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Comparative efficacy of β-irradiation and mitomycin-C in primary and recurrent pterygium

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PURPOSE. *To determine the efficacy and safety of mitomycin-C as adjunctive treatment and to compare this drug with beta irradiation with strontium-90 after surgical excision of primary and recurrent pterygia.*

MATERIALS AND METHODS. *The study group consisted of 193 patients with primary and recurrent pterygia who underwent surgical excision with the bare sclera technique. They were divided into two groups according to the type of adjunctive treatment. In group I, 130 patients (141 eyes, 67.8%) were treated with beta irradiation with Sr-90 doses of 1000-7000 cGy. In group II 63 patients (67 eyes, 32.2%) received topical mitomycin-C at a concentration of 0.02% four times daily for one week postoperatively. Recurrence rates, complications and efficacy of these treatments were compared with the chi-square of Fisher's exact test.*

RESULTS. *The recurrence rates were 6.4% in group I after a mean postoperative follow-up of 89 months and 17.9% in group II after a mean follow-up of 14.9 months. Recurrence rates and complications were higher in group II and the difference was significant ($p<0.05$, $p<0.001$). Life-table analysis showed a success rate of 93.6% for Sr-90 and 81.9% for the mitomycin-C, the difference being significant ($p<0.005$).*

CONCLUSIONS. *Beta irradiation with Sr-90 after surgical excision was more effective than topical mitomycin-C in patients with primary and recurrent pterygium in terms of recurrence rates, and safer in terms of complications. (Eur J Ophthalmol 2001; 11: 126-32)*

KEY WORDS. *Primary pterygium, Reccurent pterygium, Strontium-90, Mitomycin-C drops*

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INTRODUCTION

Pterygia are fibrovascular overgrowths of the bulbar conjunctiva onto the cornea. They are usually triangular and horizontally oriented on the nasal side. Invasion of the cornea by degenerative and hyperplastic conjunctival tissue is usually asymptomatic and accepted as benign, but loss of visual acuity due to induced astigmatism or growth across the visual axis, cosmetic blemish and threat to the corneal metabolism due to tear film abnormalities and formation of surface irregularities can make surgical removal necessary (1-4).

In spite of advances in surgical techniques, instruments and microsurgery, there is still no single treatment modality that can prevent or lower the recurrence rate. Many different adjunctive treatment modalities such as thio-tepa, thermal cautery, argon laser application and conjunctival auto-grafting are reported, with different levels of success in lowering recurrence rates (1, 5-14).

Sr-90 is used as a source of beta irradiation that

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inhibits mitosis in rapidly proliferating endothelial cells. It also prevents fibroblast migration by causing obliterative endarteritis in newly formed vessels. It is more effective on immature, rapidly proliferating tissues and no effect is seen on the surrounding normal tissues. The aim of beta irradiation after surgical excision of pterygium is to inhibit new vessel formation and fibroblastic activity without causing complications such as cataract, scleral atrophy and telengiectasia, and 2400-3000 cGy is usually adequate for this purpose. The irradiated zone is believed to act as a fibrous barrier which inhibits the regrowth of pterygium (15).

Mitomycin-C (MMC) is an antibiotic used as an anti-neoplastic agent. It is an alkylating agent and selectively inhibits the synthesis of DNA, cellular RNA and protein. It is a potent inhibitor of fibroblast proliferation and its topical or intraoperative application can lower the recurrence rate of pterygium (13, 14).

In order to verify the efficacy of different treatment modalities in primary and recurrent pterygium, we designed a study to compare beta irradiation (strontium-90) and mmc drops after surgical excision with the bare sclera technique.

MATERIALS

The study group consisted of 208 eyes of 193 patients with primary and recurrent pterygia. Patients without previous surgery were accepted as primary cases and patients with previous surgery, regardless of the time elapsed, were considered recurrent cases. Outpatients with primary and recurrent pterygium were divided into two treatment groups. Every patient had a thorough ophthalmological examination. Inclusion criteria were: 2 mm or more invasion of the cornea, primary or recurrent pterygia with active growth, symptomatic, and older than 18 years. Patients with asymptomatic or atrophic primary pterygia were excluded.

