7 Operations on the Iris

Healthy iris tissue tends to return spontaneously to its original shape when displaced or deformed owing to its elastic resiliency and the action of the pupillomimetic muscles. However, these forces are weak and cannot overcome even a small frictional resistance. If the anterior chamber has drained or if the iris comes into contact with *air bubbles* or *viscoelastic material*, the iris tissue loses its inherent mobility and will regain it only when reimmersed in *watery fluid*.[1]

7.1 Iris Displacement and Reposition

Owing to its very high mobility, the iris can be partially exteriorized from the anterior chamber and operated on outside the globe. We can distinguish, then, between *intrabulbar* and *extrabulbar* iris operations (Fig. 7.1).

The iris can be exteriorized by means of *traction* (with forceps) or *pressure* (expression). Expression is accomplished by first apposing the iris to the incision, effectively making it part of the chamber wall, and then raising the intraocular pressure until the iris prolapses from the eye (Fig. 7.3).[2] Because the tissue in this prolapse is distended as well as displaced, the actual amount of iris extruded from the eye cannot be determined from the size of the prolapsed bleb. This amount can be estimated, however, by evaluating the *undistended* iris tissue remaining in the anterior chamber (Fig. 7.2).

[1] Pupillomimetic agents per se are ineffective in these situations and therefore should be combined with the injection of watery fluid.

[2] Iris prolapsing spontaneously through the incision when the anterior chamber is entered signifies an elevated intraocular pressure that must be quickly brought under control (main danger: Expulsive hemorrhage!).

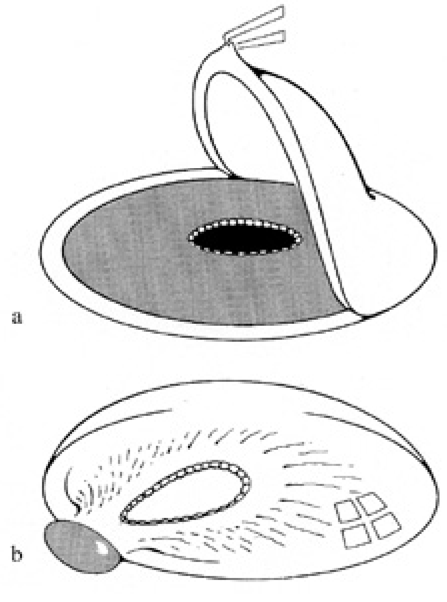

Fig. 7.1. **Approaches for iris operations**

a In the intrabulbar approach, the iris remains in its natural position while surgical instruments are passed into the anterior chamber.

b In the extrabulbar approach, the iris is brought out of the anterior chamber and operated on outside the eye

