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Historical Issue

TRAUMATIC INJURIES TO THE EYE AND ITS ADNEXA*

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The scope of this subject is so vast that consideration of each phase must of necessity be brief. Case reports and statistics have been purposely avoided. The material has been divided into separate headings and each part discussed by stressing the fundamentals from an ophthalmologic point of view, based on experience and observations made on cases in this clinic.

INJURIES TO THE LIDS

Lacerations of the lids are often poorly repaired due to the minuteness of the anatomic structures and a lack of appreciation of the functions of this part of the eye.

Lids may be torn from either the outer or inner canthus and left hanging at one extremity or the other. This is particularly true of the upper lid. A line of tear at first vertical will often follow the retrotarsal fold across the lid. This indicates that the levator muscle has been disrupted and must first be sewed back to the posterior border before considering the orbicularis muscle and cutaneous structures. Adherence to this procedure will often prevent a permanent ptosis. The function of the lid appears lost at first but will gradually return.

The vertical portion of the laceration, as well as all other vertical tears or cuts wherever placed along the lid margin, must be closed, as Wheeler has proposed, by the "halving" method taken from the principles of carpentry. The tarsal plate must first be brought into exact alignment and coaptation. Sufficient paring of jagged edges to accomplish this may be done without fear of too much loss of substance. The orbicularis fibers and cutaneous structures are then lapped over this tarsal plate closure, and reinforced by mattress sutures through all structures. This procedure will prevent many unsightly notches or colobomata which later require correction.

Injuries to the lower lid which involve the inner canthal region are very difficult to repair. Two conditions are likely to occur: (1) severing of the canaliculus;

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(2) retraction of the lower lid due to lack of proper coaptation of the laceration at this point.

A reunion of the canaliculus is an extremely difficult but not impossible task. This clinic has been very fortunate in accomplishing it in several cases. The repair is made by passing a number one Bowman probe through both the punctum and the portion of the canaliculus in the severed lid, then through that portion still attached to the lacrimal sac if it can be located. This holds the sectioned ends together until the lid repair is completed. Attempts have been made to do the so called retrograde bouginage from the open tear sac but with very little success.

In order to avoid retraction of the lower lid due to poor coaptation of inner canthal tear, the tarsal plate must be reunited to the inferior portion of the tarsal ligament. Skin suturing alone will not suffice as relaxation will result.

In regard to skin closures in lacerations about the eye, emergency sutures are frequently very poorly applied. This probably happens because of insufficient training or instruction during the internship years. Too large suture material, too widely and too deeply placed sutures resulting in poor coaptation, and inadequately pared edges are the errors most often seen. Such work should be done over, if found early. Wounds about the eye, if deep, should be closed by suturing the subcutaneous tissue with triple 0 catgut. The skin closure should be done with interrupted dermal sutures at close intervals and including the smallest amount of skin possible. Drains should be avoided.

INJURIES TO THE EXTRAOCULAR MUSCLES

Injuries to these muscles may be caused by objects penetrating the orbit or by fractures involving the apex. When such injuries occur, the function of the extra-ocular muscles should always be tested. Injury to the external rectus and to the inferior rectus has been encountered in separate cases. The torn bellies of these muscles are difficult to find, but there is much more difficulty if the wound is allowed to heal and the attempt made later.

The third, fourth, and sixth cranial nerves enter the orbit at the apex and may be injured by a fracture of that region. Paralytic muscles have resulted, causing compensation difficulties from a visual function standpoint. Consequently it is very important to repair muscles if possible at the time of the original injury. Paralyzed muscles resulting from nerve injury may receive plastic support from adjacent functioning muscles, giving sufficient aid to avoid obnoxious diplopia and loss of binocular vision. Paresis of a muscle has occurred from a simple blow to the globe and orbit. Recovery has taken place in one to three months in all such cases observed.