METHODS

The bare sclera technique with microscope was the procedure in all cases. Local anesthesia was induced with oxybuprocaine HCl, with an additional subconjunctival injection of 2% lidocaine into the body of the pterygium with a 25-gauge needle. The pterygium was dissected from the cornea with a surgical blade and the body was excised. Adjacent Tenon's capsule was also dissected towards he medial rectus muscle and excised. Conjunctival sutures were placed whenever needed, leaving 4 mm bare sclera from the limbus. Antibiotic drops were prescribed during the first postoperative week and steroid drops (1% prednisolone acetate, qid) and artificial tear drops during the following month. The sutures were removed within 7 days after surgery.

TABLE I - DOSES OF STRONTIUM-90 IN 130 PATIENTS WITH PTERYGIUM

Total strontium (cGy)	No. of eyes
1000-2000	14
2100-3000	110
3100-4000	5
4100-5000	6
5100-7000	6
Total	**141**

After surgery, patients were divided into two groups for different further treatment modalities.

Group I: In the immediate postoperative period beta irradiation (Sr-90) was applied in doses between 1000 and 7000 cGy on the bare sclera (Tab. I). Patients who had had Sr-90 treatment earlier were invited by mail to participate in the study. They were screened and those meeting the inlcusion criteria (n=65) were included in the study so as to increase the number of patients in this group.

The same device (Beta therapy source 67-850, Nuclear Association Inc, Carle Place NY) was used for all treatments. The active source diameter of the probe was 7 mm and it was mounted on a metal rod. The surface dose rate given by the manufacturer in units of 120 cGy/sec ± 25% was used to calculate the treatment time and dosage. Doses below 3000 cGy were applied in one session and the Sr-90 device probe was applied on a single scleral site. Doses over 3000 cGy were fractionated and given every other day; the total dose was divided into two or three fractions and applied on two or three adjacent areas on the bare sclera adjacent to the limbus. In patients who had already had this treatment the dosage information in the records was considered. Eye patches were re-

TABLE II - SEX, MEAN AGE, MEAN FOLLOW-UP TIME AND TYPE OF PTERYGIA IN 193 PATIENTS TREATED WITH Sr-90 (GROUP I) OR MMC (GROUP II)

	Group I (Sr-90)	Group II (MMC)
Patients		
Mean age (range)	42.78 years (20-80)	42.48 years (18-74)
Female	49 (37.7%)	35 (55.6%)
Male	81 (62.3%)	28 (44.4%)
Total	**130**	**63**
Pterygium		
Primary	62 (44%)	55 (82.1%)
Recurrent	79 (56%)	12 (17.9%)
Total	**141 eyes**	**67 eyes**
Follow-up (months)	89 (7-144)	14.9 (3-30)

TABLE III - RECURRENCES IN 208 EYES WITH PTERYGIUM

	Recurrence rates	
	Group I (Sr-90)	**Group II (MMC)**
Primary	4/62 (6.5%)	10/55 (18.2%)
Recurrent	5/79 (6.3%)	2/12 (16.7%)
Total	**9/141 (6.4%)**	**12/67 (17.9%)**

TABLE IV - COMPLICATIONS IN 193 PATIENTS TREATED WITH Sr-90 (GROUP I) OR MMC (GROUP II)

	Complications	Number of patients (%)
Group I	Lens opacities	4 (2.8)
	Scleral melting	3 (2.1)
	Conjunctival scar formation	3 (2.1)
	Granuloma formation	1 (0.7)
	Iris prolapse	1 (0.7)
Group II	Scleral melting	6 (8.9)
	Punctate keratopathy	4 (5.9)
	Purulent conjunctivitis	2 (2.9)
	Corneal microabscess	1 (1.5)
	Increased pigmentation	1 (1.5)

moved on the first postoperative day and visits were scheduled on the tenth day, first, second, third and sixth months and at the end of the first year. At every office visit, visual acuity (uncorrected and corrected) and intraocular pressure were measured and slit-lamp examination done. Fluorescein staining of the cornea was evaluated as well as scleral thinning, evidence of necrosis and lens opacities.

Group II: In the second group of patients, MMC eye drops (0.02%) were given four times a day after surgical removal of the pterygium, depending on corneal healing. The eye drops were prepared by the same physician by diluting 2 mg MMC with 0.9% NaCl solution and given to the patient in an ophthalmic dispenser. These drops were not used for more than one week. Patients were asked to remove the patch the day after surgery and to instill one drop of medication every six hours, four times a day for one week. If corneal fluorescein staining was greater than 2x2 mm, the patient was seen every day and MMC drops were started when corneal healing was complete. Patients were seen again after using the drops for a week. At every follow-up visit the cornea was examined with fluorescein staining and the wound healing pattern at the surgical area, scleral thinning and necrosis were assessed.

