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Change in Exposure Index according to the Subject and Foreign Body Movement of Position

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Abstract

In most of the Digital Radiology Equipment, they have the system to provide exposure information to the inspector, and call this Exposure Index. EI can be classified as ROI Based EI and Histogram EI. We tried to see the change of EI according to the place of foreign body and subject in the detector, having chest PA inspection condition as the center. The first experiment method is to see the change of EI according to the movement of subject. Second method is the comparison of EI according to the foreign body movement by the set-up of EI. The third method is to compare and evaluate EI by the set-up ways of EI and the movement of shielding material. By the result of movement of the subject, for ROI based EI left and right, for Histogram EI middle and down, and in left and right had the same EI. By the result of movement of foreign matter, in the other 4 sectors, there were no changes in ROI Based EI and Histogram EI, and it was same for the each sectors. By the result of movement of the shield, ROI based EI, when Pb Protector was in the place of 14~20cm, the EI was same as the standard. Histogram EI Pb Protector Place was in 2~20cm, EI was 500, which is the same with the standard. In the same condition, by the EI set up method, the patient position and foreign body changed the quality of image by the position, and this shows that ROI based EI has big influence in Subject and Foreign Body Detector by the place and size. However Histogram EI can provide steady image because it doesn't get influenced by such environment.

Keywords: EI, Exposure Index, Histogram, ROI

1. Introduction

Digital Radiology Equipment has been increasing business improvement by the advantage of acquisition of convenient medical image, wide dynamic range, and reusing media of image[1]. By this there was significant development in the aspect of administrating image quality and patient dose of radiation inspection technique[2]. Because of the decrease of certain amount of dose not affecting image quality, we were able to lessen the dose without the decline of quality[3]. The factors that determinate image quality in DR are related to dose, if the dose increases the Signal to Noise Ratio (SNR) improves[4], but shows degradation in the image contrast or sharpness in the scattered radiation which happens after penetrating patient[5].

Therefore, when using radiation, even though the dose is permitted range, by decreasing radiation exposure if possible, this can decrease the occurrence of stochastic effects and non-stochastic effects. Because of this, in most of the Digital Radiology Equipment, they have the system to provide exposure information to the inspector, and call this Exposure Index (EI). Especially in the work of radiation, inspector is used as an important index to recognize exposure information related to examination[6]. The ROI based EI, which is the first method of configuration, gets the EI by ROI which is the area that's 25% of the middle which is placed in the range of 14*17 size when examining chest, and Histogram EI, which is the second method of configuration calculates the average value from 14*17 size of the whole range and gets final EI and decides the quality of image. In the existing research, EI is related to dose, but by the configuration of EI there were difference in the quality of image for the same patients, and it was same when there were a lot of foreign bodies.

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In this research, we tried to see the change of EI according to the place of foreign body and subject in the detector, having chest PA inspection condition as the center.

2. Materials and Methods

2.1 Experimental Equipment

- Equipment.
  - Digital Diagnost (Philips Healthcare, Holand, 2006).
  - EI: Detector Exposure Index.
  - Proper chest EI: 200~400.
  - EI Setting method: Histogram EI and ROI Based EI.
  - Phantom.
  - Chest Phantom PBV-50.
  - Others.
  - Exposure Conditions: 125kVp, 4mAs, SID 180cm.
  - Korea Metal Coin (Diameter: 2.65cm x 2.65cm, Weight: 7.70g, Quality of the material: Cupro-nickel).
  - Pb Protector.

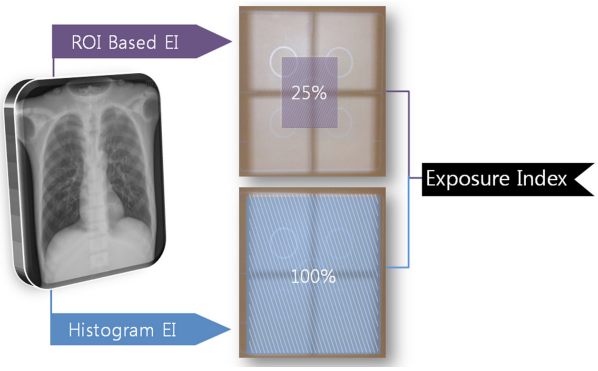

Figure 1. EI Setting method.

Figure 2. Digital diagnost.

Figure 3. Pb Protector.

Figure 4. Chest Phantom PBV-50.

Figure 5. Korea Metal Coin.