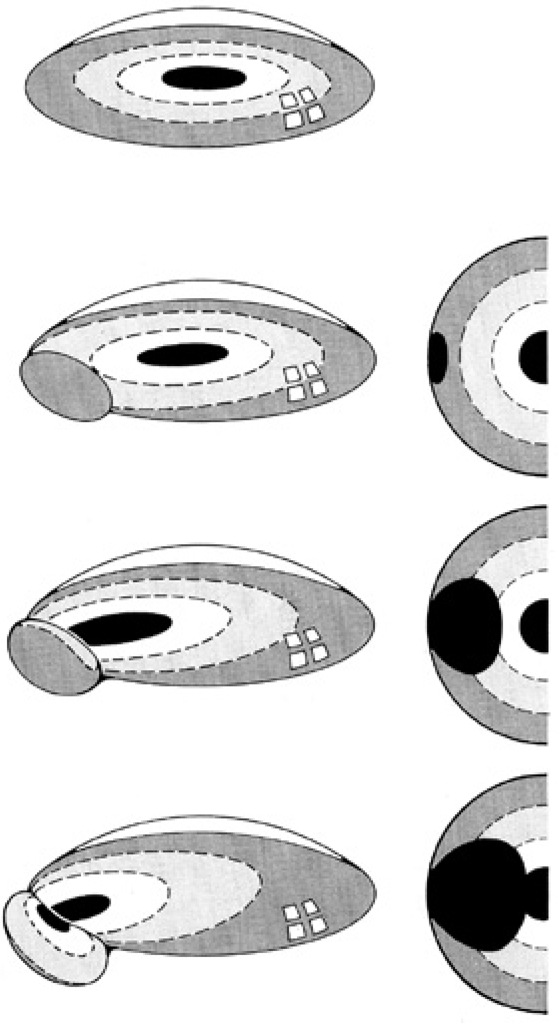

Fig. 7.2. **Visual evaluation of prolapsed iris tissue.** The size of the prolapse is a poor indicator of the quantity of exteriorized tissue. A better indicator is the position of the pupil, which shows how much iris remains in the anterior chamber. For clarity, the drawing shows the iris divided into concentric zones colored different shades of gray. *Left*: All the prolapses appear to be of nearly equal size, but contain different amounts of tissue. *Right*: The true extents of the prolapsed iris are shown in *black*. They indicate the size of the iridectomy that would result if the prolapsed tissue were sectioned flush with the eye surface

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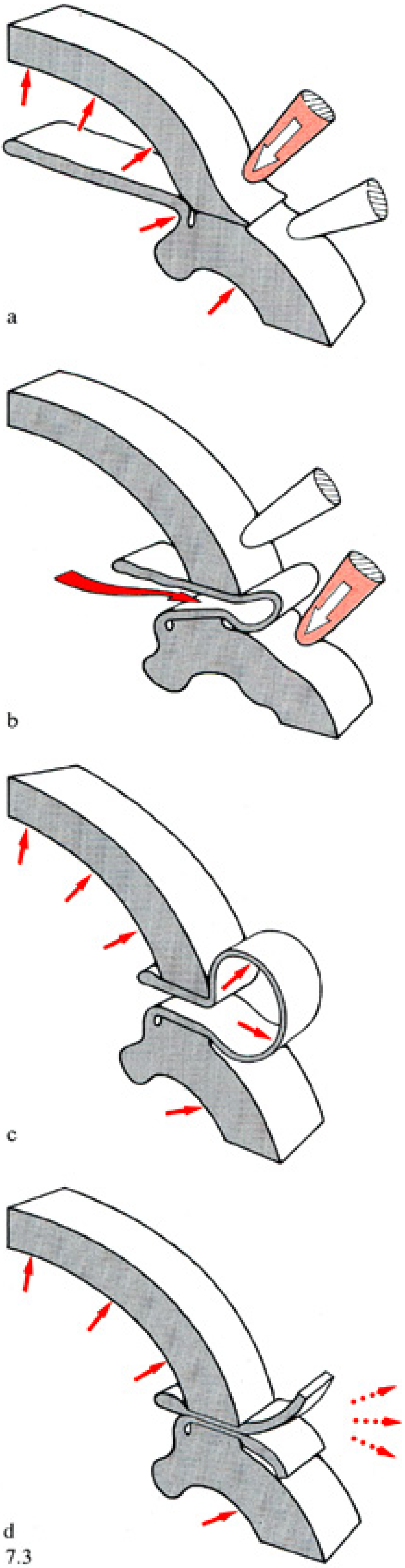
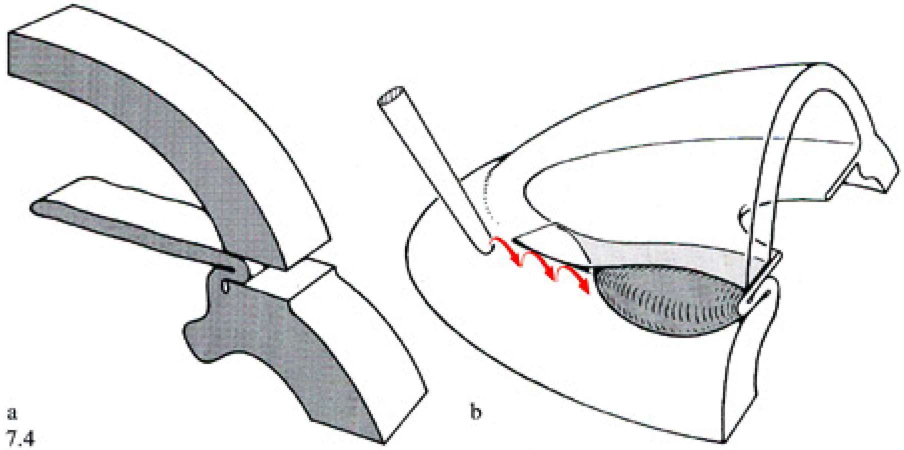


