The Experience in Dose Measurement of IVR with Glass Dosimeter System

Kanae Nishizawa[a], Takashi Moritake[b], Kazuo Iwai[c], Yuji Matsumaru[b], Koji Tsuboi[b] and Takashi Maruyama[a]

Dept. Medical Physics, NIRS, 4-9-1 Anagawa, Inage-ku, Chiba, Japan, [b] Department of Neurological Surgery, Institute of Clinical Medicine, University of Tsukuba, 1-1-1, Tennnoudai, Tsukuba-shi, Ibaragi, Japan[c] Fac. Dentistry, Nihon Univ. 1-8-13, Kanda Surugadai, Tokyo, Japan
e-mail:nisizawa@nirs.go.jp

ABSTRACT

It is reported that exposure for the patient and the medical staff from IVR is large. Direct measurement of patient exposure is difficult, since the measurement disturbs reading of images. The fluorescence glass-dosimeter system consisting of small-size glass chips is developed in recent years. Owing to its small size and physical characteristics, direct monitoring of surface dose may be feasible. The dose measurement for patient and medical staff during head interventional radiology (IVR) examinations was tried by using the fluorescence glass-dosimeter system. A dose response of the glass dosimeter is almost linear in large dose range but its energy dependency is high. About 20% variation of sensitivity was observed in the effective energy of 45-60keVwhich was used in IVR. In spite of this shortcoming, the fluorescence glass-dosimeter system is a convenient means for a dose monitoring during IVR performance.

Key words: Glass Dosimeter, Interventional Radiology, Medical Exposure

1. INTRODUCTION

Recently considerable amount of IVR have been carried out in angiographies for various body regions. It is not rare that fluoroscopy takes prolonged period of time in some cases. In the case of IVR, treatment follows diagnostic examination, and because of this IVR is beneficial in clinical situations. However, it is reported that exposure for the patient is so large that sometimes it causes serious skin injury. By displaying the dose during the IVR performance in real time using the dose-area product dosimeter, the reading may warn the operator of the dose level. But, it is not evaluation of the real patient dose. Although the surface dosimeter is available, it does not suite measurements of many points. In this study, it is reported that direct measurement of surface dose of the patient using the small glass dosimeter that was developed in recent years. Although it does not allow real time dosimitry, it gives us more accurate evaluation of surface dose.

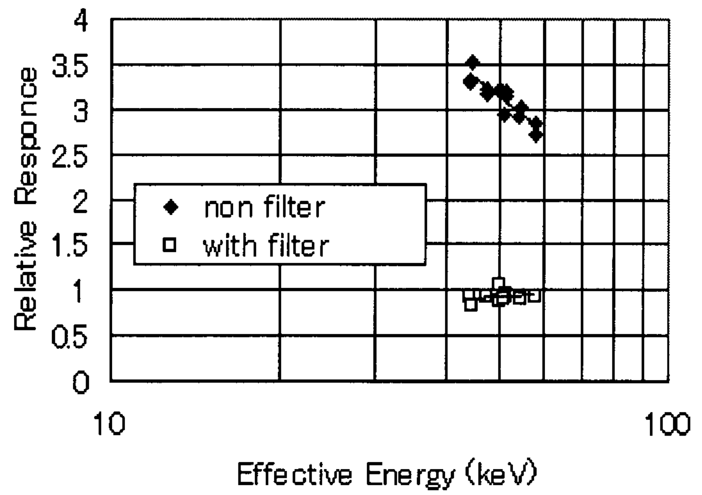
2. MATERIALS AND METHODS

The angiography unit used in this experiment was the system INTEGRIS V5000 (Philips Medical Systems Co. Germany). It has two sets of X-ray tubes that are installed by the L type and C type arm, respectively, and the patient imaging from various angles is feasible. In almost all cases, the tube voltage of the X-ray used for IVR ranged 70-90 kV. The IVR system can be changed into two modes, namely "Low dose" and "Normal", by the X-ray filtration conditions. The effective energy for tube voltage of 70-90kV was 50keV-58 keV for "Low dose" and was 44keV-51keV for "Normal". A glass-dosimeter small chip system was Dose Ace (Asahi techno glass, Japan). The glass chip is of cylindrical shape, 1.5mm in diameter and 12mm in length with an ID number incised on each chip. A filter for energy compensation is supplied as an accessory and its use is recommended for the X-ray energy range for diagnostic purpose. However, since the shadow of the filter appears on the image and interferes medical examination, glass chip was used without the filter. The energy dependency of glass dosimeter for 45keV-60keV and dose response was measured. Actual dose during IVR was monitored by the dosimeter attached to the body surface of the patient and total exposure during the performance was measured. Dosimeters were calibrated on a tissue equivalent phantom (MixDp). The dose on the tissue equivalent phantom was measured by the ionization chamber (0.6ml effective volume) traceable to the national standard in the diagnostic X-ray area. At each measurement point for correction, two sets of 10 glass chips were used. One set was placed in close contact and another were placed 2mm apart to see the effect of scatter among them. For the measurement of patient surface dose, five glass chips were used for one point. 27 points were measured. In the case of doctors, three glass chips were use for one point. 16 points were measured.

