R/F

Investigation of the reliability of spino-pelvic parameter measurements -Intraobserver and Interobserver Reliabilities-

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On March 12, 2016, Yasuhide Koshika, M.D., Ph.D. of the Spine Center, Chiba Central Medical Center, gave an academic presentation titled "Investigation of the reliability of spino-pelvic parameter measurements -Intraobserver and Interobserver Reliabilities-" that related to a Shimadzu SONIALVISION series R/F system at the 6th Annual Meeting of The Japanese Society for Adult Spinal Deformity held in Niigata. This article describes the content of that presentation.

1. Introduction

Although the accurate measurement of spino-pelvic parameters is indispensable to select appropriate surgical procedures for adult spinal deformity (ASD) patients, the intraobserver and interobserver measurement errors are the issue **(Fig. 1)**.
Potential causes of these errors are arising from measurements taken by eyes, by using inaccurate lateral view radiography such as femoral heads not completely being overlapped, with the inconsistent superior edge lines of S1 among observers, and by the edges being obscured due to osteoporosis or severe scoliosis. We believe that observers can improve the measurement reliability by exercising ingenuity in the initial 4 items listed below **(Fig.2)**.

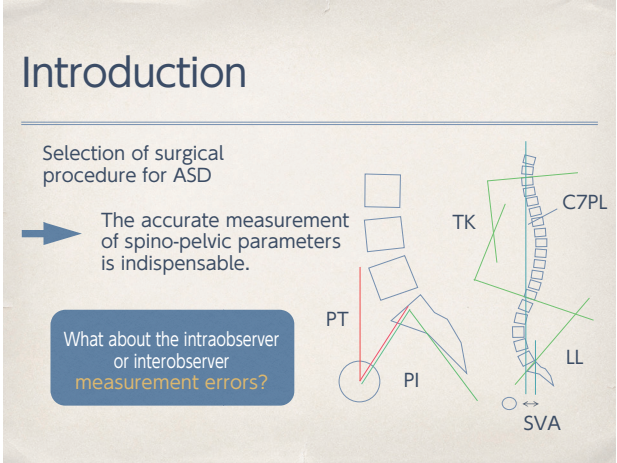

Fig.1

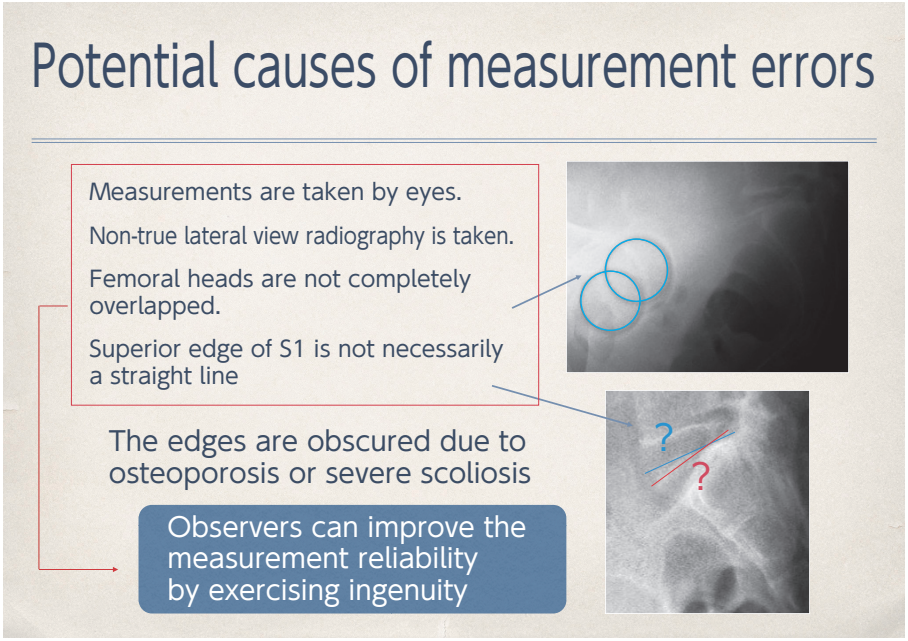

Fig.2

2. Measurement Methods and Equipment

We have been using a dedicated measurement software to ensure the accuracy in our hospital [1]. For the measurement of pelvic incidence (PI), radiological technologists have been using fluoroscopy of the SONIALVISION system to overlap femoral heads before the radiography exposure. For the determination of superior edge line of S1, we decided to ignore the curvature of superior edge of S1, and unified the method by drawing the straight line connecting the most anterior and most posterior points of the edge. Then, we took measure after drawing the perpendicular line to the determined superior edge line of S1 as shown in **Fig. 3**.

