Utilization Status of SCENARIA at the Diagnostic Imaging Center and Breast Center

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In August 2013, our conventional system, ECLOS*1 (16-channel MDCT), was replaced by the present system, SCENARIA*2 (128-slice, 64-channel MDCT). This system allows imaging of every region of the whole body in 0.35s/rot and also realizes image quality improvement and radiation exposure reduction by applying Intelli IP*3 (Advanced). The following is a report on the utility of SCENARIA at the only diagnostic imaging center and Breast Center in our area.

1. Introduction

Our hospital, established in 1997, is a diagnostic imaging center. Sixty percent of the examinations conducted here are referrals from hospitals and private-practice physicians (regional medical alliances). We utilize a wide range of modalities including CT, XP, DEXA, MMG, MRI, PET/CT and PEM (Positron Emission Mammography), and take orders from requesting physicians. The images obtained from the examinations are returned by film or CD as media, or delivered as images via the WEB (a service in which the distinctive cloud server of our clinic is made public and an account and password are provided to each medical institution with a contract, where examination data for fulfilled orders can be referenced by each approved account).

Additionally, given the background of the increased prevalence of breast cancer in Japanese women1 and the low rate of breast cancer screening (Fig. 1)*2, we established the Breast Center (a specialized examination center

Fig. 1: Prevalence of breast cancer among Japanese women and screening rates

Key Words: SCENARIA, Intelli IP, Coronary CT Angiography, CT Colonography, MPPS
for women) in 2013 – the first of its kind in Tochigi Prefecture – with the aim of ultra-early detection (Fig. 2).

In this paper, we report on the operational status of SCENARIA systems at the diagnostic imaging center and the Breast Center, which had been installed during the establishment of the latter facility.

Fig. 2: Utsunomiya Central Clinic Breast Center

2. Features of SCENARIA (128 slice/64 row MDCT)

(1) High-speed scanning at 0.35s/rot and advances toward multi-detector systems

The scan time of our previous ECLOS system was 0.8s/rot. However, SCENARIA has enabled high-speed scans of 0.35s/rot not only at the heart but also at trunical areas such as the chest and abdomen. It has also reduced the scan time in association with the increase in the number of detector rows from 16 to 64. With the addition of the cone-beam reconstruction (CORE) method, satisfactory images can now be obtained in which streak artifacts during high-pitch scanning along with motion artifacts are reduced (Fig. 3).

Fig. 3: Comparison of motion artifacts between conventional system and SCENARIA

(2) Intelli IP

Intelli IP (Advanced), which was newly installed in SCENARIA, is a reconstruction method that applies an iterative reconstruction technique and reduces noise components generated during low-dose scanning (Fig. 4).

For a scan region of 350mm, we measured the time required for reconstruction when the slice thickness or Recon Index (reconstruction interval) was varied at post-reconstruction (Table 1). Although the required calculation time is slightly longer than that for the conventional image reconstruction method, the performance is more than adequate when considering a noise-reduction effect of more than 40% and a reduction in radiation exposure. Thus, the throughput is unlikely to be affected.

Fig. 4: Comparison between FBP and Intelli IP

Table 1: Comparison of reconstruction times

<table>
<thead>
<tr>
<th>Slice thickness or Recon Index / number of images (s)</th>
<th>10mm/35</th>
<th>5.0mm/70</th>
<th>2.5mm/139</th>
<th>1.25mm/278</th>
<th>0.625mm/556</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBP</td>
<td>12</td>
<td>12</td>
<td>19</td>
<td>30</td>
<td>54</td>
</tr>
<tr>
<td>Intelli IP</td>
<td>31</td>
<td>31</td>
<td>39</td>
<td>68</td>
<td>125</td>
</tr>
</tbody>
</table>

(3) CardioConductor (automatic setting of cardiac scan conditions), CardioHarmony (optimal cardiac phase selection)

Prior to the installation of SCENARIA, coronary scanning used to be conducted with the 64-row MDCT of a PET/CT system. The scan conditions had been modified on the basis of the patient’s heart rate during scanning. However, by using CardioConductor integrated in SCENARIA, the scan conditions recommended by the system from the range of heart rates during breath-holding practice are automatically configured. This results in reduced time needed to set the scanning protocol. In addition, the time required to select the optimal cardiac phase was reduced by CardioHarmony. At our hospital, the optimal cardiac phase is primarily determined by a radiological technician. We describe the basic flow of this process below.

