Advantage of temporal subtraction for interpretation of medical checkup chest X-ray radiogram

Poster No.: C-0740
Congress: ECR 2015
Type: Scientific Exhibit
Authors: M. Shimada¹, K. Yoshikawa¹, K. Ito², H. Moriguchi¹, T. Okada¹, Y. Okuyama¹, S. Namba¹, ¹Tokyo/JP, ²Yokohama/JP
Keywords: Cancer, Comparative studies, Digital radiography, Lung
DOI: 10.1594/ecr2015/C-0740

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR’s endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys’ fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Aims and objectives

From the photographed image in two different conditions, subtracted techniques to emphasize visualized by subtraction lesions of interest, have been used since ancient times in the medical image. Film subtraction and DSA in angiography can depict the only vessel contrast agent is filled. Energy subtraction method in simple images is possible to create a bone image and soft tissue image. Recent years emphasize temporal subtraction image technology changes with time of new lesions that appeared during the photographed timing two images have come to be introduced in clinical practice. Chest X-ray, which is performed in the medical examination center will be poor interpretation accuracy because it takes time and effort to the number of cases is enormous interpretation. We therefore used the temporal subtraction method as interpretation aid for improving the interpretation accuracy. Temporal subtraction method is a technique for coordinated display the shadow of purpose do the subtraction processing of the current image from the past images of the same subject.

Interpretation of small lesions, the lesion in the hilar or diaphragmatic region in particular, is very difficult in chest X-ray. When radiologist interprets the chest X-ray of this medical examination, radiologist often miss the lesion in the hilar or diaphragmatic region in particular. Diagnostic accuracy is better than the diagnostic accuracy only in this chest X-ray at the time of the interpretation by comparing the current chest X-ray image and the past chest X-ray image. But I will miss both bilateral hilar lesions and lesions near the diaphragm.

We evaluated the advantage of the image subtracted to improve accuracy of interpretation.

Methods and materials

We interpreted the subtracted image and present and past images. The subtraction image was obtained using the FUJI imaging work station (Temporal Subtraction Advance: T-SUB677), and was interpreted with a free software "radiant DICOM Viewer (32-bit). In temporal subtraction, the present and past images on the different dates are used. The past image is warping-treated to change by local area, position of the structure is matched and subtracted, and their time-course changes are emphasized#Fig.1#. Subjects were 200 cases which included 8 cases essential for diagnosis (2 cases of lung cancer in the diaphragm area, 2 cases of lung cancer in pulmonary hilum, 2 cases of swelled hilar lymph node induced by sarcoidosis, and 2 cases of pleural effusion).
These 200 cases chest X ray were interpreted by 3 radiologist with experience more than 10 years. These 200 cases were interpreted continuously with their present images alone, with present and past images by comparison, and with present and subtracted images, respectively. Their correct answer rates, sensibilities, and specificities were compared.

Images for this section:

**Fig. 1** The principle of temporal subtraction

In temporal subtraction method, a warping process of two images is performed to change each local region in the present and the past images, to match the position of the structure, to subtract the differences, and to emphasize the change over time between these images.

**Fig. 1**
Results

Percentages of the accuracy of interpretation by radiologists are summarized in Table 1. Accuracy rates diagnosed by radiologists with the present image alone, the present and the past images, and the present image and the image subtracted from the past image were 62.5%, 75.0%, and 100%, respectively. A rate of wrong diagnosis was 0% with the present image and the image subtracted from the past image. Frequency of lesion detected is estimated by the case each 1) diagnosed with the present image alone, 2) diagnosed with the present image compared with the past image, 3) diagnosed with the subtraction image added to the present image, and diagnosed by mistake. Sensitivity and specificity of diagnosis based on all images of the present, past, and temporal subtraction images are listed in Table 2. The sensitivity and specificity of interpretation with the present image alone were 62.7% and 99.3% for the radiologists. The sensitivity and specificity of interpretation with the present and the past images were 80.0% and 99.6% for the radiologists. The sensitivity and specificity of interpretation with the present and their subtraction image were 100% and 100% for the radiologists.

The images of typical four cases are presented in Figs. 2 to 7. Fig.2 shows a normal chest X-ray (Case1: 27 years old male). In the present image and past image, the radiologists were not able to diagnose normal chest X-ray. Fig.3 shows a right hilar lung squamous cell carcinoma (Case2: 40 years old male). In the present image and past image, the radiologists were not able to find this hilar lesion, but they could easily find the right hilar lesion in the subtraction image (Fig.3). Fig.4 shows a left hilar lung squamous cell carcinoma (Case3: 56 years old male). In the present image and past image, the radiologists were not able to find this hilar lesion, but they could easily find the left hilar lesion squamous cell carcinoma in the subtraction image (Fig.4). Fig.5 shows a right lower lobe tumor (adenocarcinoma) (Case4: 74 years old male). In the present image, past image and subtraction image, the radiologists were able to find this right lower lobe tumor (adenocarcinoma) easily (Fig.5).