We used Shimadzu SONIALVISION R/F system (SONIALVISION) **(Fig.4)** for taking measurements in our hospital. The SONIALVISION, unlike conventional general radiography system, can acquire rectangular projection images while moving the X-ray tube in parallel to the table top (SLOT radiography), which allows us to obtain true lateral long view radiography along the entire length from the cervical-spine to the pelvis. We took same measurements with another manufacturer's 3D-CT system, and assumed that 3D-CT would provide more accurate measurement results than that of the SONIALVISION system.

3. Objectives

The objectives of this study were to measure spino-pelvic parameters by the SONIALVISION and by the 3D-CT systems to investigate the reliability of these measurements, and to investigate the effect of efforts employed to reduce measurement errors in our hospital **(Fig. 5)**.

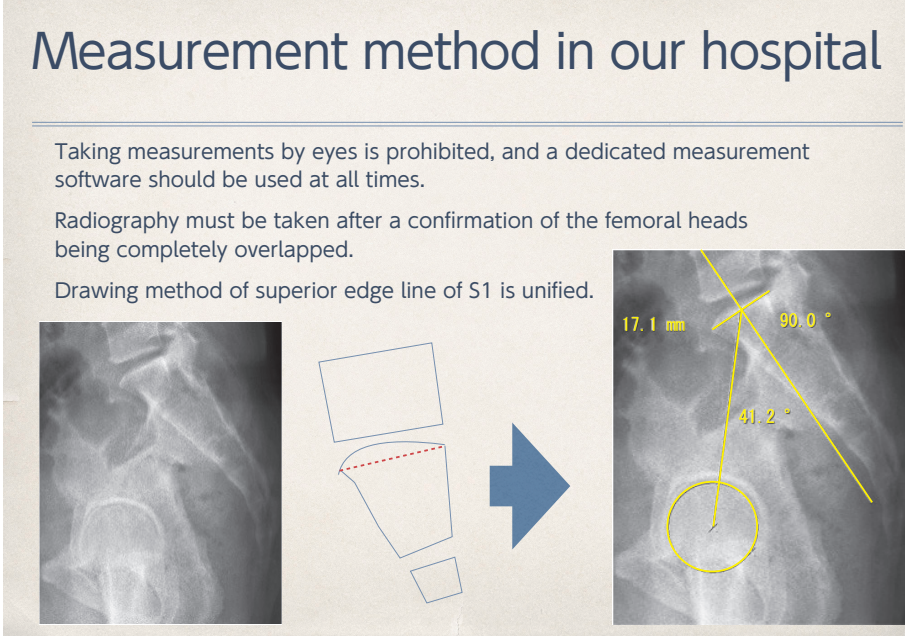

Fig.3

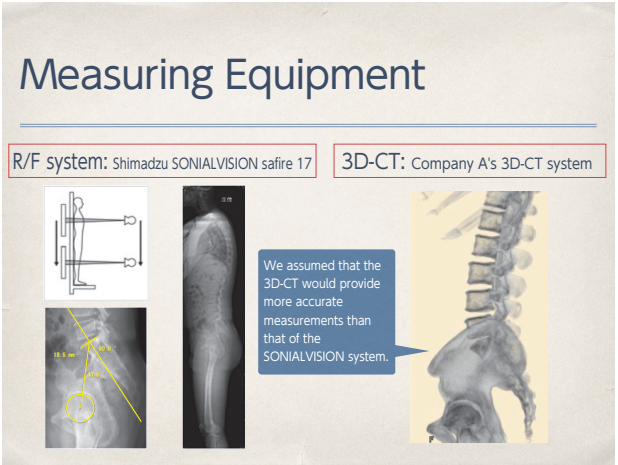

Fig.4

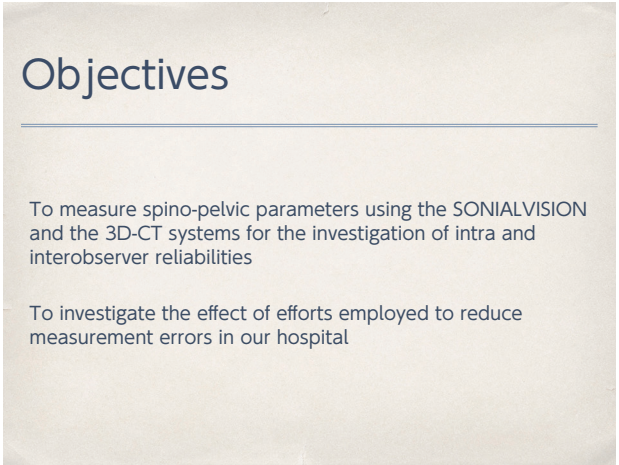

Fig.5

4. Subjects and Methods

The subjects were 20 patients who underwent measurements using both the SONIALVISION and 3D-CT systems **(Fig. 6)**. 5 orthopedic surgeons, as observers, measured PI twice. Intraobserver and interobserver reliability were investigated for each system using the intraclass correlation coefficient (ICC). The closer the ICC is to 1, the higher the reliability.

