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## **EIGHTEEN-YEAR RESULTS OF TREATMENT OF UVEAL MELANOMA USING RUTHENIUM-106 + RHODIUM-106 BRACHYTHERAPY**

**Abstract.** The objective of the study was to evaluate the results of Ruthenium-106 ( $^{106}\text{Ru}$ ) + Rhodium-106 ( $^{106}\text{Rh}$ ) brachytherapy in uveal melanoma (UM) patients.

The data for the period 2001–2018 were taken from the Belarusian Cancer Registry and medical records of patients with clinically diagnosed uveal melanoma who received treatment at the N. N. Alexandrov National Cancer Centre of Belarus. A total of 383 patients were included in the study.  $^{106}\text{Ru}$  +  $^{106}\text{Rh}$   $\beta$ -ophthalmic applicators were used for brachytherapy (BT). The calculated dose to the tumor apex was 120–130 Gy, while the reduced 100–110 Gy was administered to tumors close to the optic nerve. To analyze the treatment outcomes, patients were divided into three groups based on a basal diameter of a tumor.

Out of a total 383 patients, complete tumor resolution was observed in 282 (73.6 %), tumor stabilization was present in 76 (19.8 %). Continued tumor growth and tumor relapse were observed in 34 (9.13 %) and 50 (13.05 %) patients, respectively. 59 (15.1 %) patients underwent enucleation. The metastatic disease developed in 47 (12.3 %) cases. BT adverse effects were observed in 21.3 % cases. The relapse-free survival in the group of patients with a basal tumor diameter of up to 9 mm was  $76.0 \pm 6.3$  %, which was higher than that in the groups with a large basal diameter ( $p = 0.002$ ). Over a 15-year follow-up period, almost half of the patients ( $52.2 \pm 15.6$  %) with a tumor base of more than 12 mm relapsed.

Considering the high rates of the continued tumor growth during treatment in patients with a basal tumor diameter of more than 12 mm, combined therapy must be used in this group.

**Keywords:** choroidal melanoma, brachytherapy, basal tumor diameter, tumor thickness, eye-preserving treatment, survival

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## **18-ЛЕТНИЕ РЕЗУЛЬТАТЫ ЛЕЧЕНИЯ МЕЛАНОМЫ ХОРИОИДЕИ С ИСПОЛЬЗОВАНИЕМ БРАХИТЕРАПИИ С $^{106}\text{RU}$ + $^{106}\text{RH}$**

**Аннотация.** Цель работы – оценить результаты лечения пациентов с меланомой хориоидеи (МХ) глаза с использованием брахитерапии (БТ) с изотопами  $^{106}\text{Ru}$  +  $^{106}\text{Rh}$ .

Исследование было выполнено на основании данных Белорусского канцер-регистра, медицинской документации на пациентов с клинически установленным диагнозом меланомы сосудистой оболочки глаза (С69.3 по МКБ-10) за период с 2001 по 2018 г., получавших лечение в РНПЦ ОМР им. Н. Н. Александрова. В группу исследования вошли 383 пациента. Для проведения БТ использовались  $\beta$ -офтальмоапликаторы ( $\beta$ -ОА) с изотопами  $^{106}\text{Ru}$  +  $^{106}\text{Rh}$ . Расчетная доза на вершину опухоли составляла 120–130 Гр, при локализации опухоли в зоне диска зрительного нерва (ДЗН) – 100–110 Гр. Для анализа результата лечения пациенты были разделены на три группы в зависимости от базального диаметра опухоли.