Formation of a wing-shaped fibrovascular tissue at the position of a previously excised pterygium with the apex crossing the limbus more than 0.5 mm, extending onto the cornea, was considered a recurrence.

Success rates were calculated by the chisquare test and life-table analysis was used to calculate the survival curve by the Kaplan Meier method. The difference between survival curves was tested by the log rank test. Fisher's exact test was used to analyze differences in complications between groups.

RESULTS

We included 208 eyes (193 patients) with pterygium. Group I consisted of 141 eyes (67.8%) treated with Sr-90 and group II consisted of 67 eyes (32.2%) treated with mmc drops. Mean age, sex, mean follow-up time and the types of pterygia in both groups are shown in Table II.

Of 141 eyes treated with Sr-90 in group I, recurrence was seen in 9 cases (6.4%). Recurrences were

mostly seen around 6 months, ranging between 2-12 months. Four of the cases were primary and 5 were recurrent pterygia (Tab. III). There was no real difference between primary and recurrent cases in terms of the effect of Sr-90 (χ^2=0.1, p>0.05). There was also no significant difference in age, sex and location of the lesions as the total number of recurrences was low (p>0.05). Seven of the recurrent cases received Sr-90 treatment below 3000 cGy and two had treatment above 3000 cGy; however there was no difference between the doses of Sr-90 and recurrence rate (p>0.05).

In terms of complications, almost all patients complained about pain photophobia, tearing and foreign body sensation after Sr-90 treatment in the first postoperative week. In one case (0.7%) granuloma developed and was excised (Tab. IV). Desmatocele and iris prolapse developed in one patient who had had surgical excision four times previously, and sclerokeratoplasty was performed. Scleral melting was seen in three cases after Sr-90 treatment, one of these was primary and two were recurrent pterygia. Mean time to scleral metling was 5.3 months (1, 5 and 12 months). There was no significant relationship between the dosage of beta irradiation and scleral melting (2400, 3000 and 4000 cGy beta irradiation were applied in these three cases) (p>0.05). In three of four recurrent pterygia cases who had had Sr-90 treatment twice a conjunctival scar developed, but no recurrence was seen in these cases. Peripheral lens opacities were seen in four eyes, two of them primary and two recurrent cases. After follow-up at 3 to 6 years none of these cases had progression of the opacities and there was no need for surgical treatment. The mean dose of Sr-90 in the patients with lens opacities was 4750 cGy (3000-6500) and there was a significant relationship between the development of opacity and the dose (χ^2=10.61, p<0.01).

Recurrences were seen in 12 cases in group II (Tab. III). Ten were primary and two recurrent pterygia. Recurrences were seen at about 15 days to 8 months, with a mean 3.62 months. The effect of MMC on recurrences did not differ in primary and recurrent cases (p>0.05). There was no difference either between the recurrences in relation to age or sex and the location of pterygium.

Almost all patients treated with MMC complained of burning and foreign body sensation, tearing and photophobia during treatment (Tab. IV). Purulent conjunctivitis was seen in two patients, who were treated with antibiotic drops and ointments. Four cases had punctate keratopathy and were treated with antibiotic drops. A corneal microabscess was seen in one case, treated with fortified antibiotic drops. Healing was achieved in three weeks but the same eye presented conjunctival irritation symtomps resistant to treatment and was followed up with artificial tears and steroid drops. Scleral melting was seen in six patients, five of them primary and one a recurrent case. Conjunctival grafting was needed in one case and the rest of them showed regression in 2-3 months. During this time, patients were seen at short intervals for signs of infection and perforation. One patient had pigmentation on the eyelid (Tab. IV).

