

ORIGINAL ARTICLE

내시경 역행성 담췌관조영술에서 시술자에 대한 방사선 방호의 부족

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Lack of Radiation Protection for Endoscopists Performing Endoscopic Retrograde Cholangiopancreatography

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Background/Aims: ERCP using fluoroscopy should be practiced with an adequate radiation protection. However, the awareness of gastrointestinal endoscopists to radiation protection was considered insufficient. In Korea, a country with a rapid increase the number of ERCP procedures, there is no data about radiation protection practices for gastrointestinal endoscopists. The purpose of this study was to investigate current clinical practices and the awareness on radiation protection in ERCP performing physicians in Korea.

Methods: An anonymous questionnaire regarding radiation protection practices was mailed to 100 members of Korean Pancreatobiliary Association who was performing ERCP. The questionnaire included ERCP volume of each endoscopist, use of protection devices such as apron, thyroid shield, lead glasses and any mobile shield for scattered radiation, and whether they monitored their own radiation exposure dosage.

Results: All respondents wore lead aprons during ERCP. While 52.5% of endoscopists answered that they always wear thyroid guards, 26.9% rarely or never wore it. Only 14% wore lead glasses during the procedure and 69% never wore it. The preparation rates of mobile shields or lead curtains were only 14% and 24%, respectively. Only 10% of endoscopists attached an X-ray badge and 66.7% never used it. Moreover, 75% of endoscopists responded that they did not monitor their own exposure dose to radiation during ERCP.

Conclusions: The lack of radiation protection of ERCP endoscopists in Korea was seemed serious. Awareness of radiation hazard should be more concerned and educated in parallel with the preparation of radiation protection equipments. (**Korean J Gastroenterol** 2011;58:93-99)

Key Words: Radiation protection; Endoscopic retrograde cholangiopancreatography

INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) is an essential medical tool for the diagnosis and manage-

ment of pancreatobiliary diseases. Fluoroscopy is commonly used for ERCP and creates ionizing radiation that can lead to chemical or biological damage in exposed personnel. Exposure to radiation can result in somatic effects or genetic

Received February 22, 2011. Revised May 23, 2011. Accepted July 4, 2011.

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Financial support: None. Conflict of interest: None.

effects.^{1,2} As ERCP requires fluoroscopy, endoscopists must be aware of the radiation hazards and try to minimize the exposure of patients and their own exposure. ERCP should be practiced with the same level of radiation protection as other interventional radiological procedures.

Korea is one of the countries with a rapid increase in diagnostic and therapeutic ERCP procedures. However, awareness of the radiation hazards for gastrointestinal endoscopists has never been evaluated, and there is no data on radiation protection practices for endoscopists performing ERCP.

The objective of this study was to investigate current clinical practices for radiation protection and monitoring among ERCP-performing physicians.

SUBJECTS AND METHODS

The survey subjects were selected among general hospital ERCP practitioners who were members of the Korean Pancreatobiliary Association. Fellows, trainees, and private doctors who did not perform ERCP were excluded, regardless of their membership status. An anonymous questionnaire with an explanatory introduction was twice emailed to 100 ERCP endoscopists. Questions were asked about the ERCP

volume of the hospital and, for each endoscopist, regarding the following: the use of a lead apron, including the type and thickness; the presence of a dedicated hanger for apron storage to prevent cracks; the use of thyroid guards and lead glasses; the use of a mobile shield or lead curtain to protect from scattered radiation; the use of an attached radiation badge (dosimeter) during ERCP and for regular evaluation of radiation exposure. For most of questions, four choices were provided for answers: 'always', 'mostly', 'rarely', and 'never' (Table 1).

Responses were collected by the Secretary of the 'Committee established for ERCP guidelines on radiological protection' under the Korean Society of Pancreatobiliary Disease. Duplicate data from two or more endoscopists in the same hospital were not counted.

