Annals of Clinical and Analytical Medicine

Determinants of Spine Radiography among Patients with Severe Trauma

Mohammed Nasser Hamad Alhokash (1) *, Hamad Hussain Ali Alalshahi (2), Hamad Hadi Saleh Alalshahi (3), Mana Hamad Salem Alyami (4), Hussain Hassan Saleh Alsharyah (5), Ali Hassan Saleh Alsharyah (6), Salem Rajeh Muhammad Al Suleiman (7), Saleh Mana Saleh Al Kulayb (8)

(1) Nurse Assistant, Al-Ghad International College of Applied Medical Sciences.
(2) Emergency Medical Services, Al-Ghad International College of Applied Medical Sciences.
(3) Medical Device Technician, Community College - Al-Kharj University.
(4) Radiological Technology, King Saud University.
(5) Health Care Assistant, International Academy For Health Sciences.
(6) Radiography Technician, The Intermediate Health Sciences College For Boys in Dammam.
(7) Hospital Administration, King Abdulaziz University.
(8) Nursing Specialist, Al-Ghad International College of Applied Medical Sciences.

Received 15/10/2022; revised 27/10/2022; accepted 4/11/2022

****Corresponding author***

Abstract

Introduction: Radiographs have low sensitivity in detection of cause-specific backpain that resulted from trauma or infection. Thus, radiography could be considered as an initial diagnostic modality for backpain before referral to more sophisticated radiological techniques. The aim of the review is to study the determinants of spine radiography, particularly in patients with severe trauma.

Methods: The following databases were searched without language restrictions for articles published in any year up to January 2022: "PubMed, MEDLIN, EMBASE, and Google-Scholar". Designing and conducting the electronic search strategy were performed by an expert reference librarian based on input data from investigators. The database searches were supplemented with manual searches of reference lists of the potentially eligible articles. Article about spine or pelvic radiography were included in this study.

Results: Several studies aimed to assess methodological radiographic factors that can improve the performance of radiography in different parts of the body. many studies focused on pelvic radiography found that body positioning and axial load were significant predictors for radiation dose and image quality. In lumber supine region, the most common cause of spinal pain in 70% of cases is diagnosed as "non-specific". In such cases, radiographic assessment is recommended for patients with chronic backpain, patients with osteoporosis, patients suspected to have vertebral compression problems, or those under steroids treatment.

Conclusions: Improvement of the performance by identifying the key operational factors, in the lumber spine region, may significantly reduce the rejection rate of radiographs in the clinical practice.

Keywords: Radiography, Trauma, Spine, Surgery, Factors

Introduction

Radiographs have low sensitivity in detection of cause-specific backpain that resulted from trauma or infection [1]. Thus, radiography could be considered as an initial diagnostic modality for backpain before referral to more sophisticated radiological techniques.

In the era of pandemics and increased health expenditure due to aging phenomenon of the populations, it is indicated to increase use of feasible and cost-effective diagnostic modalities, such as radiography [2]. Hence, improvement of radiographic accuracy in detection of spine pain will increase its use with subsequent preserving of scarce health resources. To enhance the performance of radiographic imaging, it is important to identify factors related to image quality without excessive use of radiation dose. This is particularly true in the diagnosis of spinal conditions, as radiographic features become less known by examiners in the clinical practice when compared to other techniques [3]. Despite its reduced popularity , radiography is still recommended as an initial assessment technique in spinal conditions, particularly in low-energy traumatic injury [4]. Moreover, avoidance of unnecessary radiation, particularly in children, is another reason to consider radiography as the first imaging modality in the absence of red flags such as trauma, infection, or history of cancer.

Occasionally, the effect of body positioning on radiography could be detected even within the same position. For instance, in pelvic radiography, different eight standing points, with different positions of feet and arms, were evaluated [5]. significant differences were reported between different standing points in lumber lordosis and thoracic kyphosis angels. Presence of differences in the radiographical features within the same position make it possible to find more significant differences when compare it to another position. However, some radiographical features, such as lumber lordosis angel in erect position could be reproduced in supine position by straightened patients' lower extremities with a median deviation of 3° [6]. Lumber spine region are surrounded by soft tissues with similar structure to that in upper pelvic region, which may lead to similar effect of body positioning on the radiography. The aim of the review is to study the determinants of spine radiography, particularly in patients with severe trauma.

Methods

The following databases were searched without language restrictions for articles published in any year up to January 2022: "PubMed, MEDLIN, EMBASE, and Google-Scholar". An extensive search was performed using various combinations of the Mesh terms: "pelvic radiography, gonad shield/ing, radiation protection, x-ray, reproductive organs, testes, ovary, prevalence, and positioning". Designing and conducting the electronic search strategy were performed by an expert reference librarian based on input data from investigators.