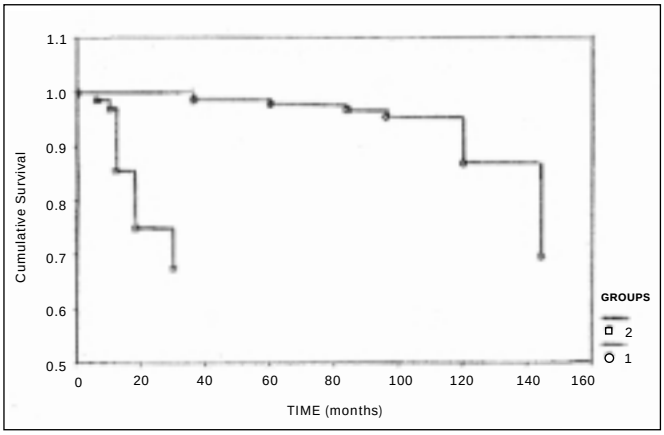

Fig. 1 - *Kaplan Meier curve for groups I (Strontium-90) and II (Mitomycin-C).*

Comparing the recurrence rates in the two groups, Sr-90 was found to be more effective in prevention of recurrences (χ^2=5.44, p<0.05). Kaplan Meier estimates of local control for both groups are presented in Figure 1. Life table analysis showed success rates of 93.6% for Sr-90 and 81.9% for the MMC group and the difference was significant with the log rank test (log rank 7.84, p < 0.005). The success rate for Sr-90 was 93.5% for primary pterygia and 93.6% for recurrent cases. The difference was not significant (log rank 0.00, p>0.1). In the MMC group, the success rates were 82.3% for primary pterygium and 80% for recurrent pterygium – again not significant (log rank 0.02, p>0.5). When primary and recurrent pterygia were compared, regardless of the adjunctive treatment, success rates were 89% for primary pterygia and 92.1%

for recurrent cases. This difference was again not significant (log rank 0.88, p>0.5).

More complications were seen in group II, the difference being significant (χ^2 6.37, p<0.01). Scleral melting was seen in both groups but with a higher rate in the mmc group (2.1% in group I and 9.0% in group II); however the difference was statistically insignificant.

DISCUSSION

Pterygium is a benign degenerative disease of the conjunctiva. However, clinical progression is not predictable and after surgical excision there is a high recurrence rate, ranging between 30 and 80% in different reports (13, 16, 17). Recurrence after surgical removal was suggested to be due to accelerated fibroblast proliferation produced by surgical trauma (7). Recurrent cases cause more complaints in patients and treatment is harder. Even keratoplasty is needed in some cases to deal with complications. Adjunctive treatments such as Sr-90 and topical MMC can lower the recurrence rates.

Recurrences after Sr-90 were reported to be about 0-20% in different studies (6, 15, 18). We found 6.5% recurrences in primary pterygia and 6.3% in recurrent cases. The recurrence rates in recurrent cases after irradiation were reported as 33% by Hayasaka, 10.4% by Campbell and 28% by Dussenbery, and they concluded that the rate was significantly higher in recurrent pterygia and Sr-90 was less effective in those cases (19). On the other hand, Campbell found Sr-90 was as effective in recurrent pterygia as in primary cases and suggested it should be the treatment of choice after surgical excision (20). We found Sr-90 was as effective on recurrent cases as on primary ones.

There are different opinions about the application technique, dose and timing of Sr-90 (21, 22). While some researchers recommend a single dose, others use fractionated treatment (6, 15, 23). However, there is no significant difference in complications and recurrence rates with single or fractionated doses of Sr-90. Campbell et al reported a significant dose-related tendency to recurrence in patients given a single dose of 1000-1500 cGy and recurrence was higher in the lower dose group (20). A prospective study (23) found that irradiation in the immediate postoperative period, as a single dose of 2000 cGy to recurrent and primary pterygia, was associated with a lower rate of recurrence than irradiation four days postoperatively. Another report suggested that starting beta irradiation 1-8 h postoperatively gave a higher local control rate than therapy started 16-24 h postoperatively (15). On the other hand, Beyer found that delay in starting treatment did not affect the recurrence rate (6). Proliferation of fibroblasts and new vessels begins immediately after surgery. Therefore for better results Sr-90 should be applied as soon as possible – even in the operating room right after excision.

Complications after beta irradiation vary in the different studies. Common complications are cataract, scleral necrosis and endophthalmitis. Beyer, Wilder and Levine reported no significant complications (6, 15, 24). However, MacKenzie found 13% scleromalacia and 4.5% serious scleral ulceration (25). Moriarty reported 0.5% scleral necrosis and severe bacterial and fungal infection in 11 patients, even needing keratoplasty. The latency between irradiation and infection can be as long as 14 years (18). Complications of beta irradiation are more frequent in recurrent pterygia that has already been treated with Sr-90. Dussenbery reported a 28% complication rate in the first trial of beta irradiation treatment and 80% in re-irradiated patients (19).

