9 Anterior Vitrectomy

9.1 General Problems of Surgical Technique

Anterior vitrectomy in the present context refers to the excision and removal of dislocated vitreous tissue, i.e., of structurally normal vitreous that has accidentally prolapsed from its natural position into the anterior chamber or even out of the eye.[1] The major clinical problem in such vitreous dislocations are adhesions on anterior segment tissue surfaces (wound, posterior corneal surface, iris), which may transmit traction to the retina in the postoperative period.

The **goal** of *anterior vitrectomy*, then, is to eliminate such adhesions and ensure that no new adhesions will form. This means that existing vitreous adhesions are cleared, vitreous that has prolapsed into the anterior segment is removed, and sufficient volume is removed from the vitreous chamber itself to ensure that no additional fibers will herniate back into the anterior segment.

The **prevention** of adhesions is a matter of *protecting tissue surfaces* from vitreous contact, and this is a problem of surface tactics. Viscous and viscoelastic protective coatings are an effective prophylaxis whenever the possibility of undesired vitreous contact is anticipated.

From the standpoint of *surgical technique*, vitreous is a difficult tissue to manipulate. It is not compact enough to be held with a grasping instrument (e.g., forceps), it is not sectile enough to be cut with precision, and it tends to adhere to tissue or instrument surfaces with which it comes in contact.

Vitreous can be **grasped** with suction instruments such as sponges or aspiration cutters. When *sponge swabs* are used, the sucking force of capillary attraction is reinforced by the tendency of the vitreous to adhere to the rough surface of the sponge. However, sponges are difficult to control as grasping instruments – the amount of vitreous grasped is difficult to define, and material that has been grasped cannot be released. Moreover, the volume of the sponge expands through fluid uptake, and its rough surface may scrape against delicate intraocular tissues such as the corneal endothelium. Consequently, sponge swabs are best suited for use on the ocular surface. For **cutting** the vitreous, instruments are needed which limit shifting of the tissue in front of the cutting edge and thus improve its sectility. *Scissors* must have long blades to compensate for forward shifting of the vitreous by the cutting point.[2] For optimum cutting effect, scissors should be applied at sites where the shifting tendencies of the tissue are constrained, e.g., close to a grasping sponge or at the margins of an incarcerating incision.

In *suction cutting instruments*, the cutting action is most efficient when the blade is either applied directly at the site where the tissue is held fast by suction (see Fig. 2.88) or when the blade moves so rapidly that the inertia of the tissue keeps it from shifting (see Fig. 2.89). Owing to their small dimensions, suction cutters are excellent for use in the interior of the eye. They are less suitable for use on the ocular surface, for there the vitreous layer is too thin for establishing and maintaining occlusion. Air is aspirated, and once this occurs, control of the suction is lost.[3]

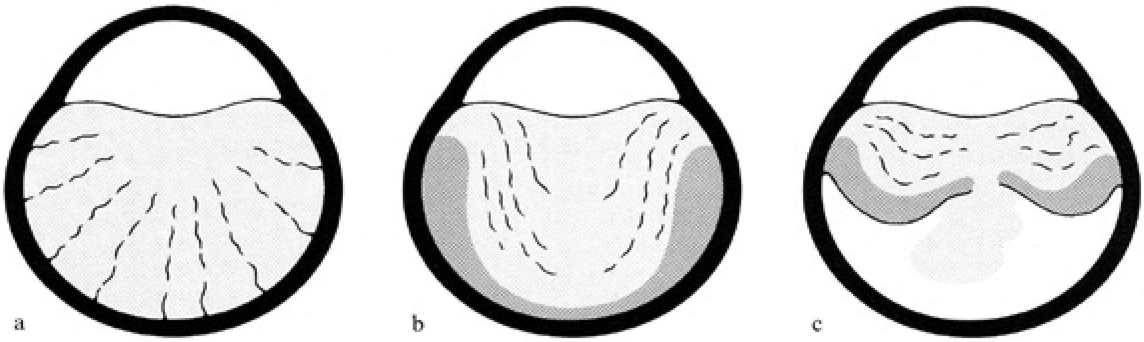
All manipulations on the vitreous are associated with *traction*. The potential for stress transfer from vitreous to retina thus depends on **anatomic factors**, i.e., the distensibility and resistance of the vitreous fibers and the condition of the vitreoretinal attachments.

Relatively compact vitreous with a *homogeneous* structure (Fig. 9.1a) can transmit traction to the retina regardless of the site where the traction is applied (Fig. 9.3a). If the vitreous is *differentiated* into a relatively fluid center surrounded by a more compact cortex (Fig. 9.1b), traction on the central vitreous will

[1] By contrast, posterior vitrectomy is concerned with pathologic vitreous structures that have remained in their natural compartment.

[2] Conversely, scissors with short blades are appropriate for posterior segment vitrectomy, because there the targets are fibrotic strands that are more sectile than normal vitreous.

[3] Air bubbles, unlike fluid, are distensible and compressible. They behave as elastic cushions that can store energy and release it abruptly. Phases of inadequate suction (below the instrument setting) alternate with phases of excessive suction (above the instrument setting), posing a danger to neighboring tissues (analogous to elastic tubing, see Fig. 1.9). Once air bubbles have gained entry, the instrument and tubing system must be purged of air before reuse.



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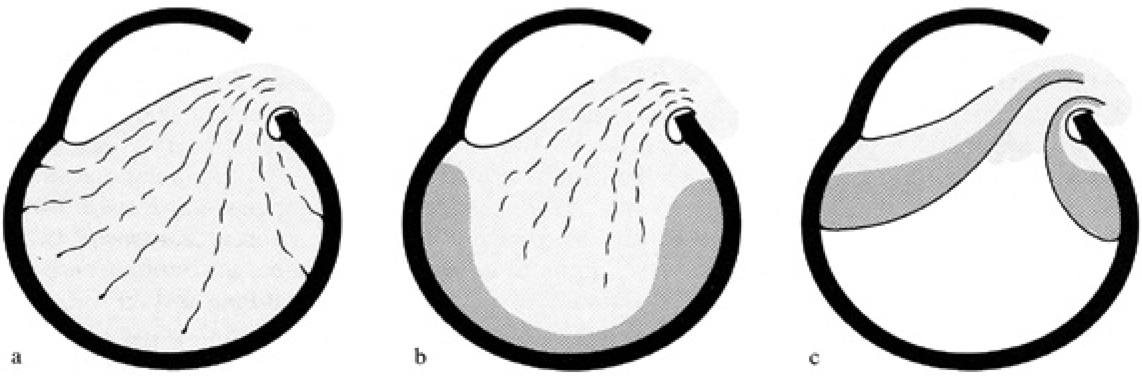