За период наблюдения полная резорбция опухоли в общей группе зарегистрирована у 282 (73,6 %) пациентов, стабилизация опухолевого процесса – у 76 (19,8 %), отсутствие эффекта от лечения – у 25 (6,6 %). При динамическом наблюдении продолженный рост зафиксирован у 35 (46,1 %) пациентов. Рецидив МХ зарегистрирован у 50 (17,7 %) пациентов, метастатическая болезнь развилась у 47 (12,3 %). Осложнения разной степени выраженности после проведенной БТ зафиксированы у 21,3 % пациентов. Энуклеация выполнена 58 (15,1 %) пациентам. Безрецидивная выживаемость в группе пациентов с базальным диаметром опухоли до 9 мм составила  $76,0 \pm 6,3$  % и была выше, чем у пациентов с большим базальным диаметром опухоли ( $p = 0,002$ ). Безметастатическая выживаемость пациентов с основанием опухоли более 12 мм была достоверно ниже и составила  $61,2 \pm 6,9$  % ( $p < 0,001$ ).

Учитывая высокие показатели рецидивов при проведении лечения у пациентов с базальным диаметром опухоли более 12 мм, необходимо решить вопрос о выборе комбинированных методик лечения данной категории пациентов.

**Ключевые слова:** меланома хориоидеи, брахитерапия, базальный диаметр опухоли, толщина опухоли, органосохраняющее лечение, выживаемость

**Для цитирования:** 18-летние результаты лечения меланомы хориоидеи с использованием брахитерапии с  $^{106}\text{Ru} + ^{106}\text{Rh}$  / Л. В. Науменко [и др.] // Вест. Нац. акад. наук Беларусі. Сер. мед. навук. – 2021. – Т. 18, № 3. – С. 284–291 (на англ. яз.). <https://doi.org/10.29235/1814-6023-2021-18-3-284-291>

**Introduction.** Uveal melanoma (UM) is a malignancy that develops from clones of uveal melanocytes [1]. The incidence of UM in Europe decreases from north to south from 2 per million per year in Spain and southern Italy to 8 per million in Norway and Denmark [2]. The mean standardized incidence rate over a 20-year study period in Belarus is 4.8 per million [3].

In late 1990s Collaborative Ocular Melanoma Study (COMS) showed, that there was no difference in survival rates between patients after enucleation and brachytherapy [4]. Since that organ-preserving orientation in the UM treatment became preferable. Nowadays, the choice of a treatment method depends on tumor location and size, while the patient's opinion is also taken into account [4].

The structure of the sclera is unique and brachytherapy (BT) with a dose of up to 2500 Gy provides positive treatment outcomes for UM without postradiation necrosis [5]. In Belarus the eye-preserving therapy with Ruthenium-106 ( $^{106}\text{Ru}$ ) + Rhodium-106 ( $^{106}\text{Rh}$ )  $\beta$ -ophthalmic applicators ( $\beta$ -OA) became available only in late 2000. Prior to that, all UM patients had been sent abroad for treatment.

The aim of this study was to evaluate the 18-year results of  $^{106}\text{Ru} + ^{106}\text{Rh}$  brachytherapy for uveal melanoma.

**Objects and research methods.** Data for the period 2001–2018 were derived from the Belarusian Cancer Registry and medical records of patients with clinically diagnosed UM (International Classification of Diseases, 10th Revision, code C69.3). All patients were treated in the N. N. Alexandrov National Cancer Centre of Belarus. For BT, we used  $^{106}\text{Ru} + ^{106}\text{Rh}$   $\beta$ -OA. 388 patients with UM had received treatment. However, 5 patients dropped out of observation and their outcome information was obtained from the Cancer Registry. A total of 383 patients were included in the retrospective analysis. The initial examination confirmed the absence of distant metastases in all patients. 331 patient underwent one BT course. 43 (11.2 %) patients whose tumors relapsed or continued growing were administered a repeated BT session. Three BT courses were received by 8 (2.1 %) patients, and one patient (0.2 %) underwent 4 courses of BT. The calculated dose to the tumor apex was 120–130 Gy, while the reduced dose of 100–110 Gy was applied to tumors close the optic nerve disc. Tumor pigmentation was assessed visually (pigmented and weakly pigmented) [6].

