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Pursuing What a Diagnostic X-ray Radiography System Ought to Be: Three Key Points and Two Evaluations of the RADspeed Pro SR5 Version

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Abstract

This article describes the diagnostic X-ray radiography system RADspeed Pro SR5 Version installed at our hospital, focusing on three key features, including its camera function and wireless capabilities, and on two evaluations concerning examination efficiency and physical workload. With its real-time camera image, Auto-Positioning, and power-assist functions, the SR5 contributed to streamlining workflow, lowering retake rates, and reducing the physical burden on radiological technologists. Comparative evaluation between the new and previous systems demonstrated the SR5's usefulness in clinical practice and its future potential.

1. Introduction

Imamura General Hospital is a 428-bed emergency-designated hospital located in Kagoshima City, Kagoshima Prefecture. In November 2024, we installed Shimadzu Corporation's latest diagnostic X-ray radiography system, the RADspeed Pro SR5 Version (hereafter, SR5). This system is equipped with up-to-date features, including a camera function that allows patient positioning to be observed in real time, and it has contributed to further workflow improvement beyond the previous model. This article presents this latest system through three key points and two evaluations.

2. Features and Appearance of the RADspeed Pro SR5 Version

This system newly incorporates an optical camera in the collimator section, and the camera image can be checked both on the display on the X-ray generator console and on the X-ray tube support itself **(Fig. 1)**. The view from the same angle the X-rays pass through is the kind of image we radiological technologists had been picturing in our heads—and wanting—all along.

Here is a case in which the camera image may have prevented a misdiagnosis. **Figure 2(a)** is a chest X-ray image obtained in the supine position, showing a finding suspicious for inflammation in the right lung field. However, compared with the image from the previous day **(Fig. 2(b))**, the change is just too abrupt. In fact, the patient was restless on the stretcher, and although the arms had been lowered to the sides to make the body symmetrical, one arm was raised at the exact moment of exposure, making it look as though there was an inflammatory change. This movement could not be observed through the window in the radiography room door **(Fig. 3)**, but it could be confirmed on the camera image displayed at the X-ray control console, which allowed us to decide on a retake.

In addition to the Live View Display described above, the SR5 camera function also provides Motion Detection, which detects patient motion and reduces radiography errors caused by movement, and Last Position Display, which is useful for positioning during retakes. With Last Position Display, the camera image from the most recent exposure within

Fig. 1 Display on the X-ray control console (left image) and display on the X-ray tube support (right image).

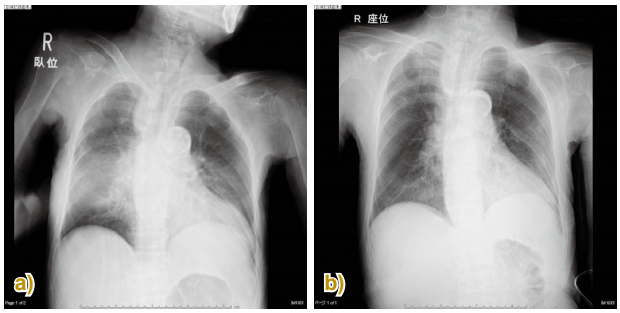

Fig. 2 a) Chest X-ray image. b) Chest X-ray image of the same patient from the previous day.

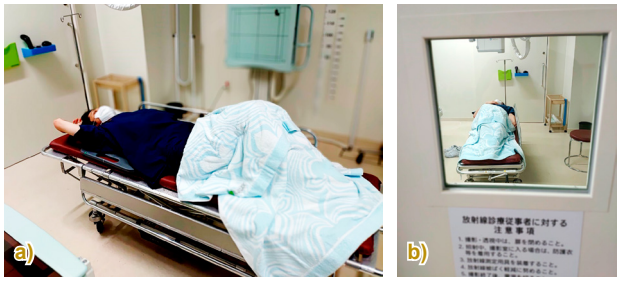

Fig. 3 Patient condition at the time the chest X-ray image in Fig. 2 a) was obtained (recreated).
From the observation window, it was not possible to grasp the whole situation (right).

the same examination can be referenced, which helps us achieve accurate positioning for retakes.

