

# Comparison with Overlap Area of Scapular and Lung Field according to Position on Chest Radiography

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## Abstract

**Background/Objects:** The purpose of this study is to compare a representative position and two positions what are used clinically at Chest PA examination. **Methods/Statistical Analysis:** The first position is generally known for minimizing overlap of lung fields and scapulae, and the other 2 positions are mainly used in actual clinics. 3 Radiologic technologists with an average of 7 years' experienced reviewed the images. The overlapping area was measured by connecting the overlapping part of the lung field and the scapula in the radiograph with dots and lines. **Findings:** We compared the incidence of overlap of scapulae and lung fields depending on sex and age. There were no statistically significant differences between males and females in CP ( $p>0.05$ ). However, in IRP and HP, there were meaningful differences in the incidence of overlap depending on sex ( $p<0.05$ ). The images from males were less likely to have overlap than were those from females in both positions. There were no statistically significant differences depending on age ( $p>0.05$ ). CP showed the least overlapping area followed by HP and IRP. Regarding the ratio of overlapping area, CP had the highest ratio and IRP had the least ratio, but this difference was not statistically meaningful according to Kruskal-Wallis H examination. For reference, a value closer to 1 in this test indicates less of an overlap between the scapula and lung field. Therefore, a position with a value closer to 1 is more useful in separating the scapula and the lung field when conducting Chest PA. **Applications/Improvement:** The research revealed that both positions are useful in minimizing the overlap between the lung field and scapula.

**Keywords:** CP, Chest PA, Chest Radiography, HP, IRP

## 1. Introduction

Chest radiography (CXR) is used as a basic examination method in medical check-ups since it permits for non-invasive analysis of lung and cardiac diseases<sup>1</sup>. CXR accounts for 30-60% of all radiographic inspections that use X-rays<sup>2</sup>.

There are several ways of positioning a patient when obtaining a CXR image. A chest postero-anterior projection (Chest PA) is taken by sending X-rays through the back of a patient to the Image Receptor (IR) located anteriorly while the patient is in a standing or sitting position, whereas a chest Antero-posterior Projection

(Chest AP) is taken from the patient's front to back with the patient in a supine/sitting position<sup>3</sup>. This study defines CXR as Chest PA.

CXR is done during inhalation to maximize the volume of the lungs. It is desirable to have a minimum amount of overlap between the lung fields and scapulae. To get such an image, most books recommend having patients place the front of their chest and both shoulders on the IR, bend their elbows outwards, and have the back of the hands touch the hips in order to bring the humerus and forearms far from the chest<sup>3,4</sup>.

This position is difficult for children, patients with limitations in their shoulder or elbow joints, and certain

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others to maintain. Also, most radiation generators have grips on the backside or under the IR, and, by making use of these, patients can be examined in a stable position.

The purpose of this study is to consider the best position in which to place a patient to minimize the overlap between the lung field and the scapula in a CXR image when taking a Chest PA, and to help educate practitioners on the best pose for Chest PA by studying the utility of different poses as applied in an actual clinic.

## 2. Materials and Methods

### 2.1 Subjects

Seven hundred ninety-one patients underwent Chest PA on Oct 17<sup>th</sup>, 24<sup>th</sup>, or 31<sup>st</sup>, 2014 in the Department of Diagnostic Radiology chest x-ray room of 'S' hospital, located in Seoul. Of these 791, 738 patients were included in this study. Those who were excluded were under 20 years of age or had severe symptoms of scoliosis.

### 2.2 Equipment

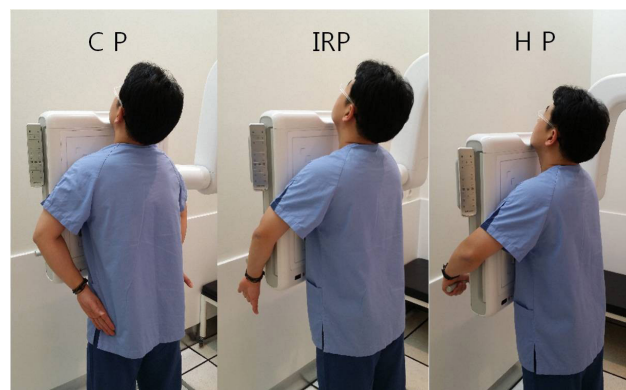
We used an XGEO GC80 (Samsung Electronics, Korea) and a Revolution xq/I (General Electronics, USA) X-ray generating device, and a Centricity Radiology RA 1000 (General Electronic, USA) PACS system.