The entire cohort was divided into 3 groups based on basal tumor diameter and tumor thickness. The first group (group A) included 117 patients with T1-2N0M0 tumors with a mean basal diameter of  $7.2 \pm 1.4$  mm (range, 2.5–8.97 mm) and a mean thickness of  $3.2 \pm 1.3$  mm (range, 0.6–7.5 mm). The second group (group B) had 156 patients with T2-3N0M0 tumors with a mean basal diameter of  $10.9 \pm 0.6$  mm (range, 9.1–12.0 mm) and a mean thickness of  $4.6 \pm 1.7$  mm (range, 1.3–11.9 mm). The third group (group C) comprised 110 patients with T2-3N0M0 tumors with a mean basal diameter of  $13.9 \pm 1.5$  mm (range, 12.1–17.9 mm) and a mean thickness of  $5.9 \pm 1.7$  mm (range, 2.4–10.7 mm).

The assessment of local response after treatment was based on the following definitions:

1. **Complete tumor resolution** is a condition when an atrophic focus has been formed at the tumor site (slight accumulation of pigment is possible).
2. **Tumor stabilization** is a condition when the tumor has decreased in size or remained the same with blood flow absent (by ultrasonography).
3. **No response to treatment** is the absence of changes in the tumor or an increase in its size with tumor blood flow preservation or increase (by ultrasonography).
4. **Continued tumor growth** is a condition when the tumor size or its blood flow has increased after tumor stabilization.
5. **Tumor relapse** is the condition when despite the atrophic chorioretinal focus formed a tumor growth is observed.

**Disease progression** means the development of distant metastases of uveal melanoma.

The Kaplan–Meier method was applied to estimate 5-, 10-, and 15-year survival rates (adjusted, disease-free, and metastasis-free), the significance rate was estimated with the log-rank test. Statistical significance was evaluated using  $\chi^2$  methods.

**Research results.** A total of 383 patients included 159 (41.5 %) men and 224 (58.5 %) women. Patients' average age was  $58.6 \pm 13.7$  years (range, 20–87 years). Group A had the largest number of posterior pole tumors (23.1 %) and most tumors were less than 4 mm from the optic disc (22.2 %). In group B most tumors were observed in the posterior pole (27.6 %) and macular (20.5 %) regions. In group C, tumors were mainly located in the posterior pole (26.4 %) and were more than 4 mm from the macula (28.2 %). Tab. 1 summarizes data on the localization of the tumor margin relative to anatomically important eye structures in the study groups.

Table 1. Localization of tumor margin in groups

| Tumor margin localization                                       | Group A (n = 117) | Group B (n = 156) |          | Group C (n = 110) |          |
|---|-------------------|-------------------|----------|-------------------|----------|
| Basal diameter, mm  | $7.2 \pm 1.4$     | $10.9 \pm 0.6$    |          | $13.9 \pm 1.5$    |          |
| Thickness, mm   | $3.2 \pm 1.3$     | $4.6 \pm 1.7$     |          | $5.8 \pm 1.6$     |          |
| Tumor margin:   |                   |                   |          |                   |          |
| close to the optic disc   | 11 (9.4 %)        | 10                | (6.4 %)  | 5                 | (4.5 %)  |
| <4 mm from the optic disc                                       | 26 (22.2 %)       | 29                | (18.6 %) | 12                | (10.9 %) |
| >4 mm from the optic disc                                       | 27 (23.1 %)       | 43                | (27.6 %) | 29                | (26.4 %) |
| 4 mm or less from the macula                                    | 20 (17.1 %)       | 32                | (20.5 %) | 18                | (16.4 %) |
| >4 mm from the macula   | 18 (15.4 %)       | 25                | (16.0 %) | 31                | (28.2 %) |
| Tumor in the periphery of the eye with no ciliary body invasion | 15 (12.8 %)       | 17                | (10.9 %) | 15                | (13.6 %) |

**Assessment of local tumor response to therapy.** During the follow-up period, complete tumor resolution was observed in 282 (73.6 %) patients. The mean time to complete tumor resolution was  $11.0 \pm 8.0$  months. Tumor stabilization was observed in 76 (19.8 %) patients during a period of 1 month to 1.5 years ( $9.0 \pm 6.0$ ). Twenty-five (6.6 %) patients had no response to treatment during a period of 3 months to 1 year. Out of 282 patients with chorioretinal atrophic foci, 50 (17.7 %) patients subsequently had tumor relaps.