a
b
c
d
7.3



a
7.4
b

Fig. 7.4. **Repositioning the iris by tapping the wound**

a Incarceration of iris in the wound.

b Reposition is effected by tapping along the lower wound margin to momentarily reopen the wound and allow the prolapsed iris to retract into place. This is started well back from the outwardly visible prolapse, because the incarceration is considerably larger internally (*light gray*) than its external portion (*dark gray*) would suggest

7.3. **Expression of the iris**

a Two blunt expressors (e.g., spatulas) are applied to the wound margins. The pressure on the upper instrument seals off the valvular wound and initially raises the intraocular pressure.

b Next the lower instrument is slightly depressed to open the wound and allow extrusion of the iris by the intraocular pressure.

c While lining the wound, the iris becomes part of the ocular wall. A further rise of intraocular pressure will stretch the iris more than the cornea, causing it to bulge outward. The prolapse has the same pressure as the anterior chamber.

d Incising the prolapse destroys its status as a pressure chamber. Once the prolapse has collapsed, additional iris will not be extruded by a further rise in intraocular pressure. Instead, the pressure rise reactivates the valvular mechanism of the wound, and the iris tissue is incarcerated

The first step in *repositioning* the prolapsed iris is to eliminate the factor sustaining the prolapse – the raised intraocular pressure. This pressure is lowered by the removal of aqueous, either by allowing the fluid to drain adjacent to the prolapse (by briefly opening the incision) or by incision of the prolapse itself (Fig. 7.3d). The repositioning maneuver is then completed by aiding spontaneous retraction of the iris or by using an iris repositor.

To fully utilize the **retractile tendency** of the iris, it is necessary to decrease frictional resistance. Friction at the *incision* is eliminated by separating the lips of the incision, taking care in critical situations to hold the wound open as briefly as possible (Fig. 7.4).[3] Friction inside the *anterior chamber* is reduced by

[3] If the vitreous pressure has not been adequately lowered, keeping the incision open too long will only aggravate the iris prolapse and may allow the undesired prolapse of other intraocular tissues.