RESULTS

1. ERCP case volume

The questionnaire was completed and returned by 78 (78%; 70 men and 8 women) endoscopists. Of these, 69 worked at university hospitals, and 11 worked at general hospitals. Wide variations existed in the number of ERCP procedures per mo, as follows: ≤ 10 (9%), 11-15 (17%), 16-20

Table 1. Anonymous Questionnaire Regarding Radiation Protection Practices during ERCP

Question	Answers
1. What is your sex?	a) Male, b) Female
2. Where do you work?	a) University Hospital, b) General Hospital (not 1), c) Clinic
3. What is your ERCP volume per month?	a) ≤ 10 , b) 11-15, c) 15-20, d) 21-25, e) 26-30, f) 31-35, g) 36-40, h) 41-45, i) 46-50, j) 51-55, k) 56-60, l) ≥ 61
4. Do you work with an ERCP special team (such as a nurse practitioner and expert radiological technician)?	a) Yes, b) No
5. How many ERCP endoscopists work at your center?	a) 1, b) 2, c) 3, d) ≥ 4
6. How often do you wear a lead apron during ERCP?	a) always, b) mostly, c) rarely, d) never
7. Which type of lead apron is used to perform ERCP?	a) one-piece frontal cover, b) one-piece wrap apron (front, back, and sides covered), c) two-piece wrap apron, d) other
8. What is the thickness of the lead apron that you are using?	a) 0.25 mm, b) 0.5 mm, c) 1 mm, d) other
9. Do you have a dedicated hanger for apron storage?	a) Yes, b) No
10. How often do you wear a thyroid guard during ERCP?	a) always, b) mostly, c) rarely, d) never
11. How often do you wear lead glasses during ERCP?	a) always, b) mostly, c) rarely, d) never
12. Is a mobile shield (for upper body protection) prepared for radiation protection?	a) Yes, b) No
13. Is a lead curtain or table shield (for lower body protection) prepared for radiation protection?	a) Yes, b) No
14. Do you use any other radiation protective device except those mentioned above?	If yes, please write it (or them).
15. How often do you wear a radiation badge (dosimeter) during ERCP?	a) always, b) mostly, c) rarely, d) never
16. Have you been monitored with regard to your exposure dose?	a) Yes, b) No

(14%), 21-25 (11%), 26-30 (8%), 31-35 (11%), 36-40 (2%), 41-45 (2%), 46-50 (8%), 51-55 (2%), 56-60 (2%), and ≥ 61 (14%).

2. Lead apron wearing

All respondents answered that they always wore lead aprons during ERCP. However, most aprons (55%) were the frontal cover-type, which did not fully protect the back and