### 2.3 Hypotheses

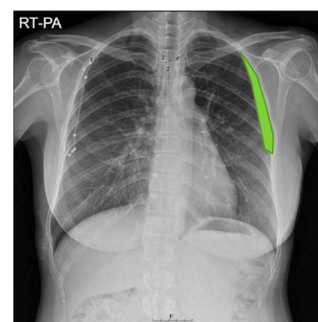
- The most textbook type position will have a minimum amount of overlap between the scapula and lung field among the 3 positions.
- The extent of overlap will differ depending on sex and age.

### 2.4 Methods

- From Sep 22<sup>nd</sup> to Oct 12<sup>th</sup>, 2014, radiologic technologists were asked to change a patient's position and become trained on the 3 examination positions used in this study Figure 1.
- Beginning on 13<sup>th</sup> Oct, patients' positions were changed weekly and CXR results from Oct 17<sup>th</sup>, 24<sup>th</sup>, and 31<sup>st</sup> were used as data in this study.
- Three Radiologic technologists with an average of 7 years' experience assessed the images. The overlapping area was measured by connecting the overlapping part of the lung field and scapula in the CXR with dots and lines Figure 2.



**Figure 1.** Positions used in this study.



**Figure 2.** Overlap between lung field and scapula on CXR.

Figure 1 shows the three positions used in this study. CP (Classical Position) is the most common Chest PA position, in which a patient bends his/her elbows to separate the humerus and forearm from the chest and touches the backs of the hands to the hips. IRP (Internal Rotation Position) is the position in which patients hug the IR with their arms internally rotated so their forearms touch the sides of the IR. HP (Hug Position) is the position in which patients hug the IR and hold the handles inside the equipment. Figure 2 shows a measurement of overlap between the lung field and scapula.

### 2.4 Statistical Methods

CXR data were taken with patients in 3 different positions. This study shows the average and standard deviation of the overlapping area of the lung field and scapula depending on sex and age. To compare whether overlap exists or not depending on sex and age, cross analysis was conducted. The overlapping area was divided by a weighted value (5000) and subtracted from 1 to get the percentage of the overlapping area; groups were then ranked [Formula 1]. For statistical analysis, the SPSS (Version 22.0, SPSS,

Chicago, IL, USA) statistical package was used and results with a 'p' value below 0.05 were considered meaningful.

$$Entropy = H_{\alpha(X)} = \frac{1}{1-\alpha} * \log \sum ((p_i)^\alpha)$$

$$\text{Percentage of overlap} = 1 - \{[(RA + LA)]/5,000\} \quad (1)$$

### 3. Results

#### 3.1 Demographic Characteristics

A total of 738 people participated in this study (CP : 278 people, IRP : 237, HP : 223). 365 of the subjects were male and 373 were female. Their average age was  $57.57 \pm 15.65$  years (range, 20 to 88 years) [Table 1].

**Table 1.** Demographic characteristics

|                   |        | Position         |                  |                  | Total             |
|-------------------|--------|------------------|------------------|------------------|-------------------|
|                   |        | CP               | IRP              | HP               |                   |
| sex (people)      | male   | 128              | 125              | 112              | 365               |
|                   | female | 150              | 112              | 111              | 373               |
| total             |        | 278              | 237              | 223              | 738               |
| mean age $\pm$ sd |        | 58.6 $\pm$ 15.00 | 58.1 $\pm$ 15.08 | 55.6 $\pm$ 16.91 | 57.57 $\pm$ 15.65 |

#### 3.2 Scapular and Lung Field Overlap according to Position, Sex, and Age

We compared the incidence of overlap of scapulae and lung fields depending on sex and age. There were no statistically significant differences between males and females in CP ( $p>0.05$ ). However, in IRP and HP, there were meaningful differences in the incidence of overlap depending on sex ( $p<0.05$ ). The images from males were less likely to have overlap than were those from females in both positions. There were no statistically significant differences depending on age ( $p>0.05$ ) [Table 2].

