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The lateral wrist radiograph - To retake or not to retake

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ABSTRACT

Introduction: Patient positioning may impact diagnostic quality when obtaining radiographs of the musculoskeletal (MSK) system. Hence, knowledge on patient positioning, as seen in the radiograph, followed by informed adjusted retake if appropriate, is key when undertaking MSK radiographs. Forearm positioning is particularly important in lateral wrist radiographs where rotation impacts anatomic measurements. The purpose was to evaluate the accuracy of MSK and non-MSK radiographers’ immediate assessments of wrist positioning including need for retake.

Methods: A questionnaire including images of 18 lateral wrist radiographs and questions regarding positioning, i.e. forearm rotation and flexion of the wrist, were developed and distributed to radiographers worldwide via the European Federation of Radiographer Societies (EFRS) and the Research Hub at the European Congress of Radiology (ECR) 2021. Demographic data such as area of expertise, years of experience etc. were collected.

Results: In total, 156 replies were included in the analyses. The inter-observer agreement of radiographers’ assessment of the need for a retake was 47% (kappa = 0.25) and the intra-observer agreement was 81% (kappa = 0.62). Radiographers working with MSK radiography had more correct positioning assessments than radiographers who did not routinely obtain radiographs of the MSK system (p = 0.0003).

Conclusion: Results indicated that MSK radiographers are more consistent in assessment of the need for a retake in lateral wrist radiographs and more able to correctly judge positioning compared to non-MSK radiographers.

Implications for practice: Constant focus on image quality may lead to increased awareness and adherence to image criteria. Improved image quality will in turn improve the diagnostic value for the benefit of the patients potentially leading to better outcomes.

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Introduction

The distal radius fracture (DRF) accounts for approximately 15–20% of all fractures and consequently, radiographic imaging of the wrist is performed frequently, most often planar X-rays.1,2 Treatment is decided partly based on fracture displacement as measured radiographically and thus, reliable measurements are crucial.3-5 A commonly used measurement when quantifying displacement of a DRF is the amount of dorsal angulation of the articular surface as measured on the lateral wrist radiograph.3,6-9 However, the measured value of dorsal angulation may be affected by radiographic positioning of the forearm. Both supination and pronation have been shown to affect various radiographic wrist measurements5-9. A recent study by Jensen and colleagues for instance identified that each degree of supination and pronation respectively increased and decreased palmar tilt by up to 0.68°-6. Going from flexion to extension of the wrist in 5° intervals has also been shown to effect several carpal indices such as the radioscaphoid (−0.4°), scapholunate (−1.0°), scaphocapitate (−1.3°) and the radiolunate angles (±3.0°) 10. It is therefore important that radiographers are aware of positioning and the potential affect of incorrect positioning. When assessing image quality of a lateral wrist radiograph, the radiographer should, apart from assessing the technical image quality, also be able to determine if the forearm is pronated or supinated, flexed or extended and eventually perform a sufficiently adjusted retake if needed.

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The overall aims of this study were to explore the knowledge of radiographers on positioning in wrist radiographs and to assess how radiographers distinguish between correct and incorrectly positioned wrist radiographs. Particularly to compare radiographers who work with projectional X-ray imaging of the musculoskeletal system (MSK) (hereafter referred to as MSK radiographers) to non-MSK radiographers, i.e. radiographers who work primarily with other imaging modalities than planar radiographic imaging.

The objectives were to assess

i) Inter- and intra-observer agreement of radiographers’ immediate opinions about the need for retake of lateral wrist radiographs.

ii) Accuracy of MSK radiographers assessment of positioning, i.e. supination/pronation and flexion/extension in lateral wrist radiographs versus non-MSK radiographers.

Methods

Lateral wrist radiographs were acquired using 12 skeletally mature cadaveric forearms that were fresh frozen and thawed on the day of use. Radiographs were obtained with the forearms in different degrees of rotation i.e. supination and pronation and with flexion/extension of the wrist. The radiographs were collected for a previous study and the methods used for image acquisition etc. are described in detail elsewhere. The Regional Ethics Committee of Southern Denmark waived requirement for official approval to use the radiographs in future studies (Project-ID: S-20180077).

An open online survey was developed using a secure Health Insurance Portability and Accountability Act (HIPAA) compliant research data capture and data management tool (REDCap - Research Electronic Data Capture) hosted by Open Patient data Explorative Network, University of Southern Denmark. The content, face validity, wording, and comprehensibility of the questionnaire were evaluated by an external expert radiographer who did not suggest any changes before distribution. Furthermore, the technical functionality of the survey was tested by an external data manager. The survey was promoted online via European Federation of Radiographer Societies’ (EFRS) Research Hub initiative two weeks before and during the European Congress of Radiology 2021 and distributed online October—December 2021. Data was recorded automatically by the electronic data capture system. No sensitive data was collected and respondents could not be identified from the dataset. Results were reported according to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES).

