Osteoarticular x-ray reading by medical students followed by eye-tracking: better understanding for better training

Sirs,

Osteoarticular x-rays play a central role in medicine (1) but can be complex, especially for medical students. The strategies implemented by medical students in learning x-rays reading and interpretation have been insufficiently studied. Eye-tracking technology, which monitoring and records eye movements and positions, has diverse applications across various fields, from advertising (2) to medical domains (3-6). This technology is increasingly used in medical training (7, 8) to analyse how medical students or professionals interact with visual information. Eye tracking has the potential to improve knowledge of the strategies employed by medical students and can play a role in tracking students' progress and assessing the effectiveness of learning methods. In this study, eye-tracking technology was employed to evaluate the strategies adopted by students when analysing radiographs and to examine their correlation with the quality of interpretation and responsiveness to dedicated instruction.

To study the impact of reading methods on multiple-choice questionnaires (MCQs), a group (Group A) of 51 students in their third, fourth, or fifth year of medical school were recruited from various hospital departments of the Brest Hospital (France), and analysed three radiographs sequentially and answered MCQs. To evaluate the impact of a lesson on reading, a second group (Group B) of 40 students was randomly assigned (1:1) to receive or not receive a lesson in radiograph reading before reading and answering the MCQs. Eye-tracking data were recorded using Tobii Pro Lab software during all readings, which is validated, high-precision eye-tracking software that records gaze data at a sampling rate of 120 Hz and analyses the eye movements of readers.

Concerning group A, the average score on the questionnaires was 14.0 ± 2.0/20 points. The average reading time was 6.1 ± 1.6 minutes, number of fixation points was 568 ± 165 and number of saccades was 485 ± 164. No correlation was found between the score obtained on the MCQs and reading time (*rho*=0.09), the number of fixation points (*rho*=0.11) or the number of saccades (*rho*=0.11). Figure 1 shows examples of reading by eye-tracking. Based on the subjective analysis of gaze plots, 54.9% of students conducted an analysis of soft tissues, 39.2% focused on vertebral structures, 9.8% focused on vertebral contours, and only 5.9% performed a combined analysis of these different structures. The analysis of vertebral structures (p=0.03) and bone contours (p=0.02) were associated with higher MCQ scores. No significant association was found regarding the analysis of soft tissues (p=0.20). Concerning group B, the initial reading, which was conducted before the teaching was implemented by randomisation, revealed no significant differences between the two groups. Concerning the second reading, students who received dedicated instruction had a greater number of fixation points (p=0.02) and a greater number of saccades (p=0.01). These students were more likely to perform contour (p=0.04) and structure analysis (p<0.001). No significant difference was found for soft tissue analysis. MCQ scores did not differ between the two groups.

To conclude, students had significant heterogeneity in the reading strategies, as evidenced by the dispersion and amplitude of the reading time, number of fixation points and saccades. The number of fixation points and saccades increases significantly among medical students exposed to specific training. While eye-tracking is a promising tool for studying x-rays interpretation, it should be combined with other methods for a fuller understanding of the cognitive processes (9). Eye-tracking technology is an efficient and acceptable method for evaluating medical students' proficiency in analysing standard radiographs. We believe that eye tracking should be implemented in larger cohorts of medical students with the aim of confirming its additional value, particularly for monitoring individual progress and assessing the effectiveness of learning methods.