CONTUSIONS OF THE GLOBE

Since vision may be impaired by the quick snap of a rubber band as well as by a heavy pugilistic blow, all such injuries involving the globe should receive careful consideration. Intraocular hemorrhage usually occurs, but need not be present.

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It is necessary to recall that a contusion of the eyeball may produce any one or more of the following conditions: traumatic iritis with segmental paresis, dislocation of the lens, early cataractous changes, contusion of the retina at the point of keenest vision, tears of the retina with resulting separation from the choroid, and tears of the retina and choroid without separation. This latter injury occurs most frequently about the optic disc, radiating outward. Invariably such lines of tear manage to cross entirely or partially between the disc and the macula, thus destroying central vision. The reason for this may be explained by the mechanism of a contrecoup blow plus the character of the retina in this region and the position of the macula. All of the conditions mentioned above require absolute bed rest and atropine until satisfactory examination of the eye can be made and the fear of a separated retina or dislocated lens is allayed. The best results in treatment of separated retina, however, have been obtained in the traumatic group.

PERFORATING WOUNDS OF THE GLOBE

Any puncture wound of the eyeball, however small, requires careful investigation and treatment. Some may be overlooked even with the most careful observation. The location of a perforation may be in the sclera, the limbus, or the cornea. Many involve both limbus and cornea.

Small wounds of the cornea are easy to miss without the aid of the slit-lamp. Simple indirect focal light, however, with some magnification before the observer's eye is often adequate. Although fluorescein is preferred, mercurochrome in any of its strengths makes a good stain and aids greatly in defining the extent of the injury. These small wounds are important because they frequently indicate the presence of a foreign body.

The limbus has long been considered a vital spot in injuries to the globe because of trauma to the underlying ciliary body, and because this area is regarded as the danger zone for sympathetic ophthalmia. It may be noted, however, that in the treatment of a great number of industrial cases in this clinic in the past twenty years, no cases of sympathetic ophthalmia due to trauma of the ciliary body have been encountered.

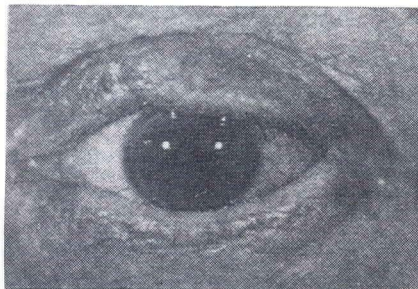


Fig. 1. Poor lid repair.

Perforations of the sclera may be easily obscured by conjunctival hemorrhage, but early recognition of these wounds enables one to take proper precautions against detachment of the retina. A careful fundus examination is always necessary. The presence of blood in the vitreous may indicate a perforation or a foreign body. The x-ray should be resorted to in all such instances not only to help determine the presence of a foreign body but also to protect the surgeon in case of medicolegal difficulties.

Rupture of the eyeball as a result of a severe contusion is not unusual. The lens has been found nicely extracted and lying under the conjunctiva. Regardless of the cause of injury, many of these wounds heal by first intention after masterful inactivity on the part of both the patient and the surgeon.

Prolapsed iris must always be removed from corneal wounds and should not be tucked back into the anterior chamber. It probably would not remain there and furthermore it may carry infection back with it. Suturing of corneal wounds is practiced by some surgeons but requires skill and special instruments. Unless one is so equipped, less trauma will result by using a conjunctival flap or the closed lids as a splint. A badly injured eye is easily made worse by too much manipulation. One should not be too hasty in advising removal of an eye, for vision of 20/30 or better has been obtained in what looked like a hopeless eye. Both surgeon and patient should have a few days' leeway to consider such an important step.