Out of 76 patients with tumor stabilization, 35 (46.1 %) experienced continued tumor growth. In case of relapse or continued tumor growth, further therapy was chosen for each patient individually.

Enucleation was performed in 58 (15.1 %) cases, of which in 18 (31.0 %) due to continued tumor growth, in 19 (32.8 %) due to no response to therapy, in 17 (29.3 %) due to relapse, and in 4 (6.9 %) for secondary painful glaucoma. Eyes were retained in 325 (84.9 %) patients overall.

In group A, complete tumor resolution with chorioretinal atrophic scarring was observed in 91 (77.8 %) patients for a mean 11-month period (range, 1–36 months). 23 (19.7 %) patients had tumor stabilization, 3 (2.6 %) did not respond to treatment. 10 (8.5%) had continued tumor growth during a mean follow-up of 4.5 months. 11 (9.4 %) patients relapsed during the follow-up of 6 months to 6 years. Enucleation was performed in 7 (6.0 %) patients: in 1 case due to tumor recurrence in a year, in 3 cases due to continued tumor growth, in 2 cases due to no response to therapy, and in one case due to secondary glaucoma.

In group B, 123 (78.8 %) patients had complete tumor resolution with chorioretinal atrophic scarring for a mean 11-month period (range, 2–50 months). Tumor stabilization was observed in 27 (17.3 %) during a follow-up period of 1 month to 1.1 years. The therapy had no response in 6 (3.9 %). Relapses developed in 27 (17.3 %) during a follow-up period of 10 months to 7 years after atrophic scarring or tumor stabilization. Continued tumor growth was observed in 10 (6.4 %) at a mean 16-month follow-up (range, 1 month–5 years). 23 (14.7 %) patients underwent enucleation due to relapse in 10 cases, due to continued tumor growth in 6, due to secondary glaucoma in 2, and due to no response to treatment in 5.

In group C, chorioretinal atrophic foci were observed in 68 (61.8 %) patients at a mean 10-month follow-up (range, 4 months – 2.8 years). Tumor stabilization was observed in 25 (22.7 %). 17 (15.5 %) cases had no response to treatment. 14 (12.7 %) experienced continued tumor growth. After chorioretinal atrophic scarring 12 (10.9 %) patients relapsed during a follow-up period of 7 months to 8 years. Enucleation was performed in 29 (26.4 %) patients: in 6 due to relapse, in 9 due to continued tumor growth, in 2 due to secondary painful glaucoma, and in 12 due to no response to treatment.

Data on local tumor response to therapy by group are shown in Tab. 2.

Table 2. Local tumor response to therapy by groups

| Index   | Group A (n = 117) | Group B (n = 156) | Group C (n = 110) |
|---|-------------------|-------------------|-------------------|
| Basal diameter, mm  | 7.2 ± 1.4         | 10.9 ± 0.6        | 13.9 ± 1.5        |
| Thickness, mm   | 3.2 ± 1.3         | 4.6 ± 1.7         | 5.8 ± 1.6         |
| <i>Immediate treatment results</i>                            |                   |                   |                   |
| Resolution  | 91 (77.8 %)       | 123 (78.8 %)      | 68 (61.8 %)       |
| Stabilization   | 23 (19.7 %)       | 27 (17.3 %)       | 25 (22.7 %)       |
| No response to treatment                                      | 3 (2.6 %)         | 6 (3.9 %)         | 17 (15.5 %)       |
| <i>Number of relapses and continued tumor growth by group</i> |                   |                   |                   |
| Relapses  | 11 (9.4 %)        | 27 (17.3 %)       | 12 (10.9 %)       |
| Continued tumor growth  | 10 (8.5 %)        | 10 (6.4 %)        | 14 (12.7 %)       |
| Enucleation   | 7 (6.0 %)         | 23 (14.7 %)       | 29 (26.4 %)       |

**Assessment of brachytherapy complications.** Complications of varying severity after BT were observed in 21.3 % patients.