The database searches were supplemented with manual searches of reference lists of the potentially eligible articles. Article about spine or pelvic radiography were retained. To assess eligibility, the initial search results were screened independently by two reviewers. First, the title and abstract of each article were carefully screened. Then, the full texts of articles that were deemed potentially relevant were retrieved for inclusion and additional searches of their reference lists were performed to identify other potentially relevant articles that may have been missed during computerized search of databases. The discrepancies between reviewers in study selection were resolved by consultation. If two reviewers could not reach a consensus, we planned to resolve the disagreement through discussion and consultation with a third reviewer..

Results and discussion

Several studies aimed to assess methodological radiographic factors that can improve the performance of radiography in different parts of the body. In 2018, a review of 25 articles aimed to assess the role of body positioning in pelvic radiography [7]. The review highlighted the lack of the evidence regarding the

effect of body positioning on radiation dose. From theoretical point of view, erect positioning with weight bearing structures should provide better functional appearance than supine position. However, the standardization of radiographic technique in erect position was not well discussed, which hinders comparison between the included studies. The authors found that the evidence of body-positioning effect on image quality and radiation dose is inconclusive and requires further research [7].

Later on, many studies focused on pelvic radiography found that body positioning and axial load were significant predictors for radiation dose and image quality [8-10]. Among 60 patients who were subjected to pelvic radiography in either erect or supine position, the sagittal diameter at iliac crest region was significantly higher by 21% on erect position compared to that in supine position [8]. This difference led to significant differences in image quality and estimated effective dose. Image quality was lower in erect position than that in supine position (78% versus 87%), while effective dose was 47% higher in erect position than supine position. Despite these findings, patients preferred standing position during radiological examination more than laying down in a supine position [8]. Similarly, a significant reduction in image quality and a significant increase in effective dose were associated with erect position in comparison to supine position during pelvic radiography as reported by Alzyoud et al. The authors concluded that the differences could be related to the changes in the contour of anteroposterior tissues between erect and supine positions [10].

In lumber supine region, the most common cause of spinal pain in 70% of cases is diagnosed as "non-specific". In such cases, radiographic assessment is recommended for patients with chronic backpain, patients with osteoporosis, patients suspected to have vertebral compression problems, or those under steroids treatment [3]. Few studies were found in the literature attempted to evaluate diagnostic ability of lumber radiography. Most of these studies were conducted in anthropometric phantom and focused on dose optimization by comparing anteroposterior (AP), posteroanterior (PA), and lateral projections.

Image quality and effective dose of lumber radiographs were assessed in a phantom with AP and PA views by Davey and England. Using a method 2-alternative force choice (2AFC), five examiners assessed the images based on EC guidelines. They found a 19.8% significant reduction in mean effective dose for PA view in comparison to AP view, however, the image quality were not statistically different. They recommended using PA view in routine imaging of lumber spine [11]. Another comparison between AP and PA views were performed by Alukic et al., in an anthropometric phantom and real patients. First, they assessed image quality and effective dose in the phantom. In the second phase, they divided 100 patients randomly into two equal groups (AP and PA groups) to assess the BMI, image quality, effective dose, and diameter of abdomen.

Similar non-significant difference in image quality to that reported by Davey and England was found in either phantom or patients. However, the estimated effective dose was 25% and 53% significantly lower in PA compared to that in AP view in phantom and patients, respectively. Moreover, the diameter of patients' abdomen was 10% significantly lower in PA than in AP view. This study provided more support to use of PA view in routine clinical practice [12]. The reduced dose benefit of PA view was also reported by Brennan and Madigan who used phantom to assess radiation dose and image quality. Again, no significant difference in image quality was detected in this study [13]. The main reason of dose reduction in PA view could be attributed to tissue displacement, as Brennan and Madigan found 1.8 cm reduction in patient with PA in comparison to AP view.

In regards to positive findings during assessment of image quality, only one study reported a little significant improvement by 6.3% in AP over PA views. The investigators found that the PA have adequate diagnostic capacity despite of lower image quality than AP view [14]. The main limitation of PA view is patients discomfort in case of acute injury and respiratory distress. For most patients, PA view could be conveniently performed with lower radiation dose without additional equipment.

Other body positions, such as lateral radiography, were evaluated by some researchers in purpose to

improve diagnostic accuracy of lumber radiography. A study with 59 participants was done to investigate the effect of supine lateral radiography on segmental instability at lumber spine region [15]. In degenerative spondylolisthesis, erect flexion-extension lateral projection is routinely used to assess segmental instability. The authors hypothesized that supine position will increase visualization of segmental instability due to decrease in anterolisthesed segment. They found that supine radiographs led to more reduction in anterolisthesed segment than the routine extension radiographs and they recommended introducing supine radiography in the assessment of degenerative spondylolisthesis [15]. However, a previous study showed a wide normal variation in the segmental range at the lumber spine during functional radiography, which may limit the clinical benefit of the supine lateral radiography [16].