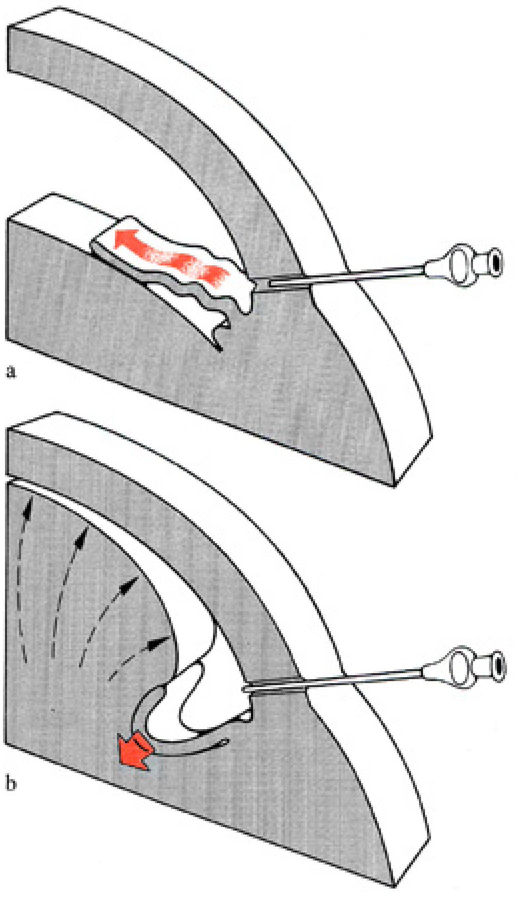


Fig. 7.5. **Repositioning the iris by refilling the anterior chamber**

a The gentle injection of a fluid stream (which may contain a miotic) restores iris mobility and aids spontaneous reposition.

b If the iris is driven downward by a direct fluid jet, the compensatory upwelling of vitreous forms a "mushroom" that hinders pupillary contraction (this is prevented by injecting through a "water-tight" orifice thus restoring the pressure chamber, see Fig. 2.25)

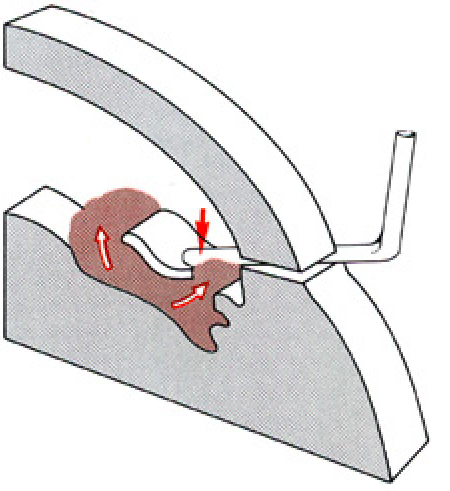


Fig. 7.6. **Repositioning the iris with a spatula** (for the case where there is viscoelastic material behind the iris). The viscoelastic material is not removed from behind the iris by stroking the spatula just in a horizontal direction. The spatula must also press the iris downward (*red arrow*) to extrude the viscoelastic material through the pupil (and through any iridectomy) (*black arrows*). *Note*: The spatula should be moved slowly and held in the depressed position for sufficient time to allow the viscous fluid to flow away

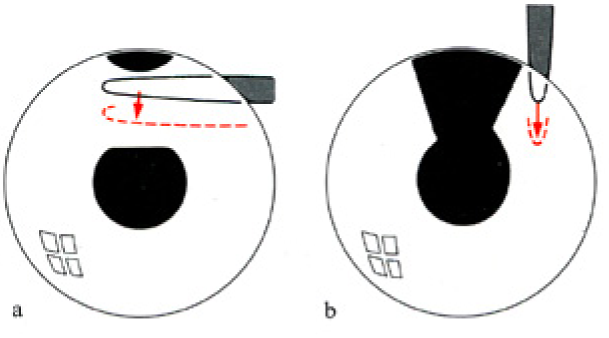


Fig. 7.7. **Repositioning the iris by stroking the stroma.** Spatula movements that go beyond the stroma into the pupil or iridectomy do not improve the effect and actually endanger structures deep to those openings.

a Following peripheral iridectomy, the spatula is inserted beneath the iridectomy from the side and stroked toward the pupil with its long (blunt) side leading.

b Following a sector iridectomy, the spatula may be stroked parallel to the iridectomy and pupil, but not toward them

the injection of watery fluid, to which a miotic (e.g., 0.1%–0.5% acetylcholine) may be added if necessary to stimulate the repositioning action of the iris musculature (Fig. 7.5).

Iris reposition can also be effected directly by applying **spatulas** (repositors) to the trabeculae. In a *watery* milieu the spatula can be stroked horizontally in the natural direction of the iris trabeculae. But if *viscoelastic material* has been placed behind the iris, the spatula also must be pressed downward to indent the viscous mass (Fig. 7.6). Care is taken to *direct* the repositor in a way that avoids vectors toward the pupil or iridectomy; this ensures that any excessive motion of the instrument will not harm structures behind the iris plane (Fig. 7.7).