In our study, three cases in the Sr-90 group (2.1%) developed a conjunctival scar, three (2.1%) had scleral melting and four (2.8%) had lens opacity complications. There were no recurrences among re-irradiated cases. However, two of the three cases that developed a conjunctival scar had already been irradiated. In the long term (7.5 years) no infection was observed.

As another adjunctive treatment modality, MMC was used initially at a concentration of 1 mg/ml; however, due to high rate of complications such as conjunctival irritation, superficial keratitis and excessive lacrimation, the concentration had to be reduced to 0.04, 0.02 or 0.01%. We used a concentration of 0.02%. Recurrences after mitomycin-C were reported to range between 0 and 16% (16, 26-28). We found a recurrence rate of 17.9%. Scleral ulceration, secondary glaucoma, corneal perforation, iritis, cataract, infection, scleral calcification and necrotizing scleritis have all been reported, with different rates (13, 16, 29, 30). In our study, scleral melting (9.0%), punctate keratopathy (6.0%) and corneal microabscess (1.5%) were seen,

but no loss in visual acuity or serious infections were observed after an average 15 months' follow-up. Intraoperative mmc is an alternative to drops and merits further controlled studies (31-33).

In conclusion, in this non-randomised partially retrospective study, Sr-90 was more effective in the treatment of primary and recurrent pterygia. In previous studies comparing these treatment modalities, Hayasaka reported recurrence rates of 11% with MMC and 15% with Sr-90. However, in our study Sr-90 was applied in low doses and the follow-up with MMC was short (34). In another study, Frucht-Perry found a 20% recurrence rate after Sr-90 and 8% recurrence after MMC but again the Sr-90 dose was low (27). In our study, with a longer follow-up the recurrence rate in the Sr-90 group was lower than with MMC and complications were less frequent.

MMC must be used with caution in limited numbers of patients because of the high complication rates. In must not be used in Sjögren syndrome, keratoconjunctivitis sicca or herpetic keratitis, where wound healing is defective and difficult. The concentration should be 0.02% or lower and treatment should last no longer than one week. As MMC drops can be widely effective but can cause more adverse effects on the cornea and palpebral conjunctiva, extensive follow-up evaluations are necessary. Patients should be warned of possible complications and followed up at short intervals.

Further studies on intraoperative application of MMC are needed, to lower recurrence and complication rates. Considering the carcinogenic and radiomimetic effects of MMC its use should be decided after weighing up the pros and cons in every case. Instead of drops an intraoperative single dose of MMC may be the choice, especially in primary cases. Easy application, high efficacy and reliability are the advantages of Sr-90 and it should be given in 2400-3000 cGy doses in the immediate postoperative period in order to prevent recurrences and complications. Even though the complications of Sr-90 are lower than with MMC, possible, serious complications – even threatening vision – must be kept in mind.

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REFERENCES

1. Adamis AP, Starck T, Kenyon KP. The management of pterygium. In: Sugar A, Soong HK, eds. Ophthalmology Clin North Am. Philadelphia, Pa: Saunders 1990; 611.
2. Arffa R. Grayson's disease of the cornea, 3rd ed. St Louis, Mo: Mosby Year Book; 1991: 342-5.
3. Duke-Elder S. Disease of the outer eye. System of Ophthalmology. St. Louis, Mo: Mosby, 1965; 573.
4. Townsend WM. Pterygium. In: Kaufman HE, Mc Donald MB, Barron BA, Waltman SR, eds. The Cornea. New York: Chruchill Livingstone 1988; 461.
5. Allan BDS, Short P, Crawford GJ, Barret GD, Constable IJ. Pterygium excision with conjunctival autografting: an effective and safe technique. Br J Ophthalmol 1993; 77: 698-701.
6. Beyer DC. Pterygia: Single fraction post-operative beta irradiation. Ther Radiol 1991; 178: 569-71.
7. Jaros PA, DeLuise VP. Pingueculae and Pterygia. Surv Ophthalmol 1988; 33: 41-9.
8. Kenyon KR, Wagoner MD, Hettinger ME. Conjunctival autograft transplantation for advanced and recurrent pterygium. Ophthalmology 1985; 92: 1461-70.
9. Krag S, Ehlers N. Excimer laser treatment of pterygium. Acta Ophthalmol (Copenh) 1992; 70: 530-3.
10. Ling RT. Treatment of pterygium using thermal cautery. Ophthalmic Surg 1989; 20: 511-3.
11. Mc Coombs JA, Hirst LW, Isbell GP. Sliding conjunctival flap for treatment of primary pterygium. Ophthalmology 1994; 101: 169-73.
12. Monselise M, Schwartz M, Politi F. Pterygium and beta irradiation. Acta Ophthalmol (Copenh) 1984; 62: 315-9.
13. Singh G, Wilson R, Foster S. Mitomycin eye drops as treatment for pterygium. Ophthalmology 1988; 95: 813-21.
14. Singh G, Wilson MR, Foster CS. Long-term follow-up of study of mitomycin eye drops as adjunctive treatment for pterygia and its comparison with conjunctival