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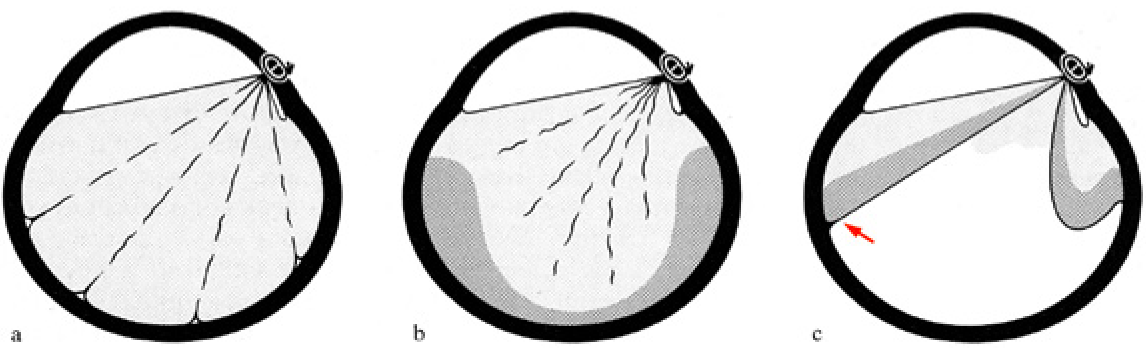

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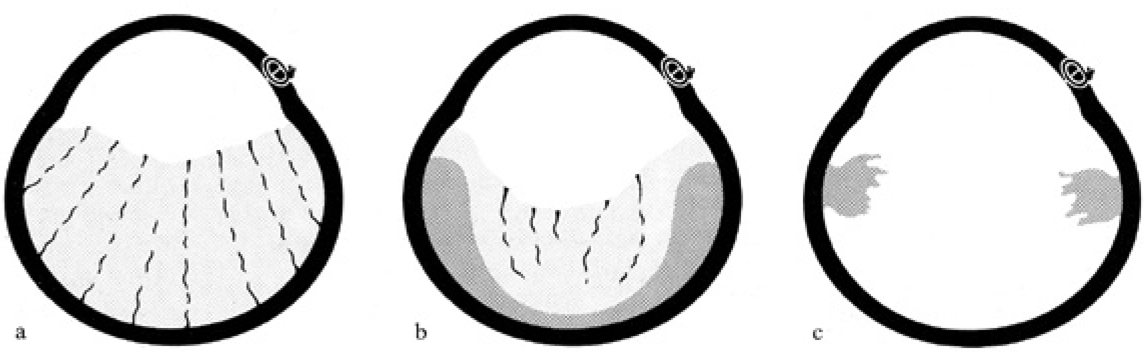

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Fig. 9.1. **Structure of the vitreous**[4]

a In youth the vitreous has a practically homogeneous structure with no demarcation between the central vitreous and cortex. All the vitreous tissue is semisolid and therefore distensible while still being structurally cohesive.

b With aging, the vitreous undergoes a structural change characterized by the demarcation of a semifluid central substance and a relatively compact cortex. This cortex forms a 1–3 mm thick layer lining the entire retina (*dark gray*). The central substance extends to the ciliary epithelium anterior to the ora serrata and is bounded in front by the anterior hyaloid.

c In posterior vitreous detachment, the retinal surface loses contact with the vitreous as far as the posterior boundary of the vitreous base. The compact vitreous cortex remains adherent only to the most peripheral parts of the retina

Fig. 9.2. **Structure of a vitreous prolapse**

a In young patients the prolapse contains fibers that can transmit traction directly to the retina.

b In adult patients the prolapse consists of the semifluid central substance while the peripheral cortical layers (and their connections with the retina) may remain unaffected.

c In posterior vitreous detachment the prolapse also includes cortex that has strong connections with the peripheral retina

Fig. 9.3. **Status following resection of the external vitreous prolapse**. Patterns of vitreous incarceration where management of the prolapse has been confined to excision of the expelled tissue and subsequent wound closure.

a In young patients the incarcerated vitreous contains relatively tense fibers that have direct attachments with the entire retinal surface.

b Incarcerated adult vitreous contains lax fibers that have attachments with the undisplaced vitreous cortex. This cortex may act as a buffer against the transmission of tension from the wound to the retina.

c Following posterior vitreous detachment, the cortex and the posterior hyaloid are incarcerated in the wound. Any subsequent contraction of the cortex will mainly affect the vitreous base on the opposite side of the wound (*arrow*)

Fig. 9.4. **Criteria for an adequate anterior vitrectomy**. Resection of a volume sufficient to prevent recurrence of the prolapse.

a If the vitreous is semisolid, its relatively compact structure makes postoperative relapse unlikely, so resection of only a small part of the retrolenticular vitreous may suffice.

b With a liquid central vitreous, there is a greater danger of relapse, so a greater volume of the central substance has to be removed. However, the cortex and its connections to the retina must not be disturbed.

c Following posterior vitreous detachment, anterior vitrectomy becomes a subtotal vitrectomy that leaves only a narrow rim of cortex along the vitreous base

have little effect since stress transfer through a fluid medium is poor and is additionally buffered by the cortex. However, direct traction on the cortex is transmitted extensively to the retina (Fig. 9.3b). In *vitreous detachment* (Fig. 9.1c), the cortex remains attached to the retina only at the vitreous base.[5] Consequently traction is transferred only to the retinal periphery while having no effect on the posterior segments of the retina (Fig. 9.3c).

Thus, the nature of the vitreous structure has a major bearing on the management of vitreous prolapse. From the standpoint of surgical tactics, there is a basic distinction between:

- the prolapse of nondetached vitreous (structurally homogeneous or differentiated into central substance and cortex, Fig. 9.2a and b) and
- the prolapse of detached vitreous (Fig. 9.2c).

