Full-thickness eye wall resection: An experimental approach for treatment of choroidal melanoma

I. Dacron-graft

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To overcome the problems of surgical treatment of tumors of the posterior segment, we have developed a ring-shaped instrument. This is sutured to the sclera or the area where resection should be performed. Besides stabilizing the operative area, the two side arms of the instrument prevent collapse of the eyeball. The full-thickness eye wall resection is performed with the cutting needle of the cautery. The resected area is replaced with a silicon-coated dacron patch which is glued to the sclera by a-cyanoacrylate. The experimental work was done on rabbits. The encouraging preliminary results of this study are reported.

Key words: malignant melanoma, full-thickness eye wall resection, “eye basket,” holograft, a-cyanoacrylate, cautery cutting needle

Unfortunately, the range of diagnostic procedures, such as ophthalmoscopy, fluorescence angiography,1-3 transillumination,4-5 ultrasonography,6-7 and examination of subretinal fluid, have not prevented misdiagnosis. As of now, there is no invariably reliable diagnostic procedure to differentiate malignant melanoma from other benign conditions; consequently, there are still some misdiagnoses.10-13 Conservative measures for treatment of choroidal tumors of the posterior segment (photocoagulation,14-15 diathermy,16-17 radiotherapy18-22) have not been generally accepted, and there is great limitation in their use. Moreover, none of these methods has been effective in tumors with a base diameter of 7.5 mm. or larger.15-17,22

The purpose of this experiment was to provide evidence that a full-thickness eye wall resection is possible and, furthermore, that resection can be developed to be used in ophthalmology when indicated.
Figs. 1 to 8. 1, Instrument ("eye basket") used in sector resection. a, Ring stabilizing operating area. b, Two arms stabilizing eyeball. c, Side arm which is held by assistant. 2, Frontal view of the eye, side arms of the instrument are sutured behind the limbus. 3, Side view of the eye with the instrument's arms sutured to the sclera. 4, Operative area is fixed by the ring of the "eye basket." Arrow, Tapping the anterior chamber. 5, Resection using needle cautery (C→). 6, After full-thickness eye wall resection. Arrow, The resected area. 7 and 8, Replacement by silicon-coated Dacron patch. White arrow, Dacron-graft.
Materials and methods

Fifteen rabbits weighing two to three kilograms were used in this study. After general anesthesia with Diabutol the hairs around the left eye of each animal were clipped, and a large canthotomy was performed at the temporal canthus. Tractional sutures were applied to the lids. To perform the full-thickness eye wall resection, we have designed a ring-shaped instrument with two pliable arms (Fig. 1) which are sutured to the sclera (Figs. 2 to 4). The ring of this instrument was then sutured to the portion of the eye wall which was to be resected. The two arms were sutured around the eyeball. This stabilized the area to be operated on and prevented the eye from collapsing and extruding large amounts of vitreous after the excision was performed. Prior to resection, intraocular pressure was reduced by tapping the anterior chamber (Fig. 4). The area inside the operating ring was then cut deeply by the needle electrode of the cautery (Figs. 5 and 6). The bleeding was minimal or nonexistent, and, if it occurred, it was suctioned up by an instrument which could rapidly dry the area (Fig. 8A). The remaining attachment of the tissue was cut by a scissors. The resected area was then replaced with a silicon-coated dacron patch larger than the size of the incision (Figs. 7 and 8). The interior part of the transplant was coated with e-cyanoacrylate which adhered firmly to the sclera. The cautery, plus the small amount of adhesive which diffused at the bound edge, prevented detachment of the retina. The anterior chamber was then refilled by injection of normal saline and air until the eye became normotensive (Fig. 9). The instrument was then removed and the operative area covered with conjunctiva. An antibiotic was applied locally and systemically for seven days. The eyes were examined ophthalmoscopically, and fundus photographs were taken. After two weeks, four weeks, two months, six months, and nine months, the animals were put to death with an overdose of intravenous Nembutal. The eyes were enucleated, and the anterior segments were removed. The eye cups were immersed in a one per cent glutaraldehyde–one per cent formaldehyde solution in a phosphate buffer, then they were dehydrated with alcohol and embedded in paraffin and celloidin. Sections were cut on an LKB Microtome, stained with hematoxylin-eosin and Masson Trichome, and examined under a light microscope.

Results

During the first two weeks of the postoperative period, the eyes showed marked conjunctival edema. In the first postoperative week, transient fibrinous exudates, which subsided in the following week, were present in the anterior chamber. Four weeks after operation, the anterior chambers were nearly clear. However, the conjunctivas were still hyperemic in the area of resection. Ophthalmoscopically, the fundi were normal (Fig. 10), and the retinas were in place except in the resected areas (Figs. 11 and 12). The patches were seen as white circles with a minimal amount of scar formation at the edge of the resected areas (Figs. 11 to 15). This was also evident in the histologic examination of these eyes (Figs. 16 to 18). The vitreous did not show adverse reactions.