autograft transplantation. Cornea 1990; 9: 331-4.
15. Wilder RB, Bwatti JM, Kittelson JM. Pterygium treated with excision and post-operative beta irradiation. Int J Radiat Oncol Biol Phys 1992; 23: 533-7.
16. Mahar PS, Nwahora GE. Role of mitomycin-C in pterygium surgery. Br J Ophthalmol 1993; 77: 433-5.
17. Sugar A. Who should receive mitomycin-C after pterygium surgery? Ophthalmology 1989; 96: 1645-6.
18. Moriarty AP, Crawford GJ, McAllister IL, Constable IJ. Severe corneascleral infection. A complication of beta irradiation scleral necrosis following pterygium excision. Arch Ophthalmol 1993; 11: 947-51.
19. Dussenbery KE, Alvi IH, Holland EJ, et al. Beta irradiation of recurrent pterygia: results and complications. Int J Radiat Oncol Biol Phys 1992; 24: 315-20.
20. Campbell OR, Amendola BE, Brady LW. Recurrent pterygia: results of postoperative treatment with Sr-90 applicators. Ther Radiol 1990; 174: 565-6.
21. Bernstein M, Unger SM. Experiences with surgery and strontium-90 in the treatment of pterygium. Am J Ophthalmol 1960; 49: 1024-9.
22. Cooper JS, Lerch IA. Postoperative irradiation of pterygia: an unexpected effect of the time/dose relationship. Radiology 1980; 135: 743-5.
23. Aswad MI, Baum J. Optimal time for beta irradiation of pterygia. Ophthalmology 1987; 94: 1450-1.
24. Levine DJ. Scleral complications following beta irradiation. Arch Ophthalmol 1994; 112: 1016.
25. MacKenzie FD, Hirst LW, Kynaston B, Christopher B. Recurrence rate and complications after beta irradiation for pterygia. Ophthalmology 1991; 98: 1776-82.
26. Anduze AL, Merrit JC. Pterygium: Clinical classification and management in Virgin Islands. Ann Ophthalmol 1985; 17: 92-5.
27. Frucht-Pery J, Ilsar M. The use of low dose mitomycin C for prevention of recurrent pterygium. Ophthalmology 1994; 101: 759-62.
28. Rachmiel R, Leiba H, Levartovsky S. Results of treatment with topical mitomycin-C 0.02% following excision of primary pterygium. Br J Ophthalmol 1995; 79: 233-6.
29. Dunn JP, Seamore CD, Ostler HB, Nickel BI, Beallo A. Development of scleral ulceration and calcification after pterygium excision and mitomycin therapy. Am J Ophthalmol 1991; 111: 343-4.
30. Rubinfeld RS, Pfister RR, Stein RM, Foster CS, Martin NF. Serious complications of topical mitomycin-C after pterygium surgery. Ophthalmology 1992; 99: 1647-54.
31. Bolanovsky C, Rehder JR, Carvalho MJ. Use of intraoperative mitomycin-C for the treatment of primary pterygium. Invest Ophthalmol Vis Sci 1995; 36: 34.
32. Mastropasqua L, Carpineto P, Cinacaglini M, Gallenga PE. Long term results of introaperative mitomycin C in the treatment of recurrent pterygium. Br J Ophthalmol 1996; 80: 288-91.
33. Moldanodo MJ, Cortina P, Menezo JL. The use of intraoperative 0.01% mitomycin-C for treatment of primary pterygium. Invest Ophthalmol Vis Sci 1995; 36: 34.
34. Hayasaka S, Noda S, Yamamoto Y. Postoperative instillation of low-dose mitomycin-C in the treatment of primary ptergygium. Am J Ophthalmol 1988; 106: 715-8.