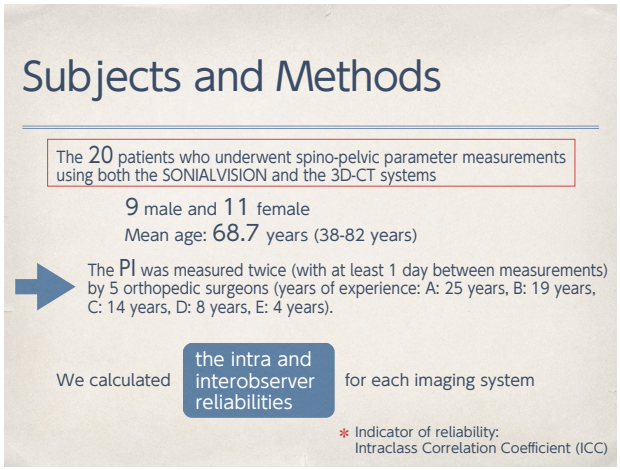

Fig.6

5. Results

The mean ICCs for the intraobserver measurement reliability of the SONIALVISION and the 3D-CT, conducted by 5 observers, were both excellent and no significant difference was observed. Also, the interobserver reliabilities of both systems were excellent without indicating significant difference between the two **(Fig. 7, 8)**.

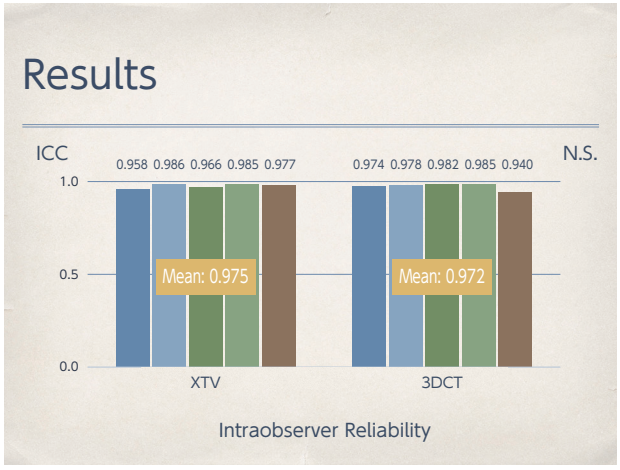

Fig.7

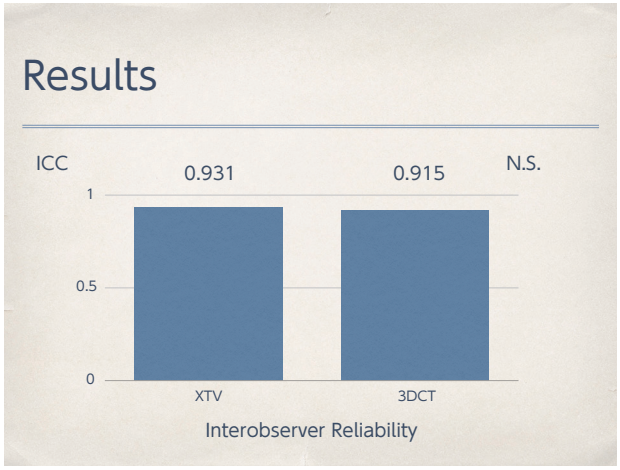

Fig.8

6. Discussion

The SONIALVISION system showed excellent measurement reliability which was equivalent to the 3D-CT system in this study. The reason is presumed that an X-ray tube of the SONIALVISION travels in parallel to the table top, and it provides perpendicular projection image to the patient, while conventional general radiography systems give oblique projection images in the distant region from the imaging center [2,3] **(Fig. 9)**.

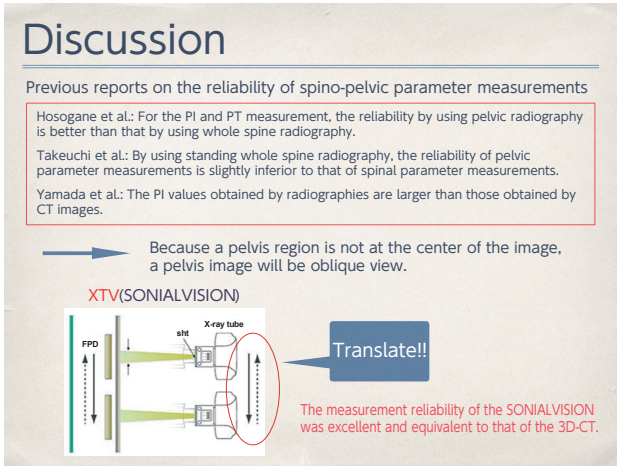

Fig.9

Although the shape variations of the superior edge of S1 were a factor in measurement errors [4], we could reduce such errors by simply drawing a straight line from the most anterior point to the most posterior point of the edge **(Fig. 10)**.