2.2 Methods

The first experiment method is to see the change of EI according to the movement of subject. We've adjusted general x-ray equipment by Adult Patients Chest PA Inspection condition (125kVp, 4mAs, 180cm), and in the front side of Detector, we've placed Chest phantom with Chest PA position. With the exam which is set-up as ROI Based EI and Histogram EI, we've measured EI which can be the standard after shooting in the same condition,

Figure 6. Movement of the subject, **(a)** Movement direction, **(b)** Standards Chest Phantom, **(c-f)** Moving Chest Phantom.

and by moving subject to 4sides of detector, we've shot 10 times each and compared/measured EI.

Second method is the comparison of EI according to the foreign body movement by the set-up of EI. When setting up the equipment, by dividing ROI sector which has been set from the 25% of the middle section and the other sectors by 4sectors in detector from the setting of Chest which is based on ROI Base EI, we've compared each exam by placing Korea metal coin in the ingredient of Cupronickel (3.5 x 3.5 cm), and measured EI 10 of each image.

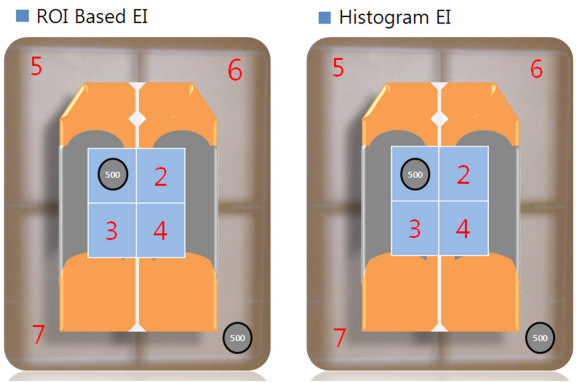

Figure 7. Movement of foreign matter.

The third method is to compare and evaluate EI by the set-up ways of EI and the movement of shielding material. We've compared and analyzed by dividing Detector into half and dividing below part in 2cm each from the middle (10 sectors), placing chest phantom instead of pregnant woman, and by moving Pb protector lower, we've measured EI 10 times each.

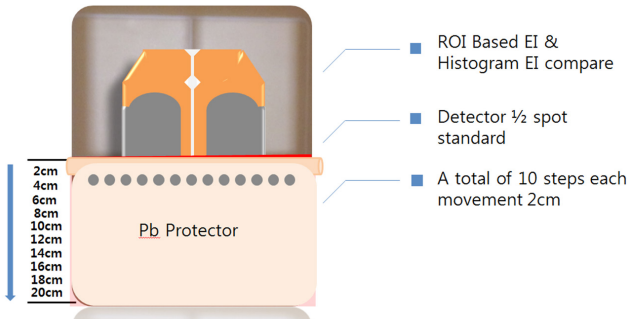

Figure 8. Movement of the shield.

For the statistics package, by using SPSS (Statistical Package for the Social Science, ver21.0, Chicago, USA), we've done one-way ANOVA, and had level of significance of 0.050.

3. Result

By the result of first experiment which was the change of detector EI of subject in the set-up method of EI, the EI

was 400 when the chest phantom was placed in the middle, when moving the subject to 4 sides, the ROI based EI was 250(up), 1000(down), 800(left), 800(right) which tells that there were change in EI in the amount of 0.63~2.50 compared to the standard ($p<0.050$), Histogram EI was 320(up), 630(down), 800(left), 800(right) which gave change in EI in the amount of 0.51~1.27($p<0.050$). In the result of multiple comparison test, for ROI based EI left and right, for Histogram EI middle and down, and in left and right had the same EI ($p>0.050$).

Table 1. The change of detector EI of subject in the set-up method of EI

Main	Sub	Mean ± SD	F	P*
ROI based EI	Center+	400±15	4804.039	<0.001
	Up	250±20		
	Down	1000±25		
	Left	800±20		
	Right	800±20		
Histogram EI	Center+	400±15	1535.312	<0.001
	Up	320±25		
	Down	400±20		
	Left	630±20		
	Right	630±20		

+Reference
*Statistically significant $p<0.05$, by oneway analysis of variances among groups, the same letters indicates non-significant
difference between groups base on Student-Newman-Keuls's multiple comparison test.
ROI based EI: Left and right had the same EI($p>0.050$).
Histogram EI: Middle and down, and in left and right had the same EI($p>0.050$).

