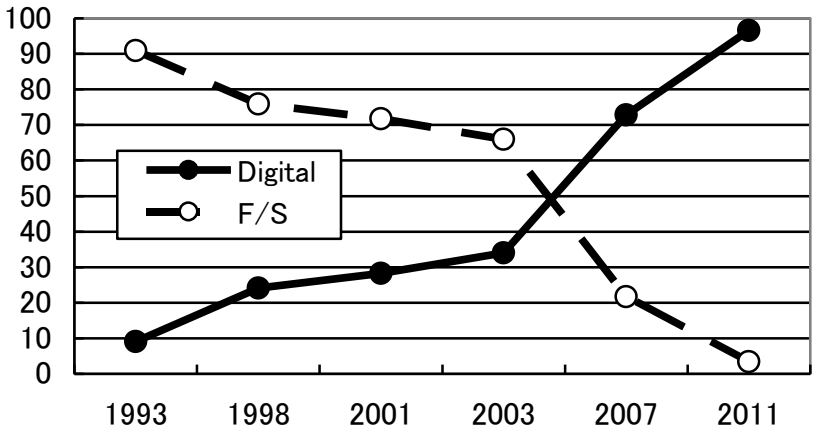

Table 2. Average glandular doses

year(the number of date)	average±S.D.(mGy)
2011 (**n=468**)	**1.58±0.47**
2007 (**n=434**)	**1.61±0.63**
2003 (**n=315**)	**1.43±1.10**
2001 (**n=375**)	**1.46±1.58**
1998 (**n=782**)	**1.42±1.58**
1993 (**n=399**)	**1.61±1.75**

Table 3. Average glandular doses for digital systems

year(the number of date)	average±S.D.(mGy)
2011 (**n=452**)	**1.59±0.48**
2007 (**n=316**)	**1.62±0.63**
2003 (**n=107**)	**1.25±0.73**
2001 (**n=106**)	**1.59±1.74**
1998 (**n=188**)	**1.54±1.31**
1993 (**n=35**)	**1.27±0.83**

4.Discussion

The International Atomic Energy Association guideline for mammography for a typical adult patient is an average glandular dose per cranio-caudal projection of 1 mGy without a grid and 3 mGy with a grid [7]. Most institutions surveyed in 2011 were within this criterion. The 75% dose was 1.91 mGy, lower than the 2.0 mGy reported as the achievable level in the European guideline [8] and as the reduction target dose in Japan [9]. Estimated average glandular dose in 2011 was approximately equivalent to the dose estimated in 2007 with the rapid increase in the use of CR image receptors. Institutes using digital systems outnumbered institutes using F/S systems in 2007, and this gap widened in 2011. We recognized that most mammographic X-ray equipment in Japan is now digital. The initial flat-panel detectors or storage-phosphor systems developed for mammography produce a spatial resolution of 5-8 line pairs per millimeter. This resolution is still 50% less than that for conventional film-screen systems [10]. However, digital equipment has continued to improve. Furthermore, full-field digital mammography has the potential to decrease the mean glandular dose in mammographic screening [11]. The tendency to use higher patient doses than necessary with digital systems should be avoided. The objective remains to avoid unnecessary patient doses, i.e., doses that have no additional benefit for the clinical purpose intended.

5.Conclusion

This survey confirmed the rapid adoption of digital systems in Japan. The patient exposure dose for mammography in 2011 was approximately equivalent to that in 2007, and lower than European and Japanese guidelines. We must clarify appropriate doses for digital systems in mammography by continuous survey.

REFFERENCES

[1] Y. Asada, S. Suzuki, S. Fujii, T. Orito, et al.. Analysis of patient radiation exposure in mammography: Estimation of average glandular dose in a 1998 questionnaire. *Jpn J. Breast Cancer* 15 (2): 173–177 (2000) (in Japanese)

[2] Y. Asada, S. Suzuki, S. Fujii, M. Kobayashi, et al. Analysis of patient exposure dose for mammography in 2001. *Jpn J. Breast Cancer* 18 (2): 127–132 (2003). (in Japanese)

[3] S. Suzuki, Y. Asada, M. Kobayashi, and S. Koga. Patient exposure doses from medical X-ray examinations in Japan. *Jpn J. Med. Instrumentation* 75 (2): 55–62 (2005). (in Japanese)

[4] Y.Asada and S.Suzuki. Analysis of patient exposure doses for mammography. *Medicine and Biology* 153(8):302 – 307 (2009).

[5] S. Suzuki. Actual condition survey of patient radiation exposures and leakage radiation in mammography. *FBNews* 416: 1–5 (2011) (in Japanese)

[6] Radiographic Group of the Japanese Society of Radiological Technology. Mammographic Quality Manual. Kyoto: *Japanese Society of Radiological Technology.* (1997). (in Japanese)

[7] IAEA. International basic safety standards for protection against ionizing radiation and for the safety of radiation sources. Vienna: IAEA. (1996)

[8] European Commission. European guidelines for quality assurance in breast cancer screening and diagnosis (fourth edition). Luxembourg: European Commission. (2007)

[9] JART. The reduction target dose in diagnostic radiology -guideline of patient exposures in 2006-. *The Japan Association of Radiological Technologists* 53(11):16-30 (2006).(in Japanese)

[10] ICRP. *Managing Patient Dose in Digital Radiology* (Publication 93). Stockholm: ICRP. (2003)

[11] I.H.R.Hauge,K.Pedersson,A.Sanderud,S.Hofvind,et al.Patient doses from screen-film and full-field digital mammography in a population-based screening programme.*Radiat Prot Dosimetry* 148 (1) :65-73(2012).