The success of the repositioning maneuver is judged from the position of the trabeculae, the collar-

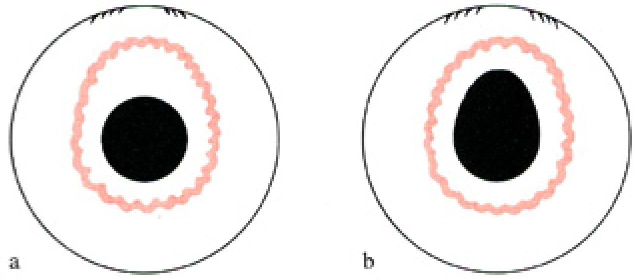


Fig. 7.8. **Diagnosis of iris incarceration**

a Discrete incarceration in distensible tissue. The pupil retains a normal shape and position, because the tissue between the pupil margin and incarceration site is adequately distended. This distention, signifying incarceration, is evidenced only by a displacement of the collarette.

b Discrete incarceration in poorly distensible tissue. The pupil is distorted into an ellipse whose long axis points toward the incarceration site. Note that here the collarette is uniformly distant from the pupil margin

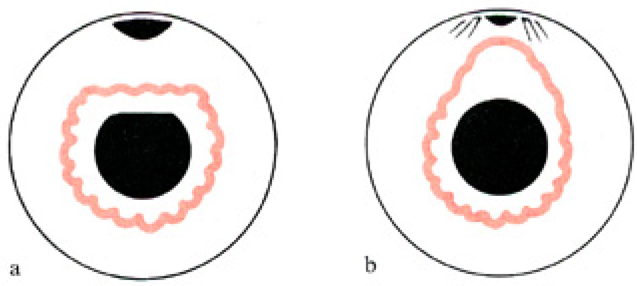


Fig. 7.9. **Iris incarceration in a peripheral iridectomy**

a The criterion for successful iris reposition after peripheral iridectomy is a pupil flattened on the side of the iridectomy, since division of the iris root causes the sphincter force to predominate at that location.

b A round pupil following peripheral iridectomy may signifie an incarceration of iris tissue (check the position of the collarette! See Fig. 7.8a)

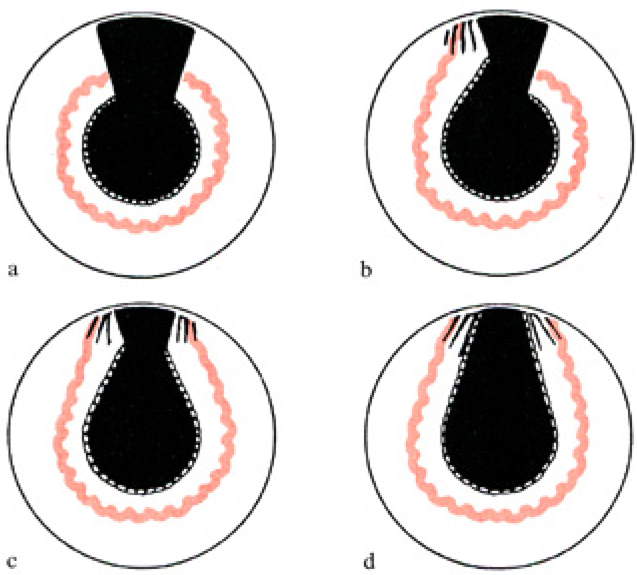


Fig. 7.10. **Incarceration in a sector iridectomy**

a The criteria for successful iris reposition: The pupil margin and the collarette are everywhere equidistant from the root, the sides of the iridectomy are of equal length, and its corners are well formed.

b Partial unilateral incarceration: The pupil margin is displaced upward, and one corner is blunted.

c Partial bilateral incarceration.

d Total bilateral incarceration. The corners of the iridectomy are ill-defined, and the pupil margins extend toward the wound