Fig.6 shows a sarcoidosis of the bilateral hilar lymph node swelling (Case5: 28 years old male). In the present image and past image, the radiologists were able to find the bilateral hilar swelling lesion, and they could easily find the lesions in the subtraction image (Fig.6). Fig.7 shows a left lower lobe tumor (adenocarcinoma) near diaphragm (Case6: 50 years old male). In the present image and past image, the radiologists were able to find the left lower lobe tumor (adenocarcinoma) near diaphragm, and they could easily find the lesion in the subtraction image (Fig.7). Correct answer rate, sensibility, and specificity in the cases interpreted with present images alone were 62.5, 72.7, and 99.3%, respectively. Correct answer rate, sensibility, and specificity in the cases interpreted with present and past images were 75, 80, and 99.6%, respectively.
Correct answer rate, sensibility, and specificity in the cases interpreted with present and subtracted images were 100, 100, and 100%, respectively.

**Images for this section:**

**Table 1  Accuracy rates diagnosed by radiologists**

<table>
<thead>
<tr>
<th></th>
<th>1)</th>
<th>2)</th>
<th>3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>radiologists</td>
<td>62.5%</td>
<td>75.0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

1) the present image alone, 2) the present and the past images, and 3) the present and their subtraction image.

Accuracy rates diagnosed by radiologists with the present image alone, the present and the past images, and the present image and subtraction image were 62.5%, 75.0%, and 100%, respectively.

**Fig. 2**
Table 2  Sensitivity and specificity

<table>
<thead>
<tr>
<th></th>
<th>sensitivity</th>
<th>specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>62.7%</td>
<td>99.3%</td>
</tr>
<tr>
<td>2)</td>
<td>80.0%</td>
<td>99.6%</td>
</tr>
<tr>
<td>3)</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

1) the present image alone, 2) the present and the past images, and 3) the present and their subtraction image.

Sensibility and specificity with present images alone were 62.7 and 99.3%, respectively.
Sensibility and specificity in the cases interpreted with present and past images were 80.0 and 99.6%, respectively. Sensibility and specificity in the cases interpreted with present and subtracted images were 100 and 100%, respectively.

Fig. 3

Fig. 2 Case 1 27 years male normal case

In the present image, past image and subtraction image, this male was diagnosed with normal chest X-ray.

Fig. 4
Fig. 3 Case 2 40 years male  right hilar small tumor

In the present image (arrow) and past image, the radiologists were not able to find this right hilar small lesion (squamous cell carcinoma), but the radiologist could easily find the lesion (arrow) in the subtraction image.

Fig. 4 Case 3 56 years male left hilar small tumor and bilateral upper lobe sclerotic lesion due to obsolete pulmonary tuberculosis

In the present image (arrow) and past image, the radiologists were not able to find this left hilar small lesion (squamous cell carcinoma), but the radiologist could easily find the lesion (arrow) in the subtraction image.

Fig. 6
Fig. 5 Case4  74 years male right lower lobe tumor near diaphragm

In the present image (arrow), past image and subtraction image (arrow), the radiologists were able to find this right lower lobe tumor near diaphragm.

Fig. 7

Fig. 6 Case5  28 years male bilateral hilar lymph node swelling

In the present image (arrow), past image and subtraction image (arrow), the radiologists were able to find bilateral hilar lymph node swelling.

Fig. 8
Fig. 7 Case 6 50 years male left lower lobe tumor near diaphragm

![Images of present, past, and subtraction images]

In the present image (arrow), past image and subtraction image (arrow), the radiologists were able to find left lower lobe tumor near diaphragm. In the present image only, the radiologists diagnosed with diaphragm adhesion.

Fig. 9
Conclusion

Subtraction image can be said to be contributing to find the hilar lesion and the lesion near the diaphragm.

Time-Couse subtraction improved correct answer rate, sensitivity, and specificity of interpretation, which suggests it is a useful tool to assist image diagnosis.

Personal information

1. Temporal subtraction chest radiography.

MacMahon H, Armato SG 3rd.


2. Temporal subtraction in chest radiography: mutual information as a measure of image quality.

Armato SG 3rd, Sensakovic WF, Passen SJ, Engelmann R, MacMahon H.


References

1. Temporal subtraction chest radiography.

MacMahon H, Armato SG 3rd.
2. Temporal subtraction in chest radiography: mutual information as a measure of image quality.

Armato SG 3rd, Sensakovic WF, Passen SJ, Engelmann R, MacMahon H.