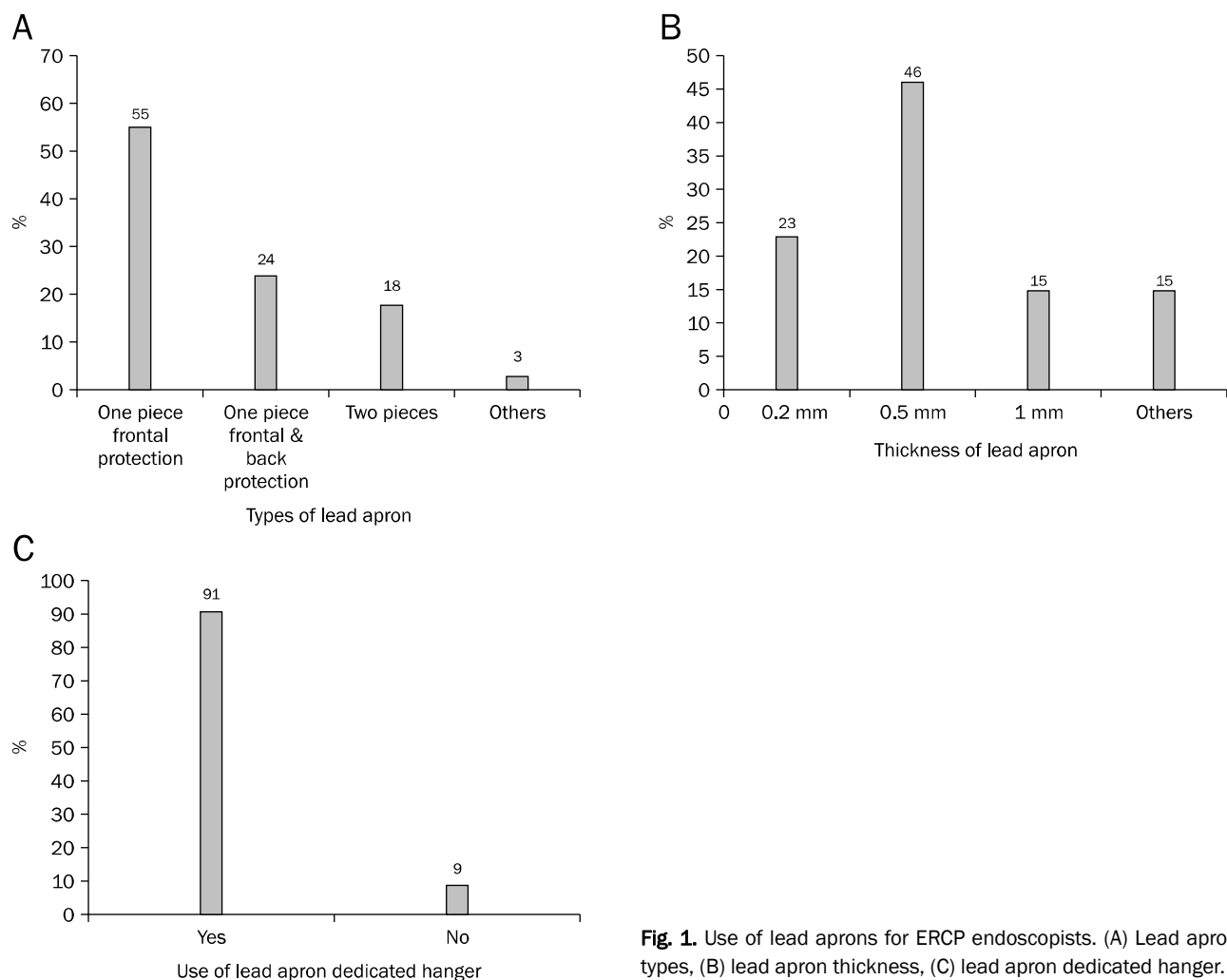


Fig. 1. Use of lead aprons for ERCP endoscopists. (A) Lead apron types, (B) lead apron thickness, (C) lead apron dedicated hanger.

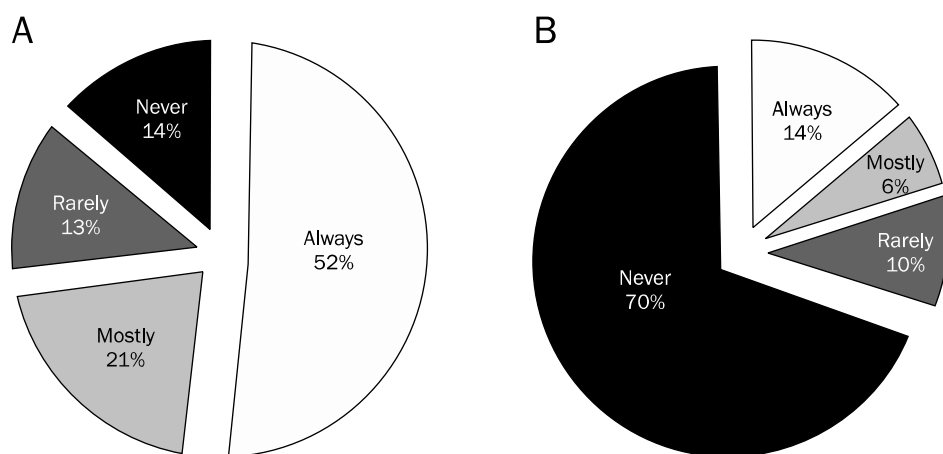


Fig. 2. Thyroid and eye protection for ERCP endoscopists. (A) Wearing a thyroid guard, (B) wearing leaded glasses.

side of endoscopists usually working at a position lateral to the radiation field. Also, 46% of lead aprons were 0.5 mm thick, a thickness known to be more protective against all kinds of radiation. However, 23% of endoscopists wore less protective, 0.2 mm thick aprons. Most lead aprons (91%) were equipped with dedicated hangers to prevent cracks (Fig. 1).