Radiographers who gave consent to be involved in the study were presented with 18 lateral wrist radiographs, i.e. 12 unique radiographs of each cadaver, 6 of those were presented twice to allow for intra-observer analyses. For each image, respondents assessed whether the radiograph fulfilled image criteria regarding positioning and if they would recommend a retake. Respondents were asked to assess whether 4 image criteria were present (pronation, supination, dorsal flexion and volar flexion). Other technical aspects of the images such as central ray, collimation, noise etc. were ignored. Annotations were masked to ensure blinded evaluation of each image. After completing the questionnaire, respondents could download a certificate of participation signed by EFRS executives.

Reference standard image criteria

A neutrally rotated forearm was defined as an image with the forearm in a midprone position where the most palmar cortex of the pisiform was projected within the central third of an interval midway between the palmar cortices of the scaphoid and the capitate (mid-scaphoid interval) or the dorsal aspects of the ulna and radius coalign. Flexion of the wrist was assessed by alignment of the longitudinal axes of the radius being approximately parallel to a line along the shaft of the 3rd metacarpal bone. Please note that due to the use of cadaveric limbs, the images were obtained with the elbow in 90° flexion.

Statistical analyses

Replies on positioning, i.e. supination, pronation, dorsal extension and volar flexion were quantified by giving correct answers 1 point and wrong or indecisive answers zero points and summed to...
a total score. The analyses comprised 12 cadaveric images, each with 4 image criteria, allowing a maximum score of 48. Similarly, inter-observer analyses comprised 12 cadaveric images, whereas six images were presented twice to allow for intra-observer analyses. Inter- and intra-observer agreement regarding the perceived need for retakes were assessed using Fleiss’ kappa and percent absolute agreement.

Positioning assessments as mean or median points were compared by MSK/non-MSK radiographers using two-sample t-test or Wilcoxon signed rank test, depending on distribution of data. Normality of data was assessed using quantile-quantile plots. P-values ≤ 0.05 were considered statistically significant. All analyses were performed using STATA/BE17 (StataCorp, College Station, Texas 77845 USA).

Results

In total, 370 radiographers from 24 countries replied partly or completely to the questionnaire. In total, 156 replies were included in the analysis, thus giving a completion rate of 42.2%. The majority of responses that were included in the final analysis were from Denmark (n = 83), United Kingdom (n = 14), Ireland (n = 9) and Norway (n = 9). A flowchart describing the inclusion and exclusion of replies is presented in Fig. 2.

Mean age of included respondents was 38.7 years (range 21–69) with a mean radiographic experience of 13.5 years (range 0–45). 116 respondents (74%) worked with MSK radiography and 40 (26%) worked with other specialties such as abdominal, neuro, vascular intervention, mammography, chest, CT, MRI or ultrasound. No statistically significant difference in age (p = 0.32) or radiographic experience (p = 0.22) was found between the non-MSK and the MSK radiographers. An overview of age, experience and workplace for MSK- and non-MSK radiographers is shown in Table 1.

Overall inter-observer agreement on the need for a retake was 47%, kappa = 0.25, p < 0.0001 and the intra-observer analysis demonstrated 81% absolute agreement, kappa = 0.62, p < 0.0001. MSK-radiographers demonstrated 81% intra-observer agreement, kappa = 0.63 and inter-observer kappa = 0.29 while non-MSK radiographers demonstrated 79% intra-observer agreement, kappa = 0.58 and inter-observer kappa = 0.16.

The mean no. of image assessments per observer was 44.5 out of 72 and the observers provided 6947 assessments of supination, pronation, dorsal and volar flexion in total. The no. of correct observations by radiographic specialty is listed in Table 2. Overall, the MSK radiographers had a median no. of correct observations of 34 versus 29 in the non-MSK group (p = 0.0003) (Fig. 3). Assessments of both rotation and flexion/extension, where the maximum no. of points was 24 respectively, also differed between the groups, with a median of 17 versus 14 correct assessments of rotation (p = 0.0027) and 18 versus 14 (p = 0.0011) (flexion/extension) for MSK and non-MSK radiographers, respectively.

Discussion

Inappropriate radiographic views may alter subsequent measurements taken from the radiographs or even cause inaccurate or missed diagnosis.10,16 This makes positioning of MSK radiographs particularly important along with the ability of radiographers to correctly assess patient positioning in a radiograph and correct positioning accordingly in case of retake.

