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SCIENTIFIC ARTICLE

Full-spine radiographs: what others are reporting—a survey of Society of Skeletal Radiology members

Takashi Takahashi[1] · David Polly[2] · Christopher T. Martin[2]

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Abstract

Objective Full-spine radiographs are frequently ordered by spinal deformity surgeons to assess spinal imbalance. The radiologist interpretation of these films varies amongst providers. Detailed numeric measurements of the deformity are time-consuming. In this study, we hoped to better define current practice patterns for interpretation of spinal deformity films amongst musculoskeletal radiologists in North America.

Materials and methods An anonymous online survey was conducted amongst Society of Skeletal Radiology members.

Results Only 26.5% of respondents ($n = 57$) routinely report pelvic tilt, 23.2% ($n = 52$) for sagittal vertical axis and 5.1% ($n = 11$) for Pelvic Incidence Lumbar Lordosis mismatch in adult spinal deformity. Furthermore, the majority of musculoskeletal radiologists (84.96%) dictate the same type of report for both adult and pediatric cases.

Conclusions The majority ($n = 199$, 70%) of 283 respondents state that no institutional standard template for full-spine dictations exists. The development of such templates listing appropriate parameters to include in the dictation may be useful in order to ensure that the radiologist's effort and clinical utility for the ordering provider are optimized.

Keywords Survey · Spine · Adult spinal deformity · Scoliosis · Pediatric · Measurement · Radiograph

Introduction

Somewhat in contrast to adolescent idiopathic scoliosis (AIS) where coronal plane parameters are the primary determinant of surgical decision-making according to the Lenke classification, patient-reported disability and surgical decision-making for adult spinal deformity (ASD) patients is heavily impacted by sagittal plane parameters [1, 2]. In part, the SRS-Schwab classification was developed specifically to incorporate the importance of these sagittal parameters [3]. Spine surgeons often order standing full-spine radiographs of ASD patients for the primary purpose of evaluating spinal balance, including the measurement parameters defined in the SRS-Schwab classification. Although the recent emphasis on sagittal plane parameters in ASD patients has resulted in a paradigm shift for the treating surgeons, the majority of heath care providers and third-party payers are unfamiliar with these new research findings [4]. Thus, we hypothesized that sagittal parameters are under-reported in radiologists' dictations of full-spine radiographs in adults.

Furthermore, the inclusion of detailed deformity measurements in the radiologist's dictation varies amongst providers. Detailed numeric measurements are time-consuming and risk-conflicting with the surgeon-derived measurements. In this study, we hoped to better define current practice patterns for interpretation of spinal deformity films, in particular, regarding inclusion of various measurement parameters, amongst musculoskeletal radiologists in North America using a survey.

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✉ Takashi Takahashi
takas005@umn.edu

[1] Department of Radiology, University of Minnesota, MMC 292 420 Delaware St. SE, Minneapolis, MN 55455, USA

[2] Department of Orthopedic Surgery, University of Minnesota, Minneapolis, MN, USA

Materials and methods

An anonymous online survey, created using a web-based tool (Qualtrics, US) was conducted amongst Skeletal Society Radiology members (Appendix). On April 7, 2018, the survey

was sent via electronic mail to all the registered members of Society of Skeletal Radiology, approximately 1480 radiologists, along with an explanation of the survey and a link to it. One reminder e-mail was sent after 1 week. All question responses were optional and respondents were allowed to continue the survey without selecting any answer choice. This makes total the number of respondents for some questions different from the others. No participant received compensation for participation. The last response was recorded June 7, 2018. All responses were pooled for analysis. The survey included questions regarding the specific measurement parameters dictated including those listed on the SRS-Schwab classification system, the most widely accepted spinal deformity classification system for adult spinal deformity. For the purposes of this survey, we excluded questions regarding sitting, bending, or supine views.

