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Determination of ^{99}Mo contamination in ^{99m}Tc elute obtained from ^{99}Mo / ^{99m}Tc- generator

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Background: ^{99m}Tc is a widely used radioisotope in nuclear medicine centers which is obtained by elution from Mo-99/Tc-99m generators. Usually the generators are either supplied by the Iran Atomic Energy Agency or by private companies from foreign countries. In this study we have measured ^{99}Mo contamination in ^{99m}Tc elute from different generators in a period of one year. ***Materials and Methods:*** The radionuclide impurity of the ^{99m}Tc elute were studied in two types of radionuclide generators (A: produced in Iran and B: Imported from other country). *In-vitro* measurements were performed using dose calibrator. Direct measurements were made, using a standard canister at the time of milking of the generators and also in subsequent hours after milking. ***Results:*** The results showed a mean of ^{99}Mo impurity in generators A and B to be 0.00932±0.0043 and 0.0170±0.0127 respectively. Although the results showed that the ^{99}Mo contamination in ^{99m}Tc elute was lesser than the maximum accepted activity limit of 0.015%, the difference in these two types may reflect different methods of productions of generator, as well as the quality control procedures. ***Conclusion:*** The mean of ^{99}Mo contamination in generators produced in Iran Atomic Energy Organization was lesser than generators imported from foreign origin. **Iran. J. Radiat. Res., 2010; 8 (1): 31-35**

Keywords: *Nuclear generators, technetium, molybdenum contamination, dose calibrator.*

INTRODUCTION

^{99m}Tc is a widely used radioisotope in nuclear medicine centers. This radionuclide is obtained from ^{99}Mo-^{99m}Tc generator by elution of generator with isotonic saline and should ideally contain no radionuclide impurity. However, due to imperfections in the production of the generator or possible occurrence of mechanical defects, ^{99}Mo may be eluted from the generator in the elution process [1-3]. The presence of ^{99}Mo in the eluted saline may interfere with labeling process and decrease the labeling yield. Also, the radionuclide impurity introduces an unnecessary and unacceptable additional dose to the patients. The dose coefficient for ^{99}Mo is about 50 times higher than that of ^{99m}Tc [2-4]. The high dose is associated with the beta particle and the higher energies of the photons emitted by ^{99}Mo [4]. Moreover, depending on the activity of the radionuclide impurity, the quality of the image can also be degraded [2]. Figure 1 shows projections from myocardial perfusion scans, projections in upper three rows showed increased background activity and poor image quality as a result of Mo contamination. The lower three rows show projections from a myocardial perfusion scan with Tc-99m-MIBI uncontaminated with molybdinium.

Mostly ^{99m}Tc generators are supplied by AEOI and by a private company from foreign countries. In this study we have measured ^{99}Mo contamination in ^{99m}Tc elute from different generators during 1 year course.

MATERIALS AND METHODS

The radionuclide impurity of the ^{99m}Tc elute in two types (A & B) of radionuclide generators were studied. Fortyfour generators from Atomic Energy Organization of Iran (AEOI) [type A] and 25 generators from foreign country (Monrol, Turkey) [type B] were studied. The measurements were

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accomplished during 1 year period and performed two times for each generator at the first day of shipment. The initial measurements were made just after milking and the second measurement was performed 3-5 hours after milking the generator on the same eluted vial, before labeling a new kit. *In vitro* measurements were made using dose calibrator. A Capintec CRC-15R calibrated dose calibrator (Capintec Inc. NJ, USA), with standard lead canister and insertion holder, was used to study the amount of ^{99}Mo contamination [1]. The procedure was as follows: At first the empty canister was measured at the Mo assay window to determine the background activity, then the elute of the sodium pertechnetate was measured inside the canister with the same window. The value showed the total amount of Mo and background and the net amount of Mo activity was determined after background subtraction (Mo – BG). To determine the activity of ^{99m}Tc, the elution was measured without the canister at the proper window (Tc). The ratio of Mo contamination was calculated by dividing the net Mo activity in μCi by the activity of Technetium (in mCi). The results were converted to MBq ^{99}Mo / MBq ^{99m}Tc by multiplying by 10^{-3}. Univariate analysis was used for description of the variables and independent *t-test* was used for comparison of the quantitative data between groups.

SPSS software (version 11, SPSS Inc. USA) was used for the statistical analysis. $P<0.05$ was considered significant in all comparisons.

