

PORTABLE $^{90}\text{Sr}/^{90}\text{Y}$ PROSTATIC HYPERPLASIA APPLICATORS

Cai Shan-Yu, Tang Ke-Jian, Zhou Chang-Ling

China Institute of Atomic Energy, China

Li Zhi

Zhelimumen Hospital, China

ABSTRACT

In order to seek a new method of curing the benign prostatic hyperplasia (BPH), two different kinds of $^{90}\text{Sr}/^{90}\text{Y}$ intracavity applicators, including a “urethra-type” and a “rectum-type”, have been developed in China since 1991. The structural design and radiation characteristics of the $^{90}\text{Sr}/^{90}\text{Y}$ prostatic hyperplasia applicator are given in this paper. The hypertrophic prostate gland can be irradiated through the wall of the urethra or rectum by $^{90}\text{Sr}/^{90}\text{Y}$ beta rays and small quantity of bremsstrahlung radiation from the applicator. Clinical tests indicate that the $^{90}\text{Sr}/^{90}\text{Y}$ prostatic hyperplasia applicators provide a safe, effective, non-invasive and economical therapeutic method for BPH. It is especially applicable for old and high-risk patients.

INTRODUCTION

In recent years, beta-emitters (such as ^{32}P , $^{90}\text{Sr}/^{90}\text{Y}$, $^{106}\text{Ru}/^{106}\text{Rh}$) have been used for treating some diseases in dermatology, ophthalmology, otolaryngology, cardiovascularology and oncology (Cai S.Y.1996), because of their excellent features:

- high ionization density;
- short range in the tissue;
- small penetrability;
- lower costs;
- easy to shield;
- simplicity of use.

It is well known that the benign prostatic hyperplasia (BPH) is a common and frequently-occurring disease in middle-age and old-age men. At present, there are many methods to treat this kind of disease, for instance, pharmacotherapy, physical therapy, surgical therapy and laser therapy etc. Clinical applications indicate that the pharmacotherapy can not control the hypertrophy of prostate gland tissue. The therapeutic time is longer and the therapeutic effect is slower. The physical therapy such as freezing, ultrasound, radio frequency, gasbag expansion etc. is also not effective. It is only suitable for the light and medium-level proliferation patients. In addition, the condition often recurs after treatment. As regards the surgical therapy, it can obtain better curative effect, but it is not suitable when the condition is complicated by cardiovascular disease and cerebrovascular disease, or for high-risk patients. Nowadays, laser therapy is an advanced technique, but the instrument is too expensive and the cost of treatment is very high. However, it does offer minimal invasion and low morbidity.

In order to seek a new method of curing BPH, beta-particle therapy has been developed. Following research, design, preparation, clinical tests and improvements, the products of $^{90}\text{Sr}/^{90}\text{Y}$ prostate hyperplasia

applicator, including a “urethra-type” and a “rectum-type”, have been successfully used in hospitals. By the end of 1996, two-thousand cases of BPH were treated. Clinical tests indicate that the therapeutic effect is excellent using the $^{90}\text{Sr}/^{90}\text{Y}$ prostatic hyperplasia applicator.

STRUCTURE

The $^{90}\text{Sr}/^{90}\text{Y}$ prostatic hyperplasia “urethra-type” and “rectum-type” applicators are designed and fabricated, to the required pathological anatomy and physiological properties. In addition, the effectiveness, safety and reliability of usage are also considered.

Urethra-type Applicator

The feature of the urethra-type applicator is that the hypertrophic prostate gland can be irradiated by $^{90}\text{Sr}/^{90}\text{Y}$ beta rays through the wall of urethra. The structure of “SRPA-104” type applicator is shown in Figure 1 (Cai S.Y. and Li Zhi, 1994). It is composed of a urinary catheter, $^{90}\text{Sr}/^{90}\text{Y}$ annular source, shield tube and controller. Comparing with three kinds of materials tested for the urinary catheter in the clinical tests, stainless steel is better than the rubber and silastic. In order to fix the irradiation position accurately, urination porthole is adopted. As the applicator is inserted gradually from the anus into the urocyt, the urine will enter the catheter from the porthole and flow out of the end of the catheter. Then, the therapeutic head is moved forward about 12 mm. So that the active area ($^{90}\text{Sr}/^{90}\text{Y}$ annular source) is just located in the position of prostate gland section.