Results

With a response rate of approximately 20%, a total of 293 responses were obtained and analyzed. Two hundred eighty-six (98%) of the respondents subspecialize in musculoskeletal radiology. Three (1%) specialize in general radiology, one in pediatric radiology, one in emergency radiology, one in both musculoskeletal and neuroradiology. One is no longer in practice. One hundred eighty (61.43%) radiologists routinely dictate both adult and pediatric spinal deformity, 104 (35.49%) adult patients only, and two (0.68%) pediatric patients only. One hundred sixty-nine (57.68%) practice in an academic hospital. Two hundred forty-one (82.25%) of the total 293 respondents routinely interpret full-spine radiographs.

A majority ($n = 199$, 70%) of 283 respondents state no standard template for full-spine dictations exists at their institution. One hundred sixty-three of 217 respondents (70.51%) routinely include numeric measure in their dictation (Fig. 1).

Regarding the detail of radiographic interpretation, the majority reported using the same measurement parameters for both adult and pediatric patients (84.96%, $n = 113$). In both the pediatric and the adult population, Cobb angle of the coronal plane deformity was the most commonly reported parameter (Fig. 2).

The reporting of sagittal parameters on ASD films was not routinely done by most providers. Only 26.5% of respondents ($n = 57$) routinely report pelvic tilt, 23.2% ($n = 52$) for sagittal vertical axis (SVA), and 5.1% ($n = 11$) for pelvic incidence-lumbar lordosis (PI-LL) mismatch. The percentage of respondents reporting these measurements on pediatric cases are similar (SVA 23.2% ($n = 32$), PI-LL mismatch 4.3% ($n = 6$), and pelvic tilt 29% ($n = 40$)).

The majority of respondents (52.86%, $n = 111$) reported that the ordering providers make their own measurements and do not use the radiologist measurements in their clinical decisions. The remainder (45.71%, $n = 96$) reported that ordering providers make their own measurements but also rely on the radiologist's interpretation for their decision-making. Only three respondents out 210 (1.43%) reported that the ordering providers routinely do not make their own measurements and rely solely on the radiologist's interpretation.

Discussion

The purpose of this survey study was to identify current practice amongst musculoskeletal radiologists when reviewing full-spine standing radiographs. Our survey results show significant variability amongst providers, and show little difference between dictated results from adult and pediatric studies. Several of these findings merit further discussion.

Notably, the majority of skeletal radiologists (84.96%) dictate the same type of report for both adult and pediatric cases. This finding can be significant because the clinical and radiographic findings differ between adult and pediatric spinal deformity cases. To illustrate this point, it is useful to have a basic understanding of the most common classification systems for pediatric and adult spinal deformity cases. While the King-Moe system remained the principal classification system for adolescent idiopathic scoliosis (AIS) for more than 20 years [5, 6], more recently the Lenke classification has been introduced to guide operative treatment of AIS [7]. The Lenke classification emphasizes the magnitude and location of the coronal plane imaging findings, which reflects the fact that in AIS, the treatment is primarily driven by the coronal/cosmetic deformity [8].

In contrast to pediatric deformity, in ASD multiple studies have shown that the patient's symptoms are most closely associated with the sagittal plane [2, 9–12]. In 2012, the Scoliosis Research Society (SRS) sought to address this discrepancy by developing a new adult-focused classification system, which has become known as the SRS-Schwab classification [3, 5, 11, 13, 14]. This classification system has shown excellent inter- and intra-rater reliability [15]. In the SRS-Schwab classification system, four parameters are measured: sagittal vertical axis (SVA), pelvic incidence minus lumbar lordosis (PI-LL), pelvic tilt (PT), and coronal curve type [3]. SVA is a measure of the horizontal distance between a vertical line drawn downward from the center of C7 vertebral body and the posterosuperior corner of the S1 endplate [16]. Pelvic incidence (PI) is an angle between a line drawn perpendicular to the middle of the superior sacral endplate and a line joining from the center of femoral heads to the center of the superior sacral end plate. This is a measure of pelvic depth and is a patient-specific parameter that determines the native sagittal contour. In SRS classification, lumbar lordosis (LL) is measured from the superior endplate of L1 to the superior endplate of S1 using the Cobbs angle technique. Pelvic tilt