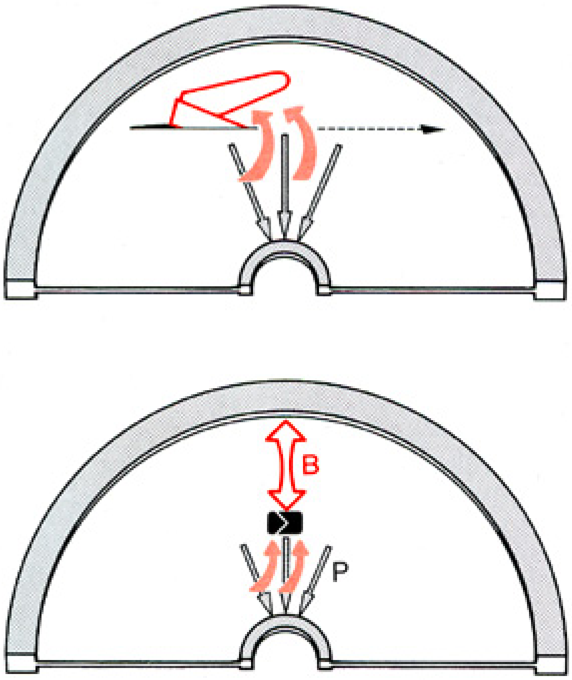
ette, and the *shape of the pupil* (Figs. 7.8–7.10).

Failure of all these maneuvers implies the presence of *other obstructions* such as incarcerated lens capsule or vitreous. Clearing these obstructions exceeds the bounds of simple iris reposition and necessitates more extensive measures geared toward the properties of the tissues involved.

7.2 Grasping and Cutting

Because the iris tissue is so mobile, its sectility is low. On the one hand this is helpful in preventing iris injury, but on the other it complicates the conduct of precise manipulations. Due to the *forward shifting tendency* of the iris (see Fig. 2.62), incisions are shorter than the distance actually traveled by the cutting edge. Thus, if the cut is to be made with a single snip of the scissors, the blades must be considerably longer than the proposed incision.

The *lateral shifting tendency* causes tissue to shift toward sites of anatomic or instrument fixation (see Fig. 2.63). In the *ungrasped* iris the tissue shifts toward the iris root, so that the resulting incision deviates toward the pupil (Fig. 7.11a). Grasping the iris with *forceps* creates new fixation sites (Fig. 7.11b), and the shift tendencies be-

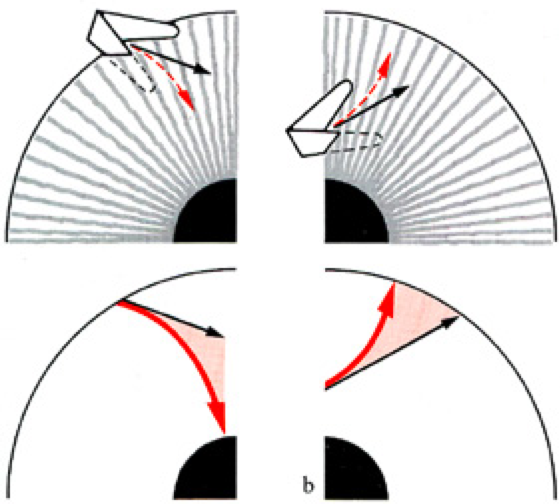


7.11 a b

Fig. 7.11. **Shifting tendencies caused by unilateral fixation**

a Tissue ahead of the cutting edge tends to shift toward the periphery (*thick arrows*), so that the resulting cut deviates progressively toward the pupil. This tendency can be partially offset by the pull of the iris sphincter (*thin arrows*). As a result, there is a marked tendency toward peripheral tissue shifting in mydriasis, but in miosis this tendency can be neutralized by sphincter traction.