The dimension of SRPA-104 type applicator is 5 mm or 6 mm in diameter and 280 mm long. The surface dose rate is about 24 cGy/s. For the clinical application, the total surface dose is controlled to 30-40Gy (for a single time irradiation).

Rectum-type Applicator

The feature of the rectum-type applicator is that the hypertrophic prostate gland can be irradiated by $^{90}\text{Sr}/^{90}\text{Y}$ beta rays through the wall of the rectum. In addition, the beta-rays irradiation can be switched off and on. When the switch is on, the $^{90}\text{Sr}/^{90}\text{Y}$ source turns to the source window that can transmit the beta-particles. This kind of applicator consists of the therapy head containing the source and an electronic controller (see fig 2). The source holder is made of aluminum. The dimension of the therapeutic head of SRPA-203 type is 20 mm in diameter and 120 mm long. The surface dose rate is about 1.5-2.5 cGy/s. In general, the total surface dose is controlled to 30-40Gy. A course of treatments is 7-10 times. The surface dose for each time is about 200-400cGy. The inserted depth of the $^{90}\text{Sr}/^{90}\text{Y}$ therapeutic head can be ascertained depending on the anal digital examination or other method.

CHARACTERISTICS

By means of beta-particles emitted from $^{90}\text{Sr}/^{90}\text{Y}$ source on the therapeutic head, the hyperplasia prostate gland is irradiated through the urethra or the rectum. The mechanism of beta-therapy is not too clear at present. In general, the beta-particle energy of ^{90}Sr is lower (0.546MeV) and the -particle range in the tissue is shorter (2-3mm). However, the beta-particle energy of its daughter, ^{90}Y , is 2.274MeV and the extreme range of ^{90}Y beta-particle in tissue is near 11 mm, so the main therapeutic effect is from the beta-particle energy of ^{90}Y .

Using LiF (Mg,Ti) as the thermoluminescence dosimeter, the preliminary results on the characteristics of radiation fields of $^{90}\text{Sr}/^{90}\text{Y}$ prostatic hyperplasia applicators have been obtained. For the “urethra-type” and “rectum-type” applicator, the ratio of bremsstrahlung radiation dose to total absorbed dose is $1.1310^{-2} \pm 7.7\%$ (95% C.L.) and $1.2310^{-3} \pm 8.1\%$ (95% C.L.) respectively (Chen J.C. and Cai, S.Y.,1997).

Relying on the ionization effect of β -particle, the cells of hypertrophic prostate tissue can be restrained and destroyed by $^{90}\text{Sr}/^{90}\text{Y}$ beta-rays, small quantity of bremsstrahlung radiation and several times scattering, so that the shrinking and other retroplasia change of the hypertrophic prostate tissue take place. Therefore, the pressure on the urethra is alleviated and the dysuria is relieved also (Cai S.Y,1996).

CLINICAL APPLICATION

More than 2000 patients were treated with the $^{90}\text{Sr}/^{90}\text{Y}$ prostate hyperplasia applicator by the end of 1996. Among them, 700 cases were treated by “urethra-type” applicator.

“Urethra-type” Tests

125 cases BPH patients with complete or incomplete obstruction were treated by the “urethra-type” applicator in Zhelimumen Hospital from April, 1992 to November, 1995 (Li Zhi, 1996). The average age of the patients is 67.5 (48-87) years and the course of disease was from 5 days to 4 years. Among them, there were 47 cases of combined hypertension, 5 cases of diabetes and 15 cases of pulmonary emphysema. The 1.11GBq (30 mCi) of $^{90}\text{Sr}/^{90}\text{Y}$ beta source on the therapeutic head is used in the clinical test. The surface dose rate is about 3.1cGy/s. The total surface dose is controlled to 30-40 Gy (irradiation time is near 20 minutes). Table 1 lists the results of clinical tests in Zhelimumen Hospital.