Clinical examples demonstrating the effectiveness of the Last Position Display are shown below. In frontal cervical spine radiography (Fig. 4), the observable range of the upper cervical spine changes depending on how much the mandible is elevated. In the initial image in this case (a), the mandible was depicted lower than the occipital bone, and the cervical spine could be observed only up to C3. The camera image of the patient position at the initial radiography (b) could be checked using Last Position Display on both the X-ray control console (c) and the X-ray tube support (d). Using that as a reference, the patient position was adjusted (f) and a retake was performed, yielding an X-ray image (e) in which the mandible and occipital bone overlapped and the cervical spine could be observed up to C2.

Next, a case of cervical oplique radiography is presented (Fig. 5). In the initial X-ray image (a), the mastoid process and other structures were superimposed, making the upper intervertebral foramina harder to visualize. By using Last Position Display, we were able to determine that the head was tilted (b), which confirmed our impression and enabled accurate correction. In the corrected X-ray image (d), the upper intervertebral foramina became easy to observe.

Until now, operators had to rely on their memory and imagination to assess X-ray images and make

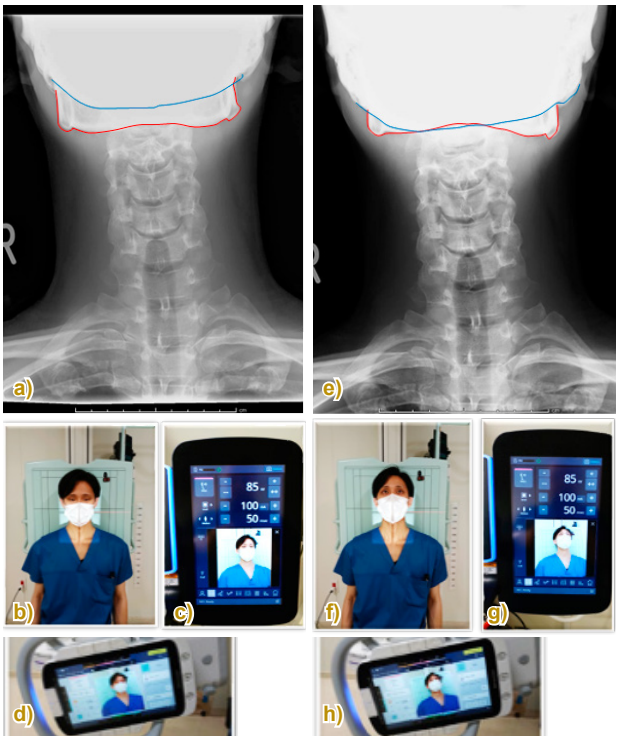

Fig. 4 Frontal cervical spine radiography. a), b), c), and d) are from the initial radiography; e), f), g), and h) are from the retake.
a) X-ray image. b) Patient position (recreated). c) Last Position Display image shown on the X-ray control console (recreated). d) Last Position Display image shown on the X-ray tube support (recreated).
e) X-ray image from the retake. f) Readjusted patient position (recreated).
g) Camera image shown on the X-ray control console (recreated).
h) Camera image shown on the X-ray tube support (recreated).