Should the removal of the eye become necessary, the surgeon should be governed in his choice of operation by the presence of acute infection or a prolonged low grade chronic inflammatory state. Although traditional ophthalmologic teaching recommends evisceration for the first and enucleation for the second of these conditions, we have used evisceration almost exclusively without extending infection or aggravating the production of sympathetic ophthalmia. There is no question but that the cosmetic results following evisceration with glass or gold ball implant in the sclera are superior to those following enucleation and ball implant into Tenon's capsule. Mucus, which is a great annoyance to patients, often collects on the prosthesis after enucleation while no such condition has been found to follow evisceration. The use of rib cartilage as an autogenous implant was used for a time in this clinic, but it added nothing to the function of the socket and its use has therefore been abandoned.

TRAUMATIC CATARACTS

Injury to the lens occurs frequently with trauma to the globe. The formation of a cataract, if sufficient to cause loss of vision, is compensable in most states, whether it is removed or not. Most industrial organizations are very willing to have everything possible done for such patients. Consequently cataract surgery is performed whenever indicated.

The diagnosis of traumatic cataract is not difficult. Occasionally, however, a medicolegal complication arises where it is necessary to give an opinion as to the type of cataract present. A careful study of the opposite lens should be made for

INJURIES TO THE EYE

similar markings, whether nuclear, cortical or capsular, in order to rule out congenital abnormalities. It must be remembered that contusion cataracts may arise without a break in the coats of the eye, therefore a diligent search for capsular scars and associated cortical changes must be made. The capsule may close or be plugged by

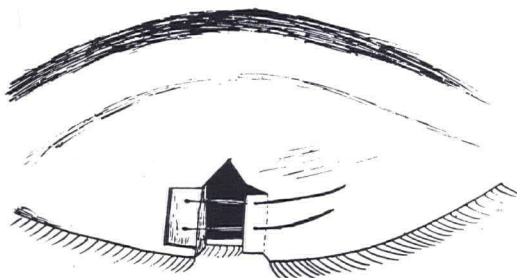


Fig. 2. Wheeler halving operation in lid repair.

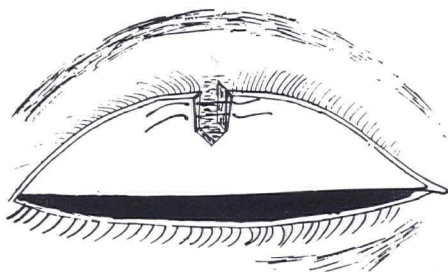


Fig. 3. Placing of sutures in the tarsal plate in the Wheeler operation.

cortical substance so that further entrance of aqueous is blocked and extension of the process in the lens substance stopped. Should this be in an eccentric position, fairly good vision will be maintained for an indefinite time. Here prognosis should be guarded for complete cataract may develop at some future time. Foreign bodies in the lens are discussed elsewhere.

Dislocation of the lens is not unusual. They may be partial or complete. When the latter occurs they are either in the vitreous, the anterior chamber, or outside under the conjunctiva. Dislocations within the globe mean secondary glaucoma sooner or later and because of this, removal is indicated before such a complication arises. Dislocated lenses become cataracts.

Cataracts, arising from puncture wounds in the anterior segment of the eye, usually progress quickly because of a considerable rupture of the capsule with exposure of the cortical substance to the aqueous fluid. These lenses swell rapidly which brings up the question of their immediate removal. If lens substance is not present in the aqueous, removal may be delayed until the general reaction of the eye subsides. The possibility of secondary glaucoma must be kept in mind. If there is considerable exposure of lens material, as much of it as possible is removed by physiologic saline irrigation. One must try to avoid the development of a thickened capsule which is difficult to remove except with scissors. It is therefore a good thing to remove as large a piece of the anterior capsule as possible at the time of removal of the lens material. If the anterior vitreous has been ruptured at the time of injury, it is preferable to wait, if possible, before removing lens substance in order to avoid loss of vitreous.

Age is a factor in deciding upon the type of operation to be used. The nucleus in the lens of an adult is quite firm and in most cases the cataract is best removed by the capsulotomy method employed for senile cataract extraction.

Due to the inequality of images, glasses are not prescribed for these patients except occasionally when requests are made in order to obtain employment.