b Grasping the iris with a fixation forceps creates two zones in which different tensions prevail. From the iris root to the forceps (peripheral zone *B*), the iris behaves as if it were fixed bilaterally, but from the forceps to the pupil margin (pupillary zone *P*) it behaves as if fixed unilaterally (i.e., by the fixation forceps alone)



7.12 a b

Fig. 7.12. **Lamellar deflection in the iris.** The cut tends to deviate onto a path parallel to the iris trabeculae.

a Cuts angled away from the iris root tend to deviate toward the pupil (*red arrow*). This leaves more tissue in the area between the iris root and the incision than planned.

b Cuts angled toward the periphery are deflected onto a path perpendicular to the iris root. The area between the iris root and the incision (*red arrow*) is smaller than that corresponding to the guidance direction (*black arrow*). The discrepancy between the intended cut and the resulting cut is shown in pink (*below*)

come more complex: The tissue between the iris root and forceps behaves like tissue with bilateral fixation, so the "rule of retraction" applies (see Fig. 2.64). There is only unilateral fixation between the forceps and pupil. This produces a lateral shifting tendency whose extent depends on the countertraction of the iris sphincter.

Lamellar deflection is a less important phenomenon in the iris, but it can affect an incision that is carried obliquely across the trabeculae (Fig. 7.12). The extent of the deflection depends on the difference between the resistances of the trabeculae and the interstitial tissue.[4]

Pathologic tissue changes[5] can radically alter the tactics of iris operations. The altered iris tissue becomes inelastic and immobile; thus it becomes more sectile and tears in response to the slightest insult. The primary task of the surgeon in this situation is to *restore iris mobility*. Pathologic fixation to surrounding tissue (synechiae) must be divided, and rigid tissue must be mobilized by relaxing incisions.

[4] Thus, lamellar deflection is most conspicuous in the pale iris and less so in the heavily pigmented iris, which has a more homogeneous structure.

[5] E.g., scarring after inflammations, atrophy following acute glaucoma or previous laser treatments, pronounced senile degeneration, etc.

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7.3 Iridectomies

It is difficult to predict the exact size of an iridectomy because of the shifting tendencies of the tissue, which change constantly during manipulations. When dealing with a specific clinical problem, therefore, the surgeon must decide which criteria are the most important (e.g., securing a basal position of the iridectomy, Fig. 7.13) and where compromises may be tolerated (e.g., the shape and size of a peripheral iridectomy).

The basic technique for iridectomy is to excise the tissue at the apex of the **pyramid** formed when the tissue is tented with a forceps. The portion of the pyramid lying above the guidance path of the scissors is excised, and the underlying portion retracts into the anterior chamber. But the shape of the iridectomy cannot simply be estimated from the geometry of the pyramid and the plane of the scissors, because the different faces of the pyramid are under different degrees of tension (Fig. 7.16). Thus, excisions in pyramids of identical geometric configuration can yield strikingly different results.

Controlling the shape and position of the iridectomy is basically a matter of properly coordinating the *fixed* and the *variable* quantities that are associated with the cutting and grasping of iris tissue.

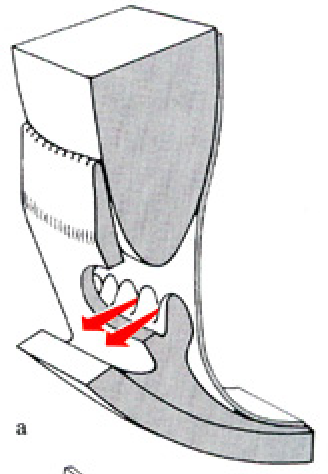
A major *fixed, predetermined quantity* in **cutting** is the starting point of the iridectomy, i.e., the site where the scissors are applied. Also predetermined is the longitudinal axis of the excised oval, which follows the direction of motion of the cutting point, i.e., the direction of the scissor blades (Figs. 7.14, 7.15). The width of the iridectomy is *variable*, however, for it depends on the shifting tendency of the tissue. The length of the iridectomy is also variable for the same reason (except when the cut is directed toward the iris root, see Fig. 7.15).