The prolapse of **nondetached** vitreous involves the herniation of central substance. Depending on the compactness of the tissue, traction on the prolapsed vitreous may either have no effect, or it may jeopardize all portions of the retina (Fig. 9.3a, b). With the prolapse of **detached** vitreous that includes the herniation of vitreous cortex and posterior hyaloid, traction will endanger the peripheral retina but will not threaten the posterior retina (Fig. 9.3c).

Regarding the **quantity** of vitreous that must be excised to prevent a recurrence of vitreous prolapse into the anterior segment, it is sufficient to remove the anterior central substance in the *nondetached* vitreous (Fig. 9.4a, b). In the *detached* vitreous, however, the excision should include the detached vitreous cortex while leaving only the portion attached at the vitreous base (Fig. 9.4c).

[4] For details see G. Eisner, Clinical anatomy of the vitreous, T.D. Duane and E.A. Jaeger, Biomedical Foundations of Ophthalmology, Harper & Row, 1982, Chap. 16.

[5] In juveniles the posterior limit of the vitreous base is at the ora serrata, so the cortex can become detached as far as the ora serrata. With aging, the vitreous base migrates toward the equator, so vitreous detachment terminates somewhere between the ora serrata and equator.

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9.2 Strategic Decision-Making Criteria in Vitreous Prolapse

Vitreous prolapse results from a rise of pressure in the vitreous chamber. The *sources* of this pressure rise may be external factors, which act on the globe from the outside, or internal factors that arise within the eye itself. Each of these two causes demands totally different responses from the surgeon. Thus, when vitreous prolapse is recognized, it is important to establish at once whether external or internal factors are causative.

The **external factors** are deforming forces which indent the scleral coat of the vitreous chamber (see Fig. 1.42c) or forces which press the diaphragm downward (see Figs. 1.53, 8.2a). Usually the external cause can be eliminated quickly, whereupon the vitreous pressure will return spontaneously to the previous level without any further intervention by the surgeon. Once the vitreous pressure has returned to a low level, there is no danger of further vitreous loss.

The situation is quite different when the prolapse is caused by **internal factors**. Here the mass effect in the vitreous chamber is caused by a pressure rise in the retrochoroidal space secondary to extravasation from the choroidal vessels (expulsive hemorrhage).[6] This extravasation will persist until the intraocular pressure equals that of the leaking vessel. Treatment strategy, then, aims at raising the intraocular pressure to a sufficient level promptly before too much of the intraocular volume is expelled.

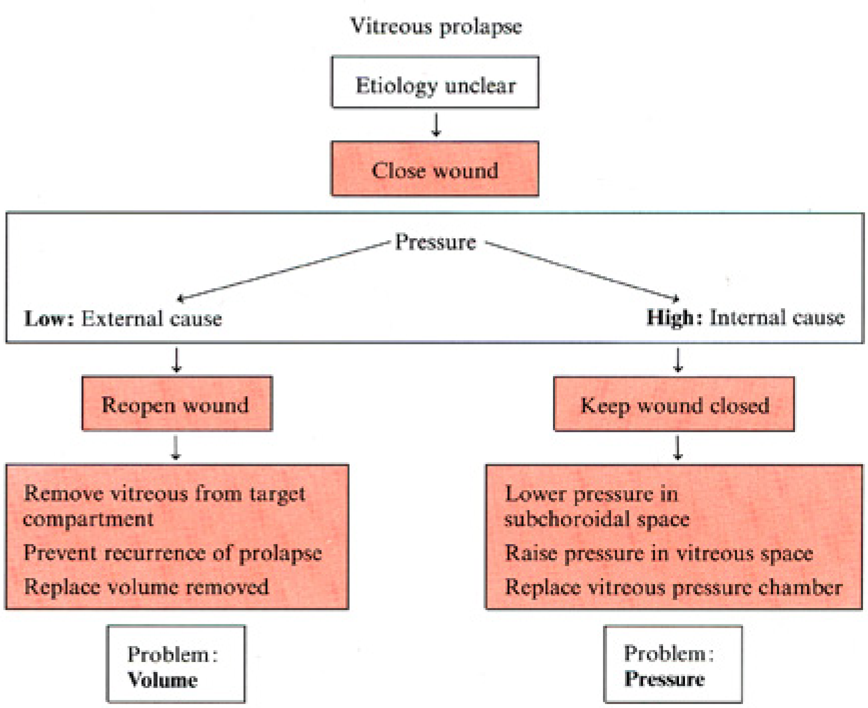
The flowchart in Table 9.1 shows the *decision-making criteria* for the intraoperative management of vitreous prolapse. If there is the least suspicion of expulsive hemorrhage, the incision should be closed at once and secured against the further expulsion of vitreous. Only then may the situation be assessed in detail. First, any external deforming factors are eliminated. Subsequent measures are determined by the intraocular pressure:

If the pressure *falls* after elimination of the external factors, the prolapse obviously was caused by them. The incision may be reopened, and further measures consist in evacuating the herniated vitreous. The essential problem is one of *volume*.

If the intraocular pressure is *high*, choroidal hemorrhage is presumed, and the incision should remain closed. Further measures are directed toward lowering the pressure in the retrochoroidal space while raising the pressure in the vitreous chamber. The essential problem is one of *pressure*.

[6] The rate of expansion of the retrochoroidal space depends on the pressure in the bleeding vessel. Thus, the rate of vitreous prolapse is high with bleeding from the larger ciliary arteries but is much slower with venous bleeding.

Table 9.1



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9.3 Anterior Vitrectomy for Vitreous Prolapse Caused by External Factors

The anterior vitrectomy consists of four phases (Fig. 9.5):

- removal of extraocular vitreous;
- removal of vitreous from the wound surfaces;
- removal of vitreous from the anterior chamber;
- clearing of an additional volume ("safety zone") adequate to prevent postoperative recurrence.