3. Thyroid and eye protection

The thyroid gland is susceptible to radiation hazard. Cataract development is also known to be directly related to radiation exposure. Thyroid guards and lead glasses were evaluated because they were strongly recommended, particularly to the main operator who worked nearest to the radiation field. Only 55% of endoscopists always wore thyroid collars, and 26.9% rarely or never wore them (Fig. 2A). Furthermore, 80% of respondents answered that they never wore leaded glasses, and only 14% wore them during every

procedure (Fig. 2B).

4. Protection from scattered radiation

It is well known that a significant amount of wave scattering occurs when radiation flows through the patient's body. This scattered radiation is high-energy and is known to be harmful to workers in the fluoroscopy room. We evaluated the preparation rates of lead curtain or mobile shields that were known to be effective as secondary devices to protect endoscopists and clinical staff from scattered radiation. In this study, only 24% of hospitals prepared mobile shields, and only 14% had lead curtains (Fig. 3).

5. Monitoring of radiation exposure

All fluoroscopy room workers should monitor their radiation exposure to assess cumulative radiation dose and prevent serious complications. We evaluated the rates of use of dosimeter badges and regular checks of radiation exposure.

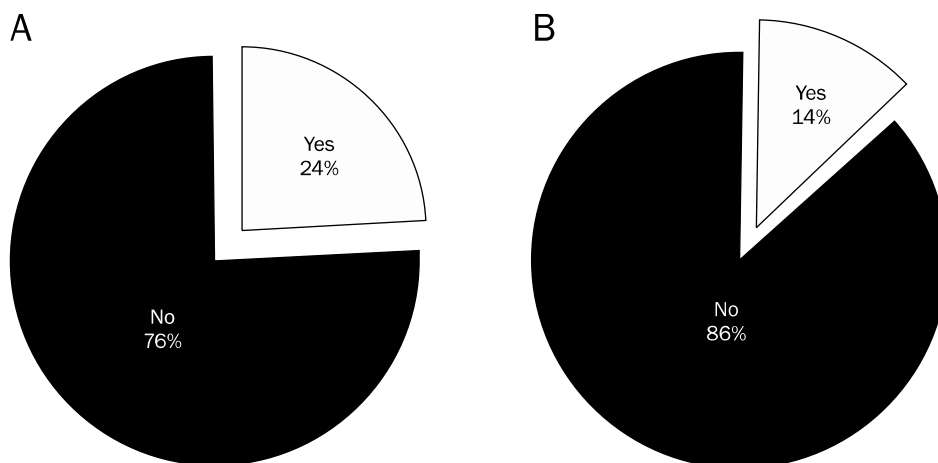


Fig. 3. Use of equipment to protect scattered radiation for ERCP endoscopists. (A) Preparation and use of a mobile shield, (B) a lead curtain or table shield.

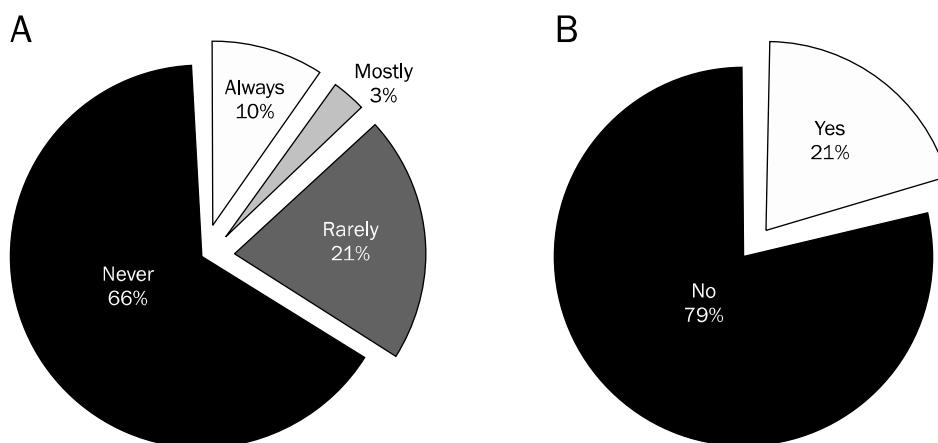


Fig. 4. Monitoring of radiation dose for ERCP endoscopists. (A) Wearing a radiation dosimeter, (B) measuring radiation exposure doses.