3. RESULTS AND DISCUTION

The glass chips are transparent to X-rays and are barely seen on the screen. Dose response and energy dependency of the glass dosimeter are shown in Fig. 1 and 2, respectively. There was no significant difference between two sets, a set in close contact and a set place 2mm apart. An example of the skin dosage monitoring of the patient by the glass dosimeter is shown in Table 1. Since there are too many unknown factors such as the contributions of two X-ray tubes, the effect of bed etc., effectively energy cannot be assessed. By recording the X-ray tube voltage in every 5 minutes, the average tube voltage was used to estimate the conversion factor of glass dosimeters. The dose of operator during the same performance is also included in Table 1. In order to avoid excessive light exposure to the photo-multiplier, the

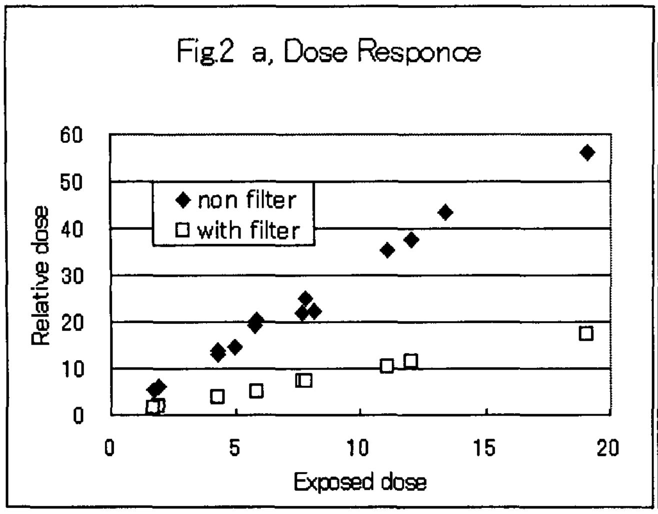
Fig..1 Characteiristic Curve



glass-dosimeter system is equipped with two reader units that should be switched at about 3Gy for diagnostic X-ray energy range. According to ICRP Publ.85[1], it is likely that the surface dosage exceeds 3Gy. Therefore the reader must be so designed for operational ease that it can handle up to actual dose of 10Gy without changing the reader units. In spite of its minor shortcoming, the small chip type glass dosimeter system is applicable to the dosimetry of surface dose of patients and of medical staffs.

4. SUMARRY

1. Energy dependency of glass dosimeter is high to the X-ray energy range of diagnostic applications. The variation in energy range 50-60keV was 20%.
2. The dosage response linearity was confirmed from few mGy to some 10Gy.
3. Switching of two reader units around actual dose of 3Gy is cumbersome, so that it should be modified to cover up to actual dose of 10Gy without change of units.
4. Owing to its size and transparency to X-rays, a glass dosimeter chip does not interfere imaging and is applicable to the monitoring of the surface dose of patients and medical staffs during the IVR performance. Dose does not allow real time dose assessment, but it gives us rather accurate dose within a few days after IVR performance. It is beneficial to the patient care, since it gives dose information to the doctor in charge.



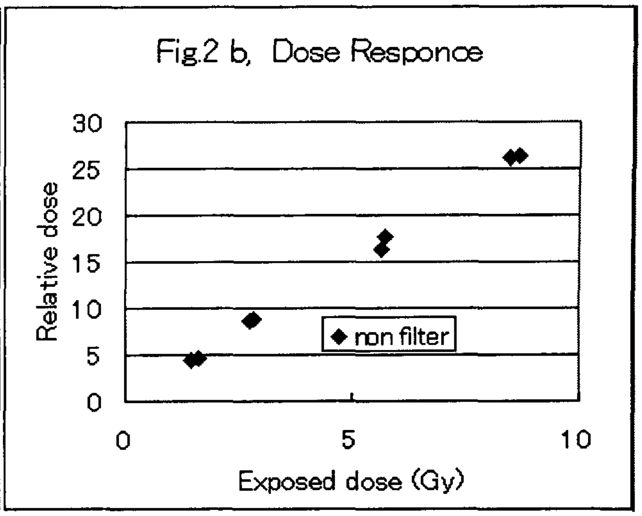


Table 1. IVR for Head

Total fluoroscopy time	15.5min
DSA (influence for only patient)	15 times
Operator	Upper arms : 0.2mGy Hand : 0.04mGy Eye : 0.1mGy
Patient (27 measured point on head)	Maximum : 840mGy Minimum : 10mGy

REFERENCES

1. ICRP Publ.85 (Annals of the ICRP vol.30 No.2,2000): Avoidance of radiation Injuries from Medical Interventional Procedures. Pergamon Press, Oxford, 2000
2. Junji Tanaka, Hisashi Hirata, Naoko Nishi, Takashi Ushimi and Atsuko Heshiki: Radiation Dose measurement of the patient in interventional radiology Using a transmission Ionization Chamber, Nippon ACTA Radiologica **60**;261-267,2000
3. J R Williams: The interdependence of staff and patient doses in interventional radiology. Brit.J. Radio l. **70**; 498-503, 1997
4. Uchida I, Miura T, Takahashi T, Kuwabara A, Ito A, Yamashita T: Energy Characteristics of Integrate Skin Dosimeter (SDM—Model 104-101). RADIOISOTOPES **47** ; 759-764,1998