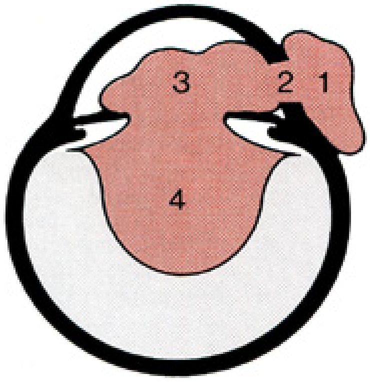


Fig. 9.5. **Parts of a vitreous prolapse removed by anterior vitrectomy**
1 Extraocular prolapse
2 Prolapse within the incision
3 Prepupillary prolapse
4 Retropupillary safety zone (see Fig. 9.4)

Extraocular vitreous is removed as close to the ocular surface as possible so that all the prolapsed tissue is excised. The technique of this phase varies according to whether the incision is closed or open.

In a tightly **closed incision** the prolapsed vitreous is incarcerated between the wound lips, and traction on its exterior portion will not be transmitted into the eye interior. Therefore, maximum traction on the prolapse is safe and can be used for exploiting the retractile tendency (see Fig. 2.64) to place the excision as close to the ocular surface as possible. The scissor cut is made directly over the wound, where sectility is greatest owing to the incarcerated tissue; i.e., the cut is made far from the grasping sponge (Fig. 9.6b).

With an **open incision**, any traction on the prolapse may jeopardize the intraocular tissues, so all measures should involve a minimum of traction. Sponge swabs grasping the prolapse should be lifted just enough to allow scissors to be applied; thereafter they are held stationary. The scissor cut is made adjacent to the sponge (Fig. 9.6c).

In each of the two situations above, different means are used to *control the extent of the vitrectomy*. With a closed incision, the quantity of excised vitreous can be influenced by *traction* to the prolapse. But with an open wound, the excision is limited basically to vitreous that is adherent to the sponge, so the extent of the excision is increased by *repeating* the grasping and cutting maneuver.

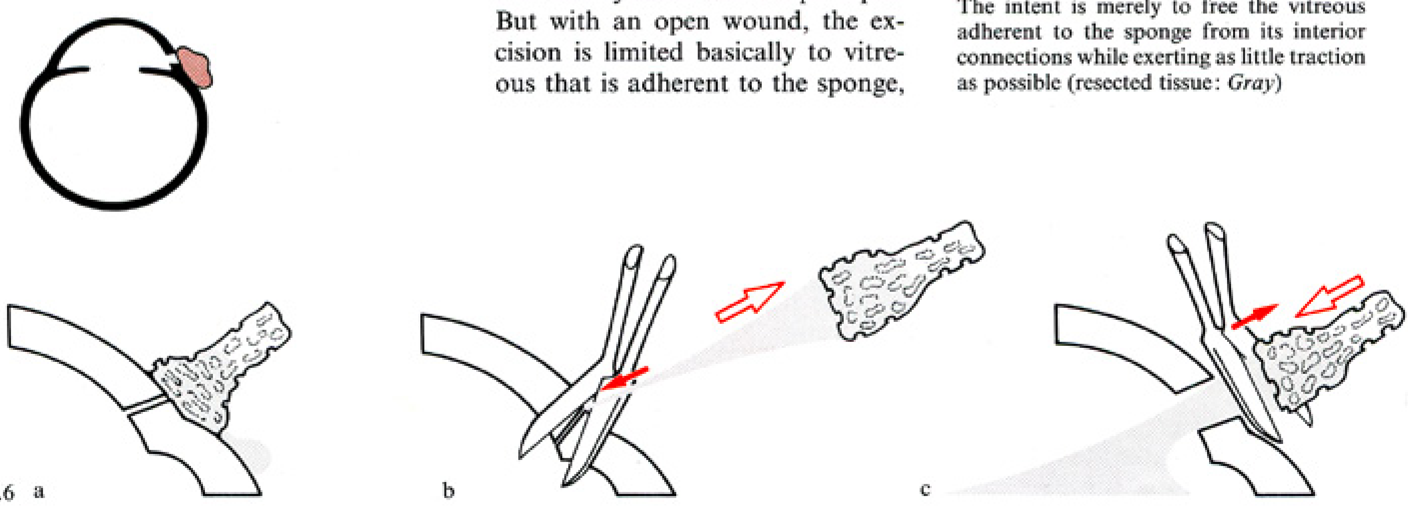
Vitreous removal **from the wound surfaces** is effected by applying outward or inward traction. For an *ab externo* removal, the upper part of the prolapse is freed by elevating the upper flap of the incision. Then the prolapse itself is grasped with sponge swabs and wiped from its attachments with the lower wound surface. At the wound angles, however, the upper flap cannot be raised enough to provide sufficient space for maneuvering the sponge. Thus, removal of vitreous incarcerated at the angles may require a lateral extension of the incisions

Fig. 9.6. **Removal of prolapsed vitreous from the outer surface of the eye**

a The vitreous is grasped with a sponge swab right at the incision so that the prolapse can be resected as close to the ocular surface as possible.

b If the incision has been closed, the vitreous is lifted with the sponge and put on maximal stretch to exploit its retractile tendency (*large arrow*). The scissors are pressed *close to the ocular surface* when the resection is performed (*small arrow*).

c If the incision has remained open, the vitreous is lifted only slightly, and the scissors are applied *close to the sponge*. The intent is merely to free the vitreous adherent to the sponge from its interior connections while exerting as little traction as possible (resected tissue: *Gray*)