RESULTS

Table 1 shows the results of the ^{99}Mo contamination measured in 6 generators on the first day at the time of milking of the generators, and at subsequent hours to milking. The last two columns show the calculated ratio of contamination and the

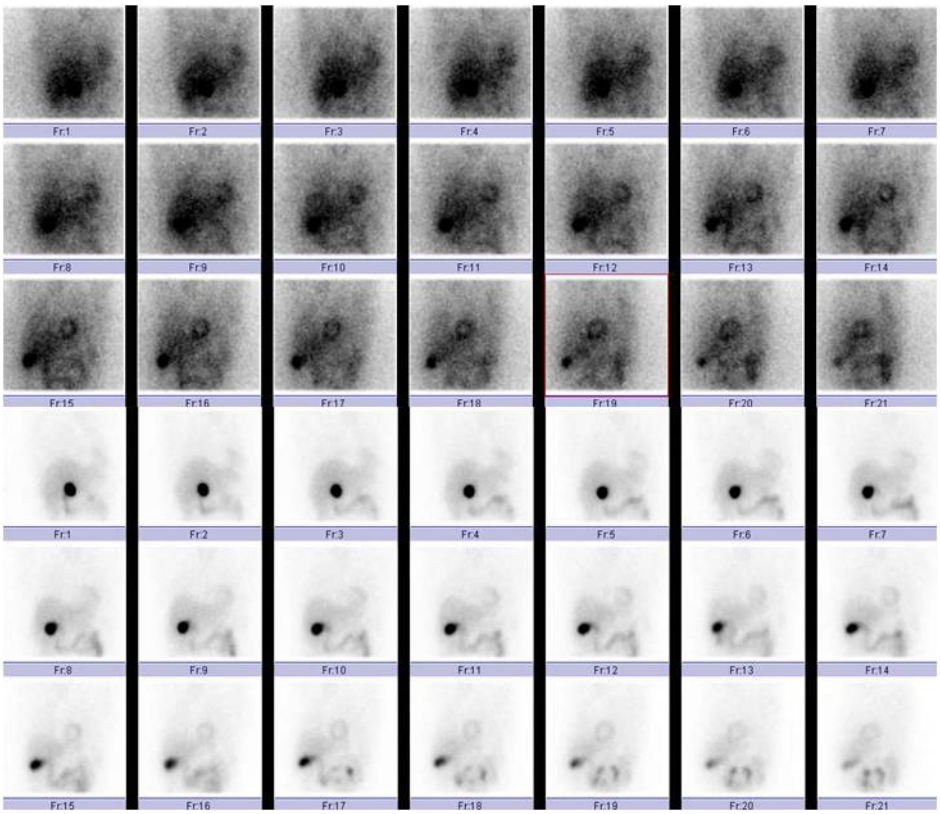

Figure 1. Projections from myocardial perfusion scans: the upper three rows show increased background activity and poor image quality as a result of Mo contamination compared to the normal state (lower three rows).

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acceptable limit of ^{99}Mo impurities, respectively.

Figure 2 shows the ratio of contamination measured in two types of generators compared to standard curve.

The results showed the mean of ^{99}Mo impurity in generators A and B were 0.00932±0.0043 and 0.0170±0.0127, respectively. Independent sample *t-test* showed that the mean of the ^{99}Mo impurity was significantly higher in group B of the generators.

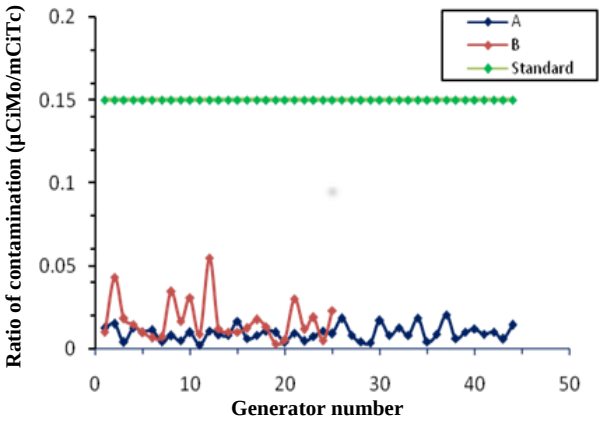

Figure 2. The ratio of ^{99}Mo contamination measured in generators A and B compared to acceptable amount.

DISCUSSION

The results of our study showed that the ^{99}Mo contamination in ^{99m}Tc elute was lesser than the maximum accepted activity limit of 0.15 µCi of ^{99}Mo per mCi of ^{99m}Tc in all generators. The mean of ^{99}Mo contamination in generators produced by AEOI was lesser than imported generators which may be caused by different methods of production, possible mechanical damage in transportation and quality control procedures. It is important to note that whenever the generator is eluted, minimal amount of ^{99}Mo is removed from the column; therefore, any eluted vial should be checked for ^{99}Mo contamination. The amount of contamination can be estimated by direct measurement or in doubtful cases by means of energy checking and gamma spectrometry. When there is high contamination of ^{99}Mo in the solution, the spectrum can be investigated for high energy peaks in the range of 700-900 keV and the down scatters of ^{99}Mo can broaden the photopeak of ^{99m}Tc at 140 keV [6]. Figure 3 shows the energy spectrums of ^{99m}Tc in normal condition (left) and in a high Mo contamination (right).

Table 1. Molybdenum contamination measured in 6 generators on the first day at the times of milking and at the subsequent hours after milking.