INTRAOCULAR FOREIGN BODIES

The literature is voluminous on the subject of intraocular foreign bodies, their complications and methods for their removal. There is a paucity of records on visual results, because most of these injuries occur in industry to transient employees and final records are difficult to obtain. Because of the compensation laws, such records are necessary and valuable for reference.

In studying a foreign body case, the following questions present themselves: (1) What kind and of what character is it? (2) What structures has it entered; what damage has been done, and where is it located? (3) What is the present status of vision? (4) How shall it be removed?

1. The history will help to determine the kind of substance of which the foreign body may be composed. The place, the tools, the machines used by the

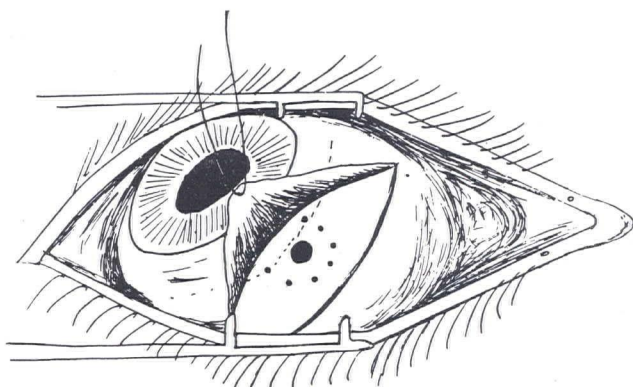


Fig. 4. Electrocoagulation with trephine opening in the center for posterior route extraction of the intraocular ofreign body.

patient, also by those near by in case of flying chips, the type of metal, whether magnetic or not, and the time the accident occurred, give valuable information.

2. The use of the slit-lamp is very valuable in determining the place of entry to the eye and in the search of the anterior segment area for the foreign body. Transillumination of the globe aids in locating a hole in the iris and must not be overlooked. A careful survey of the entire lens is essential. A wide dilatation of the pupil will be necessary for this procedure; however, it is assumed that the anterior surface of the iris and angle have been examined before this is done. The course of the foreign body may be seen by a survey of the vitreous unless it has been obstructed by cataract or blood. When seen with the ophthalmoscope a metallic foreign body will appear black and shiny, not unlike a piece of coal. A survey of the retina is important, as the foreign body may be seen sticking in it or else the puncture wound of exit into the coats beyond may be found.

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Localization plates are always made even though the foreign body may be seen. This is important alike for legal purposes and to aid the surgeon in knowing the size and position of the object. Haste in such cases is not essential and adequate time should be taken to study the conditions carefully before attempting the removal.

3. The status of the vision on admission to office or hospital is essential for both medical and legal purposes. The exact amount of vision and the preservation of vision are two points of great importance.

4. The method of removal is determined by the findings. If the foreign body is in the anterior segment of the eye, i.e., in the ciliary body, lens, iris, or anterior chamber, the anterior route is used. Cataracts may be produced by bringing a jagged piece of metal forward from the vitreous. If there already is a cataract, this route is used from the vitreous. Otherwise all posterior segment foreign bodies are removed by the posterior route.

It is interesting to note that since the advent of the electrocoagulation instrument, only one detachment of the retina has occurred and that was due to an early variation in the use of this method. The method is described as follows: A barrage of micropin coagulations is set up around the point where a 2 mm. trephine opening is to be made. Then the foreign body is extracted through the opening. If the piece of metal has been calculated to be larger than 2 mm., the opening is enlarged with a Von Graefe knife. The inferior nasal quadrant near the ora serrata is usually the site selected. It is believed that detachment of retina, as a complication of intraocular foreign bodies, may arise from other causes than the exit made for the extraction.

