Editorial

Dynamic chest radiography in the workup of lung cancer

Thomas S. FitzMaurice[1,2,3], Dilip S. Nazareth[1,4], Martin J. Walshaw[1,4]

[1]Department of Respiratory Medicine, Liverpool Heart and Chest Hospital, Liverpool, UK; [2]Institute of Life Course and Medical Sciences, University of Liverpool, Liverpool, UK; [3]Liverpool Centre for Cardiovascular Science, University of Liverpool, Liverpool, UK; [4]Institute of Infection and Global Health, University of Liverpool, Liverpool, UK

Correspondence to: Thomas S. FitzMaurice. Department of Respiratory Medicine, Liverpool Heart and Chest Hospital, Thomas Drive, Liverpool, L14 3PE, UK. Email: thomas.fitzmaurice@lhch.nhs.uk.

Comment on: Hanaoka J, Shiratori T, Okamoto K, *et al.* Reliability of dynamic perfusion digital radiography as an alternative to pulmonary perfusion scintigraphy in predicting postoperative lung function and complications. J Thorac Dis 2022;14:3234-44.

Submitted Sep 14, 2022. Accepted for publication Oct 09, 2022.
doi: 10.21037/jtd-22-1266
View this article at: https://dx.doi.org/10.21037/jtd-22-1266

Patients with lung cancer often have concomitant co-morbidities associated with smoking, in particular poor lung function due to chronic obstructive pulmonary disease (1). Although tumour resection is the gold standard treatment for early (stage I-II) non-small cell lung cancer (2-4), inevitably a portion of uninvolved lung is removed by the surgical procedure. This can be problematic in those with limited lung function and can result in a reduction in exercise tolerance and quality of life (5), or even oxygen dependence (6). Preoperative assessment of lung function is therefore of paramount importance: a successful technique must be straightforward, accessible and acceptable, with an ability to determine accurately postoperative lung function. In low-risk cases, measurement of air flow (FEV_1) and diffusion capacity (DL_{CO}) may be sufficient, but in high-risk cases measurement of lung volumes, and lung ventilation and perfusion, may better predict outcomes. Traditionally, pulmonary perfusion scintigraphy (PPS) has been employed, but it is technically complex and of limited availability. Thus, other techniques including Single Photon Emission Computed Tomography (SPECT), perfusion magnetic resonance imaging (MRI) and CT volume or segment counting (7,8) have been proposed. Each has its advantages; a recent meta-analysis has identified combined CT volume and density measures as the most accurate method to-date (9).

Dynamic chest radiography (DCR), a low-dose fluoroscopic digital imaging system, has recently been employed for a range of different cardiopulmonary imaging applications. In one such application, by measuring change in X-ray absorption in different areas of the visualised lung relative to cardiac motion during a breath hold over several cardiac cycles, blood flow through discrete areas of lung can be measured (10). DCR employed for this purpose is referred to as dynamic perfusion digital radiography (DPDR). The ionising radiation dose of DCR is low (11), and the posteroanterior images of the entire thorax are acquired in an erect or supine position in much the same manner as a standard chest radiograph. Prior to automated image analysis, these breath-hold inspiratory images are similar to a chest film and can be used for this purpose. DCR can also be used to calculate lung volume subdivisions (12), assess diaphragm motion (13,14), measure ventilation (15) and quantify lung nodule motion (16). These attributes may afford it a role as a thoracic imaging technique in the workup of individuals with lung cancer.

In this issue of the *Journal of Thoracic Disease*, Hanaoka *et al.* (17) measured blood flow ratios using both DPDR and PPS in a group of 44 individuals (6 female, mean age 73±6 years) undergoing radical surgical resection for primary lung cancer, both comparing the results of blood flow ratios directly and using the results to predict postoperative spirometry, long term oxygen requirements and cardiorespiratory complications such as pneumonia and atrial fibrillation. In their retrospective observational work, they found a good correlation of distributions of affected side to total ratios (r=0.87, P<0.01) and predicted postoperative lung function (r=0.98, P<0.01) between the two techniques. Prediction of cardiorespiratory complications by receiver operating characteristic analysis was also good, with predicted postoperative percentage

DL_{CO} by DCR and PPS both being significant (P=0.008, P=0.025 respectively).

