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X-RAY PHOTOGRAMMETRY FOR ENDOCAVITARY RADIATION THERAPY

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Abstract

X-ray photogrammetry has been applied to reconstruct the disposition of the radioactive sources in a patient to be treated by endocavitary radiation therapy.

Introduction

Since some years at the "Istituto Nazionale per lo Studio e la Cura dei Tumori" X-photogrammetry techniques have been applied for particular radio-therapies /1//2/.
The subject of this short note deals in particular with endocavitary Curie-therapy.
In the radiation therapy of uterine cancer the endocavitary Curie-therapy is usually employed. This treatment consists in the introduction of radioactive sources directly in vaginal and uterine cavities, in order to avoid any irradiation of the skin or other surrounding parts of the organism not concerned in the cancer /3/.
The employment of X-photogrammetry and computers allows to localize radioactive sources, and to execute dosimetric calculations.
The length of the base, the distance between source and plate, and the coordinates of the corresponding points on the two plates are the input data.
The computer's role can be synthetized as follows:

1) it reconstructs the actual position of radioactive sources introduced in the patient body;
2) it calculates the length of every radioactive source; since the length of the source is known it is possible to calculate the error, i.e. the difference between the calculated and the real length. If the error is out of tolerance, it stops; otherwise the program corrects the obtained results;
3) it calculates the isodose lines in all planes concerning the anatomical parts to be irradiated, and it gives dosimetric data needed by Curie-therapist. This study allows the clinician to make a different treatment for each patient, with a careful view of the distribution of the dose. The calculation of the distribution of the dose takes a very short time (or real time);
4) it calculates the theoretical dose attributed to the critical organs, as the urinary bladder, the rectum, the lymphatic chains and the femoral heads;
5) it allows to recalculate the distribution of the dose, if the source changes its initial position. This occurrence can be verified by radiographic controls during the treatment;

6) it calculates the center of the mass of the radioactive device in comparison with which the distribution of the dose in the planes wanted by the radiotherapist will be calculated.

At present the output of dose values is presented on a print-out. The possibility to connect a plotter to the computer is already under study, in order to get an easier and more direct interpretation of the results.

The calculation code used is the RAPID (Radioactive Inplanted Sources Program) by the Washington University Computing Facilities.

Taking Radiograms

Radiograms were taken by a radiological equipment with a fixed table and a mobile X-ray source.

The scheme of the taking, the spatial coordinate system and the radiographic one are shown in fig. 1 a) b) and c).

S' and S" represent the two subsequent positions of the X-ray source in the two stereoscopic takings; b is the base and it is longitudinal to the patient and direct as the axis z.

The patient lies on a cot; under the cot there is a horizontal structure in which two series of three small lead pellets arranged in two lines parallel to the axis x are fixed.

The two small central pellets have to supply in the takings the feet P' and P" of the perpendiculars drawn from S' and S" to the plane plate.

In order to control the positions of the source in S' and S", two targets T' and T" (fig. 1b)) are placed on a bridge overpassing the patient. The setting is obtained by the coincidence of a light mark on the targets.

The above mentioned conditions are controlled in X-scopy on a monitor.

The taking base b is 200 mm long and the distance H between source and plate is 1000 mm.

With this H it is not advisable to increase the base, since that increases the errors in the identification of the corresponding points, as it is already happened in previous experiences /4/.

The base has been taken in longitudinal direction to the cot since the Potter-Bucky grid placed upon the plate holder (having the purpose to absorbe the scattered radiations) is longitudinally focalized in every position, but it is transversally focalized only in one position: that one of the taking.

Plotting Radiograms

In fig. 2 the geometry of the plotting and the coordinate equations of the plotted points are drawn.

The plate coordinates X_R and X_L, which should have the same value, can be different due to the errors of reading or to small movements of the patient between the two takings.

The differences are usually under 1 mm; the program employs the arithmetical mean among the measured values of X.

Conclusions

X-photogrammetric method which is now used, surely perfectible, has allowed to improve the previous studies in dosimetry/5/; moreover it has allowed to evaluate the errors one can make in the plotting of the radioactive sources and to correct the obtained results.

