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Effects of different carriers for adsorption of ^{125}I on brachytherapy sources

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Background: One of the key techniques for the preparation of ^{125}I seeds is adsorption of ^{125}I onto silver bits coated by palladium (pd). Carriers played an important role in the adsorption of ^{125}I on palladium. KI is used as a carrier for fixing of ^{125}I onto silver wire bits coated with palladium. ***Materials and Methods:*** Three procedures KI, KOH, NH_4OH were investigated for adsorption of ^{125}I activity by different carriers. ***Results:*** Adsorptions percentage of ^{125}I on treated silver beads showed about 85% by using KI as a carrier, the KOH showed 74% and 65% for NH_4OH. ***Conclusion:*** The results indicated that, the use of KI as a carrier was suitable for adsorption of ^{125}I on treated silver seeds with Pd than KOH and NH_4OH. **Iran. J. Radiat. Res., 2012; 10(2): 105-107**

Keywords: *I-125, brachytherapy, seed source.*

INTRODUCTION

Iodine-125 brachytherapy sources are being used for interstitial brachytherapy implants in various tumor sites and particularly for prostatic carcinomas. Patients with malignant tumors continue to have a poor prognosis despite treatment with surgery, radiation therapy and chemotherapy. Although external beam radiation is quite effective in tumor control, the treatment is limited by the incidence of radiation injury in the surrounding normal tissue (1, 2). By implanting the radiation source directly into the tumor, a relatively high dose can be delivered to the tumor, while the surrounding tissue receives a much more modest dose (3-7).

Brachytherapy involves the delivery of high doses of radiation to the tumor while sparing normal surrounding tissue using temporarily or permanently implanted radioactive sources (8). While interstitial I-125 brachytherapy appears to be beneficial, the risk of radiation necrosis and the need for reoperation for necrosis has prompted investigation of other options to reduce or limit the radiation dose while enhancing tumor control (8).

Almost all stereo tactic implants are made with either I-125 or Ir-192 sources. Of the two, commonly used radio nuclides I-125 is the more popular choice. Its low-photon energy makes shielding easy, and tends to reduce normal tissue dose with respect to tumor dose.

Implants with I-125 seeds, because of lower energies and greater absorption in tissue, require much higher source strength than those indicated in the classical tables (for the same implant area).

Iodine-125 fixed on silver bars make a source core which, after being sealed in titanium capsules, are recognized as the so-called seed sources used in radiation therapy for treatment of intraocular and brain tumors, and as permanent implants for prostate cancer (9-10). The commercial manufacturers apply different methods for preparing source cores such as, adsorption on organic materials, ion-exchange resins, ceramic beads, palladium bars, silver coated beads, etc. Although some results of investigations concerning fixing of iodine-125 on silver are reported (11-13).

MATERIALS AND METHODS

^{125}I as sodium iodide in dilute sodium hydroxide solution was obtained from MDS Nordions. Silver wire of 0.5mm (ø) with pt. 99.9% was obtained from local suppliers,

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and it was cut to 3 mm length mechanically. Palladous chloride, KI, KOH and NH_4OH were obtained from Merck-Schuchardt, 8011 Hohenbrunn bei munchen.

Pretreatment of silver wires

The silver wire was cut mechanically to a length of 3 mm. Twenty five pieces of such wires were selected. The wires were washed with acetone and then with hot and cold water 3 times. The washed wires were treated with HCl 3M and subsequently were washed with acetone, and then with hot and cold water. The wires were completely dried under an IR lamp. The silver beads were immersed in aqueous palladous chloride solution (0.5mg/ml) 0.03 M at pH 5.5-6.5. The solution was gradually heated to 100˚C and maintained at that temperature for 5 minutes and cooled in the room temperature. The wires were washed with acetone and distilled hot and cold water three times and dried and they were stored in sealed vials under normal atmospheric pressure.

Adsorption of ^{125}I on silver wires

Treated silver wires were immersed in ^{125}I solution (30 mCi/ml) at alkaline pH. The solution was heated in different times for the different volume of ^{125}I solution and for the different activities.

The result of ^{125}I coating using KI as carrier was indicated that solubility of Pd into KI solution is an important parameter. Therefore, the other carriers can be used for ^{125}I coating on Pd coated silver wire such as KOH and NH_4OH.

In these experiments, KI, KOH and NH_4OH were used as carrier which adsorption of ^{125}I on Pd coated silver wire were founded 85%, 75% and 62%, respectively:

If KI was used as carrier, layer of ^{125}I would have PdI_2 form and for excess KI would have PdI_4 form. In case of using NH_4OH as carrier, layer of ^{125}I would have $PdI_2(NH_3)_4$ form and excess NH_4OH would have $Pd(NH_3)_4I_2$ form.

Treated silver wires with palladous chloride were immersed in 50 µL ^{125}I solution accompaniment by 10 µL KI (0.03 M), 10 µL KOH (0.03 M) and 10 µL NH_4OH (0.03 M) then heated at different temperature for various times.

Cumulative preparations of cores

Fifteen coated silver wires with Pd were taken and were subdivided into 3 groups of 5 pieces. Pieces of treated silver wires with palladium chloride in group of 5 were immersed cumulative in 160 µL ^{125}I solution accompaniment by 30µL, KI (0.03 M), 30µL KOH (0.03 M) and 30µL NH_4OH (0.03 M) then heated at 60ºC for 6 hours.