#### 3.3 Overlap in Scapulae and Lung Fields according to Position

CP showed the least overlapping area followed by HP and IRP. Regarding the ratio of overlapping area, CP had the highest ratio and IRP had the least ratio, but this difference was not statistically meaningful according to Kruskal-Wallis H examination. For reference, a value closer to 1 in this test indicates less of an overlap between the scapula

**Table 2.** Overlap between scapulae and lung fields in three positions according to sex and age

| sex and age         | Position                                    |             |                         |             |                         |             |
|---------------------|---------------------------------------------|-------------|-------------------------|-------------|-------------------------|-------------|
|                     | CP                                          |             | IRP                     |             | HP                      |             |
|                     | number of overlap or non overlap in CXR (%) |             |                         |             |                         |             |
|                     | overlap                                     | non overlap | overlap                 | non overlap | overlap                 | non overlap |
| male                | 55(43.0)                                    | 73(57.0)    | 47(37.6)                | 78(62.4)    | 43(38.4)                | 69(61.6)    |
| female              | 79(52.7)                                    | 71(47.3)    | 62(55.4)                | 50(44.6)    | 65(58.6)                | 46(41.4)    |
| total               | 134(47.2)                                   | 144(51.8)   | 125(46.0)               | 112(54.0)   | 108(48.4)               | 115(51.6)   |
| Fisher's exact test | $\chi^2=2.602, p=0.118$                     |             | $\chi^2=7.499, p=0.009$ |             | $\chi^2=9.077, p=0.003$ |             |
| 20s                 | 9(56.2)                                     | 7(43.8)     | 3(27.3)                 | 8(72.7)     | 9(56.3)                 | 7(43.8)     |
| 30s                 | 8(44.4)                                     | 10(55.6)    | 9(47.7)                 | 10(52.6)    | 16(50.0)                | 16(50.0)    |
| 40s                 | 14(37.8)                                    | 23(62.2)    | 17(48.6)                | 18(51.4)    | 12(41.4)                | 17(58.6)    |
| 50s                 | 32(53.3)                                    | 28(46.7)    | 25(50.0)                | 25(50.0)    | 21(47.7)                | 25(52.3)    |
| 60s                 | 29(38.7)                                    | 46(61.3)    | 27(45.8)                | 32(54.2)    | 21(44.7)                | 26(55.3)    |
| 70s                 | 32(56.1)                                    | 25(43.9)    | 22(41.5)                | 31(58.5)    | 17(43.6)                | 22(56.4)    |
| 80s                 | 10(66.7)                                    | 5(33.3)     | 6(60.0)                 | 4(40.4)     | 12(75.0)                | 4(25.0)     |
| total               | 134(48.2)                                   | 144(51.8)   | 109(46.0)               | 128(51.0)   | 108(48.4)               | 115(51.6)   |
| Fisher's exact test | $\chi^2=8.906, p=0.177$                     |             | $\chi^2=3.191, p=0.796$ |             | $\chi^2=6.137, p=0.410$ |             |

**Table 3.** Comparison between overlapping area and percentage of overlapping area according to position

|                            |                         | Position                |                      |                      |
|----------------------------|-------------------------|-------------------------|----------------------|----------------------|
|                            |                         | CP                      | IRP                  | HP                   |
|                            |                         | mean $\pm$ sd           |                      |                      |
| (mm <sup>2</sup> )         | overlap only right side | 511.31 $\pm$ 794.41     | 726.07 $\pm$ 1151.81 | 585.92 $\pm$ 899.45  |
|                            | overlap only left side  | 590.64 $\pm$ 913.55     | 727.83 $\pm$ 1027.72 | 758.82 $\pm$ 1030.37 |
|                            | overlap all side        | 550.98 $\pm$ 786.75     | 726.95 $\pm$ 1049.72 | 671.06 $\pm$ 901.23  |
| percentage of overlap area |                         | 0.8898 $\pm$ 0.1573     | 0.8546 $\pm$ 0.2099  | 0.8657 $\pm$ 0.1802  |
| Fisher's exact test        |                         | $\chi^2=1.056, p=0.590$ |                      |                      |

and lung field. Therefore, a position with a value closer to 1 is more useful in separating the scapula and the lung field when conducting Chest PA [Table 3].