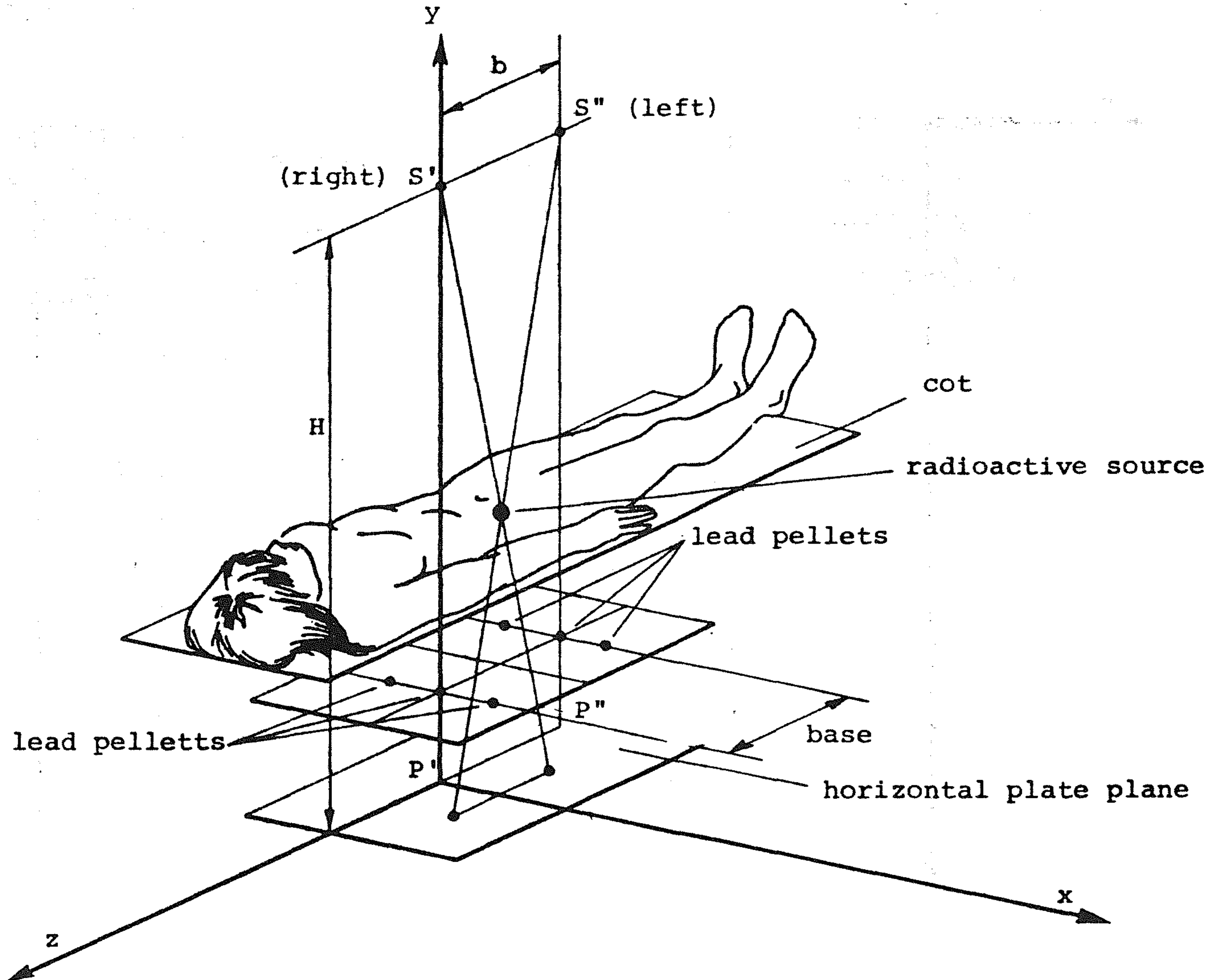
y
b
S" (left)
(right) S'
H
cot
radioactive source
lead pellets
lead pelletts
P"
P'
base
horizontal plate plane
x
z

fig. 1 a)

