Technical Note

Elution Test of an Ionic \(^{68}\)Ga Generator†

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1. Introduction

A newly developed generator for ionic \(^{68}\)Ga yields a satisfactory \(^{68}\)Ga elution. The ionic \(^{68}\)Ga generator requires HCl but needs no EDTA for the elution. We examined this generator and evaluated the elution yield, the \(^{68}\)Ge breakthrough and the elution stability, and good results were obtained. The ionic \(^{68}\)Ga generator, with its simple procedure, will certainly be widely accepted for yielding \(^{68}\)Ga.

2. Materials and Methods

The \(^{68}\)Ga generator, obtained from New England Nuclear, Boston MA, USA through the Japan Radioisotope Association, uses \(^{68}\)Ge fixed by tin dioxide (SnO\(_2\)) and placed in a glass column. This column is connected to inlet and outlet tubes and placed in a small lead casing. The generator activity was measured by an ionization chamber from the top (the top shield was removed for measurements). The eluate activities were also measured with an ionization chamber or a Ge(Li) semiconductor detector. Germanium-68 breakthrough is determined by a scintillation counter from the daughter \(^{68}\)Ga present in the eluate at least 72 hours after the end of elution. Standard analytic reagent grade chemicals were used without further purification.

3. Results

3.1 Gallium-68 elution

A 511 keV energy peak was detected in the eluate and the half-life obtained from the plotted activity curve of the eluate was 68 minutes. Figure 1 shows the activity curve of the generator in three elutions at 68 minute intervals. About 62% of the radioactivity of the generator was removed by the first elution. The rest (38%) was unchanged by the consecutive elutions.

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**Fig. 1** Elutions and generator activity.

The values on this curve were almost the same as the values calculated from the equation;
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Elution curve (—), and integrated elution curve (—·—) of the SnO$_2$ generator eluted with 1N-HCl solution.

Fig. 2 Elution curves.

$A(t) = (A_1 - A_2) \times (1 - \exp^{-0.693/68t}) + A_2$, where $A(t)$ is the expected generator activity at time $t$ (min) after elution, $A_1$ is the generator activity before the initial elution and $A_2$ is the generator activity just after the elution.

Figure 2, showing the elution curve, indicates that 60% of the generator activity may be obtained in the first 5 ml eluate (>95% of elutable $^{88}$Ga). The maximum concentration was about 24 MBq/0.1 ml (0.65 mCi/0.1 ml). About 185 MBq (5 mCi) of $^{68}$Ga was obtained 280 days after the generator was made (one half-life of $^{68}$Ge).

3-2 Stability of the generator

A total of 200 elutions using 10 ml of 1N-HCl were carried out. At the end of this series of elutions the $^{68}$Ga yield was almost unchanged compared with the first yield.

3-3 $^{68}$Ge breakthrough

One hundred elution samples were studied for $^{68}$Ge breakthrough. The eluates were measured by a semiconductor detector, and no apparent peaks were detected except for background and a 511 keV peak. The relative (generator activity=1) mean activity of the daughter $^{68}$Ga in 10 ml eluate was about $3.6 \times 10^{-5}$ (S.D. $=2.3 \times 10^{-5}$), with some variant values found among them. Then we investigated the relationship between the breakthrough and the elution flow rate and found that the breakthrough increases as the flow rate increases showing a constant value after several elutions at a constant flow rate (about $1.9 \times 10^{-5}$ (2.1$ \times 10^{-5}$) at 8 ml/min) and that it decreases as the flow rate decreases. It is, therefore, recommended that the elution should be performed as slow as possible to reduce the $^{68}$Ga breakthrough.

4. Discussion

The first $^{68}$Ge-$^{68}$Ga generator was a solvent extraction type\(^3\): $^{68}$Ge in a complex form with acetylacetone in a buffered solution was extracted with cyclohexane with the $^{68}$Ge remaining in the aqueous phase. A separation based on chloroform extraction of the $^{68}$Ga-oxine complex was also reported\(^4\). While this type of generator usually gives high extraction yields (>70%), $^{68}$Ga is obtained in a complex form. A chromatographic type generator\(^3,4\) using EDTA solution for elution produces a satisfactory $^{68}$Ga yield, but with this type of generator the $^{68}$Ga yield decreases considerably with time and the $^{68}$Ga obtained by this method is in a tight complex form with EDTA. The ionic $^{68}$Ga generator\(^5\) requires only 1N-HCl eluate and the preparation of $^{68}$Ga labeled agents will be the easiest with this type of generator.

As ionic $^{68}$Ga can not be used for in vivo administration, radiochemical purity and chemical contamination in the eluate are not mentioned here. This further analysis will be presented when the preparation of radiopharmaceuticals using this generator is performed. The extraction fraction found in this study (about 62%) wasn't completely satisfactory, but the simple procedure, the stability of the generator and the very low $^{68}$Ge breakthrough were quite sufficient.

5. Conclusion

We studied an ionic $^{68}$Ga generator and obtained good results. The elution required only 1N-HCl and the procedure was simple. About 62% of the generator activity was eluted by a 10 ml eluate and results were reproducible. Stability of the generator was thought to be sufficient. The $^{68}$Ge breakthrough was minimal, but it increases with the increase of the elution
flow rate.

References

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