No	Generator	Milking Time	Reading Time	Tc (mCi)	Mo (uCi)	BG (uCi)	Mo-BG	Mo/Tc	Standard
1	A	8	8	284	3.8	2.6	1.2	0.004225	0.15
1	A		11	202	3.7	2.7	1	0.004950	0.15
2	A	8	8	283	3.7	2.6	1.1	0.003887	0.15
2	A		11	203	3.7	2.7	1	0.004926	0.15
3	A	8	8	190	3.9	2.6	1.3	0.006842	0.15
3	A		11	136	4	2.7	1.3	0.009559	0.15
4	B	8	8	1393	18	4.8	13.2	0.009476	0.15
4	B		11	785	15	4.2	10.8	0.013758	0.15
5	B	8	8	1188	55.3	4.11	51.19	0.043089	0.15
5	B		13	200	20.3	4.55	15.75	0.078750	0.15
6	B	8	8	849	37.1	8.12	28.98	0.034134	0.15
6	B		12.3	86.5	12.38	7.11	5.27	0.060925	0.15

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The high energy peaks of the solution which has been due to ^{99}Mo contamination are shown in figure 4. This spectrum was obtained by multi channel analyzer and a scintillation probe.

A similar study has shown that the Mo contamination in one generator was more than ten times of impurity activity limit of 0.015% in the ^{99m}Tc elutes [3]. According to our knowledge, no other study was found in the literature regarding comparison of different generators in a large scale.

The presence of Mo contamination in the body can be confirmed using other *in vitro* techniques, and direct *in vivo* measurements, while more time is required by these methods [2, 4].

In conclusion this study indicated the importance of performing quality control procedures in nuclear medicine centers, especially on the radionuclide generators. Every Tc-99m elute should be tested for radionuclide purity and any vial with unacceptable Mo-99 contamination must be discarded. The Molybdenum break through (MBT) must be determined at least for the first elution of each generator [7, 8].

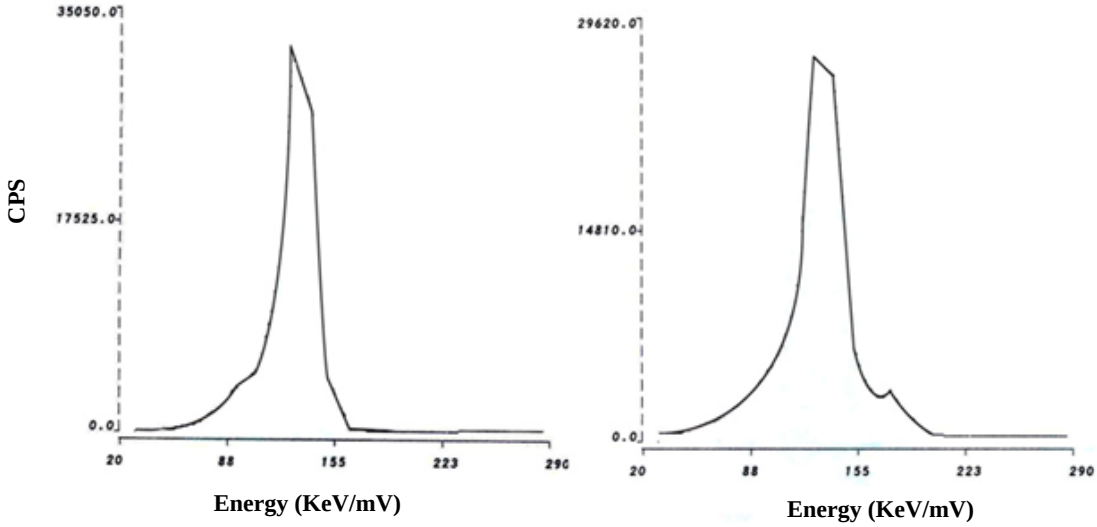

Figure 3. The photopeak of ^{99m}Tc recorded by a gamma camera with no ^{99}Mo contamination (Left) versus high ^{99}Mo contamination (Right). Note the widening of the peak on the right.

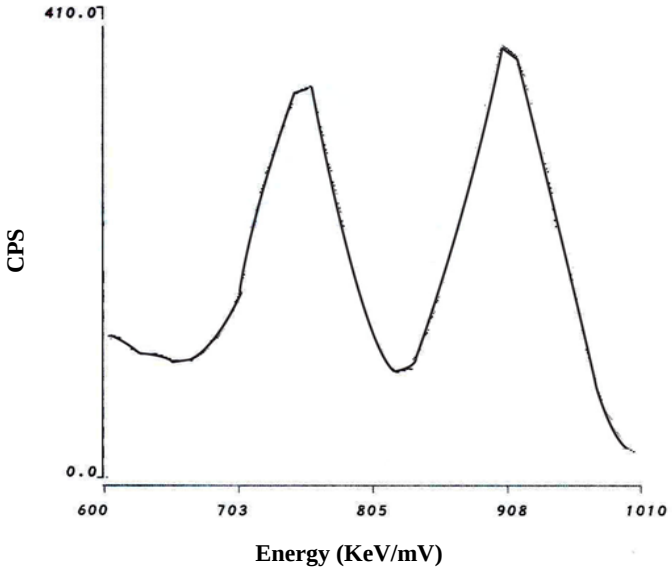

Figure 4. The high energy photopeak of Pertechnetate solution due to ^{99}Mo contamination.

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