Figure 2. Enrollment chart describing inclusion and exclusion of respondents.
The measured value of dorsal tilt in patients with a distal radius fracture might be higher in case of forearm pronation. Therefore, improper positioning might influence management of a distal radius fracture highlighting the need for constant focus on positioning not only of wrist X-rays but projectional radiography in general. Recognizing and correcting mal-positioning is important in other anatomical regions as well. It has been reported, that fractures of the elbow are missed due to inaccurate positioning.

The importance of recognizing projectional (MSK) radiography as a specialty within the field of radiography was introduced back in 2005 by Professor Snaith. The results from the current study demonstrate that this topic is still highly important, particularly given the potential implication for the patient.

The study had some limitations. The convenience sampling method/open distribution without IP-address check did not allow for control for multiple entries from the same individual. However, multiple entries are unlikely in a study requiring 15 min of intensive image evaluation where no obvious personal interests are at stake. Due to the open distribution method, a response rate could not be calculated however a completion rate of 42.2% was achieved. The aforementioned 15 min of intensive image evaluation may also explain why so many respondents began but did not complete the survey. Another inherent limitation to the result is that in some hospitals, the wrist radiograph is viewed with the fingers pointing superiorly whilst in other hospitals the fingers point inferiorly, thus some respondents would have been viewing the radiographs ‘upside-down’ compared to how they would normally view. This may have caused confusion particularly in regards to supination and pronation and may also explain, in part, why 193 started but did not complete the survey. Moreover, individual performance and viewing conditions could not be controlled, and may explain some of the variation in data. Another limitation may be that non-MSK radiographers may have been less likely to take part in a study that is outside their specialist area, which would explain why 116 MSK radiographers took part compared to 40 non-MSK radiographers.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>MSK (n = 116)</th>
<th>Non-MSK (n = 40)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, years (SD)</td>
<td>39.2 (9.8)</td>
<td>37.2 (13.0)</td>
<td>0.32</td>
</tr>
<tr>
<td>Radiographic experience, years</td>
<td>14.1 (9.7)</td>
<td>11.8 (11.7)</td>
<td>0.22</td>
</tr>
<tr>
<td>Workplace: University/Regional Hospital</td>
<td>81.9%</td>
<td>80%</td>
<td>-</td>
</tr>
</tbody>
</table>

Data from the current study indicated that radiographers accustomed to obtaining radiographs of the MSK system were able to identify correct positioning more accurately than non-MSK radiographers. There was not a significant difference in experience within the field of radiography that would explain the difference in accuracy between the dedicated MSK radiographers. The mean experience of radiographers working with MSK was 14.1 years versus 11.8 years of the non-MSK radiographers (p = 0.22). Thus years of experience as a radiographer cannot explain the difference in ability to assess positioning in wrist radiographs uncovered in the current study. However, results do emphasize not only the importance of experience in accuracy of image critique but also that general radiography is a specialty in its own right, particularly since diagnostic quality can be directly linked to improperly positioned radiographs.

Forearm rotation during the radiographic procedure can alter the measured value of dorsal tilt in patients with a distal radius fracture. This becomes particularly important when operative treatment may be considered since clinical practice guidelines suggest that surgery or reduction should be considered in cases with more than 10 degrees of dorsal tilt. In theory, the measured value of dorsal tilt may be measured at 10° in a neutral wrist X-ray but fall below the 10° if the forearm is supinated during the radiographic procedure. Conversely, the measured value of dorsal tilt may be higher in case of forearm pronation. Therefore, improper positioning might influence management of a distal radius fracture highlighting the need for constant focus on positioning not only of wrist X-rays but projectional radiography in general. Recognizing and correcting mal-positioning is important in other anatomical regions as well. It has been reported, that fractures of the elbow are missed due to inaccurate positioning.

The importance of recognizing projectional (MSK) radiography as a specialty within the field of radiography was introduced back in 2005 by Professor Snaith. The results from the current study demonstrate that this topic is still highly important, particularly given the potential implication for the patient.

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Conclusion

Data from the current study indicated that MSK radiographers were more consistent when offering an opinion on the need for a retake. Moreover, MSK radiographers were able to correctly identify correct positioned to a higher degree that non-MSK radiographers, however non-dedicated MSK radiographers are still able to obtain plain film radiographs of the MSK system to a satisfactory standard.

The authors of the current study stress the importance of recognizing the field of MSK as a specialty in itself within the field of radiography that require skills, knowledge and dedicated continuous education. Advancement of new technologies such as virtual reality (VR) that enables training of radiographic procedures, including patient positioning, where mistakes can be corrected without patient involvement and with ample time for reflection and learning may become an integrated part of radiography in the near future. Depending on the simulator, it may be used for students of radiography or for continuous education of radiographers.

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Conflict of interest statement

No conflicts of interest.

Acknowledgements

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Appendix A

Supplementary data to this article can be found online at https://doi.org/10.1016/j.radi.2022.10.013.

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