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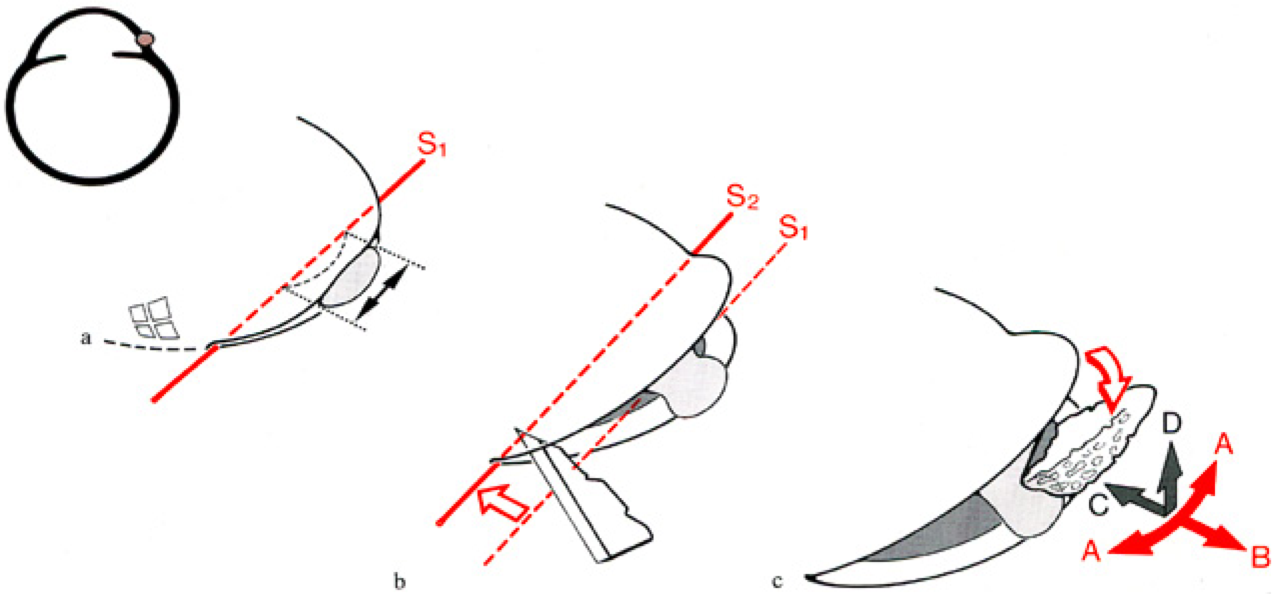

Fig. 9.7. **Freeing vitreous incarcerated between the wound lips.** Extension of the wound for gaining access to the lateral edges of the prolapse.

a Vitreous is incarcerated to the outermost corners of a wound with a given length *L*.
S_1: Hinge axis.

b The extension moves the hinge axis from S_1 to S_2. The new hinge position allows the upper wound surface to be raised from the lower wound surface beyond the lateral edges of the prolapse; now the wound surfaces lateral to the prolapse are free of vitreous. Further with a more posterior position of the hinge, the corneal endothelium on the fold is moved away from the range of action of the sponge swab.

c Clearing the vitreous adhesions begins by wiping the sponge from the vitreous-free wound surfaces toward the center of the prolapse. The optimum direction for this action is parallel to the wound line for separating the adhesion (*A*) and horizontally away from the wound margins for applying traction (*B*). Motion toward the wound (*C*) or upward (toward the upper wound surface, *D*) jeopardizes the endothelium

(Fig. 9.7a). The new hinge axis will then allow the flap to be raised above the lateral borders of the prolapse (Fig. 9.7b, c), reducing friction and facilitating the lysis of adhesions, and all wiping maneuvers with the sponge can proceed from clean wound surfaces toward the prolapse. Vitreous removal by *inward* traction relies on an indirect transfer of forces. But this transfer is hampered by the extreme compliance of the vitreous, so forces are most effective when applied at sites where the compliance of the vitreous is reduced by other tissue (i.e., where the vitreous surface is covered by *iris*, Fig. 9.8) or by an instrument (e.g., an *air bubble*, Figs. 9.9, 9.10).

When vitreous is removed **from the anterior chamber**, unnecessary traction can be avoided only when the grasping and cutting instruments are introduced into the chamber. Vitrectomy with sponge and scissors basically follows the technique shown in Fig. 9.6c, except that there are greater space limitations, and expansion of the sponge threatens surrounding tissues (Fig. 9.11a). Providing sufficient space for safe maneuvering may require wound extension, which not only will give better access for insertion of the instruments but will also protect the endothelium at the hinge fold by moving the hinge axis out of the danger zone for manipulations (Fig. 9.7b). All vectors of instrument motion are directed away from the posterior corneal surface.

The use of a *suction cutter* (Fig. 9.11) largely eliminates the problem of restricted space. Traction effects are minimized by using a high cutting frequency.[7]

For the **removal of retroiridal vitreous**, the instruments must be inserted behind the iris. The sponge-and-scissors technique requires that the incision be widely opened so that the hinge axis is beyond the pupil margin (i.e., far more than 180°).[8]

[7] The relationships between cutting frequency and suction are discussed on p. 84. A traction-free vitrectomy is initiated at a high cutting frequency, and the frequency is gradually reduced until a suction effect is apparent.

[8] This method may be used, therefore, when vitrectomy is performed in conjunction with a perforating keratoplasty.

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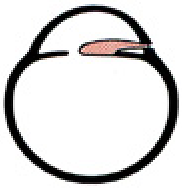

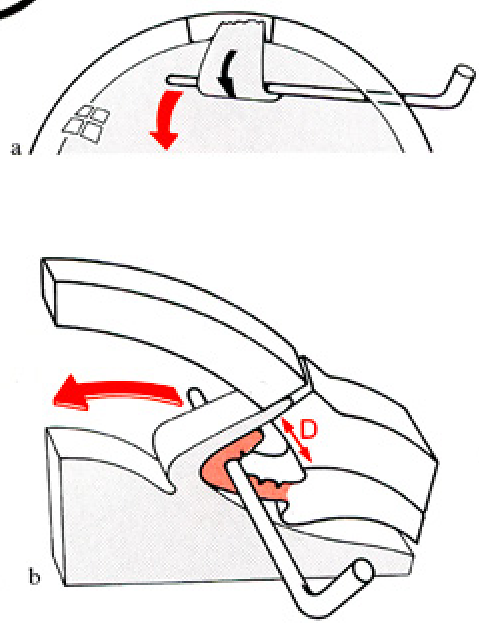

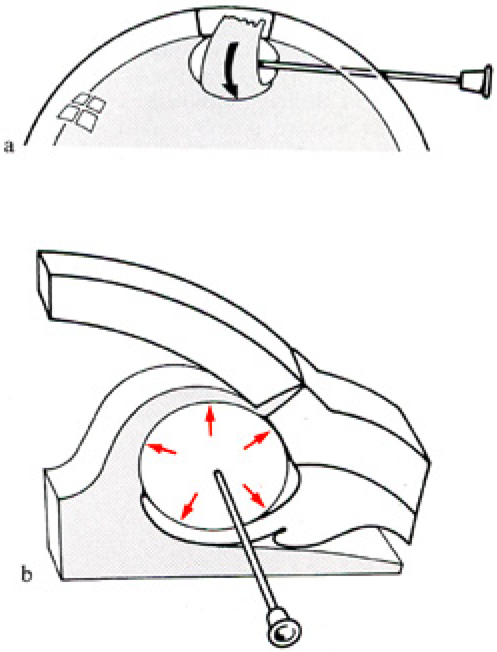

Fig. 9.8. **Freeing incarcerated vitreous with a spatula toward the inside.** With the wound closed, a spatula is inserted beneath the prolapse. For access there must be an adequate distance (*D*) from the interior wound opening to the iris root.