Care in the use of the electric magnet is important. It is not used as a diagnostic agent unless necessary. Under the direct vision of the ophthalmoscope, it may be

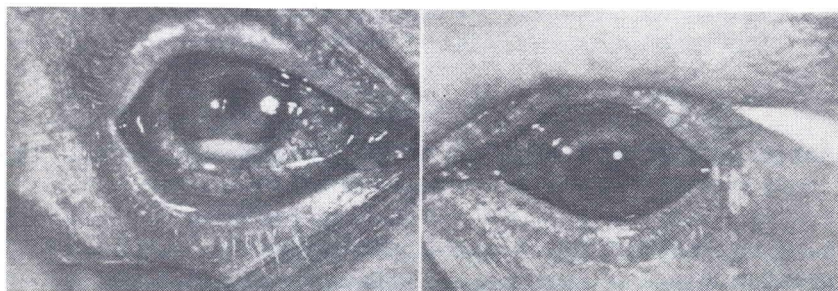


Fig. 5. Hypopyon following intraocular foreign body.

Fig. 6. The eye twenty-four hours later, following fever therapy in the Kettering hypertherm cabinet.

gently used to test small clots of blood in the vitreous for movement or for magnetic properties of the foreign body. X-ray localization always precedes the use of the magnet. It must be emphasized however, that the x-rays have erred both in localization and in suggesting the presence of a foreign body. By repeating the x-ray after an unsuccessful application of the magnet, a shift in position may often be found. Do not attempt operative procedure after using a magnet until another x-ray is made.

Experience has proved that application of the magnet repeated at several day intervals is important if there is suspicion that the body is magnetic. A Sweet hand magnet is preferred and used first, as undue magnetic force can do much harm to the anterior segment of the eye. The giant ring magnet of Professor Mellinger of Basle, made by Weis of London, which is used in this clinic, permits the patient to lie down for its application and allows more freedom of movement of the magnet tip.

Foreign bodies lodged in the retina and choroid have been observed to produce detachment of the retina and degeneration of the eye. By observing the movement of a foreign body in the retina under the action of a magnet, it is easily understandable why it is so difficult to remove the foreign body without damaging trauma. It is better to attempt to remove the metal through the sclera much as one attempts to approximate the position of a tear in the retina.

The lens tolerates surprisingly the presence of foreign bodies from the standpoint of irritating the anterior segment of the eye, as these seem to encapsulate themselves and remain for indefinite periods without producing complete cataract. Therefore there is no need of haste in removing them. Several such cases are under observation at the present time. There are some who advocate removal of these pieces of metal at once with equally good visual results. If it is evident that cataract is developing, then it is best to proceed at once with the extraction of the metal, for there will be less autolysis of lens substance and toxic effects upon the anterior segment of the eye.

Foreign bodies may remain in the eye for years, as many records attest, without destroying the eye. Oxidation of a piece of metal has been known to take place, leaving no residue — while on the other hand reactions may take place early with rapid loss of the eye. Some eyes have been much worse after removal of the foreign body. Especially is this true of the non-magnetic group of metals, stone, glass, etc. On the whole, however, experience has shown that the best treatment is to remove the foreign body early, if at all possible.

FEVER THERAPY IN TRAUMATIC INJURIES OF THE EYE

The practice in this clinic has been to give foreign protein to every patient with a penetrating wound of the globe or a severe traumatic ulcer of the cornea. All the prevailing types have been used but typhoid H-antigen is preferred because of the ease of administration and lack of sequelae. The dosage has ranged from 25,000,000 to 100,000,000 bacilli, depending on the individual case. The fever thus induced ranges from 100° to 102°F. This has not been considered quite sufficient, but higher dosage has not been used because of the possibility of grave systemic reactions. Just how valuable this form of treatment may be is difficult to determine. Some penetrating wounds do not develop infection anyway. It is questionable whether corneal ulcers are arrested by its use. Panophthalmitis and endophthalmitis have not been stopped. Because of the work of Dr. Albert L. Brown which showed a definite increase of the antibody content in the aqueous fluid following the use of typhoid antigen it has seemed advisable and necessary to administer it at the outset of all such cases.