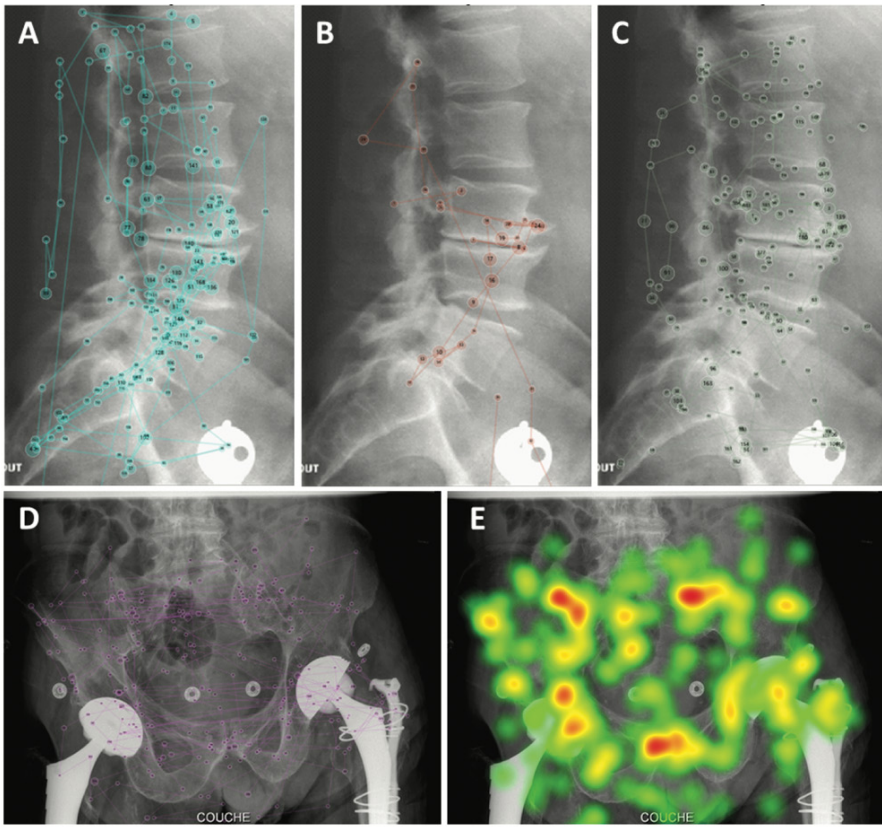

Fig. 1. Three examples of spine readings by three different students using a gaze plot (**A**-**C**) and one example of a pelvic radiograph reading evaluated by a gaze plot (**D**) and heatmap (**E**). In Figure 1A, the student looked all the data (vertebral contours, vertebral structure and soft tissues). Figure 1B shows the abnormality at L3-L4 without considering the other bone structures or soft tissues. In Figure 1C, the student looked at the bone contours and soft tissues but less at the bone structure.

Acknowledgements

We would like to thank all the students at Brest University Hospital who agreed to take part in the study.

B. Quéré, *MD,*
V. Laurier
M. Laurier
V. Devauchelle-Pensec, *MD-PhD,*
D. Guellec, *MD,*
A. Saraux, *MD, PhD*

Université de Bretagne Occidentale (Univ Brest) and Department of Rheumatology, CHU Brest, INSERM (U1227), LabEx IGO, 29200 Brest, France.

Please address correspondence to:
Alain Saraux
Rheumatology Unit,
Hôpital de la Cavale Blanche, BP 824,
F 29609 Brest cedex, France.
E-mail: alain.saraux@chu-brest.fr

Competing interests: none declared.

References

1. NORTON CL: The x-rays in medicine and surgery. *Science* 1896; 3(72): 730-31. https://doi.org/10.1126/science.3.72.730
2. WEDEL M, PIETERS R: Eye tracking for visual marketing. *Found TrendsR Mark* 2008; 1(4): 231-320.
3. BORASTON Z, BLAKEMORE SJ: The application of eye-tracking technology in the study of autism. *J Physiol* 2007; 581(Pt 3): 893-98. https://doi.org/10.1113/jphysiol.2007.133587
4. GREDEBÄCK G, JOHNSON S, VON HOFSTEN C: Eye tracking in infancy research. *Dev Neuropsychol* 2010; 35(1):1-19. https://doi.org/10.1080/87565640903325758
5. WANG S, CHANDRAVADIA N, MAMELAK AN, RUTISHAUSER U: Simultaneous eye tracking and single-neuron recordings in human epilepsy patients. *J Vis Exp* 2019; (148). https://doi.org/10.3791/59117
6. GARRY J, CASEY K, COLE TK *et al*.: A pilot study of eye-tracking devices in intensive care. *Surgery* 2016; 159(3): 938-44. https://doi.org/10.1016/j.surg.2015.08.012
7. ASHRAF H, SODERGREN MH, MERALI N, MYLONAS G, SINGH H, DARZI A: Eye-tracking technology in medical education: A systematic review. *Med Teach* 2018; 40(1): 62-69. https://doi.org/10.1080/0142159X.2017.1391373
8. GRIMA-MURCIA MD, SANCHEZ-FERRER F, RAMOS-RINCÓN JM, FERNÁNDEZ E: Use of eye-tracking technology by medical students taking the objective structured clinical examination: descriptive study. *J Med Internet Res* 2020; 22(8): e17719. https://doi.org/10.2196/17719
9. BRUNYÉ TT, DREW T, WEAVER DL, ELMORE JG: A review of eye tracking for understanding and improving diagnostic interpretation. *Cogn Res Princ Implic* 2019; 4(1): 7. https://doi.org/10.1186/s41235-019-0159-2