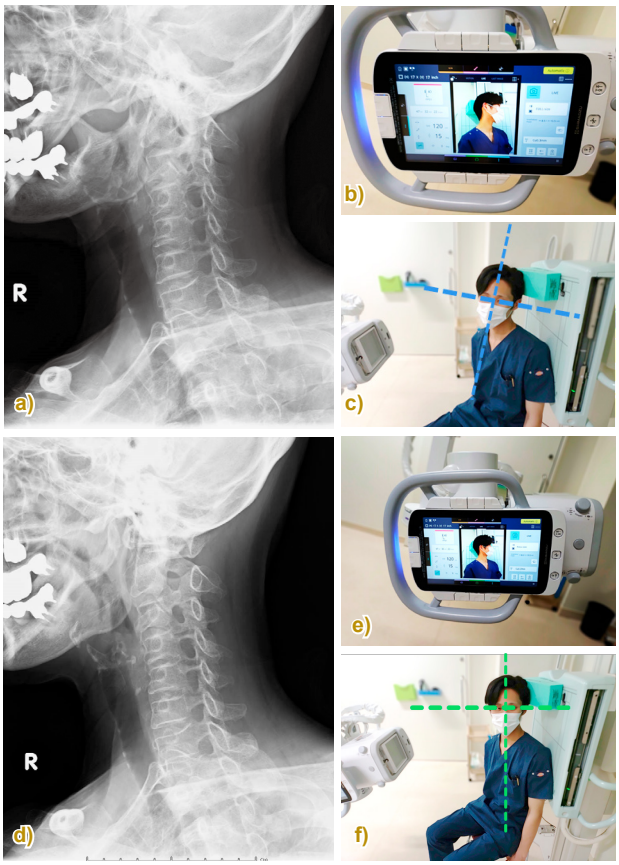

Fig. 5 Cervical oblique radiography. a), b), and c) are from the initial radiography; d), e), and f) are from the retake.
a) X-ray image. b) Last Position Display image (recreated). c) Patient position (recreated).
d) X-ray image from the retake. e) Camera image (recreated). f) Patient position (recreated).

corrections. Last Position Display may become the function that supports “the first step from an era of relying on memory to an era of referring to records.” Besides the camera function, there are other points that have been revamped in the SR5.

3. Three Key Points of the SR5

3.1 Point 1: Auto-Positioning Using a Wireless Remote Control

The Auto-Positioning function using a wireless remote control is on a completely different level from the wired remote control on the previous model. Because it is cable-free and does not restrict where the operator can stand, it can be used in a wide range of situations. It fits naturally into tasks that previously required single-tasking, such as assisting patients, cleaning up after an exam, preparing for the next one, or sending images to the PACS. This flexibility steadily supports workflow improvement and ulimately provides significant benefits.

3.2 Point 2: An All-Free Switch at the Bottom of the Operation Panel

On the SR5, the operation panel on the X-ray tube support has been changed to a vertically elongated design, and an All-Free switch has been placed at the bottom. On the back of the switch there is a nicely shaped recessed area where you can hook your fingers **(Fig. 6)**, so even petite female staff members can operate it without any awkwardness when moving the X-ray tube support up or down or parking it after radiography **(Fig. 7)**.

Also, thanks to the power assist, you can simply press the button with your thumb, hook the other fingers around it, and the unit moves very lightly. Our hospital’s previous model did not have power assist, so the first time I used it, it was honestly a shock. It felt like switching from an everyday city bike to a high-performance e-bike. The power-assist level can be changed between L, M, and H, and clinically I feel that M is probably the best setting. A rear switch is located on the back of the column, and it is useful for positioning such as axial patellar views. However, if you only press this switch, the power assist—which detects force via the sensor at the base of the front handle—does not work, so you need to operate it while applying force to the front handle. This operation requires some knowledge and getting used to, so it should be kept in mind. Also, the power assist on Shimadzu’s mobile X-ray systems is highly refined, so if you expect the SR5 to feel exactly the same as the power assist on those mobile systems, it may feel a little different. I hope it matures a bit more.

3.3 Point 3: Wireless Hand Switch

A wireless hand switch had already been available on Shimadzu’s mobile systems, but the truth is that outside the ICU—where radiography is often performed repeatedly on the same floor—we had not felt the wireless hand switch was so convenient as to be indispensable. However, the wireless hand switch on the SR5 is useful in a completely different way. In clinical practice, its handover function is particulary valuable. You can initiate the ready-up sequence inside the examination room using the wireless hand switch, then step out to the control room, close the door, and expose at exactly the right moment. To put it another way, it is like having a perfectly in-sync coworker who watches the timing, starts the

Fig. 6 **a)** Recess on the back of the X-ray tube support operation panel. **b)** Front All-Free switch.