The authors are to be congratulated on their application of a novel imaging technique to a pertinent clinical problem. Not only do they report good test values for prediction of postoperative lung function, but employ DPDR in the prediction of postoperative complications with a good degree of success. Whilst FEV_1 alone is an important predictor of health in chronic lung disease, the additional inclusion in this study of DL_{CO}, long-term oxygen requirements and cardiorespiratory complications is arguably more reflective of the real-world utility of a technique applied to surgical patients with a high degree of cardiac and respiratory morbidity; many similar studies on other techniques use FEV_1 alone as the outcome measure of interest. Procedural outcome is not judged solely on surgical success, but on the postoperative quality of life afforded to the patient, and inclusion of these measures is recommended (9).

While DCR may suffer from technical limitations such as interference from unintentional patient motion and a lack of 3D imagery (available with CT or MRI), its strength may lie in its versatility for periprocedural diagnostic workup, its comparatively low radiation dose compared to CT and its ease of image acquisition. The footprint and cost of a DCR system are similar to that of a standard radiography suite (11) and the rapid image acquisition in an erect or sitting posture may be more tolerable to a patient group with a high prevalence of dyspnoea, especially when compared to MRI and SPECT, which require lengthy, supine positioning.

There are, however, some limitations to this work: it is small, and did not reach its recruitment target of 100 [to counter this, it is not alone in this regard; many similar studies have similarly small numbers (9)]. The study disproportionately features male participants (n=38), and the inclusion only of those scheduled for PPS for clinical purposes (excluding over half the recruited participants from the final analysis) risks selection bias. The authors do not report any *a priori* thresholds of cardiorespiratory complications, limiting the relevance of their findings in this regard, and no account appears to have been taken of patient factors that might influence or stratify risk prediction. No attempt was made to include any of the other abilities possible with DCR such as lung volume calculation or ventilation assessment, which might have provided further information to incorporate into predictive models of postoperative lung function—most likely to limit radiation dose, since these would require additional manoeuvres over a longer exposure time. Although PPS has been regarded as the traditional gold standard for prediction of postoperative lung function, dynamic perfusion MRI (18) and volumetric CT (19) have enviable test performance characteristics and are recommended in the British Thoracic Society lung cancer guideline (2), yet no comparison is made to these other techniques in the work of Hanaoka *et al.*; similarly, although the correlation between DPDR and PPS was high, PPS itself may underestimate lung function (20), hence need for comparison between DCR and other reference techniques. In this work, although correlation between predicted and measured postoperative spirometry is reported, mean differences are not. In this study no workflow, costing or ionising radiation exposure comparison was performed in this work to justify any formal comparison to CT or MRI.

