Effective dose increase of cyclotron-produced ^{99m}Tc labelled radiopharmaceuticals

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Introduction

Alternative Technetium-99m production via ^{100}Mo(p,2n)^{99m}Tc reaction route using medical cyclotrons, is reliable and relatively cost-effective[1]. However, it was found that the ^{99m}Tc thus produced contains small quantities of several ^{9x}Tc radioisotopes (^{93m}Tc, ^{93}Tc, ^{94}Tc, ^{94m}Tc, ^{95}Tc, ^{95m}Tc ^{96}Tc and ^{97m}Tc)[2]. The aim of this work was to estimate the effective dose-increase (DI) due to the contribution of ^{9x}Tc contaminants, after intravenous injection of four radiopharmaceuticals prepared with cyclotron-produced ^{99m}Tc (CP-^{99m}Tc) using 99.05% ^{100}Mo-enriched molybdenum metallic targets.

Materials and methods

In this study four ^{99m}Tc-radiopharmaceuticals were considered (pertechnetate, sestamibi (MIBI), hexamethylpropylene-amine oxime (HMPAO) and disodium etidronate (HEDP)). The biokinetic models reported by the International Commission on Radiological Protection (ICRP) for each radiopharmaceutical were used to select the main source organs (SO) and to determine the number of disintegrations per MBq in each SO (N_{SO}) for each ^{9x}Tc radioisotope present in the CP-^{99m}Tc solution. The N_{SO} obtained values and the adult male phantom were used as input data for the OLINDA/EXM software v.1.1 and 2.0, to calculate the effective dose for each ^{9x}Tc radioisotope. The total effective dose produced by all ^{9x}Tc impurities present in the CP-^{99m}Tc solution, was calculated using the fraction of total activity corresponding to each radioisotope generated by the bombardment of ^{100}Mo-enriched (99.05%) metallic target. Finally, the effective dose obtained was compared with the one delivered by the generator-produced ^{99m}Tc.

Results and discussion

The total effective DI of CP-^{99m}Tc radiopharmaceuticals, calculated with both versions of the OLINDA software, remained within the 10% limit in all cases, from 6 up to 12 h after the end of bombardment (EOB). The ^{9x}Tc radioisotopes with the highest concentration in the CP-^{99m}Tc solution at EOB were ^{94m}Tc and ^{93m}Tc. However, their contribution to DI 6 h after EOB is minimal, due to their short half-lives. At last, ^{96}Tc is the radioisotope with the largest contribution to the effective DI, followed by ^{95}Tc and ^{94}Tc, due to the types of their emissions and relatively long half-lives, although their concentration in the CP-^{99m}Tc solution is negligible at the EOB.

Conclusion

The effective dose-increase caused by ^{9x}Tc contaminants available in CP-^{99m}Tc as here described is quite low. Although ^{94}Tc and ^{95}Tc radioisotopes concentrations in the CP-^{99m}Tc solution exceed the limits established by the European Pharmacopoeia, CP-^{99m}Tc radiopharmaceuticals could be used in routine nuclear medicine diagnostic studies if administered from 6 to 12 h after the EOB, thus maintaining the effective DI within the 10% limit.

References

1. Martini P, *et al.* [2018]. Appl Radiat Isot.139:325–331.
2. Uzunov NM, *et al.* [2018] Phys Med Biol 63:185021.