In the second experiment, the change of EI from the area of detector according to the set-up of EI of 1 coin, the EI were all 500 when there were no coins in chest phantom. When inserting 1 coin in the ROI sector, there were change in EI by increasing 1.26, which had 630($p<0.050$). Histogram EI were same with the standard as 500($p>0.050$). In the other 4 sectors, there were no changes in ROI Based EI and Histogram EI($p>0.050$), and it was same for the each sectors ($p>0.050$).

Table 2. The change of EI from the area of detector according to the set-up of EI of 1 coin

Main	Sub	Mean ± SD	F	P*
ROI based EI	No coin+	500±20	35.312	<0.001
	ROI area 1	630±15		
	ROI area 2	630±20		
	ROI area 3	630±20		
	ROI area 4	630±20		
	Other area 1	500±15		
	Other area 2	500±30		
	Other area 3	500±30		
	Other area 4	500±30		
Histogram EI	No coin+	500±30	<0.001	1.000
	ROI area 1	500±30		
	ROI area 2	500±30		
	ROI area 3	500±30		
	ROI area 4	500±30		
	Other areas 1	500±30		
	Other areas 2	500±30		
	Other areas 3	500±30		
	Other areas 4	500±30		

+Reference
*Statistically significant $p<0.05$, by oneway analysis of variances among groups, the same letters indicates non-significant
difference between groups base on Student-Newman-Keuls's multiple comparison test.
ROI based EI: No coin and In the other 4 sectors had the same EI ($p>0.050$).

According to the third experiment, the change of EI by the place of Pb protector by the setting up of EI, each exam had 500 EI when chest phantom didn't have Pb protector. Having middle of the detector as the standard, when moving Pb protector 2cm each, when the ROI based EI Pb protector was 2~4cm EI was 630, 6~8cm was 580, and 10~12cm was 540. The EI became higher than when there were no Pb protector ($p<0.050$). When Pb Protector was in the place of 14~20cm, the EI was same as the standard ($p>0.050$). However, Histogram EI Pb Protector place was in 2~20cm, EI was 500, which is the same with the standard ($p>0.050$).

Table 3. The change of EI by the place of Pb protector by the setting up of EI

Main	Sub	Mean ± SD	F	P*
ROI based EI	No shields+	500±30	425.312	<0.001
	2cm	630±15		
	4cm	630±30		
	6cm	580±15		
	8cm	580±20		
	10cm	540±15		
	12cm	540±15		
	14cm	500±20		
	16cm	500±30		
	18cm	500±30		
	20cm	500±25		
Histogram EI	No shields+	500±25	<0.001	1.000
	2cm	500±25		
	4cm	500±20		
	6cm	500±20		
	8cm	500±15		
	10cm	500±15		
	12cm	500±20		
	14cm	500±30		
	16cm	500±30		
	18cm	500±20		
	20cm	500±20		

+Reference
*Statistically significant p <0.05, by oneway analysis of variances among groups, the same letters indicates non-significant
difference between groups base on Student-Newman-Keuls's multiple comparison test.
ROI based EI: No shields and 14~20cm had the same EI (p>0.050).

4. Discussion and Conclusion

From the index that evaluates image proper exposure there is Exposure Index which is provided by the equipment company. This index is influenced by equipment characteristic such as Exposure dose and detector. In the existing research, there is a lot of exposure index research related to exposure dose but less about EI set up. However in the same condition, by the EI set up method, the patient position and foreign body changed the quality of image by the position, and this shows that ROI based EI has big influence in subject and foreign body detector by the place and size. Especially, ROI based EI quality is decided by ROI zone which is in about 8cm outside of Detector, other sectors are safety zone which doesn't influence quality of the image so the quality can be influenced by the patient position or large amount of foreign body. However Histogram EI can provide steady image because it doesn't get influenced by such environment. Therefore, for pregnant woman, elders, or children, they need the use of Histogram EI, and for health screening patients who can stay in the same position, by choosing ROI based EI, it will help improve Exposure Index. So by checking the difference in quality of image in the change of EI set up, and by checking the patient position or foreign body and progress examination, even if the change is small, we will be able to get steady image quality for patients. For a limit, the equipment version is limited and because this thesis is experiment of phantom, the data can differ with clinical applied data. In this Thesis, we've done the experiment bases of chest examination, so there needs to be more research about other exams. When there is research about ROI Zone, the dose management by Proper Image quality inspection condition might be possible, especially, the ROI based EI set up had no difference in the quality of Film/Screen or DR system by the exposure point.

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