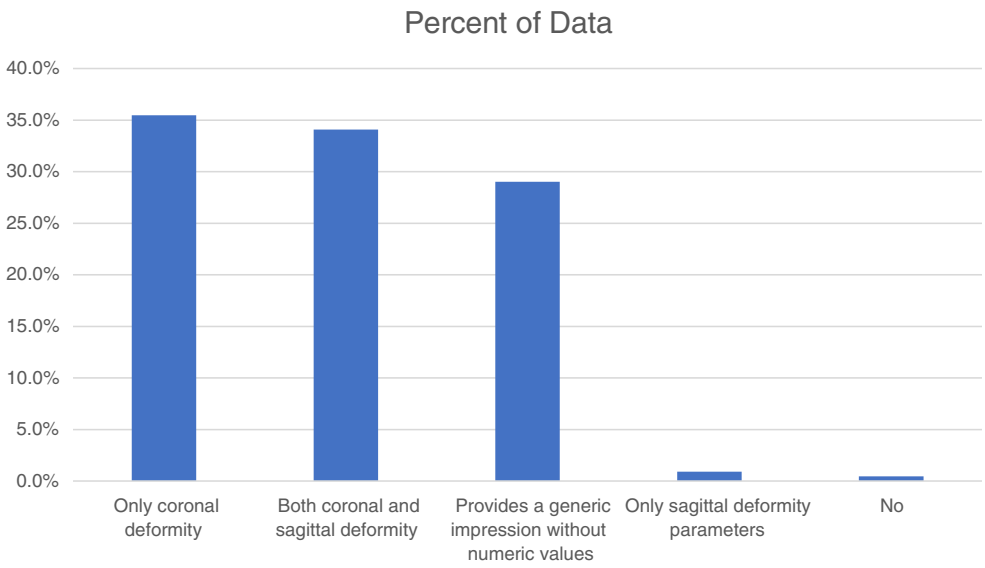

Fig. 1 Response to the question "Do you provide numeric measurements of the patient's deformity on their full-spine films?" Total respondents 217

(PT) is an angle measured between the lines connecting the center of the superior endplate of S1 to the center of femoral heads from its vertical perpendicular line [17].

However, Ames et al. reported that the majority of health care providers and third-party payers are unfamiliar with these new research findings and ASD patients continue to experience difficulty obtaining the proper medical treatment [4]. Our survey results suggest that appreciation of the difference in measurement parameters between adult and pediatric cases may be low amongst musculoskeletal radiologists, given that the majority do not alter their dictation strategy based on patient age.

Furthermore, the current survey demonstrates that the critical sagittal parameters identified in the SRS-Schwab classification are rarely reported by musculoskeletal radiologists reviewing ASD films. Only 26.5% of respondents ($n = 57$) routinely report pelvic tilt, 24.2% ($n = 52$) for sagittal vertical axis (SVA) and 5.1% ($n = 11$) for PI-LL mismatch in spite of studies having shown ten-times-higher risk for undergoing revision surgery if sagittal malalignment remained after lumbar fusion surgery [18–20]. Parameters outside those defined in the Lenke or SRS-Schwab classification system were even less likely to be reported by the radiologists in our study. For instance, T1 pelvic angle is a routinely measured parameter amongst surgeons in our institution [21]. However, these values are essentially never reported by musculoskeletal radiologists in our survey. Furthermore, the percentage of respondents reporting these measurements on pediatric cases are similar [SVA 23.2% ($n = 32$), PI-LL mismatch 4.3% ($n = 6$), and pelvic tilt 29% ($n = 40$)]. These sagittal parameters are not a part of any recognized classification scheme for pediatric spinal deformity, and have much less clinical utility in pediatric cases.