While promising, this work—as with many applying DCR to clinical problems—is small and does not include comparison with arguably more frequently clinically-utilised imaging techniques. No formal comparison is made with regards to cost or ionisation radiation exposure, limiting the broader applicability of this small but interesting work. Studies with larger cohorts of individuals, longitudinal follow-up, comparison to CT and robust analysis of whether its putative advantages in radiation dose and acquisition simplicity are accurate are necessary for DCR to demonstrate any real-world utility.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Journal of Thoracic Disease*. The article did not undergo external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1266/coif). TSF reports support for educational meeting attendance from Konica Minolta, Inc. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Young RP, Hopkins RJ, Christmas T, et al. COPD prevalence is increased in lung cancer, independent of age, sex and smoking history. Eur Respir J 2009;34:380-6.
2. Lim E, Baldwin D, Beckles M, et al. Guidelines on the radical management of patients with lung cancer. Thorax 2010;65 Suppl 3:iii1-27.
3. Brunelli A, Charloux A, Bolliger CT, et al. ERS/ESTS clinical guidelines on fitness for radical therapy in lung cancer patients (surgery and chemo-radiotherapy). Eur Respir J 2009;34:17-41.
4. Howington JA, Blum MG, Chang AC, et al. Treatment of stage I and II non-small cell lung cancer: Diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest 2013;143:e278S-313S.
5. Schulte T, Schniewind B, Dohrmann P, et al. The extent of lung parenchyma resection significantly impacts long-term quality of life in patients with non-small cell lung cancer. Chest 2009;135:322-9.
6. Nicastri DG, Alpert N, Liu B, et al. Oxygen Use After Lung Cancer Surgery. Ann Thorac Surg 2018;106:1548-55.
7. Ohno Y, Koyama H, Nogami M, et al. Postoperative lung function in lung cancer patients: comparative analysis of predictive capability of MRI, CT, and SPECT. AJR Am J Roentgenol 2007;189:400-8.
8. Yabuuchi H, Kawanami S, Kamitani T, et al. Prediction of post-operative pulmonary function after lobectomy for primary lung cancer: A comparison among counting method, effective lobar volume, and lobar collapsibility using inspiratory/expiratory CT. Eur J Radiol 2016;85:1956-62.
9. Oswald NK, Halle-Smith J, Mehdi R, et al. Predicting Postoperative Lung Function Following Lung Cancer Resection: A Systematic Review and Meta-analysis. EClinicalMedicine 2019;15:7-13.
10. Tanaka R, Sanada S, Fujimura M, et al. Pulmonary blood flow evaluation using a dynamic flat-panel detector: feasibility study with pulmonary diseases. Int J Comput Assist Radiol Surg 2009;4:449-55.
11. Hata A, Yamada Y, Tanaka R, et al. Dynamic Chest X-Ray Using a Flat-Panel Detector System: Technique and Applications. Korean J Radiol 2021;22:634-51.
12. Ueyama M, Hashimoto S, Takeda A, et al. Prediction of forced vital capacity with dynamic chest radiography in interstitial lung disease. Eur J Radiol 2021;142:109866.
13. FitzMaurice TS, McCann C, Nazareth DS, et al. Characterisation of hemidiaphragm dysfunction using dynamic chest radiography: a pilot study. ERJ Open Res 2022;8:e00343-2021.
14. Hida T, Yamada Y, Ueyama M, et al. Decreased and slower diaphragmatic motion during forced breathing in severe COPD patients: Time-resolved quantitative analysis using dynamic chest radiography with a flat panel detector system. Eur J Radiol 2019;112:28-36.
15. Tanaka R, Sanada S, Fujimura M, et al. Ventilatory impairment detection based on distribution of respiratory-induced changes in pixel values in dynamic chest radiography: a feasibility study. Int J Comput Assist Radiol Surg 2011;6:103-10.
16. Kitamura K, Takayama K, Yamazaki R, et al. A new method for assessing lung tumor motion in radiotherapy using dynamic chest radiography. J Appl Clin Med Phys 2022;23:e13736.
17. Hanaoka J, Shiratori T, Okamoto K, et al. Reliability of dynamic perfusion digital radiography as an alternative to pulmonary perfusion scintigraphy in predicting postoperative lung function and complications. J Thorac Dis 2022;14:3234-44.
18. Ohno Y, Koyama H, Nogami M, et al. State-of-the-art radiological techniques improve the assessment of postoperative lung function in patients with non-small cell lung cancer. Eur J Radiol 2011;77:97-104.
19. Fernández-Rodríguez L, Torres I, Romera D, et al. Prediction of postoperative lung function after major lung resection for lung cancer using volumetric computed tomography. J Thorac Cardiovasc Surg 2018;156:2297-2308.e5.
20. Zeiher BG, Gross TJ, Kern JA, et al. Predicting postoperative pulmonary function in patients undergoing lung resection. Chest 1995;108:68-72.

Cite this article as: FitzMaurice TS, Nazareth DS, Walshaw MJ. Dynamic chest radiography in the workup of lung cancer. J Thorac Dis 2022;14(11):4215-4217. doi: 10.21037/jtd-22-1266