In group A, complications after treatment were observed in 25 (21.4 %) patients for a period of 1 month to 3.6 years (mean 14 months): 18 had postradiation retinopathy, 2 developed secondary glaucoma, uveitis occurred in 1 case, 3 had vitreous haemorrhage, and there was one case of secondary retinal detachment.

In group B, 28 (17.9 %) patients experienced complications during a follow-up period of 1 month to 6 years: postradiation retinopathy developed in 14 patients, three patients had secondary glaucoma, uveitis occurred in 2 patients, secondary retinal detachment and haemorrhage developed in 4 and 5 patients, respectively.

In group C, complications after treatment were observed in 27 (24.5 %) patients during a follow-up of 11 days to 4 years: 12 cases of postradiation retinopathy, 5 cases of secondary glaucoma, 5 cases of ocular haemorrhage, secondary retinal detachment occurred in 5 patients.

The incidence of complications was mostly associated with tumor location in a posterior pole of the eye.

**Assessment of long-term brachytherapy results.** Out of 383 UM patients after BT, 40 died of underlying disease at different follow-up periods. 71 deaths were due to other causes (the leading ones were cardiovascular diseases, old age, and competing tumors). There was no outcome information on 3 patients who had left the country.

Metastatic disease developed in 47 (12.3 %) of 383 patients, among whom were 2 (1.7 %) in group A at 2 and 5 years, 17 (10.9 %) in group B at a follow-up period of 6 months to 14 years, and 28 (25.5 %) in group C at a follow-up period of 9 months to 17 years.

Tab. 3 and Fig. 1 show the adjusted cumulative survival rates by groups.

Table 3. Adjusted survival rates

| Group       | Basal diameter, mm | Adjusted survival rates, % |               |               |                |                | Quantity of patients with disease progression (distant metastases) |
|-------------|--------------------|----------------------------|---------------|---------------|----------------|----------------|--|
|             |                    | after 1 year               | after 3 years | after 5 years | after 10 years | after 15 years |  |
| A (n = 117) | 7.1 ± 1.5          | 100                        | 100           | 98.6 ± 1.4    | 94.8 ± 2.9     | 90.9 ± 4.8     | 2 (1.7 %)  |
| B (n = 156) | 10.7 ± 1.0         | 98.2 ± 1.8                 | 94.4 ± 3.1    | 95.6 ± 1.8    | 91.4 ± 2.7     | 85.1 ± 5.3     | 17 (10.8 %)  |
| C (n = 110) | 13.8 ± 1.5         | 97.4 ± 2.5                 | 84.2 ± 5.9    | 84.4 ± 4.1    | 71.1 ± 5.8     | 63.2 ± 9.1     | 28 (25.5 %)  |

The 15-year survival rate in group A with a basal tumor diameter less than 9 mm was 90.9 ± 4.8 %. With choroidal tumor greater than 12 mm, 63.2 ± 9.1 % of patients survived for at least 15 years ( $p < 0.001$ ).

Tab. 4 and Fig. 2 show relaps-free survival rates by groups.

Relapse-free survival in the group of patients with tumors smaller than 9 mm was higher than that in the other groups ( $p = 0.002$ ).