a Principle of the method: A slender spatula is passed beneath the prolapse and swept toward the center of the anterior chamber.

b A spatula thin enough to be introduced into the narrow interspace between the inner wound lip and chamber angle presents such a small surface area that the vitreous structures may yield to the spatula more readily than the vitreous adherent to the wound surfaces. Thus, the sweeping maneuver is more effective when the deep surface of the prolapse is covered by everted iris, and the spatula can engage against its compact surface

Fig. 9.9. **Freeing the incarcerated vitreous with an air bubble**

a If iris does not cover the vitreous surface, an air bubble can be used as a "bullous" spatula to apply force to the prolapse more diffusely.

b The cannula is passed below the prolapse, and air is injected

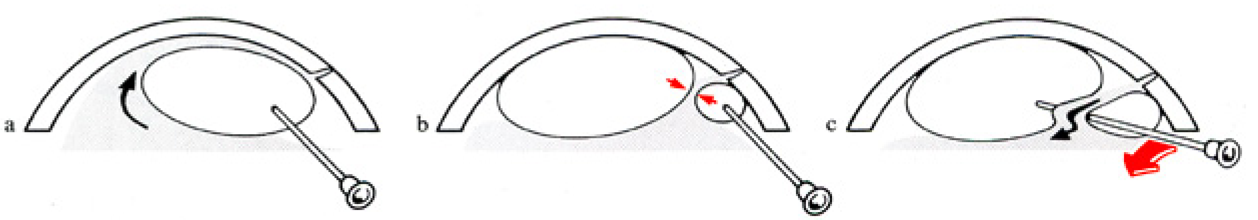

Fig. 9.10. **Use of double air bubble in very compliant vitreous**

a The vitreous may be so compliant that an air bubble placed beneath the incarceration (i.e. at the chamber angle) merely stretches it without extracting it from the incision.

b Vitreous compliance is exhausted by injecting a second large bubble above the incarceration (i.e. between the corneal dome and the surface of the prolapse).

c Thus immobilized, the incarcerated vitreous can be pulled from the wound with a sweeping motion of the cannula. The two bubbles will coalesce when the incarceration is relieved

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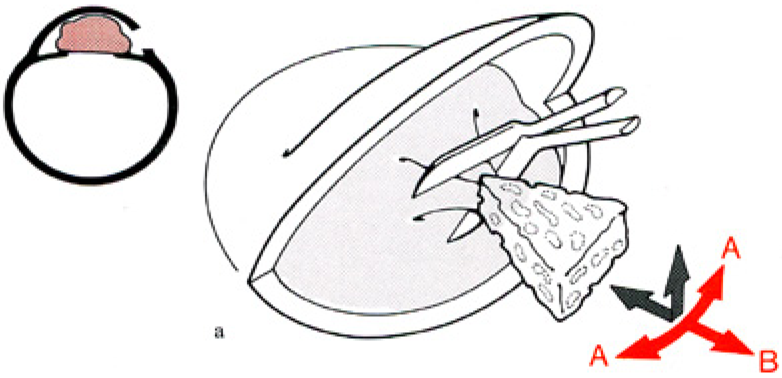

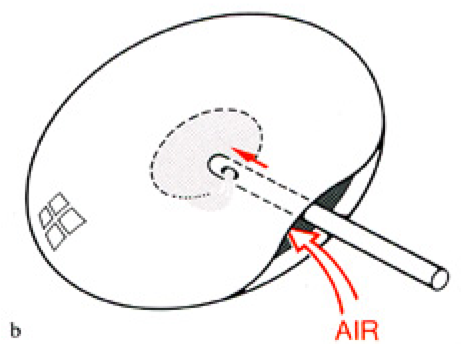

Fig. 9.11. **Evacuation of vitreous from the anterior chamber**. Removal of prepupillary vitreous (*inset*).

a A large incision is required for insertion of the sponge swab and scissors; the space must also be sufficient for the anticipated expansion of the sponge. Motions of the sponge parallel to the iris plane, outward (*A*), and laterally (*B*) pose the least danger to the endothelium. Motion directions inward or upward (*black arrows*) are the most hazardous.

b Use of a suction cutter. Motion of the instrument is toward the pupil so that no vitreous is dragged against tissue surfaces to which it could adhere. The incision is held open so that air can enter and facilitate evaluation of the extent of the anterior vitrectomy. However, the aspiration port of the cannula should not come in contact with air and should remain surrounded by fluid; otherwise air would get into the tubing system