Of the total evaluated, 87% of endoscopists rarely or never wore dosimeter badges, and only 10% attached them every time. Moreover, only 21% checked their radiation exposure dose regularly, and 79% answered that they never monitor their own radiation exposure dose from ERCP procedures (Fig. 4).

DISCUSSION

Any fluoroscope used for ERCP emits radiation that can cause biological damage. The detrimental effects of radiation exposure are classified as somatic and hereditary effects. Somatic effects occur to the person directly exposed to radiation and are further classified as early or late effects. Early effects include acute bone marrow damage or gastrointestinal syndrome, and late effects include increased incidence of cancer or immune dysfunction. Hereditary effects may cause serious problems in offspring due to DNA changes or gene mutations caused by radiation exposure of reproductive organs.³ Biological effects can be also classified into deterministic effects and stochastic effects, according to the probability of derangement at any dose of radiation exposure. The deterministic effects are certain to occur above a certain level of dose, called the threshold, and above this level their severity increases with dose. In stochastic effects, the probability of occurrence also rises with an increase in radiation dose. However, the occurrence is all or none, and the effect itself does not worsen with increased dose. Hereditary effects are regarded as being stochastic.^{4,5}

Radiation hazards to medical professionals vary depending on treatment types and the exposure dose.⁶⁻⁸ Thus, the amount of occupational exposure risk is not easily ascertained. Although it is assumed that the cancer incidence for ERCP-performing physicians is lower relative to the radiation exposure, biological damage can be expected with low amounts of exposure, as in the case of stochastic effects. Therefore, it is absolutely necessary to minimize the exposure dose.

The objective of radiation protective measures is to lower the biological danger of radiation to a minimum possible level. This is thoroughly explained in the ALARA (as low as reasonably achievable) principle which consists classically of 3 parts: time, distance, and shielding. Reducing the exposure time of the ERCP scan will decrease the exposure dose, but

most ERCP physicians are used to paying more attention to the treatment rather than the scanning time; thus, reducing the time of exposure for physicians is not easy. The radiation exposure amount decreases by the Inverse Square Law: the exposure rate is inversely proportional to the square of the distance from the radiation source. Therefore, theoretically speaking, further distance from the patient will decrease the exposure dose dramatically. However, considering the ERCP treatment environment, it is not convenient to create such distance from the patient when endoscopic examinations must be performed. Therefore, the most effective way to reduce the exposure dose is to reduce the amount of fluoroscopic time and to be fully equipped with effective protective shielding.

Adequate protective equipment is known to dramatically decrease the danger of radiation exposure. The most basic protective devices for ERCP are lead aprons, thyroid collars, and lead glasses. Additional equipment includes lead curtains, lead gloves, and lead helmets. The American Society for Gastrointestinal Endoscopy Technology Assessment Status Evaluation 1994 recommends that all personnel in the endoscopy suite wear well-fitting aprons and thyroid collars during procedures. Furthermore, it is recommended that treatment providers who are working close to patients wear lead glasses and that lead curtains be placed between the endoscopists and the patients.⁹

A lead apron is the most common protective device and can dramatically reduce the radiation exposure dose. For thickness, there are no clear recommendations, although most studies show slightly different results for the thickness and protection rate. Conventionally, a 0.25-mm-thick equivalent lead apron has been known to reflect 90% of scattering waves.¹⁰ However, another study showed that 0.5-mm or thicker lead aprons are necessary for protection purposes when performing ERCP.^{11,12} Therefore, it is safe to assume that 0.5-mm or thicker lead aprons will be more effective for protection against radiation exposure when performing therapeutic ERCP. In our study, 45% of lead aprons had a 0.5 mm thickness, which is known to be more protective against all kinds of radiation.

The type of lead apron is another important factor for effective radiation protection. During ERCP, unlike conventional interventional radiological procedures, in which practitioners directly face patients and radiation sources, endoscopists

are not usually facing the radiation source and patient but rather standing to the side for better viewing of the fluoroscopic monitor and endoscopic video screen. This means that a front-only lead apron may not be adequate in providing coverage to the endoscopist. Therefore, it is more effective to wear wrapping-type aprons rather than frontal cover types.⁹ Our survey results show that, although all practitioners wore lead aprons, the majority wore frontal cover types. Additionally, lead aprons should be kept on dedicated hangers to prevent damage or loss, because creases and puckers on the lead apron can result in cracks where scattering waves can penetrate. In this survey, 9% of responders were not equipped with dedicated hangers, and so they may need to purchase apron hangers for safe storage.