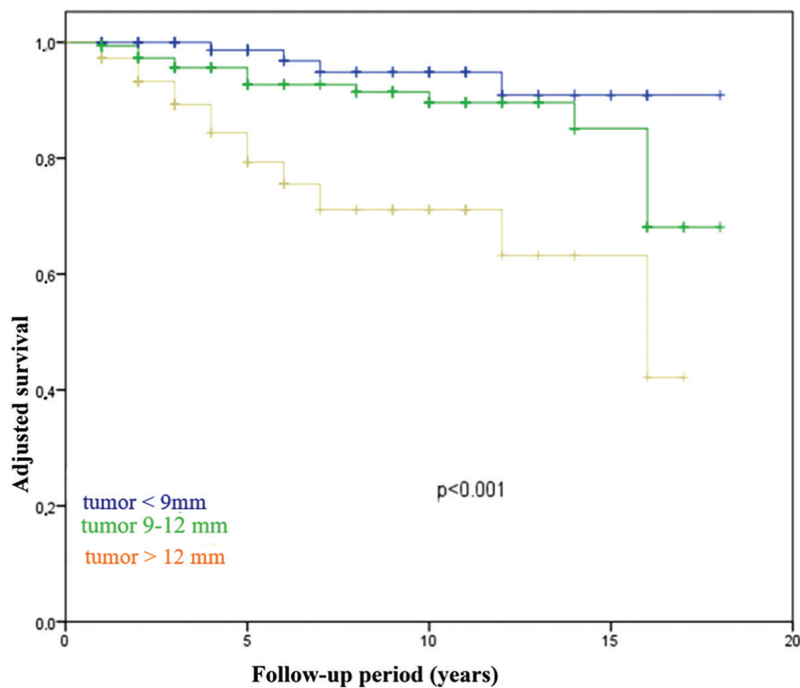


Fig. 1. Adjusted survival rates

Table 4. Disease-free survival by groups

| Group       | Disease-free survival |                |                | Median      |
|-------------|-----------------------|----------------|----------------|-------------|
|             | after 5 years         | after 10 years | after 15 years |             |
| A (n = 117) | 91.6 ± 2.9 %          | 79.8 ± 5.3 %   | 76.0 ± 6.3 %   | –           |
| B (n = 156) | 83.1 ± 3.3 %          | 74.4 ± 4.1 %   | 71.5 ± 4.9 %   | –           |
| C (n = 110) | 84.2 ± 4.5 %          | 78.3 ± 15.6 %  | 52.2 ± 15.6 %  | 16.0 ± 3.46 |

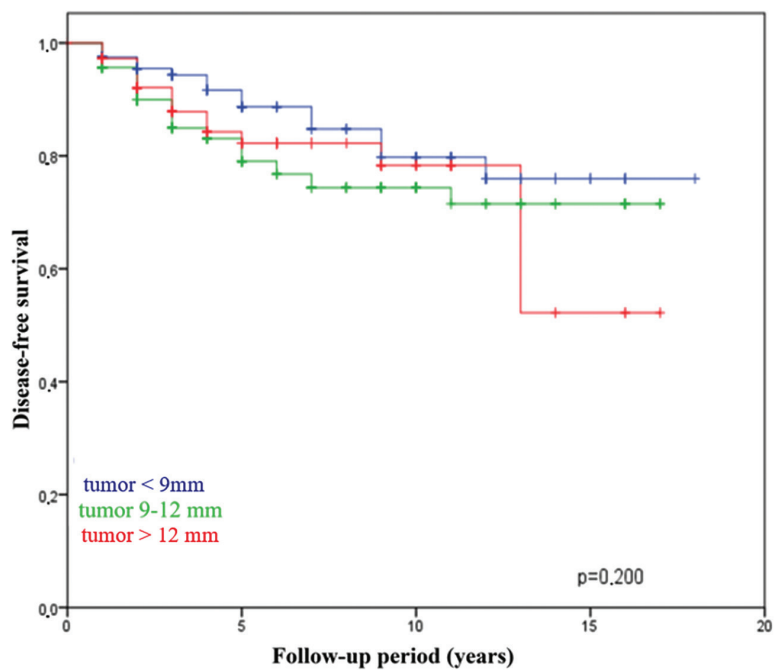


Fig. 2. Disease-free survival rates by groups



Tab. 5 and Fig. 3 show metastasis-free survival rates by groups, which were calculated from the date of diagnosis to the date of event (metastases).