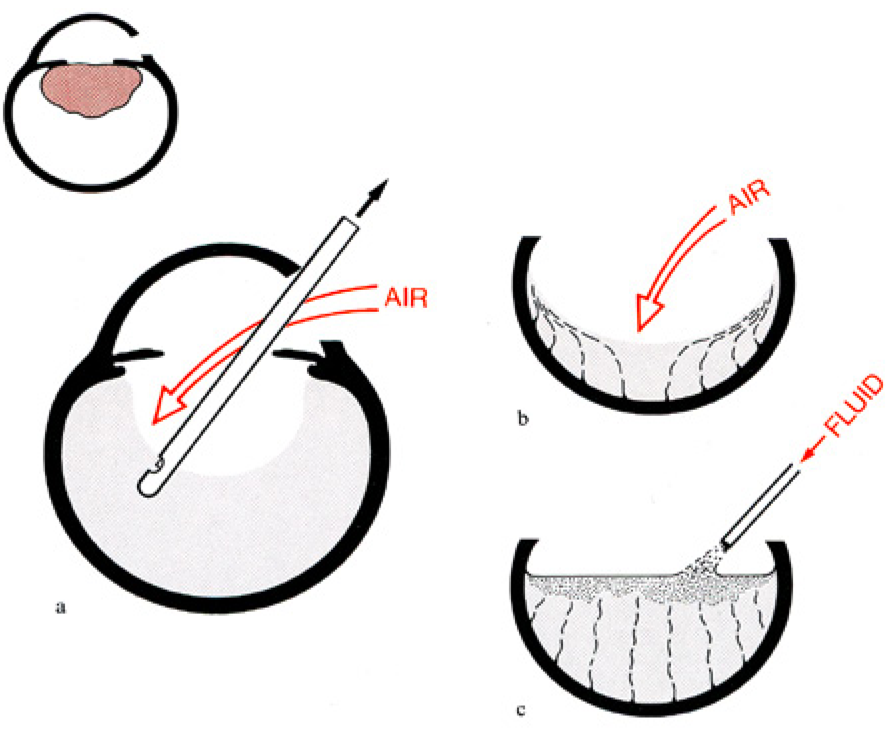

Fig. 9.12. **Removal of vitreous from the vitreous chamber**. Resection of retropupillary vitreous to prevent postoperative relapse into the anterior chamber (see Fig. 9.4).

a Insertion of the suction cutter behind the pupil. To avoid the aspiration of peripheral vitreous, the tip should not stray from the central axis of the globe. Air is allowed to enter through the open incision to replace the aspirated volume.

b Air as an indicator: Due to surface tension, air displaces the vitreous fibers backward, and the vitreous face becomes spherically concave.

c If the air is subsequently replaced by fluid, the vitreous fibers will move forward again and reassume their anatomic position. This "fluid indicator" maneuver thus demonstrates that the excision has cleared less vitreous than the "air indicator" suggested

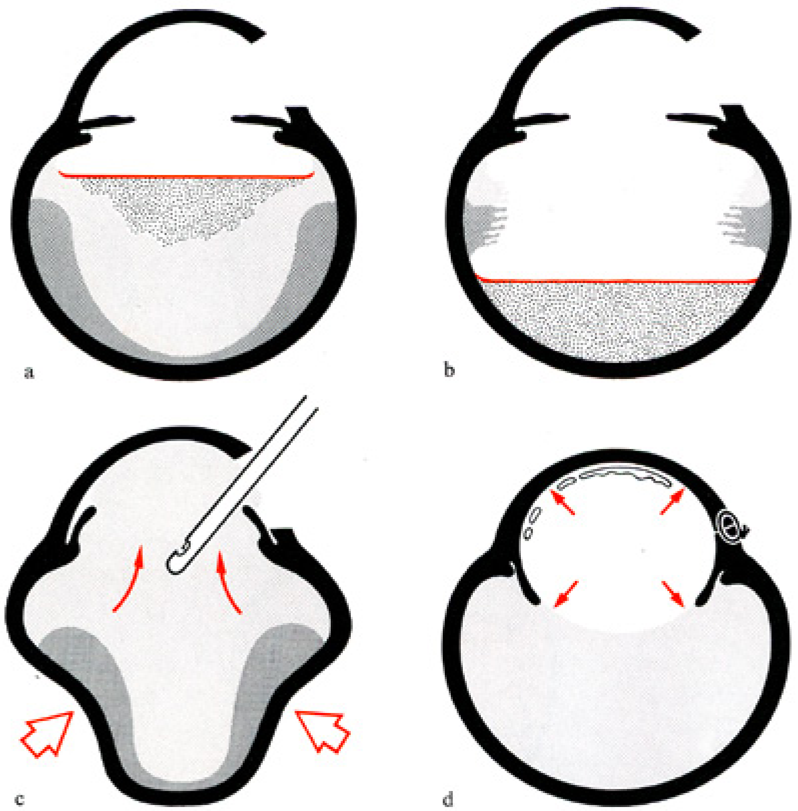

Fig. 9.13. **Criteria for evaluating the extent of the vitrectomy**

a Nondetached vitreous. The iris (and, if present, the perforated lens capsule) are exposed to the open air. If the underlying meniscus is flat at its center, it signifies a pool of watery fluid over the completed vitrectomy.

b Detached vitreous. A pool of watery fluid remains behind the remnants of the vitreous base. The fluid surface is level.[12]

c Absence of compensatory air inflow. The lack of air inflow during vitrectomy is a warning sign. It signifies that the vitreous is coming forward, and preretinal vitreous cortex may move into range of the suction tip. This is caused by deformation of the vitreous compartment by a rise of choroidal or orbital pressure.

d Air injection with a closed wound. While air entering an open chamber serves only as an indicator for the aspirated fluid volume, air injected in the presence of an airtight wound has an entirely different function: It forms an artificial pressure chamber able to exert counterpressure against external forces. However, its deforming effect on surrounding structures makes it a poor indicator of vitreous topography

Suction cutters, on the other hand, can be introduced deeply through a small incision (Fig. 9.12). Retinal traction during the vitrectomy is avoided by keeping the tip opening close to the axis of the globe. This reduces the risk of aspirating vitreous cortex (i.e., the whole cortex in a nondetached vitreous, or the cortex at the vitreous base in a detached vitreous).[9]

Vitreous adhering to wound surfaces cannot be cleared with suction cutters, so when the operator has completed the deep vitrectomy he should reexplore the wound with sponge swabs to confirm that the surfaces and corners of the incision are clear.

Visual monitoring of the extent of the vitrectomy is difficult in a *watery* or *viscoelastic* medium due to lack of contrast with the transparent vitreous structures.[10] The extent of the excision can be assessed by indirect signs such as displacement or deformation of adjacent tissues by relatively solid vitreous structures or movements imparted by instrument manipulations – but the absence of these signs does not prove that the vitrectomy is complete.

A more reliable method of defining the evacuated space is by *space occupation with air*. This is done in anterior vitrectomy by holding the incision open and allowing air to enter and replace the aspirated vitreous. The depth of the excision is then evaluated by noting the location and shape of the residual vitreous surface.[11] However, air may be deceptive as an indicator because the surface tension of the air bubble displaces the vitreous fibers (Fig. 9.12b), which later reassume their original position after the air has been absorbed and replaced by aqueous. Consequently the extent of the vitrectomy may prove to be much smaller postoperatively than it appeared at operation. To confirm that a vitrectomy has been carried to the desired depth, *fluid* may be injected when the apparent target depth has been reached (Fig. 9.12c). The residual vitreous

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[9] This operation contrasts with posterior vitrectomy, where surgery is performed close to the retinal surface and the tip opening may be placed close to the retina to peel away vitreous and membranes.