In these experiments, KI, KOH and NH_4OH were used as carrier which adsorption of ^{125}I on Pd coated silver wire were found 93%, 89% and 85% respectively.

RESULTS AND DISCUSSION

The result of ^{125}I coating, using KI as carrier, indicated that solubility of Pd into KI solution has been an important parameter. Therefor the other carriers can be used for ^{125}I coating on Pd coated silver wire such as KOH and NH_4OH.

In these experiments, KI, KOH and NH_4OH were used as carrier which adsorption of ^{125}I on Pd coated silver wire were found to be 85%, 74% and 62% (table 1).

Table 1. Comparison of adsorption of ^{125}I by different carrier.

Carrier	Activity range (mCi)	Percentage adsorption
KI	0.70 - 2.08	85%
KOH	0.85 - 2.03	74%
NH_4OH	1.02 - 2.63	65%

The present study showed that, superiority of using KI as carrier in low activity experiments.

By using KOH as a carrier, 15 mCi of 25 mCi (60%) activity of ^{125}I on silver seeds coated with palladium was adsorbed.

When some pieces of treated silver wires with palladium immersed in KI, KOH and NH_4OH; adsorption of ^{125}I were found to be

93%, 89% and 85% respectively (table 2).

Carriers played an important role in the adsorption of ^{125}I on the palladium coated silver wires. The use of KI as carrier has been studied by Mathew *et al.* (11).

The results indicated that, the use of KI as a carrier was more effective for adsorption of ^{125}I on treated silver seeds with Pd than KOH and NH_4OH. It was found that, the percentage of adsorption was dependent on surface area (tables 1 and 2).

Table 2. Comparison of adsorption of ^{125}I by different carriers when some pieces of treated wires were immersed.

Carrier	Solution activity (mCi)	Seeds activity (µCi)	Percentage adsorption
KI	1.688	S_1= 325 S_2= 319 S_3= 294 S_4= 328 S_5= 310	93%
KOH	1.719	S'_1= 319 S'_2= 308 S'_3= 278 S'_4= 321 S'_5= 302	89%
NH_4OH	1.528	S''_1= 366 S''_2= 342 S''_3= 354 S''_4= 359 S''_5= 343	85%

REFERENCES

1. Sheline GE, Wara WM, Smith V (1980) Therapeutic irradiation and brain injury. *Int J Radiat Oncol Biol Phys,* ***6:*** *1215-28.*
2. Walker MD, Strike TA, Sheline GE (1979) An analysis of doseeffect relationship in the radiotherapy of malignant gliomas. *Int J Radiat Oncol Biol Phys,* ***5:*** *1725-31.*
3. MT Mayr, et al. (2002) Results of interstitial brachytherapy for malignant brain tumors. *International Journal of Oncology,* ***21:*** *817-23.*
4. Ravinder Nath and Ning Yue (2000) Dose distribution along the transverse axis of a new 125I source for interstitial brachytherapy. *Med Phys,* ***27:*** *2536-40.*
5. Mark J Rivard (2002) Comprehensive Monte Carlo calculations of AAPM Task Group Report No. 43 dosimetry parameters for the Model 3500 I-Plant 125I brachytherapy source. *Applied Radiation and Isotopes,* ***57:*** *381-9.*
6. KT Sowards and AS Meigooni (2002) A Monte Carlo evaluation of the dosimetric characteristics of the EchoSeed™ Model 6733 ^{125}I brachytherapy source. *Brachytherapy,* ***1:*** *227-32.*
7. B Reniers, S Vynckier, P Scalliet (2002) Dosimetric study of a new palladium seed. *Applied Radiation and Isotopes,* ***57:*** *805-11.*8. P Narayan, I Crocker, E Elder, JJ Olson (2004) Safety and efficacy of oncurrent interstitial radiation and hyperthermia in the treatment of progressive malignant brain tumors. *Oncology Reports,* ***11:*** *97-103.*
9. Chunfu Zhang, Yongxian Wang, Haibin Tian, Duanzhi Yin (2002) Preparation of 103Pd seed–molecular plating of 103Pd onto silver rod. *Applied Radiation and Isotopes,* ***57:*** *309-11.*
10. AS Meigooni, H Zhang, C Perry, Sh A Dini, RA Koona (2003) Theoretical and experimental determination of dosimetric characteristics for brachyseedt Pd-103, model Pd-1, source. *Applied Radiation and Isotopes,* ***58:*** *533-41.*
11. Mathew C, Majali MA, Balakrishnan SA (2002) A novel approach for the adsorption of iodine-125 on silver wire as matrix for brachytherapy source for the treatment of eye and prostate cancer. *Applied Radiation and Isotope,* ***57:*** *359-67.*
12. Manolkar RB, Sane SU, Pillai KT, Majali MA (2003) Comparison of methods for preparation of ^{125}I brachytherapy source cores for the treatment of eye cancer. *Applied Radiation and Isotopes,* ***59:****145-50.*
13. A.H. Brakera, F.P. Moetb, R.E. van der Zwartb, J.L.H. Eerselsa, J.D.M. Herscheid (2002) Adsorption of radioiodine on platinum: a fast and simple column method to obtain concentrated and pure radioiodide in either water or anhydrous solvents. *Applied Radiation and Isotopes,* ***57:*** *475-82.*