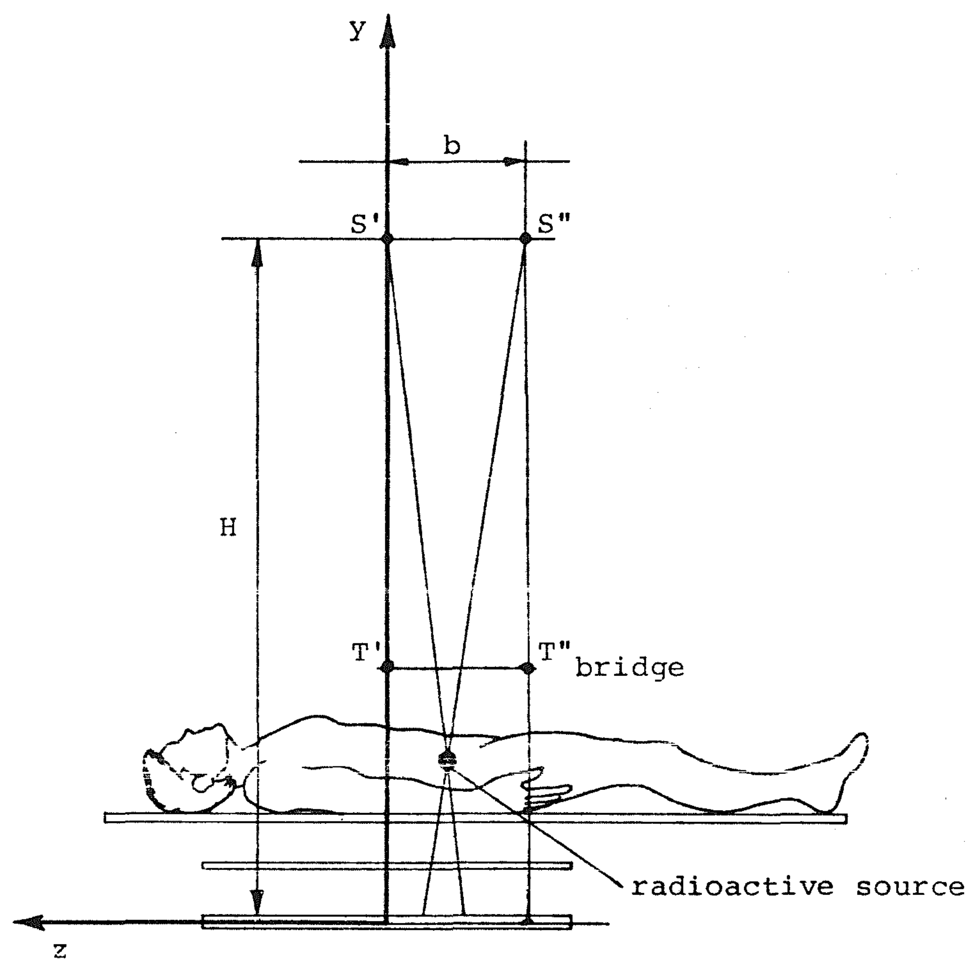

fig. 1 b)