One study suggested that thyroid collars could reduce the total body effective dose by 46% per year.¹³ Therefore, thyroid collars are an essential protective device not only to protect physicians' thyroids but also to reduce the entire body exposure dose. However, a number of physicians are unaware of or indifferent to thyroid protection. There are reports that only 47% of interventional radiologists¹³ and 52% of ERCP practitioners¹⁴ always wear thyroid collars during the procedure. In this study, only 52% of endoscopists answered that they are wearing thyroid collars during every procedure. This result suggests that it is necessary to educate endoscopists on the importance of thyroid collars in Korea.

Radiation cataracts are another common danger for ERCP endoscopists. A study showed that cataracts can occur in cases where the accumulated exposure dose is more than 2 Gray.¹⁵ It is absolutely essential for the main operator, who works closest to the radiation source, to wear lead glasses. However, many endoscopists are not aware of the radiation hazard to the lenses of the eye and often neglect lead glasses, which can be uncomfortable to wear. Surprisingly, only 14% of the ERCP practitioners in this study wore lead glasses.

Lead curtains and mobile shields are widely recognized as effective secondary devices to protect endoscopists and clinical staff from scattered radiation. Radiation flows straight upward or downward from the probe. Theoretically, there is no radiation exposure outside of the radiation field if there is no radiation leak. However, it is known that significant amounts of scattered waves develop when the radiation flows through the patient's body. This scattered radiation is

high-energy and is harmful to workers in the fluoroscopy room. Mobile shields and lead curtains can protect the treatment providers' body parts that cannot be covered by personal protective devices, such as lead aprons, thyroid collars, and lead glasses. A research result showed that 0.5-mm-thick equivalent lead mobile shields can decrease the exposure dose from 2.5 to 0.27 miliroentgen.¹¹ In the other study, the radiation exposure to endoscopists and assistants was significantly reduced by the use of a protective lead shield.¹⁶ In this study, the preparation rate and usage of a mobile shield or lead curtain were quite low, reflecting the lack of knowledge among ERCP endoscopists regarding scattered radiation.

Radiation monitoring is a basic practice that must be conducted in order to minimize the exposure dose. However, radiation dosimeters are often not worn. Surveys reported that 43% of the radiologists and 47% of ERCP practitioners rarely or never use dosimeters.¹⁴ In our survey, only 10.2% of ERCP practitioners used dosimeters, and more than 79% of all survey participants responded that they never examined their exposure dose. Therefore, it is necessary for ERCP practitioners to pay more attention to their radiation exposure status to maintain their own health. There are no set regulations for where the dosimeter must be placed, but it is generally placed under the lead apron or on the waist. If it is worn on minimum exposure areas, such as on the waist under the lead apron, then the reading may be drastically lower than the actual exposure rate.¹⁷ If worn near the neck line of the lead apron, then it has the advantage of being able to obtain the exposure rate of the head area, but the entire exposure rate could be exaggerated. Therefore, a study is needed to obtain data on the appropriate position of the dosimeter when practicing ERCP.

Education for radiation hygiene and safety can help physicians better understand the risks and serve as a foundation for further study of protective measures. Educating non-radiologists in radiation safety and proper radiation hygiene has been shown to decrease their subsequent exposure.^{18,19} A well-designed education program might improve the working environment of ERCP practitioners who have less understanding of radiology. Furthermore, this education program should be provided to hospital managers to prepare radiation protection equipment.

In conclusion, the results of this survey demonstrate an

alarming lack of radiation protection for ERCP endoscopists in Korea, a country with a rapid increase in ERCP procedures. In order to minimize radiation exposure during ERCP, awareness of radiation hazards should be stressed, and education programs with well-designed guidelines should be provided from Korean Pancreatobiliary Association. Preparation of radiation protection equipments in each institute also should be recommended or forced by law.

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