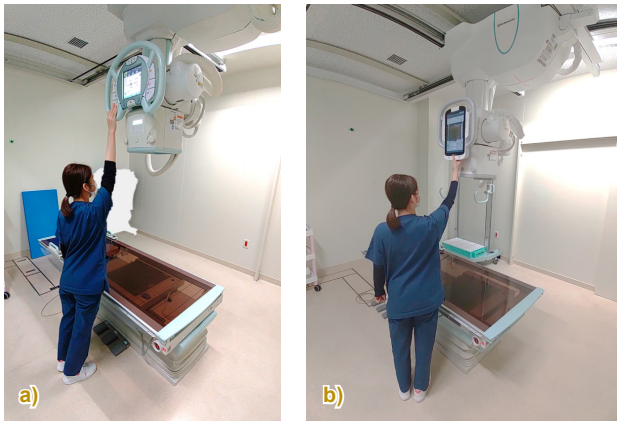

Fig. 7 Difference in operating posture between the previous model **a)** and the SR5 **b)**.
When a petite female staff member, 146 cm tall, moved the unit upward into its parked position, her elbows were fully extended and her heels were slightly lifted with the previous model. With the SR5, her elbows were not fully extended, and she could hold it with room to spare.

ready sequence for you, and then again watches the timing and makes the exposure for you. Even when radiography is being performed by a single operator, exposure can be performed at the fastest and most appropriate timing without waiting for the ready-up time. Once this confort is experienced, it becomes difficult to give up. In radiography, there is only a brief moment when the patient's body position is maintained in a good functional position and conditions such as respiration are optimal. Being able to perform radiography at that optimal timing has irreplaceable value. We also attached a strap to the bottom of the switch early on to keep it from being dropped, and have used it that way ever since **(Fig. 8)**.

Fig. 8 The wireless hand switch is used with a strap attached.

At our hospital, there are three X-ray rooms, and only one of them is the SR5. The wireless hand switch is so convenient that, when working in the other rooms, we unconsciously find ourselves looking for it. The usefulness of this wireless hand switch is not simply a matter of convenience; it also makes a real contribution to workflow efficiency. This point is explained later using data. When people first hear “wireless exposure switch,” I think the first thing they imagine is exposure while supporting the patient inside the radiography room. Considering dose reduction for healthcare staff, exposure inside the radiography room is not something we recommend in the first place, and for that purpose a foot switch that leaves both hands free would be more suitable. At our hospital, performing X-ray radiography while supporting the patient inside the radiography room is basically not allowed. If a patient has difficulty maintaining position, we change to a radiographic position that allows the examination to be performed safely, aiming both for patient safety and for dose reduction for us radiological technologists.

4. Two Evaluations Comparing the New and Previous Systems

At present, our hospital has two radiography rooms of exactly the same size, each equipped with Shimadzu radiography systems: one with the SR5 and the other with the previous model. The differences between the two radiography rooms are shown in **Table 1**.
To objectively evaluate the differences between Shimadzu’s conventional radiography system (hereafter, previous model) and the SR5, we performed various comparative evaluations, the results of which are presented below.

Table 1 Differences between the radiography systems in the two radiography rooms

	Power assist	Exposure switch	Auto-Positioning remote control
Previous model	No	Wired	Wired
SR5	Yes	Wireless	Wireless

4.1 Changes in Examination Efficiency

First, to investigate changes in examination efficiency after the system was updated to the SR5, we measured the time required for radiography. The target examinations were a combined examination consisting of standing frontal chest radiography and KUB, and KUB only, both of which included movement of the X-ray tube during the examination. The study period was from December 2024 through the end of February 2025. The method was simple: we measured the time from the start to the end of the examination using a stopwatch, and recorded the measured time at the end of each examination.
A total of 147 examinations were included, and there was no bias in the type of examination between the previous model and the SR5 **(Table 2)**. As shown in **Table 3**, the mean examination time for chest + KUB was 3 min 26 s with the previous model and 2 min 41 s with the SR5. For KUB only, the mean examination time was 1 min 56 s with the previous model and 1 min 35 s with the SR5.

Table 2 Number of examinations included in the comparison (Cases)

	Chest + KUB	KUB	Total
Previous model	41	32	73
SR5	41	33	74

Table 3 Mean examination time for each examination with the previous model and the SR5(min′ sec″)

	Chest + KUB	KUB
Previous model	3'26"	1'56"
SR5	2'41"	1'35"

Measuring examination time led to several interesting findings. If there were no special factors such as wheelchair use, the same examination took almost the same amount of time; it is hard to shorten the time beyond a certain point in the same room; and, unexpectedly, measuring examination time is actually kind of fun. The situations that take time are things like waiting for the patient to move in order to avoid contact between the X-ray tube and the patient, and this measurement made us realize that there are not many places where time can really be shaved off. Even so, the fact that the SR5 shortened the mean examination time by 45 seconds for chest + KUB and by 21 seconds for KUB is worth noting.