“Rectum-type” Tests

Up to now, more than 1000 cases of BPH were treated by the “rectum-type” applicators. The clinical effects were observed for 100 cases of BPH at 416 Hospital in Chengtu (Dang Y.W,1997). The average age was 67.5 (50-81) and the course of disease was from 2 to 20 years.

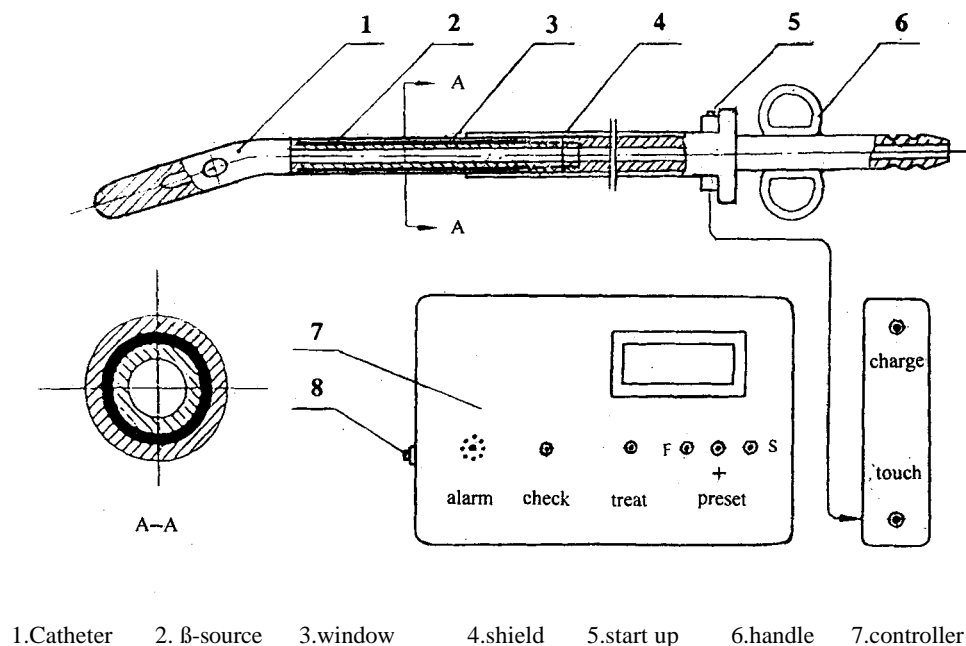


Figure 1 SRPA-104 β -intracavitary applicator (urethra-type)