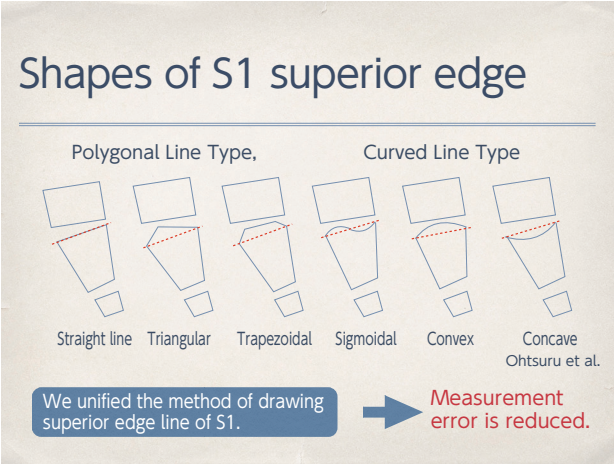

Fig.10

Before we use a dedicated measurement software, the mean interobserver error and the maximum error were 5.4 and 22.2°, respectively, and the ICC was less than 0.9. The reliability has improved since a dedicated measurement software was introduced and the measurement method was unified **(Fig. 11)**.

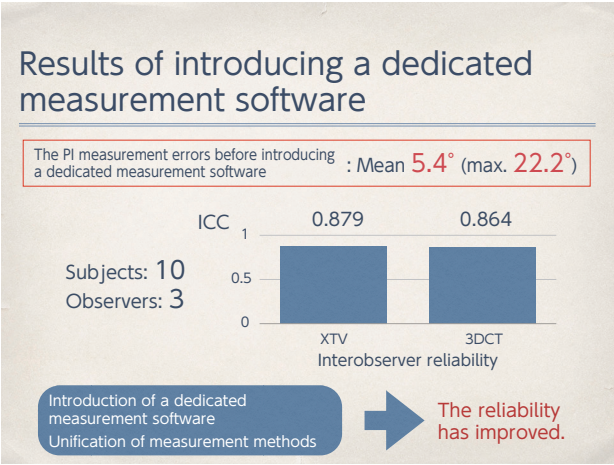

Fig.11

Recently, there are an increasing number of reports related to the whole body standing biplane radiography (WBSBR) system **(Fig. 12)**. While this system and the SONIALVISION can perform long-view radiography with much lower X-ray dose than conventional general radiography systems, the imaging speed of the SONIALVISION is approximately twice that of the WBSBR system. Additionally, the SONIALVISION can also perform conventional fluoroscopy and tomosynthesis, though the imaging area size (length) is shorter than the WBSBR system, and 3D images reconstruction is not applicable.

SONIALVISION vs. Whole Body Standing Biplane Radiography System

	SONIALVISION	Whole Body Standing Biplane Radiography System
Exposure Dose (PA/Late)*	70.42/213.2 μGy [5]	146/178 μGy
Imaging Speed	15 cm/sec	7.6 cm/sec
Size (Length)	140 cm	175 cm
3D Images	Not applicable	Possible
Applications	It can also perform conventional fluoroscopy and tomosynthesis (tomography)	The system is specifically designed for spino-pelvic imaging

* X-ray exposure dose of radiography (PA/Lateral): 1662/1862 μGy

Fig.12

7. Conclusions

For spino-pelvic parameter measurement, the SONIALVISION was equivalent to the 3D-CT systems in terms of reliability, and was considered useful. Using a dedicated measurement software, and unifying a method of drawing superior edge line of S1 among observers were effective means for reducing measurement errors.
Accurate measurements of spino-pelvic parameters will lead the selection of appropriate surgical procedures for ASD patients.

References

1) Yasuhide Koshika: Investigation of the Reliability of Spino-Pelvic Parameter Measurements -Intraobserver and Interobserver Reliability Using Different Equipment-, Journal of the Eastern Japan Association of Orthopaedics and Traumatology, Vol. 27 No. 3, 263, 2015.
2) Daisaku Takeuchi: Reliability of Spinal Deformity Parameter Measurement in Degenerative Lumbar Scoliosis, Journal of Spine Research, Vol. 5 No. 3, 203, 2014.
3) Katsutaka Yamada: Investigation of the Reliability of Pelvic Incidence Measurement, Journal of Spine Research, Vol. 4 No. 3, 718, 2013.
4) Tadahiko Ohtsuru: Investigation of the Usefulness of Tomosynthesis for Pelvic Incidence Measurement, Hip Joint, Vol.41, 719-723, 2015.
5) Shigeru Kawai: Clinical Experience of Slot Radiography, Medical Now No. 73, 58-59, 2013.