One reason the examination time could be shortened is probably the wireless design of the Auto-Positioning remote control and the exposure switch. As mentioned earlier, the Auto-Positioning function using a wireless remote control does not restrict where the operator can stand, and it can now slip into situations that used to be single-task only—while assisting the patient, while tidying up after an exam, while preparing for the next one, or while sending images to the PACS—steadily supporting workflow improvement and, in the end, leading to time savings. In addition, the wireless hand switch, which allows exposure at the very fastest timing, creates a rhythm in radiography, especially when multiple images are required, and builds an environment in which the radiographer can stay focused.

As for retake rate as well, the SR5 showed lower values: 3.7% lower for chest + KUB and 10.0% lower for KUB alone **(Table 4)**. These results suggest that advanced technologies such as live view display, the power-assist function, and the wireless design of the various remote controls create an environment optimized for radiography and may also affect retake rate.

Table 4 Retake rate for each examination with the previous model and the SR5(%)

	Chest + KUB	KUB
Previous model	11.4	16.7
SR5	7.7	6.7

Table 5 Usage rates (%) of the Auto-Positioning remote control for the radiography position and the park position

	Radiography-position use rate		Park-position use rate	
	Chest + KUB	KUB	Chest + KUB	KUB
Previous model	17.1	53.1	39.0	46.9
SR5	95.1	60.6	90.2	81.8

In this survey, we also recorded how often the Auto-Positioning remote control—which became wireless on the SR5—was used. The results are shown in **Table 5**.

The rate of using the Auto-Positioning remote control to move from standing chest radiography to the KUB radiography position was 78.1% higher with the SR5. Even in KUB-only radiography, the rate of using the Auto-Positioning remote control to move from the home position to the KUB position was 7.5% higher. The use rate when returning to the standing chest position, which serves as the park position, was also 51.2% higher with the SR5 for chest + KUB, and 34.9% higher for KUB alone. We had expected that a series of examinations involving X-ray tube movement would be the perfect opportunity for the Auto-Positioning remote control and power-assist function to really shine, and the results were exactly as expected. The previous model, being wired, naturally had a limited usable range and therefore a limited number of situations in which it could be used. The results clearly showed that once it became wireless, there were many more situations in which the Auto-Positioning remote control could be picked up and used while responding to the patient or carrying out other tasks in parallel.

4.2 Evaluation of Physical Workload According to the Presence or Absence of Power Assist

In recent years, low back pain among healthcare workers has become one of the problems in the medical field. We radiological technologists engage in daily work that involves physical strain, such as moving patients and moving the X-ray tube support during X-ray radiography. Therefore, to investigate how the power assist function, which became available at our hospital with the installation of the SR5, affects physical workload, we measured and compared muscle electrical activity during operation. The systems compared were the SR5 and the previous model. The evaluation was carried out over two days in February 2025, and there were five study participants.

The target movements were six tasks in total: moving the unit 30 cm in 10 seconds with the right hand only, in one direction each for longitudinal, lateral, and vertical movement **(Fig. 9)**. For the four longitudinal and lateral tasks, coordinate sheets showing the start and end positions were placed on the table, and the laser pointer was moved from the starting point to the end point. For the two vertical tasks, the operator visually checked the SID value on the display of the X-ray tube support and moved