① In the coronary scanning protocol, set conditions after scanning to create images for a total of 6 cardiac
phases – 75%, 70%, 45%, 40%, auto-selected diastole, and auto-selected systole – at a slice thickness of 0.625mm and a Recon Index of 5mm.

2) Simultaneously observe the images at the 4 cardiac phases of 75%, 70%, 45%, and 40%; then determine which of the following cardiac phases are optimal – the 75% ± 5% region around the mid-diastole, or the 45% ± 5% region around the systole③.

3) Simultaneously observe the images at either the cardiac phases of 75%, 70%, and auto-selected diastole or at the 3 cardiac phases of 45%, 40%, and auto-selected systole; then determine the optimal cardiac phase.

4) Depending on the case, reconstruct images at a pitch of 1% around a cardiac phase where the image observed is satisfactory, then select the optimal cardiac phase by editing the ECG waveform.

Determination of the optimal cardiac phase is essentially considered complete at step ③ above. The search time is 5min or less, although it varies according to the operator. The optimal cardiac phase is reconstructed at a slice thickness of 0.625mm and a Recon Index of 0.3125mm, and then processed analytically.

3. Operational status of SCENARIA

The system was installed in August of 2013 and is used for examinations on a daily basis. Table 2 shows changes in the number of CT examinations over time, from September after installation to the end of April, 2014. When data for the past 3 years are compared, the number at each month after installing SCENARIA shows an increase every year and exceeds 100% relative to the corresponding month of either of the previous two years, with examinations for this fiscal year showing the highest numbers. This suggests an underlying improvement in throughput due to scan time reduction, faster movement of the patient table, and multilingual compatibility. However, considering its performance characteristics, SCENARIA has the capacity to perform at least 32 examinations in an 8-h (480-min) day during examination hours at our hospital, assuming approximately 15min on average per examination. Our hospital mainly relies on regional medical alliances for patients, and radiological technicians assume a central role in actively carrying out strategy as well as working on securing examinations. In addition to the obvi-

Table 2: Number of examinations with SCENARIA (cases)

<table>
<thead>
<tr>
<th></th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2012</td>
<td>263</td>
<td>262</td>
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<td>219</td>
<td>208</td>
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<td>268</td>
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<td>224</td>
<td>292</td>
<td>292</td>
<td>328</td>
<td>282</td>
</tr>
<tr>
<td>2013-2014</td>
<td>292</td>
<td>313</td>
<td>314</td>
<td>320</td>
<td>284</td>
<td>348</td>
<td>297</td>
<td>348</td>
</tr>
</tbody>
</table>

4. Clinical cases

(1) Coronary CT Angiography

The main requests are for detailed examinations due to suspected angina or coronary artery stenosis. Previously, scanning was performed with a PET/CT system. Because PET examinations were of a higher priority, the time available for CT examinations limited the number of cases to 2 per day. The installation of SCENARIA made it possible to conduct examinations at any time and also allowed for same-day examinations if patients satisfied requirements such as those regarding renal function, blood pressure, allergies, and meal restrictions. The number of examinations also increased significantly.

The scan conditions are 120kV and 175mAs (0.35s/rot) with a beam pitch of 0.2031. The injection conditions for the contrast agent are as follows: an injection rate of 4.0 ~ 4.6ml/s, with 1mg/kg and 40ml as target injection amounts for the contrast agent and saline, respectively. The injection rate is adjusted so that the time to complete contrast agent injection approximates a target time of 14s. In addition, for examinees with a high heart rate, a beta blocker is injected intravenously based on a standard heart rate (HR) of 75 ~ 80bpm during suspended respiration.

We perform the conventional scanning for calcium scoring by a prospective scan. On the basis of the results, we then conduct a retrospective scan for contrast-enhanced scan. We use the bolus-tracking method to determine the time to initiate scanning while monitoring the descending
Coronary CT angiography is sometimes unable to yield diagnosable images owing to the timing of contrast agent injection, HR of the patient, cardiac diseases such as arrhythmia, or artifacts. From the reading reports of radiologists, we simply calculate whether diagnosable images are obtained as a measure of the success rate of scanning.