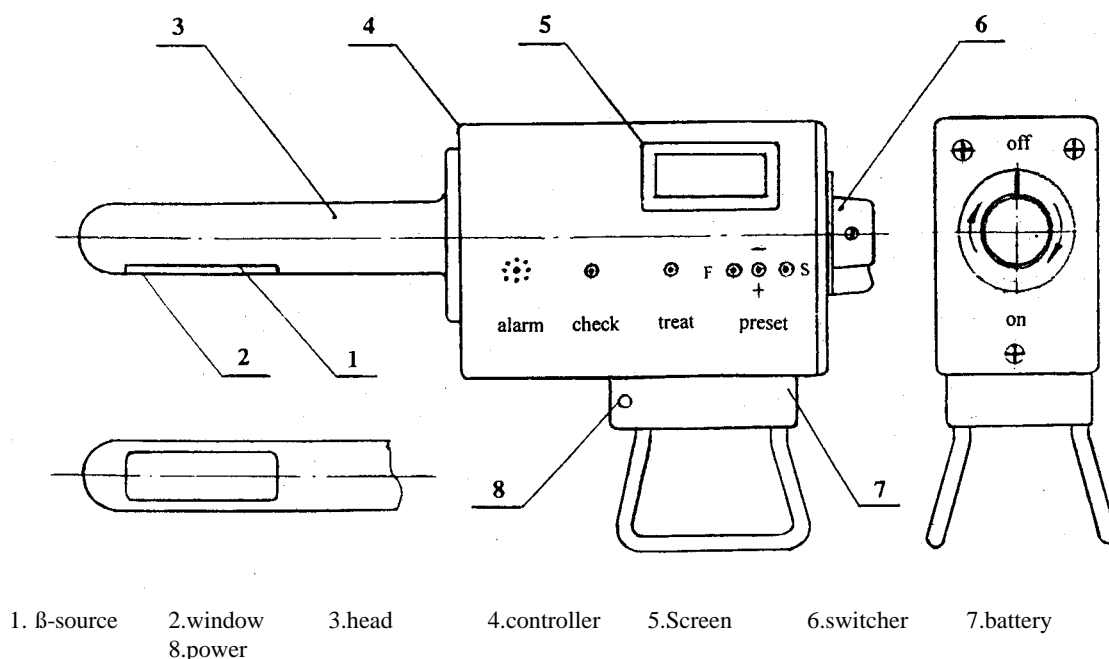


Figure 2 SRPA-203 β -intracavitary applicator (Rectum-type)

Table 1 Distribution of therapeutic effect (urethra-type) **n=125**

Symptoms	Total cases	Recovery	Remarkable improvement	Improvement	Ineffective
Bladder fistulation	11	9	2		
In-dwelling catheter	45	31	8	2	4*
Partial urethrophraxis	69	65	4		
Total	125	105	14	2	4
Improvement rate (%)		84%	11.2%	1.6%	3.2%

*The prostate gland came into the bladder and caused the obstruction of urethra.

All patients had been treated by medicine and radio frequency in the past. The activity of the $^{90}\text{Sr}/^{90}\text{Y}$ source on the therapeutic head of “rectum-type” applicator was 0.5 GBq (13.5mCi). The surface dose rate was about 1.40cGy/s. When the total surface dose was controlled to 32-40Gy (400 cGy given each time) the improvement of symptoms for BPH patients was near 90% (see table 2). The residual urea was reduced for 84.3% of patients. The B-mode ultrasound indicated that the volume of the prostate gland was contracted to at least some extent for 90% patients. For three cases of fistulation, two cases can urinate automatically after treating.

Table 2 The distribution of therapeutic effect (rectum-type n=100

	Complete relief	Remarkable improvement	Improvement	Ineffective
Cases	28	57	5	10
Improvement rate (%)	28%	57%	5%	10%

RESULTS

The results of clinical application indicate that the structure of $^{90}\text{Sr}/^{90}\text{Y}$ prostate hyperplasia applicators is reasonable and the treatment is effective. Side effects were not observed. Two different kinds of applicators have their own features. It is more uniform for the “urethra-type” applicator to irradiate the hypertrophic prostate gland (360° irradiation), so the improvement rate is more than 90%. For the “rectum-type” applicator, irradiation is carried out from one side and the improvement rate of medical care is about 80%. However it is more convenient in use and very simple to sterilize. In fact, these two kinds of applicators can mutually complementary in the period of treatment depending on the situation of patients. The $^{90}\text{Sr}/^{90}\text{Y}$ prostate hyperplasia applicators provide a safe, effective, non-invasive, new-kind and economical method for curing BPH. It is especially suitable for old-age and high-risk patients.

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KEY WORDS

Strontium-90/yttrium-90, $^{90}\text{Sr}/^{90}\text{Y}$ prostatic hyperplasia applicator,-intracavitary therapy, benign prostatic hyperplasia (BPH), urology.