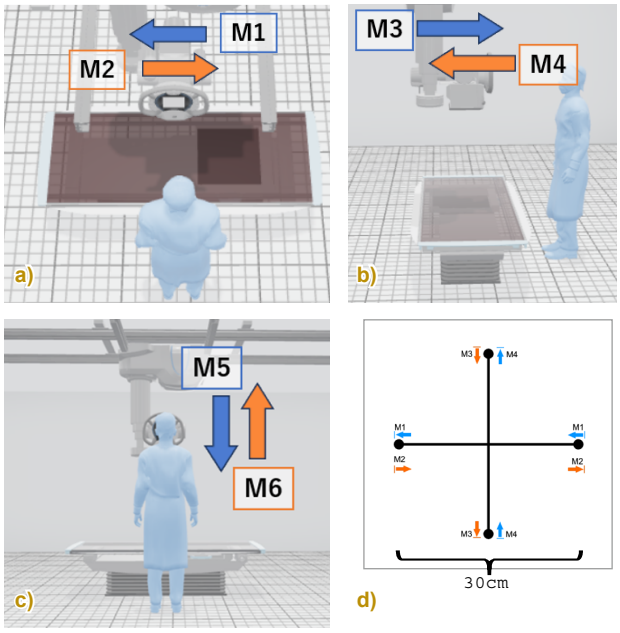

Fig. 9 Six tasks involving longitudinal a), lateral b), and vertical movement c).
In the four longitudinal and lateral tasks, movement was performed between the circled marks on the coordinate sheet d) placed on the table.

it by 30 cm. Each task was performed three times. The muscles measured were four in total: the deltoid, triceps brachii, biceps brachii, and rectus abdominis. As the measurement device, we used HuME made by Shimadzu Corporation (Fig. 10).

The electromyographic signals obtained were smoothed using RMS (root mean square; window width, 100 ms) (Fig. 11), and then normalized by dividing by the separately measured value for maximum voluntary contraction [MVC]. The mean value of [RMS%MVC] during the task time was used for analysis. Across 24 conditions—6 task types × 4 muscles—we compared the mean [RMS%MVC] values for the SR5 versus the previous model using the Mann-Whitney U test.

Of the 24 comparisons, the SR5 showed a lower mean [RMS%MVC] in 22 conditions, and in 4 conditions the difference was significant ($p < 0.05$). The four conditions with significant differences are shown in Fig. 12.

In this evaluation, hand dominance was not taken into account; all operations were performed with the right hand only. Of the four conditions that showed significant differences, three involved the triceps brachii (long head), which accounts for about 70% of the upper-arm muscle mass and is active during extension. In addition, in task M5, which involved lowering the X-ray tube support from top to bottom, the SR5 showed significantly lower muscle activity not only in the triceps brachii but also in the rectus abdominis. When moving a heavy object, flexors and extensors usually contract simultaneously to increase joint stability and achieve load transfer. In the SR5, the power-assist effect likely reduced the effortful muscle contraction required for joint stability, resulting in significant differences compared with the previous model. We believe this was a meaningful evaluation in that it statistically demonstrated a reduction in the physical burden on us radiological technologists.

Of the 24 conditions, the previous model had a lower mean [RMS%MVC] in 2 conditions, and in 1

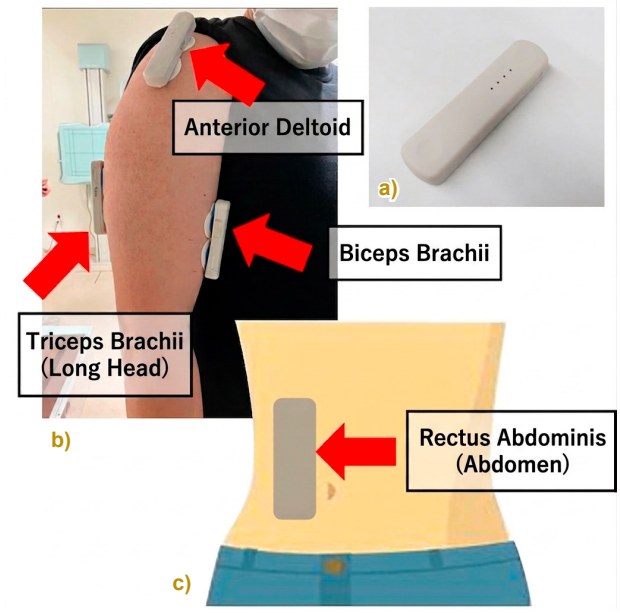

Fig. 10 HuME made by Shimadzu Corporation a), and the muscles measured with HuME attached b), c)

