Dose to professionals in epiescleral brachytherapy

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Summary.

Introduction and purposes. Ocular implant with radioactive sources of iodine 125 is a technical of brachytherapy. It allows keeping an eye vision with a low percentage of secondary effects, which depend on situation and size of tumour. It is applied for treatment of intraocular and malignant tumours as well as some non-malignant processes when another therapeutic alternatives fails or can not be applied.

Material and methods. Estimation of received dose by involved professionals are carried out with a detector of area radiation in distances approximately similar to the implied professionals would occupy in the process. Radiation is received in packing and unpacking operations of radioactive plaque as well as in implant and unimplant operations of plaque to patient. In case of the ophthalmologist and the medical physicist it is considered average distance to wrist and thyroid gland. In case of the radiotherapy oncologist it is considered only average distance to thyroid gland.

All measures were normalised to the most unfavourable case in which all the sources are implanted. Duration of the procedure was taken from our own experience and from consulted references. It is considered the received doses by the radiotherapy oncologist, the ophthalmologist, the nurse, the anaesthetist and the medical physicist.

Discussion. Due to the very low value of estimated dose in implant and unimplant operations, it seems epiescleral brachytherapy does not need any limitation in the number of procedures that the ophthalmologist or other professionals implied in the surgical intervention could carry out. The adequate control of radioactive sources is the main element of radiation protection. For medical physicists, individual calibration may increase the dose, but the use of strategies based on the shielding, and the reduction of time, allow an enough control. Termoluminiscence dosimetry and ring dosimetry facilitates a more precise estimation of the doses received by the professionals.

Introduction and purposes.

Ocular implant with radioactive sources of iodine 125 \([^{125}\text{I}]\) is a technical of brachytherapy, alternative to enucleation. It allows keeping an eye vision with a low percentage of secondary effects, which depend on situation and size of tumour. It is applied for treatment of intraocular and malignant tumours as the melanoma of the uvea [1], the metastasis choroidal carcinoma [2] and the retinoblastomas [3]. It is also applied for some non-malignant processes, as the hemangioma of choroids [4] or the age-related macular degeneration associated with the subretinal neovascularization [5], when another therapeutic alternatives fails or can not be applied. Specifically we refer to the melanoma of the uvea, which is the most frequent intraocular primary malignant tumour of adults.

The brachytherapy is a type of radiotherapy, in which radioactive sources are placed in contact with tumour, delivering a maximal dose of radiation in injury and a minimum dose in adjacent organs taking into account the high dose gradient with distance and the low energy of the photons emitted.

The use of radioactive sources, complexity in placement of applicators and necessity of to have data the most precise as possible makes necessary the collaboration of professional of several specialities, as the radiotherapy oncologist, the ophthalmologist, the nurse, the anaesthetist and the medical physicist [6]. Each of them contributes with characteristic knowledges of their profession in a
coordinated manner. The radiotherapy oncologist indicates and prescribes dose. The ophthalmologist evaluates and applies the treatment and cares for secondary effects and the medical physicist prepares the treatment and secures the quality assurance of the process. Although energy and intensity of sources used is low it is necessary an evaluation of received doses in the procedure. This dose depends on physical characteristics of the sources, total delivered intensity, duration of the procedure and distance to applicator.

The purpose of this work is to make this evaluation based on real measures bearing in mind the habitual practices for this technique.

**Background.**

The treatment depends on size of tumour, existence of extra ocular extension, state of the other eye, age of patient and general state in addition to other factors.

Before application of the treatment, it is essential to make a clinic dosimetry. First of all, we obtain data of affected eye, as size of the eyeball, or size and position of lens of the eye. For this, we performed direct measures by a T.A.C. Also we can do it with a planning system. Other ways are to photograph the bottom of the eye or the echography. These images represent correctly the eye. Data of size and position of tumour can be found by a T.A.C., echography and bottom of the eye, although besides we can draw directly over retinal diagram. Dose is usually prescribed in the apex of tumour. The size of tumour gives a clue over appropriate size of the plaque, existing possibility to design any plaque in size and form. The form and closeness of critical organs require that we must find the best number of sources, optimal position and intensity. The calculation of dose bears in mind intensity of the sources, position, anisotropy, attenuation, scattering in tissue and plaque effect. Besides the dose in interest points, we can to know which is the distribution of dose in eyes and in any plane; also, we can to know the distribution in three dimensions, so we have to check if we cover completely tumour with the dose of reference. Finally, the medical physicist emits a dosimetric report with calculated dose, data of tumour, data of the eye and recommendations of radiological protection. Also, distribution of the dose in different planes or over retinal diagram, instructions of placement of the plaque and histogram dose volume can appear in the dosimetric report.