Lastly, the survey identified significant disagreement on the importance of the radiologist dictation in impacting clinical care. Fifty-three percent of respondents ($n = 111$) reported

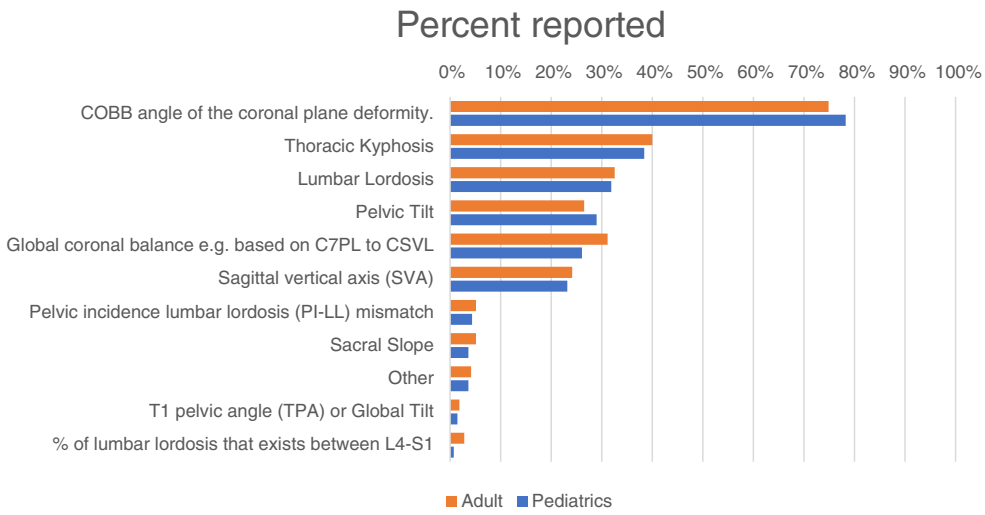

Fig. 2 For your adult or pediatric deformity cases, which of the following deformity measurements do you routinely provide in your report (check all that apply, or leave blank if none). Total respondents 215 for adult and 138 for pediatrics

that the ordering provider does not use the radiologists' measurements for clinical decision-making, while 47% ($n = 99$) reported that they felt the radiologist's interpretation played an important role. In areas where increased detail is requested of the radiologist, it makes sense to develop institutional protocols addressing the amount and type of dictation requested. The majority of respondents (70%, $n = 199$) reported that their institution currently lacks a standard template for full-spine films, thus leaving room for improvement and consistency across radiologists.

Limitations

The study has several limitations. The survey was conducted in a society where almost all of the members are musculoskeletal subspecialized radiologists. Spine plain films may also be interpreted by neuroradiologists, general radiologists, and pediatric radiologists. Differences in expertise might skew the survey result. For example, general radiologists are likely to be even less familiar with the various parameters of spinal deformities than are the specialized radiologists surveyed here. Furthermore, pediatric radiologists might follow the Lenke classification system more closely than other musculoskeletal radiologists who only interpret adult films. The survey results show under-reporting of sagittal balance parameters among radiologists. It may be that the referring surgeons do not want these parameters measured, and thus the under-reporting noted here may actually reflect provider preference. Alternatively, it may reflect a lack of recognition for the importance of these parameters, or more simply it may represent an omission due to time convenience. This survey lacks any assessment for the actual reason of this under-reporting, and we cannot say for certain which of these possibilities is most likely.

Conclusions

Currently, the most widely accepted spinal deformity classification in adults is the SRS-Schwab, which emphasizes the importance of sagittal plane deformity. Despite such emphasis, this survey found that musculoskeletal radiologists routinely do not dictate sagittal parameters on their full-length spine films in ASD patients. Although it is important for radiologists who dictate full-spine radiographs in adults to be familiar with SVA, pelvic tilt, and PI-LL mismatch concept, whether or not to report these values routinely remains unclear and it is likely to be institutionally dependent, as our survey shows nearly 50-50 split as to whether radiologists feel that their measurement plays an important role in clinical decision-making.

Compliance with ethical standards

Conflict of interest Takashi Takahashi: No disclosure or conflict of interest. David Polly: No disclosure or conflict of interest. Christopher T. Martin: No disclosure or conflict of interest. Institutional review board determined that the project does not meet the federal definition of human subjects research.

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