The lowest 5-, 10-, and 15-year metastasis-free survival was in the group with a primary tumor base larger than 12 mm ( $p < 0.001$ ).

Table 5. Metastasis-free survival rates by groups

| Group           | Metastasis-free survival |                |                | Median |
|-----------------|--------------------------|----------------|----------------|--------|
|                 | after 5 years            | after 10 years | after 15 years |        |
| A ( $n = 117$ ) | 100 %                    | 100 %          | 93.9 ± 5.1 %   | –      |
| B ( $n = 156$ ) | 93.9 ± 2.0 %             | 87.0 ± 3.3 %   | 82.6 ± 5.3 %   | –      |
| C ( $n = 110$ ) | 80.7 ± 4.2 %             | 65.3 ± 6.0 %   | 61.2 ± 6.9 %   | 16.0   |

**Discussion.** Over an 18-year follow-up period, complete tumor resolution after BT was observed in 282 (73.6 %) patients. The mean time to complete response was  $11.0 \pm 8.0$  months. 76 (19.8 %) patients had tumor stabilization during the follow-up period of 1 month to 1.5 years ( $9.0 \pm 6.0$  month). Twenty-five patients (6.6 %) had no response to treatment during the follow-up period of 3 months to 1 year.

The number of patients with complete tumor resolution in groups A and B was approximately the same (77.8 and 78.8 %, respectively), which exceeded that in group C (61.8 %). Moreover, enucleation was more frequently observed in patients of group C (26.4 %). In most cases enucleation was performed because of treatment failure (tumor relapse, continued growth or no response to therapy), rather than treatment complications.

Tumor relapse in our study was observed in 13.05 % of all patients and in 17.3 % of those with tumor stabilisation after 6 month to 8 years after BT. Tumor continued growth rate was higher in patients with tumor basal diameter more than 12 mm.

The data on the frequency and timing of UM relapses in different studies differs. Pagliara et al. reported tumor relapses in 8.4 % of patients with small and medium sized tumors over a 3-year follow-up period [7]. Rice et al. showed 18.2 % of local relapses during a follow-up period of 55.4 months [8]. Data from Le et al. demonstrated that only 1.7 % of patients with a tumor thickness of 2.5 to 10 mm and a basal diameter of up to 16 mm developed tumor relapse at 5 years [9]. Mishra et al. reported that

