ITEP-3-95

Fermilab Library
0 1160 0073982 5

INSTITUTE OF THEORETICAL
AND EXPERIMENTAL PHYSICS

FERMILAB -95
JUL 7 1995
LIBRARY

V.Tolmachev and H. Lundqvist.

Neutrondefficient nuclides for positron emission tomography. IIII. Production of ^{83}Sr for in vivo dosimetry.

MOSCOW 1995

UDK 621.039.325 M-16

NEUTRONDEFFICIENT NUCLIDES FOR POSITRON EMISSION TOMOGRAPHY.XIII.
PRODUCTION OF ^{83}Sr FOR IN VIVO DOSIMETRY: Preprint ITEP 3-95/
V.Tolmachev, H.Lundqvist - M., 1995 - 8p.

Ref. - 5.

© Институт теоретической и экспериментальной физики, 1995

INTRODUCTION.

The palliative treatment of bone metastases with strontium-89 chloride ("MetaStron") is widely used [1-3]. This method is more efficient for alleviation of bone pain than other kinds of treatment [4]. However, there is a considerable variation in the metastases uptake of this radiopharmaceutical. Since ^{89}Sr is a pure beta emitter it is extremely difficult to follow its distribution *in vivo* and the more precise radiation dose given to the metastases and to the healthy tissue is therefore difficult to estimate. It will be of value to have a gamma-emitting strontium isotope in order to estimate the individual metastases uptake of strontium. There are two candidates, ^{87m}Sr ($T_{1/2}$= 2.81 h, E_γ = 388 keV) and ^{83}Sr ($T_{1/2}$ = 33 h, positron yield 25%) for evaluation of strontium distribution *in vivo*. A strontium-83 has the advantage that it is positron emitter and can be used in the the context of positron emission tomography (PET). PET can give a quantitative assessment of individual strontium uptake and can be used to optimize the administrated dose of MetaStron.

MATERIALS AND METHODS.

Targets.

Rubidium chloride of natural isotopic composition was used as a target material. The salt was pressed (8000 kg/cm^2) to a pellet with diameter 14 mm and a thickness of 0.65 g/cm^2. The pellet was encapsulated in an aluminum box and was irradiated at the Gustaf Werner cyclotron (The Svedberg Laboratory, Uppsala). The irradiation conditions were as follows:

proton energy on target - 31.5 MeV,
proton energy out from target- 25 MeV
beam current -5-7 μA,
integrated beam current - 50-70 μA h.

Radioactivity measurement.

For the radioactivity measurement an ultra pure germanium detector working on line with a 8192 channel PC based multychannel analyzer was used.

For the separation control the gamma-lines of strontium-83 (763 keV) and rubidium-84 (882 keV) were used. The presence of ^{82}Sr in the product was evaluated with the use of daughter ^{82}Rb gamma-line (776 keV) in equilibrium with the parent nuclide. The amounts of ^{85}Sr and of other long lived impurities was measured 30 days after the separation.

Strontium separation technique.

A column containing 2 ml of Chelex 100 resin (BioRad) has been preequilibrated with 30 ml 0.1 M NH_4OH - 0.1 M NH_4Cl solution.

The irradiated targets were dissolved in 50 ml of the 0.1 M NH_4OH - 0.1 M NH_4Cl solution and the solution was passed through the column. The column was additionally washed with 40 ml of solution with the same composition.

The gamma-spectrum from the trapped radioactivity on the column was measured in order to confirm the absence of ^{84}Rb. The column was washed with 20 ml of distilled water in order to remove ammonium ions. The strontium radioactivity was removed from the column with 5 ml of 4 ml 5 M hydrochloric acid. The eluate was evaporated to dryness and heated with a Bunsen burner up to red heat in order to destroy a possible pyrogens. The radioactivity was dissolved in a sterile water for injection.

RESULTS AND DISCUSSION.

Proton energy range and production rate.

Upper limit of proton energy in target is determined by threshold for $^{85}Rb(p,4n)$ nuclear reaction, which leads to formation of the long lived ^{83}Sr. Thus, the possible proton energy range for the production of ^{83}Sr is between 22.6 MeV (the threshold of ^{83}Sr formation via $^{85}Rb(p, 3n)$ reaction) and 31.5 Mev (the threshold of ^{82}Sr formation via $^{85}Rb(p,4n)$ process). Analysis of cumulated

excitation function for Rb(p,xn)^{83}Sr and Rb(p,xn)^{85}Sr published by Lagunas-Solar [5] shows that shape of these curves are similar and it is equivocal to try to minimize ^{85}Sr production.

The energy range between 23 and 31 MeV has been chosen for ^{83}Sr production. The irradiation with protons under these conditions provides a yield of about 60 MBq/uA h.

Separation method.

The applied method gave a separation efficiency of 84% and a pure product free of any rubidium isotopes formed during the irradiation.

Radionuclidic purity.

The gamma-spectrum measurement of the product immediately after the separation gives only gamma-peaks of ^{83}Sr and peaks of its daughter nuclide, ^{83}Rb.

^{85}Sr is a known contamination, but the amount is difficult to estimate due to the overlapping of the gamma-line of strontium-85 (514 keV) with annihilation photons. For this reason, the gamma-spectra of product solution were measured again 30 days after the separation in order to evaluate amount of strontium-85 and other long-lived radionuclidic impurities. The strontium-85 contamination was 2.5 % of the ^{83}Sr radioactivity at the end of bombardment. There is no opportunity to avoid its formation or sufficiently minimize this contamination other than

using an isotopic separation.

The presence of ^{82}Sr was detected only if the proton energy exceed 35 MeV. In other cases this impurity was at zero level. No other impurities were detected in the product.

Conclusion.

The method for production of strontium-83 has been developed. Using the proton range between 31.5 and 25 MeV, this method allows a production rate of 60 MBq/μA h of ^{83}Sr. The only isotopic impurity is ^{85}Sr, at the level of 2.5% at the end of bombardment.

With the use of the ion-exchange, the goal nuclide can be separated from target material with the efficiency of 85%.

The produced nuclide can be used for optimization of palliative therapy of bone metastases with the use of $^{89}SrCl_2$.

REFERENCES.

1. Robinson R.G., Preston d.F., Spicer J.A. Radionuclide therapy of intractable bone pain: emphasis on strontium-89. Seminars Nucl. Med.,v.22 (1992), p.28.

2. Dickinson C.Z. and Hendrix N.S. Strontium-89 therapy in painful bone metastases. J. Nucl. Med. Technology. v. 21 (1993), p.133.

3. Crowford E.D., Koziovski J.M., Kirk D. The use of strontium 89 for palliation of pain from bone metastases associated with

hormone-refractory prostate cancer. Urology, v. 44 (1994), p.481.
4. McEwan A., Porter A.,McGowan D. et al. Am analysis of the cost effectiveness of adjunct Strontium-89 in patients with carcinoma of the prostate. Eur. J. Nucl. Med, v.20 (1993), p.987.
5. Lagunas-Solar M.C. Radionuclide production with >70 Mev proton accelerators: current and future prospects. Nucl. Instr. Meth. Phys. Res., B69 (19920, p.452.