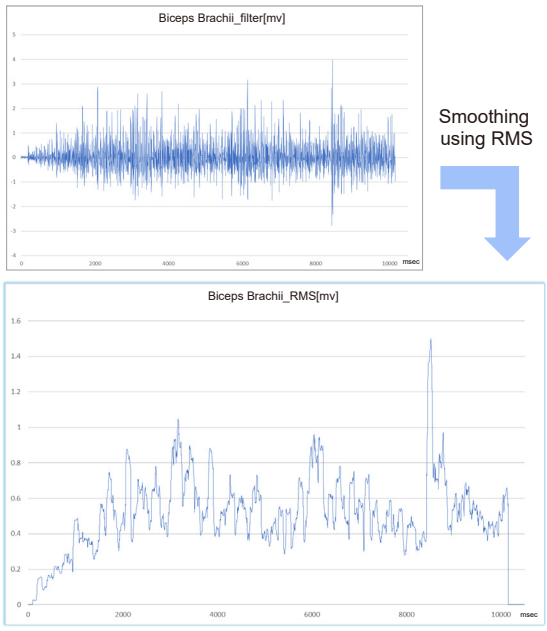

Fig. 11 Smoothing of filtered electromyographic signals using RMS.

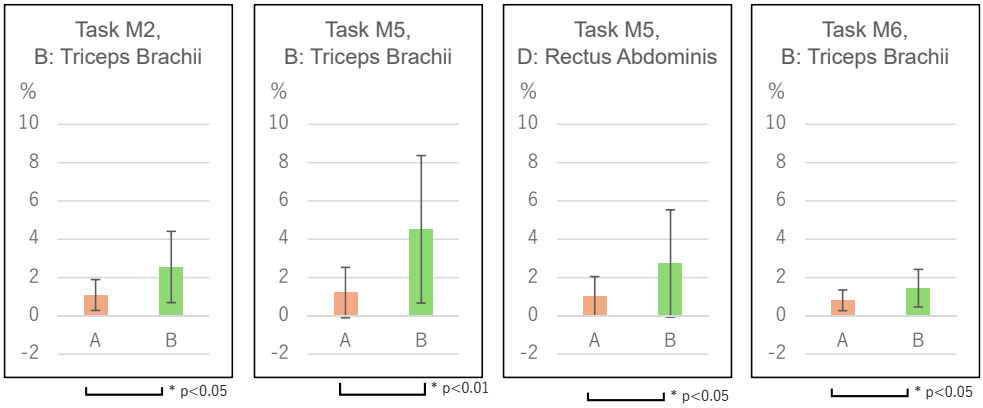

Fig. 12 Four conditions in which the mean [RMS%MVC] was significantly lower with the SR5.
A ■ : SR5, B ■ : previous model.

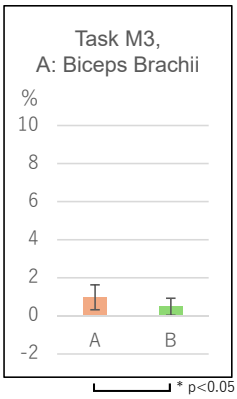

Fig. 13 One condition in which the mean [RMS%MVC] was significantly lower with the previous model.
A ■ : SR5, B ■ : previous model.

of those condition the difference was significant ($p < 0.05$). The one condition with a significant difference is shown in **Fig. 13**. The significant difference was seen in task M3, which involved pulling the X-ray tube support from the far side toward the operator. Because the SR5 has the characteristic of moving very easily, it seems that during the fine adjustment required when pulling it toward oneself, the activity of the triceps brachii—an elbow extensor—increased.

5. Summary

This time, we installed Shimadzu Corporation's latest diagnostic X-ray radiography system, the RADspeed Pro SR5 Version, and had the opportunity to compare the new and previous systems side by side under the same conditions.

For a long time, Shimadzu's diagnostic X-ray radiography systems had undergone repeated minor changes, but this time we had the valuable opportunity to experience a large-scale model change in actual clinical practice.

The diagnostic X-ray radiography system, which forms the core of what we as radiological technologists do, had long gone without a full model change, even amid dramatic changes in image-processing software and X-ray detectors, while being pulled along by both good traditions and bad habits. However, we see the RADspeed Pro SR5 Version as a system that has seriously pursued what a diagnostic X-ray radiography system ought to be. Rather than being held back by the thought that "maybe it can't be done," it seeks to embody—and go even further with—the functions that we radiological technologists have been looking for in order to obtain good X-ray images for patients. We will definitely be keeping our eyes on Shimadzu's latest diagnostic X-ray radiography systems from here on as well.