## 4. Discussion

CXR has allows physicians to observe the overall outline of the chest and monitor changes in disease states. However, the intricate anatomic structure of the thorax and inside of the chest is shown as a flat surface, which can be a critical drawback of CXR. Obtaining a clear picture means ensuring that structures that transmit light at the same rate will not overlap with one another. Thus, the position that a patient stands in becomes very important.

According to data from the Ministry of Food and Drugs, Computed Radiography (CR) accounts for 232 (46%) of 508 medical institutions, Digital Radiography (DR) accounts for 177 (35%), and Film/screen System (F/S) accounts for 99 (19%)<sup>5</sup>. DR shows an image after correcting for problems, such as underexposure in the mediastinal area due to density contrast between the lung and mediastinal area, with specialized computer software<sup>6</sup>. Therefore, DR presents clearer images and is more useful in diagnosis than is F/S. Auto exposure control (AEC) is used to create images of the same concentration even if subjects have different X-ray absorption rates, reduces the differences in quality between images, and reduces the necessary radiation dosage by rationalizing exposure through maintaining the quality of images<sup>7</sup>. This technological development allows radiologic technologists to pay more attention to patients' positioning during examination, which is an important criteria of image quality.

Today, most standing detectors used in actual clinics have pre-installed handles for patients to hold. Device manufacturers recommend using the handles during examination. But the reality is that many patients do not do so. Radiologic technologists in the field are disregarding the manufacturers' recommendations. Most of them just continue to operate off of their experience in the field and use the methods that their superiors used. Therefore, radiologic technologists use CP, IRP, and HP at will, and this knowledge and experience is being passed on to junior radiologic technologists.

We examined the differences between males and females in overlap of lung fields and scapulae using the

three different positions. CP did not generate images that were statistically significant between males and females [ $p>0.05$ ], but IRP and HP did produce differences in the extent of overlap between males and females [ $p<0.05$ ]; images taken from males had less overlap in both positions.

This phenomenon may be because of movement of the scapula caused by horizontal pivoting of the scapuloclavicular joint and acromioclavicular joint<sup>8</sup>, and because males have broader shoulders than do females<sup>9</sup>.

There was no statistically significant difference in the 3 positions depending on age [ $p>0.05$ ].

After comparing the degree of overlap between the scapula and lung field among the 3 positions, it appeared that there were no statistically significant differences. In other words, all 3 positions can be used to remove the scapula from the lung field.

According to the researcher's clinical experience, CP is a very difficult position for children, patients who have limitations in their elbow or shoulder joints, elderly patients, patients who have just undergone surgery, and others to maintain.

IRP and HP are both also effective positions since patients who find CP difficult to maintain can hold the grips or hug the IR.

While conducting this study, we had difficulty in finding other reports on methods of Chest PA examination. Since CXR is commonly used in routine clinical exams, the examination process is not being dealt with seriously enough and radiologic technologists are also not paying close enough attention to the Chest PA examination<sup>10</sup>. As we stated above, they trust the CP position blindly. In most published literature related to CXR that we found, there were no handles for patients installed on wall bucky<sup>11</sup>. Therefore, the CP position in most textbooks reflects the condition of equipment in previous times, when the first CXR image was taken.

Therefore, the contents of textbooks should be revised to reflect actual, present-day circumstances. This study is significant in that it begins to figure out which position can minimize the overlap between the scapula and the lung field among the 3 positions studied. However, there is a limitation in that we could not have each patient pose in all 3 positions because of the risk of radiation exposure. Further studies are needed on this subject.



## 5. Conclusion

This study considered the usefulness of three different positions for Chest PA, one position (CP) that is generally known for minimizing overlap between the lung field and scapula, and 2 other positions (IRP and HP) that are mainly used in actual clinics. The results of this study are as follows:

- In CP, there was less overlap than in IRP and HP. However, since the differences were not statistically significant, hypothesis 1, 'The most textbook type position will have a minimum amount of overlap between the scapula and lung field among the 3 positions,' is dismissed.
- Hypothesis 2 was that 'The extent of overlap will differ depending on sex and age.' The difference in overlap depending on sex was statistically significant only for IRP and HP. The difference in overlap depending on age was not statistically significant for any position.

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