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Fever produced by the Kettering hypertherm cabinet has been extensively used by the Division of Ophthalmology. A fever of 105° to 106°F. for four to five hours, repeated as desired every three to seven days, has been the procedure. The results of its application for exogenous infections of the eye have been disappointing. A hypopyon of the anterior chamber has disappeared in twenty-four hours and the congestion of the eye has improved, but practically every infection carried into the vitreous of the eye went on eventually to a low grade endophthalmitis or to phthisis bulbi. A few patients still retain their sightless eyes and they appear quiet. No sympathetic ophthalmia has developed during or following this therapy. Whether this type of fever has any influence on this dreaded disease has not been answered. Some cases of corneal ulcers were arrested by its use; however, other standard treatment was being given at the same time. The use of fever therapy in certain endogenous infectious or allergic manifestations in the eye has been found to be definitely valuable, but it is not within the scope of this paper.

BURNS OF THE EYE

There is much room for improvement in the management of burns of the globe, whether thermal, acid, or alkali. Experimental work on burns in this clinic has demonstrated that free washing of the eye with water should precede the use of neutralizing agents. The results from 5 per cent tannic acid, mixed with water, glycerin, or an antiseptic ointment, have been disappointing. Because of its beneficial effect on the skin of the lids and the face, it was hoped that at least in alkali burns it would be of value.

In lime burns 5 per cent ammonium chloride has been at least as effective as 10 per cent ammonium tartrate. Trisodium citrate 8 per cent has not proved to be so effective as the ammonium salts. Since lime burns are not washed away to any degree by water, gently scraping away the lime deposits has been found to be very effective, thus preventing further chemical action upon the tissues.

Ammonia burns are considered the most severe. While much is said about the delayed reactions being due to the penetration of ammonia through the cornea, animal experimentation with chemical analysis of the aqueous has not borne out this statement.

Burns involving the sclera and limbus, if of second or third degree, are likely to produce sloughing of the adjacent cornea, due probably to the lack of nutrition from the injured loops of limbal vessels. Conjunctival or mucous membrane grafts, as advised by Denig for the scleral limbal area, are advocated and appear to provide a source of nutrition and an aid to corneal conservation. Tannic acid will provide a coagulum in this area, yet it does not prevent the breaking down of the cornea.

Applications of ointment and free manipulation of the lids daily with a glass rod still seems to be as good a method as any yet found to prevent adhesions, although cellophane and thin rubber dam have been tried. Mucous membrane grafts continue to be used for adhesions of the lids to the globe as skin grafts are not very satisfactory in this region.

FRACTURES OF THE ORBIT

Fractures involving the bony structures of the orbit have become increasingly important since the majority are due to automobile and airplane accidents as well as to direct blows with fists. Fractures of the orbit are significant when viewed in the light of their relation to basal skull fractures with possible injury to the cerebral mass, along with the close relationship and likely trauma to the globe. Orbital fractures in our experience are generally due to direct blows with extension of the fracture lines into the bony orbit. The bones involved in order of frequency are: the zygoma; superior maxilla; frontal bone; lamina papyracea of the ethmoid; and the lacrimal bone, while injury of sphenoid and palate are quite infrequent.

The fact that the malar bone makes up a large portion of the floor and lateral wall, as well as the inferior and lateral margin of the orbit, and forms the prominence of the cheek, accounts for the frequency of fracture. Fracture lines may run into the frontal and maxillary sinuses. Displacement is in the direction of force which is generally downward and backward with rotation on its own axis. If fractures extend into the antrum, there is apt to be epistaxis with subsequent danger of infection. If there is enough displacement, ocular complications such as subconjunctival hemorrhage, orbital hemorrhage with decreased motility of the globe, displacement of the globe with diplopia and emphysema, may result. Involvement of the infraorbital nerve is not infrequent.