When we obtain the optimal position of the sources, we them place them in the plaque and we implant it in the patient. Operation elapses in conditions of sterility and we respect the basic standard of radiological protection. We keep proper distance from the sources with a claw of watchmaker, we interpose a shield between the sources and the most proximal parts of the body by a lead rubber gloves and we reduce the time of the placement of the plaque as much as possible.

Protection of different professionals in front of emitted radiation by sources of iodine 125 presents relatively easy problems, if we compare them with other applications. Once we place the plaque, anatomy of head herself and employing a lead ocular patch, which guarantee a minimum level of radiation near to the patient.

After treatment we make unimplant, in the operating room too. After that, we proceed to dismantle the plaque controlling radioactive sources.

**Material and methods.**

In this work we use Ropes applicators. We use sources of iodine 125, model 6711 [7]. Iodine 125 is absorbed onto a silver rod and encapsulated in a welded titanium capsule. Seeds have been placed on moulded acrylic pieces with special lodgings [figure 1], and safely covered by a steel layer [figure 2]. They emit primary gamma radiation with energy of 35 Kev, accompanied by some radiographic fluorescence radiation, lacking alpha and beta radiation. In these plaques we can insert seeds in a number and position determined by dosimetry planification according to type and size of tumour. During the procedure, the plaque is sutured by fixation loops with the concave side on the sclera [figure 3].
Estimation of received dose by involved professionals are carried out with a detector of area radiation in distances approximately similar to the implied professionals would occupy in the process. Radiation is received in packing and unpacking operations of radioactive plaque as well as in implant and unimplants operations of plaque to patient. In case of the ophthalmologist and the medical physicist it is considered average distance to wrist [10 cm] and thyroid gland [50 cm]. In case of the radiotherapy oncologist it is considered only average distance to thyroid gland [50 cm] and the other involved professionals in the procedure the typical distance is 1 m.

All measures were normalised to the most unfavourable case in which all the sources are implanted. Duration of the procedure was taken from our own experience and from consulted references. It is considered the received doses by the radiotherapy oncologist, the ophthalmologist, the nurse, the anaesthetist and the medical physicist. The patient remains with a protector in the eye while the applicator with the sources is placed [figure 4].
Results.

Results obtained appear in table 1.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Oncologist</th>
<th>Ophthalmologist</th>
<th>Nurse</th>
<th>Anaesthetist</th>
<th>Medical Physicist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>Distance</td>
<td>Distance</td>
<td>Dose</td>
<td>Distance</td>
<td>Distance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implant</td>
<td>50 cm</td>
<td>10 cm</td>
<td>140 μGy</td>
<td>10 cm</td>
<td>&lt; 1 mGy</td>
</tr>
<tr>
<td></td>
<td>50 cm</td>
<td>11 μGy</td>
<td></td>
<td>50 cm</td>
<td></td>
</tr>
<tr>
<td>Unimplant</td>
<td>50 cm</td>
<td>10 cm</td>
<td>70 μGy</td>
<td>100 cm</td>
<td>2 μGy</td>
</tr>
<tr>
<td></td>
<td>50 cm</td>
<td>5.5 μGy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion.

Bearing in mind measures and estimations, we found that received dose depends on the operational situation of involved professionals in the procedure. Besides ophthalmologist and medical physicist, it is found a considerable difference in absorbed dose to hand and thyroid gland level, due to dose variation according to the inverse square law. Hand close to the plaque receives the highest dose, whereas the thyroid gland receives only a minimal dose because of lesser proximity.

In this work we do not carry out measures and estimations in the ophthalmologist’s fingers because of difficulties associated to esterilisation. It was carried out by other groups, as for iodine-125 as for ruthenium-106 [106Ru/106Rh] [8], finding that for iodine-125, the ophthalmologist could do up to one hundred operations per year or fifty if a safety factor of 2 is used. Absorbed dose by professionals in thyroid gland is similar to other results published. Wrist dosimetry could not be a good estimation for dose in hand in this procedure [9], being useful a ring dosimetry to determine dose in hand.

Conclusions.

Due to the very low value of estimated dose in implant and unimplant operations, it seems episcleral brachytherapy does not need any limitation in the number of procedures that the ophthalmologist or other professionals implied in the surgical intervention could carry out. The adequate control of radioactive sources is the main element of radiation protection. For medical physicists, individual calibration may increase the dose, but the use of strategies based on the shielding, just like the use of shielded places, the use of a lead rubber gloves and long claws, and the reduction of time, allows an enough control. Termoluminiscent dosimetry and ring dosimetry facilitates a more precise estimation of the doses received by the professionals.
References.