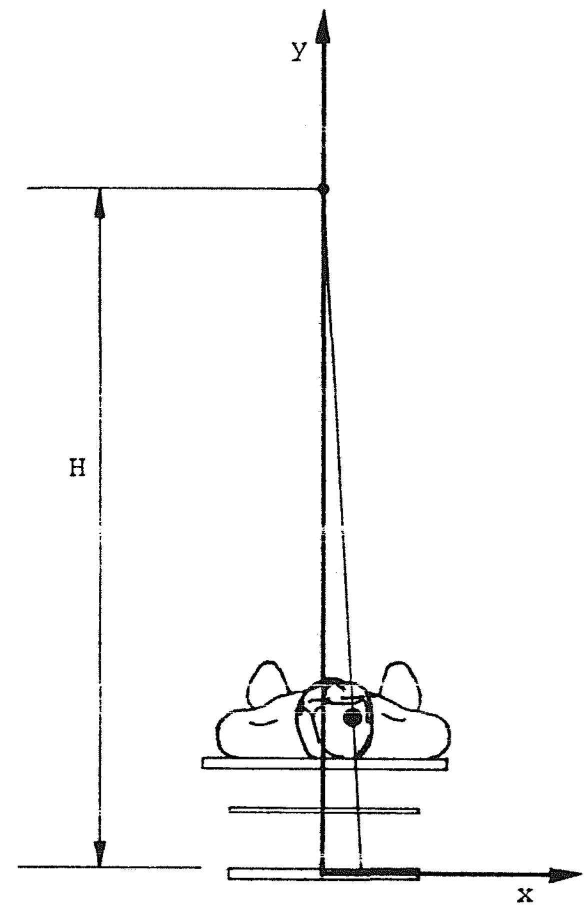

fig. 1 a)

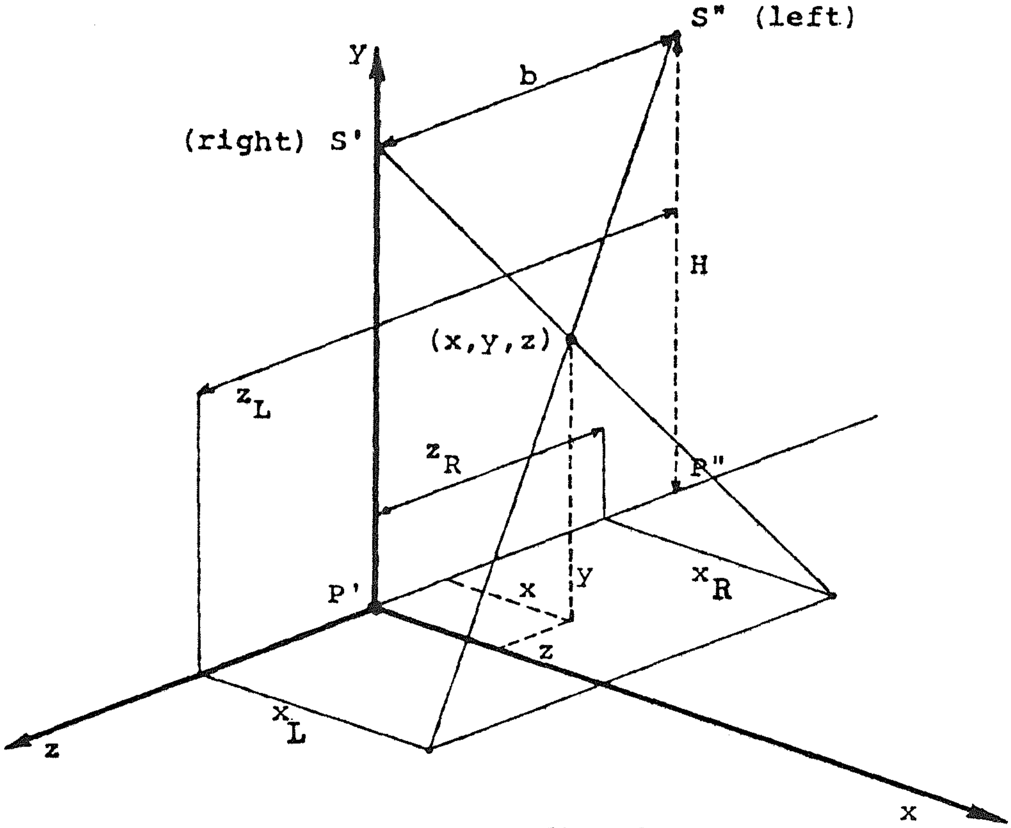

fig. 2

P'' = Origin of the plate coordinates taking from S"(L)
P' = " " " " " " " S'(R)
plate coordinates = x_L, z_L, x_R, z_R

The plotted coordinates have to be computed by means of the following formulas:

$$x = x_R . R$$

$$y = H(1-R)$$

$$z = -z_R . R$$

$$R = \frac{b}{z_L - z_R}$$

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