Diagnosis in fractures of the malar bone and maxilla hinges essentially on inspection, palpation, comparison with the opposite orbital rim, and the roentgenogram. Treatment is early reduction, unless swelling has progressed to the extent of interference, in which case proper treatment includes waiting for the swelling to subside before reduction is attempted. Although every case is individualized, the method of reduction here centers around the Caldwell-Luc approach. After reduction, the antrum is firmly packed, the buccal incision is closed and an antromeatal window is made for drainage. Any loose fragments of bone and all blood clots are removed. If malocclusion is present, close cooperation with the oral surgeon is essential.

Fractures of the frontal bone generally involve the frontal sinus and here there are the added dangers of intracranial injury and infection. Ocular complications, such as ecchymosis of the conjunctiva, orbital hemorrhage with decreased motility and exophthalmos, emphysema of the lids and orbital contents, enophthalmos, sudden blindness, corneal wounds, dislocation of the lens, traumatic mydriasis, iridodialysis, intraocular hemorrhage, lesions of the choroid, and detachment and rupture of the retina, are frequent. Treatment of a fracture involving the frontal bone includes the close cooperation and services of the neurosurgeon. If an external wound is present and the inner wall is not damaged, the external wound is closed after establishing adequate drainage by way of the nasofrontal duct. If the inner wall is damaged, the external wound is made larger and, if depressed, the fragment is elevated; if there is an opening in the inner wall it is enlarged and the dura exposed; if the dura is torn it is repaired with a free graft of fascia lata. In these latter conditions external drainage is preferable and contact between the nose and sinus cavity must be prevented.

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Fractures of the lamina papyracea of the ethmoid are generally due to perforating injuries. They are associated with epistaxis, orbital hemorrhage and emphysema. Conservative and expectant treatment is generally all that is necessary, along with thorough cleansing of the outer wound and nasal cavities. The same holds true for fractures of the lacrimal, sphenoid and palate bones. In these, complications such as sudden blindness due to hemorrhage into the sheath of the optic nerve or injury to this structure by a fracture through the optic foramen may result, as well as injury to the lacrimal sac or nasolacrimal duct.

SUMMARY

1. Restoration of proper function and appearance of the lids after injury, requires a knowledge of the anatomy and physiology of the parts and of the fundamental principles of plastic surgery. Many emergency operations are poorly done.

2. The extraocular muscles themselves are rarely injured but their functions are often disturbed by contusion of the nerve supply, fractures and lacerations.

3. Contusions of the globe, however simple, often prove serious to sight; therefore every eyeball so injured should receive careful scrutiny both inside and out.

4. The importance of detection of minute perforations of the globe is emphasized because of their aid in detecting possible intraocular foreign bodies. Bed rest and careful observation for complications in all perforating wounds of the globe are indicated. Sympathetic ophthalmia has not developed in this group.

5. Traumatic cataracts may arise from contusions as well as from penetrating wounds of the globe and should be removed at the proper time, provided the posterior segment of the eye is intact.

6. Intraocular foreign bodies may or may not prove serious to sight; their character and location plus the element of infection are the determining factors. All foreign bodies should be removed as soon as detected whenever possible. Sometimes, however, haste makes waste and should be avoided.

7. Injection of foreign protein in some form to produce fever and stimulate antibody formation is widely used in the practice of ophthalmology. The amount of fever produced seems to be the criterion of its effectiveness. Typhoid H-antigen is generally preferred for prophylactic purposes, although its exact value is difficult to judge. Induced fever by the use of the Kettering hypertherm cabinet does not destroy exogenous intraocular infection.

8. Second and third degree burns of the eye are destructive to sight and disappointing to treat. Research investigation so far has contributed little to improvement in method of treatment.

9. Fractures of the malar bone and zygomatic arch are the most disfiguring and may produce binocular imbalance and asymmetry of the eyes. Intraocular damage is also a possibility. Repair should be done if possible before swelling occurs or immediately after it subsides. The Caldwell-Luc operation is the method of approach mostly employed. Fractures of the optic foramen may produce optic atrophy.