The evaluation results of the interpreting radiologist are classified into the following four ratings.

4: The main coronary arteries are well-detected and evaluation is possible
3: Evaluation is possible for most of the main coronary arteries
2: Some of the main coronary arteries cannot be evaluated
1: Evaluation is impossible for the main coronary arteries

We investigated a total of 213 cases for successful scanning (Table 3), defined as a rating of 3 or 4 in the 4-level classification described above (Fig. 7). Results showed that of the 213 cases, 196 were classified as 3 or 4, with the success rate of scanning simply calculated as 92.0%. For the remaining 8% of cases where evaluation was impossible, the causes included electrocardiogram (ECG) abnormalities due to multiple arrhythmias, sudden elevation of heart rate during the main scan, and artifacts due to heavy calcification.

(2) CT Colonography

Since around 2006, our hospital has been performing CT colonography (hereinafter referred to as CTC) examinations. In September of 2012, we installed an automatic injector system (PROTO CO2L), which is currently being used for prognostic tests for comprehensive medical examinations and screenings as well as for fulfilling orders from medical departments. In a recent case, endoscope insertion during colonoscopy became difficult because of adhesion or complicated coursing of the intestine, which led to transfer of the patient for CTC examination within the same day. Such cases of regional medical alliances have also been increasing.

The scan conditions are 120kV and 160 ~ 200mAs (0.5s/rot) with a beam pitch of 1.0781. The prone position and dorsal position are used for scan positioning; in cases with poor colonic distension, an additional scan is performed in the right or left lateral decubitus position. Considering the flow of carbon dioxide gas into the small intestine, scanning in the dorsal position is performed after scanning in the prone position. For positioning, a rectal tube is inserted in the left lateral decubitus position and carbon dioxide insufflation is initiated. The positioning is then changed in the clockwise direction from the left lateral decubitus to dorsal and then prone positions. Furthermore, in the prone position, a towel is placed beneath the chest of the patient to prevent the transverse colon from collapsing. The scan time is approximately 6s per position, and the examination is completed in roughly 10 ~ 15min.

Before the automatic injector system was installed, colonic distension used to be confirmed in the fluoroscopy room by manually infusing carbon dioxide, after which the patient was transferred to and scanned in an adjacent CT room. With this method, a time lag occurred between carbon dioxide injection and scanning, and adequate distension images often could not be obtained. However, since the installation of the automatic injector system, scanning performed completely within the CT room has become possible and the time lag between carbon dioxide injection and scanning has been eliminated. Moreover, the shorter scan time and faster movement of the patient table has resulted in reduced patient burden, and the increased rotation speed has reduced artifacts from the intestine (Fig. 8).
5. Future prospects

(1) Individualized dose control by modality performed procedure step (MPPS) coordination

Since the nuclear accident stemming from the Great Eastern Japan Earthquake, radiation exposure has garnered much public concern, and radiation from medical exposure during diagnostic imaging is no exception. In the US, the American College of Radiology (ACR) operates a radiation dose index management system in which medical institutions throughout the US participate. Dose control is evaluated by comparing data submitted to the ACR from each medical institution with those from other institutions. Currently, our hospital is in the process of constructing a dose control system based on MPPS coordination between radiation information system (RIS) modalities (Fig. 9). One reason for selecting SCENARIA is that it also allows for MPPS coordination.

Lowering of radiation dose has become possible by using the Intelli IP installed in SCENARIA. Going forward, I would like to investigate the extent to which dose may be reduced while maintaining image quality under the guidance of assessments made by radiologists.

6. Conclusion

Here, we have reported on the operational status and future prospects of SCENARIA at the diagnostic imaging center and Breast Center.

Compared with the conventional ECLOS system, the quality of examinations has increased immeasurably due to the improved device specifications and wide variety of applications. At the same time, the number of examinations has increased. SCENARIA is an indispensable device in our center, which mainly relies on regional medical alliances.

By using SCENARIA, which also has wide-ranging response capabilities that go beyond scanning (e.g., individualized dose control by MPPS coordination) as mentioned in ‘5. Future prospects’, we believe that we will be able to provide patient-centered medical treatment.

*1 ECLOS, *2 SCENARIA, *3 Intelli IP, *4 CardioConductor, and *5 CardioHarmony are registered trademarks of Hitachi Medical Corporation.

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