Unexpected occurrence of right to left shunt during lung perfusion scintigraphy: a problem-based learning exercise

Elliott, J. and Roldao Pereira, L.
Unexpected occurrence of right to left shunt during lung perfusion scintigraphy: a problem-based learning exercise

James EG Elliott1,2 MSc, PgCert | Luisa Roldao Pereira1 BSc
1Canterbury Christ Church University, Canterbury, Great Britain
2Maidstone Hospital Nuclear Medicine Department, Maidstone and Tunbridge Wells NHS Trust, Kent, England

ABSTRACT
This case report presents a problem-based learning exercise that occurred during lung perfusion scintigraphy with technetium-99m macroaggregated albumin ($^{99m}$Tc-MAA) with the incidental finding of a previously undiagnosed right-to-left shunt. The pathology manifested with a redirection of $^{99m}$Tc-MAA-loaded blood into systemic circulation and subsequent uptake in gastric, renal, and thyroid tissues. Incorrect radiopharmaceutical administration, radiopharmacy error and independent constituents of $^{99m}$Tc-MAA offered alternative explanations which required exclusion. Subsequent recommendations included diligent use of safety procedures and appropriate documentation during receiving, dispensing and administration of radiopharmaceuticals. Clinical suspicion of RLS may warrant additional $^{99m}$Tc-MAA imaging to confirm diagnosis or quantify severity.

Keywords VQ scan, $^{99m}$Tc-MAA, nuclear medicine practitioner

LAY ABSTRACT
This case report provides an illustrated example of problem-based learning during a nuclear medicine lung imaging scan. The unexpected distribution of radioactivity within the stomach, kidneys and thyroid tissues required the attending nuclear medicine staff to provide a revised diagnosis of right-to-left cardiac shunt.

CASE REPORT
A 34 year-old female was referred for lung scintigraphy to exclude pulmonary embolism, having presented with symptoms including coughing, low oxygen saturation, raised lactate values and suspicion of sepsis. A SmartVentTM system (Diagnostic Imaging Ltd, England) was used during the ventilation phase to deliver 80 MBq technetium-99m diethylenetriaminepentaacetic acid ($^{99m}$Tc-DTPA). This was followed by intravenous administration of 127 MBq technetium-99m macroaggregated albumin ($^{99m}$Tc-MAA) for the perfusion phase. Planar imaging was performed for both phases; anterior, posterior, and left/right posterior oblique views (Figure 1). The ventilation phase showed normal distribution of radionuclide, the perfusion imaging demonstrated unusual uptake in gastric, renal and thyroid tissues. This was retrospectively explained as an anomalous left brachiocephalic drainage into the left atrium using computer tomography imaging from a previous hospital admission. Blood enriched with $^{99m}$Tc-MAA was therefore partially redirected to systemic circulation and consequently interacted with extra-pulmonary organs. A diagnosis was then made of a right-to-left shunt (RLS).

DISCUSSION
An important aspect of optimal nuclear medicine service provision includes problem solving skills.[1] We present an example where due diligence and elimination of alternative causes aided in the confirmation of a RLS during VQ planar lung scintigraphy. The patient in this case report was diagnosed as exhibiting RLS with scant indication of RLS diagnosis. The patient presented to the department with coughing, low oxygen saturation, and symptoms of pulmonary congestion. The patient was referred for a lung perfusion scan, but was subsequently diagnosed with RLS. The use of a SmartVent system during the ventilation phase allowed for the delivery of an appropriate dose of technetium-99m diethylenetriaminepentaacetic acid ($^{99m}$Tc-DTPA). This was followed by intravenous administration of 127 MBq technetium-99m macroaggregated albumin ($^{99m}$Tc-MAA). The uptake of activity outside of the normal distribution of radionuclide, the perfusion imaging demonstrated unusual uptake in gastric, renal and thyroid tissues. Incorrect radiopharmaceutical administration, radiopharmacy error and independent constituents of $^{99m}$Tc-MAA offered alternative explanations which required exclusion. Subsequent recommendations included diligent use of safety procedures and appropriate documentation during receiving, dispensing and administration of radiopharmaceuticals. Clinical suspicion of RLS may warrant additional $^{99m}$Tc-MAA imaging to confirm diagnosis or quantify severity.

The uptake of activity outside of the

www.sorsa.org.za
It is therefore advised that Tc-MAA would produce TcO₄⁻ within the administered volume. In theory a disassociation between the radionuclide and pharmaceutical label in ⁹⁹mTc-MAA would produce independent portions of ⁹⁹mTcO₄⁻, ⁹⁹mTc-MAA and MAA. A mixture of compounds within the same injected volume would produce uptake in multiple organs, with the distribution of MAA lacking radiological visualisation altogether. The presence of intravenous ⁹⁹mTcO₄⁻ may induce similar images to Meckel’s diverticulum scintigraphy which has similar gamma camera scanning parameters (albeit a higher administered activity). ⁹⁹mTcO₄⁻ has been used during first pass renal scintigraphy which has similar visualisation altogether. In terms of visualisation of renal tissues. In terms of renal scintigraphy, ⁹⁹mTcO₄⁻ has been used during first pass renal scintigraphy, but would lack the disassociation was excluded through chromatography by the radiopharmacy staff to ensure radiochemical purity.

Having eliminated all possible causes, the NMPs concluded that the imaging was a true representation of a previously undiagnosed pathology. This case report thus serves as exemplary practice by NMPs and demonstrates unusual RLS appearances during scintigraphic imaging.

CONCLUSION

The chance encounter of RLS within the nuclear medicine department was somewhat novel for the attending NMPs and was a useful problem-based learning exercise. Future cases of suspected RLS would benefit from an additional planar image of the patient’s head to identify activity within the cerebral vessels with whole body imaging to quantify the severity of the shunt. The event in this case led to increased awareness of the pathology by local NMPs. It is a valuable confirmatory example of due diligence and care during the receiving, dispensing and administration of radiopharmaceuticals.

Although avoided within this case report, the incorrect administration or production of radiopharmaceuticals may be termed as a never event due to their preventable nature. It is therefore advised that NMPs maintain vigilance at all stages of radiopharmacy production and use. Furthermore, suspicions of atypical pathologies such as RLS require close scrutiny of the patient’s medical history and previous imaging to ensure a suitable and tailored imaging protocol.

REFERENCES