Ten animals were successfully operated, and the retinas remained in place. In this group, in only four animals did the conjunctivas cover over the patch well. Patches were evident as small bulgings in the temporal parts of the eyes (Fig. 13). In the remaining six animals, the conjunctivas did not cover the transplants properly (Fig. 19), and the patches were visible in the conjunctival sacs causing chronic conjunctival reactions. Because of the fragility of the adjacent conjunctivas, we did not make another attempt to re-cover the transplants. Two of the animals were put to death after 9 months. Examination showed that the dacron grafts of the operated eyes were completely undermined by fibroblastic proliferations and that the patches were loosely adhering to the underlying tissue. The patches were easily removed and the eyes did not lose tension. Chronic simple glaucoma, the cause of which could not be established, had developed in one of the eyes.

Five eyes were lost during the postoperative period. The loss of one eye was caused by fulminating endophthalmitis. Detachment of the retina from the site of excision developed in one eye (Fig.
Figs. 9 to 15. 9, Air injection into the anterior chamber. 10, Fundus photograph one month after surgery. 11 and 12, Fundus photograph one month after surgery. Arrow, Resected area. 13, Frontal view; graft is covered by conjunctiva. 14, Oblique view inside the eye after removal of anterior segment. Arrow indicates the graft. 15, Side view of the enucleated eye. White arrow, The graft is forcefully removed. Black arrow, The resected area.
Figs. 16 to 23. 16, Histologic section at the edge of the graft (arrows). Retina is in place. (Original magnification ×2.) 17, More central section from the resected area (arrows). 18, Magnified view from the edge of the resection (arrows) chorioretinal scar formation. (×25.) 19, Frontal view of the eye; graft is visible in the conjunctival sac. 20, Histologic section. Arrow, Retinal detachment from the site of excision. 21, Histologic section of the eye with expulsive hemorrhage in the subretinal space. B→, Blood. 22, Magnified view of normal ciliary body of the Fig. 21. Arrow, Normal continuation of ciliary body to pars plana. S, sclera. (Original magnification ×20.) 23, Magnified view of the detached ciliary body (Fig. 21). Arrow, site of rupture into subretinal space. S, sclera. (Original magnification ×20.)
Three eyes showed chronic iridocyclitis and hypotony and ended in phthisis bulbi. One of these eyes showed continuous leakage from the patch area. Ophthalmoscopically, there was a massive subretinal hemorrhage with detachment of the retina. This eye was enucleated a week after the operation. Histologic examination showed signs of expulsive hemorrhage from the ciliary body and massive bleeding in the detached ciliary body which had ruptured into the subretinal space (Figs. 21 to 23). This complication had occurred from the side opposite that of the site of the resection.

Complications which occurred during the operation included choroidal effusion due to hypotony and from vitreous loss (a small amount of vitreous loss occurred in 14 animals and did not influence the postoperative course). In some cases, if the operative area was not dried sufficiently, the patch did not adhere with the first attempt.

Discussion

To eliminate the necessity of enucleation for the tumors of the posterior segment, we have developed a new surgical approach. This method eliminates the tumors completely by a complete local resection and can save the eye from enucleation. Complications in sector resections and their prevention are as follows:

1. After penetrating injury, the eyeball has a tendency to collapse. If the wound is in the posterior segment, vitreous loss is inevitable. Though the vitreous loss in itself is not of importance, the hypotony and manipulation of the collapsed eye can induce and increase the amount of massive choroidal effusion. To prevent the latter complication and keep the eyeball in form, the described instrument (Fig. 1) is indispensable. The fixation of the area surrounding the excision is of utmost importance in sector resection of the eyeball. This not only stabilizes the area of resection, but it is also important for re-gluing or suturing the transplant and the resected area. Tapping the anterior chamber prior to the excision reduces the intraocular pressure and prevents sudden decompression of the eyeball through the excision area, thus lessening the amount of vitreous loss.

2. Incision of the choroid and underlying retina can cause disturbing hemorrhage with subsequent deleterious effects on the vitreous. In our experiments, hemorrhage was prevented by use of a cauterizing needle electrode for excision. In future experiments, the usefulness of a cryoring in preventing this complication will be evaluated.

3. Retinal detachment is a result of injury to the retina, when it is not surrounded by a chorioretinal scar. In this experiment, cauterization and the diffusion of a small amount of adhesive material (cyanoacrylate) within the wound edge caused chorioretinal scar formation, and, although minimal, this adhesion was sufficient to prevent retinal detachment.

The preliminary studies described are encouraging and justify further development of this technique in experimental animals. Though not now a justifiable approach in the human eye, eye wall resection thus explored and refined may provide a basis for expanding our surgical capabilities in the management of diseases of the human retina and choroid.

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REFERENCES