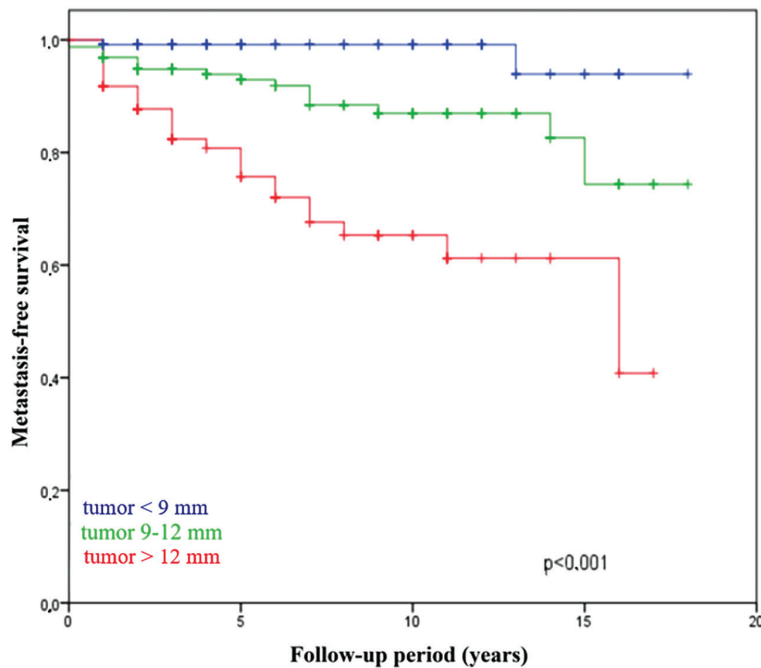


Fig. 3. Metastasis-free survival rates by group

during a 12-year follow-up 21 % of patients had local tumor recurrence, with the number decreasing (14 %) if patients with tumors close to the optic disc were excluded. However, that study also included patients with ciliary body melanoma [10]. Marinkovic et al. reported the five-year incidence of local relapses after BT of 5.2 % [11]. According to the American Joint Committee on Cancer Staging Manual, 7th Edition (AJCC 7th ed.), 9 % of patients with T3-T4 uveal melanomas developed tumor recurrence within 4 years. It is noteworthy that treatment was performed in patients with large tumors [12]. Since different countries measure BT outcomes differently, it is problematic to compare the results. For a comprehensive analysis, it is necessary to conduct multicentre studies. It can also be difficult to distinguish between recurrence and continued tumor growth thus the evaluation by an experienced ocular oncologist is required.

The sclera is a unique membrane that can be exposed to high radiation doses, in some cases repeatedly. However, postradiation changes may develop in the choroid, retina, lens, vitreous body, such as retinopathies, optic retinopathies, exudative retinal detachments, ocular haemorrhages, and secondary glaucoma. Pagliara et al. reported post-radiation maculopathy in 25 % of patients at a mean follow-up of 31 months [7]. Caminal et al. published data on 43.3 % of optic retinopathies after BT [13]. According to Chia et al., proliferative retinopathy after BT was recorded in 67 % of cases [14]. Wisely et al. showed that about 40 % of patients developed retinopathy at 60 months after BT [15]. Le et al. also reported that 43 % of patients developed retinopathy [9]. The AJCC 7th Ed demonstrated that post-radiation maculopathy developed in 66 % of patients, followed by optic neuropathy (51 %) at a mean 16-month follow-up [12]. We evaluated complications based on the basal tumor diameter. The incidence of treatment complications did not depend on the size of the tumor and was comparable between all groups (21.4, 17.9, and 26.4 %, respectively).

According to our data, metastatic disease developed in 12.3 % of patients. Survival rates were tumor-size dependent and worsened with increasing basal diameter and tumor thickness. Pagliara et al. presented data on the development of metastatic disease in 5.9 % of patients at 3 years after BT [7]. Caminal et al. reported metastatic disease in 26.4 % of patients for a 60-month follow-up after BT [13]. Rice et al. showed that metastases developed in 18.2 % of patients with a tumor thickness of 2.5 to 10 mm and a basal diameter of up to 16 mm over a 55.4-month follow-up [8]. Stalhammar et al. reported the 5-, 10-, and 15-year mortality rates for UM of 14, 24, and 27 % in men and 15, 26, and 32 % in women, respectively ( $p = 0.32$ ) [16]. The five-year metastasis-free survival rate reported by Le et al. was 88.2 % [9]. According to the AJCC 7th Ed, after T3–T4 UM treatment metastatic disease developed in 32 % patients with large tumors over a 10-year follow-up period [12].

**Conclusion.** Considering the high rates of continued tumor growth during treatment in patients with a basal tumor diameter more than 12 mm, it is necessary to use alternative to BT methods of treatment, including combined therapy in this group. BT complications are mostly associated with tumor localization, its size, the severity of pigmentation and blood flow in the tumor, the presence of concomitant pathology in the eye fundus. To reduce the number of relapses, continued tumor growth, and radiation complications, new methods of effective eye-preserving treatment of choroidal melanoma or their combinations should be searched for.

**Conflict of interests.** The authors declare no conflict of interests.

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