[10] Recall that anterior vitrectomy, unlike posterior vitrectomy, is performed on normal vitreous that is completely transparent.

[11] In anterior vitrectomy, therefore, intially no fluid is infused for volume replacement.

[12] When the resection of detached vitreous reaches the retrovitreous space during the vitrectomy, the rate of air inflow increases abruptly due to the faster evacuation rate of the watery retrovitreous fluid (lower resistance to aspiration) compared with the vitreous.

will level off in the injected fluid medium. Additional vitrectomy may then be performed if need be, and this maneuver can be repeated several times. When there is no more vitreous below the air bubble, only watery fluid, the interfacial meniscus will flatten out and the fluid level will appear flat-surfaced at the center (Fig. 9.13).

An *absence of air inflow* through the open incision during anterior vitrectomy is a warning sign that there is an elevated pressure in the vitreous space as a result of choroidal or scleral compression (Fig. 9.13c). Vitreous cortex then may bulge toward the center and become caught by the suction cutter, posing an imminent threat to the retina. The remedy is to produce a counterpressure against the deforming forces by restoring the pressure chamber of the vitreous. This is done by closing the wound and injecting air to create an artificial pressure chamber (Fig. 9.13d).

9.4 Management of Vitreous Prolapse Caused by Internal Hemorrhage

With bleeding from choroidal vessels, the virtual subchoroidal space expands and may cause expulsion of tissue from the eye (Figs. 9.14a). The degree of the expulsion depends on the point in the process at which the operator is able to effect wound closure.

The rate of the prolapse, the necessary speed of the operator's response, and the necessary quality of the wound closure depend on the pressure in the subchoroidal space, and thus on the pressure in the bleeding vessel (arterial or venous).

The surgeon directs his efforts toward *raising the intraocular pressure* above the pressure level in the subchoroidal space and maintaining that pressure until the pressure in

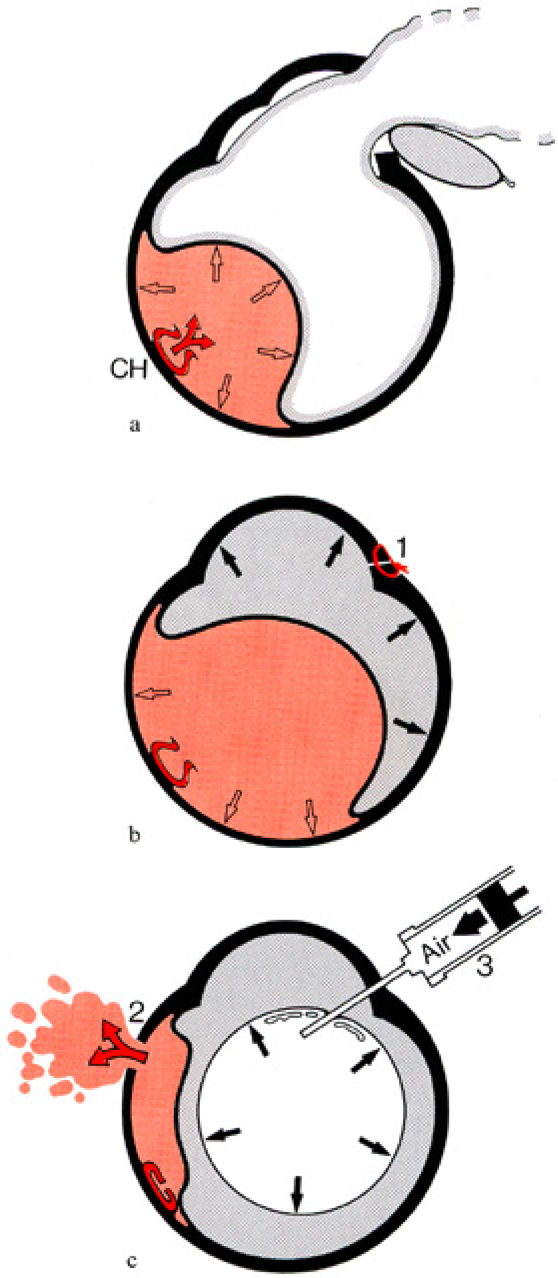

Fig. 9.14. **Management of expulsive hemorrhage**

a Mechanism of expulsive hemorrhage: Rupture of a choroidal artery (*CH*) allows extravasation into the subchoroidal space, the pressure in this space rising to the pressure of the arterial blood. The pressure in the open globe being lower, the newly created subchoroidal chamber can expand and expel the ocular contents out through the wound.

b Initial phase of management (*1*): Restoration of the intraocular pressure chamber. The outflow resistance from the anterior chamber is increased by performing a watertight wound closure. This allows the intraocular pressure to rise again to the level of the arterial pressure, arresting the hemorrhage.

c Phase two (*2*): Evacuation of the subchoroidal chamber through a sclerotomy. Phase three (*3*): The intraocular pressure must be kept high to avoid further extravasation from the damaged vessel. This is done by implanting an artificial pressure chamber in the form of an air bubble

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the subchoroidal space can be lowered. Any measure that lowers the intraocular pressure beforehand (e.g., intrabulbar vitrectomy) will intensify the choroidal hemorrhage and worsen the situation.

The first step is to increase the outflow resistance from the vitreous chamber by effecting a secure **wound closure** (Fig. 9.14b)[13]. The second step is to lower the outflow resistance from the subchoroidal space by **incision of the sclera**. The third step is to raise the pressure in the vitreous space to evacuate the opened subchoroidal chamber. This is accomplished by **injecting air** as an *artificial pressure chamber* (Fig. 9.14c). The injection is continued (or repeated with each step) so that the total intraocular pressure during all maneuvers remains higher than the pressure in the leaking vessel.

Once the pressure in the subchoroidal space definitively has been brought to atmospheric, the initial incision may be reopened for reforming the anterior segment (anterior vitrectomy, repositioning of the iris, etc.).

[13] The urgency of the intervention for arterial hemorrhage makes it advisable to preplace sutures for all intraocular procedures. These *safety sutures* will allow for rapid wound closure, provided they are strong enough to withstand the arterial pressure.

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