Other factor should be taken in the consideration during study of the role of body positioning in spine radiography. In pelvic radiography, a positive significant correlation between BMI and image quality, as well as , a negative correlation between BMI and radiation dose, were consistently reported in the literature [8]. Similar associations could be detected in lumber spine radiography as the region is in close proximity with pelvis. In lumber spine radiography, many studies found a high rejection rate of radiographs that were taken in the lumber spine region. In Saudi Arabia, a study found that the rejection rate in the lumber spine region was the highest (36.3%) among 27,238 radiographs that showed different parts of the body [17].

Conclusions

Improvement of the performance by identifying the key operational factors, in the lumber spine region, may significantly reduce the rejection rate of radiographs in the clinical practice. Furthermore, it is logical to take erect position in the consideration, as it resembles functional appearance of the spine region. In the literature, there is a lack of the evidence about the effect of body positioning on the performance of lumber spine radiography.

Conflict of interests

The authors declared no conflict of interests.

References

1. Bhatia, N.N., et al., *Diagnostic modalities for the evaluation of pediatric back pain: a prospective study.* Journal of Pediatric Orthopaedics, 2008. **28**(2): p. 230-233.
2. Beard, J.R., et al., *The World report on ageing and health: a policy framework for healthy ageing.* The lancet, 2016. **387**(10033): p. 2145-2154.
3. Santiago, F.R., et al., *The role of radiography in the study of spinal disorders.* Quantitative Imaging in Medicine and Surgery, 2020. **10**(12): p. 2322.
4. Patel, N.D., et al., *ACR appropriateness criteria low back pain.* Journal of the American College of Radiology, 2016. **13**(9): p. 1069-1078.
5. Alzyoud, K., et al. *An evaluation of eight different standing positions for undertaking erect pelvis radiography using videorastereography*. 2019. European Congress of Radiology-ECR 2019.
6. Andreasen, M.L., et al., *Reproduction of the lumbar lordosis: a comparison of standing radiographs versus supine magnetic resonance imaging obtained with straightened lower extremities.* Journal of manipulative and physiological therapeutics, 2007. **30**(1): p. 26-30.
7. Alzyoud, K., et al., *Optimum positioning for anteroposterior pelvis radiography: a literature review.* Journal of Medical Imaging and Radiation Sciences, 2018. **49**(3): p. 316-324. e3.
8. Flintham, K., et al., *Comparing the supine and erect pelvis radiographic examinations: an evaluation of anatomy, image quality and radiation dose.* The British Journal of Radiology, 2021. **94**(1123): p. 20210047.
9. Alzyoud, K.S., *Establishing an evidence-base for erect pelvis radiography: positioning, radiation dose and image quality*. 2019: University of Salford (United Kingdom).
10. Alzyoud, K., et al. *Impact on radiation dose and image quality-supine versus erect positioning in*

pelvic radiography. 2019. European Congress of Radiology-ECR 2019.

11. Davey, E. and A. England, *AP versus PA positioning in lumbar spine computed radiography: Image quality and individual organ doses.* Radiography, 2015. **21**(2): p. 188-196.

12. Alukic, E., D. Skrk, and N. Mekis, *Comparison of anteroposterior and posteroanterior projection in lumbar spine radiography.* Radiology and Oncology, 2018. **52**(4): p. 468-474.

13. Brennan, P. and E. Madigan, *Lumbar spine radiology: analysis of the posteroanterior projection.* European radiology, 2000. **10**(7): p. 1197-1201.

14. Mc Entee, M.F. and C. Kinsella, *The PA projection of the clavicle: a dose-reducing technique.* Radiation protection dosimetry, 2010. **139**(4): p. 539-545.

15. Tarpada, S.P., et al., *Utility of supine lateral radiographs for assessment of lumbar segmental instability in degenerative lumbar spondylolisthesis.* Spine, 2018. **43**(18): p. 1275-1280.

16. Dvořák, J., et al., *Functional radiographic diagnosis of the lumbar spine: flexion–extension and lateral bending.* Spine, 1991. **16**(5): p. 562.

17. Alashban, Y., et al., *An assessment of image reject rates for digital radiography in Saudi Arabia: A cross-sectional study.* Journal of Radiation Research and Applied Sciences, 2022. **15**(1): p. 219-223.


Emerging Sources Citation Index (ESCI)
Clarivate
Analytics
WEB OF SCIENCE
THOMSO
REUTER