EBioMedicine 63 (2020) 103158

Contents lists available at ScienceDirect

EBioMedicine

journal homepage: www.elsevier.com/locate/ebiom

Commentary

Automatic detection of rib fractures: Are we there yet?

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ARTICLE INFO

Article History:
Received 14 November 2020
Accepted 18 November 2020

The diagnosis of traumatic rib fractures is of clinical importance as these lesions are markers of severe injury. Whole-body computed tomography has become standard practice in the management of severely injured trauma patients, but the rate of missed diagnosis of rib fractures is likely high. Therefore, it is necessary to improve the rib fracture diagnosis accuracy on CT to reduce the error rate. This justifies the development of new post-processing tools or artificial intelligence (AI) algorithms that could help analyze and interpret whole-body CT scans.

Traumatic rib fractures represent the most common injury sustained following thoracic trauma [1]. Rib fractures are clinically relevant injuries associated with significant pulmonary morbidity and mortality, requiring prompt evaluation and management. The study of a large retrospective cohort study by Peek et al. confirmed that traumatic rib fractures must be considered as a surrogate marker of severe injury leading to worse patient outcomes [1]. In this study, the highest mortality rate was observed among patients with flail chest (13.0%). Despite some controversies, the number of rib fractures is frequently considered as an important predictor for overall trauma severity and mortality. Moreover, first rib fractures are associated with worse clinical outcomes [2].

Whole-body CT scanning is recommended as a standard of care in the primary management of polytraumatized patients [3]. Thus, radiologists are challenged to interpret thousands of images as quickly as possible to identify life-threatening injuries accurately. In this context, it is not surprising that certain injuries deemed of secondary importance are overlooked, especially in patients with multiple accompanying injuries [3]. For instance, the missed rib fractures rate may be as high as 20.7% [5]. Although the vast majority of missed injuries are considered minor, as Pinto et al. stated, missed diagnoses have potentially important consequences for patients, clinicians, and radiologists [4].

To reduce the risk of errors, some authors advocate a double-reading of the whole-body CT studies in patients with a high-risk for missed lesions, notably those with injuries to two or more body parts, older than 30 years or with a severe initial clinical status [3]. However, double-reading may not be feasible in some institutions due to limited human resources (radiologist shortage), the need for a prompt final report, and the lack of financial compensation for this activity.

Unfolded rib reformation is a new post-processing tool that provides automatic curved multiplanar reconstructions of the ribs, allowing the visualization of the entire rib cage in the same image plane [6]. This tool is a substitute for the tedious process of rib-by-rib analysis, allowing a faster and more accurate rib fractures diagnosis. One of the main advantages of unfolded rib reformation is the rapid fracture location assessment. In a study by Urbaneja et al., this tool allowed a 27% to 54% reduction in reading time while maintaining a similar diagnostic performance [7]. However, unfolded rib reformation requires an adequate training period to prevent interpretation errors (e.g., fractures located at the rib extremities may be difficult to identify) and differentiate between past and recent fractures.

A complementary approach comprises algorithms based on deep convolutional neural networks (CNN). The number of CNN algorithms for fracture detection on CT is limited, and there are only a few studies evaluating their clinical application. For Weikert and al., the CNN algorithms reached a sensitivity of 87.4% and a specificity of 91.5% for rib fracture detection on a per-examination level, and many true rib fractures unmentioned on reports were detected [8]. Zhou et al. showed that AI-assisted radiologists significantly improved their accuracy for rib fracture identification (91.1% with AI assistance vs. 80.3% without assistance) with a reduction of the reading time [9]. Finally, the algorithm developed by Jin et al. and presented in the recent issue of EBioMedicine, achieved a 92.9% sensitivity for rib fracture diagnosis, which was significantly higher than that of radiologists (75.9 and 79.1%) [10].

These studies suggest that AI-assisted rib fracture diagnosis can improve accuracy and reduce interpretation time with a potential positive impact on radiologists' workload. To be fully accepted by radiologists, ideally, such algorithms must also be able to characterize fractures to a certain extent (acute, healing, old, displaced), locate

DOI of original article: http://dx.doi.org/10.1016/j.ebiom.2020.103106.
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https://doi.org/10.1016/j.ebiom.2020.103158

them precisely and generate a structured report, and above all, highlight factors with a prognostic impact such as a flail chest, total number of fractured ribs and first rib fractures. Finally, it is important to note that at this stage of development, these tools can assist radiologists but not replace them, mainly because some artifacts, such as breathing artifacts, can generate false-positive diagnoses.

To conclude, current results on deep-learning-assisted rib fractures detection are very promising, demonstrating that AI can be seen as a "wingman" for image interpretation and should be integrated into the radiology workflow.

Contributors

All authors contributed to this commentary through literature search. All authors have read and approved the final version of the manuscript.

Declaration of Competing Interest

Two of the authors (Alain Blum and Pedro Gondim Teixeira) have a non-remunerated research contract with Canon Medical company. The other authors have no potential conflicts of interest to disclose.

Acknowledgments

The authors state that this work has not received any funding.

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