Another factor affecting the size of an iridectomy is the *bleb* of iris tissue that forms above the scissor blades as closure of the blades is initiated. As the pressure inside the bleb rises, it can create an additional force that shifts the tissue ahead of the scissor blades. When the blades are closed slowly, surrounding iris tissue tends to be drawn into the bleb, which becomes progressively larger.[6] Once incised, however, the bleb collapses, and part of the tissue previously drawn into the bleb retracts to its former position.[7] Thus, there is a "*bleb phase*" of the iridectomy in which the excision tends to be larger than planned and a "*collapse phase*" in which the excision becomes smaller. The precision of the cut can be improved by closing the scissors rapidly and allowing no time for shifting to occur.

On **grasping**, the site of application of the forceps determines several *fixed quantities*: the minimum

[6] This tendency is strongest when the scissor blades are long and the interblade angle is small during cutting (e.g., de Wecker's scissors).

[7] This may happen with a short-bladed scissors that cannot transect the whole iris pyramid at once (e.g., Vannas scissors).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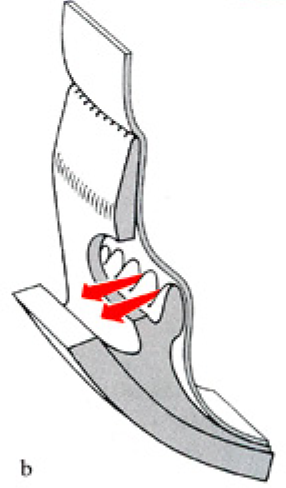

b

Fig. 7.13. **Size and placement of an iridectomy to restore aqueous circulation in case of pupillary block.** Adhesion of the margins with surrounding structures is avoided by placing the iridectomy so that it cannot come in contact with neighboring tissues. Peripheral placement of the iridectomy will ensure adequate clearance of the iris from the lens capsule and anterior hyaloid in both the phakic (**a**) and aphakic eye (**b**). Contact is unlikely even with a lax and bulging anterior hyaloid, because the ciliary processes act like a rake to hold the membrane back. The size of the iridectomy is less critical than its placement. The only caveat is that the opening should not project far enough into the optical axis to cause visual disturbance (e.g., diplopia)

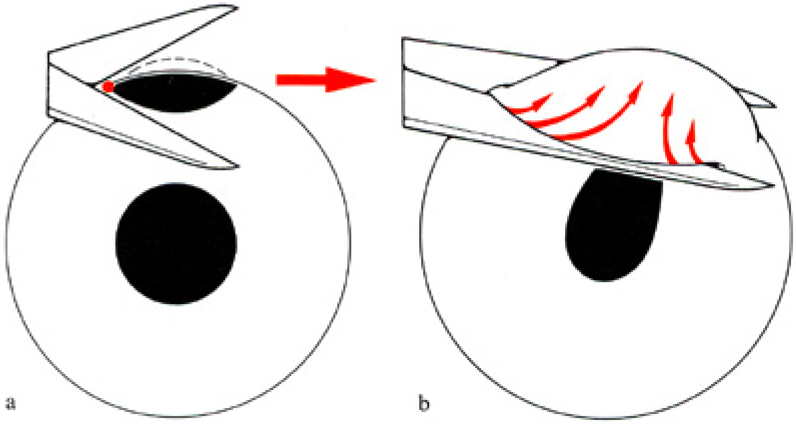


Fig. 7.14. **Directing the scissors parallel to the iris root**

a Directing the scissors parallel to the iris root produces a broad iridectomy with a transverse oval shape. The site where the cutting point is applied (*red*) defines the position of one lateral edge of the iridectomy, but the maximum pupillary extent and end point cannot be predicted.

b The tissue is shifted peripherally by the advancing cutting point. The resulting iridectomy extends farther toward the pupil than the blade position would indicate. There is a risk of sector (pupil-to-root) iridectomy

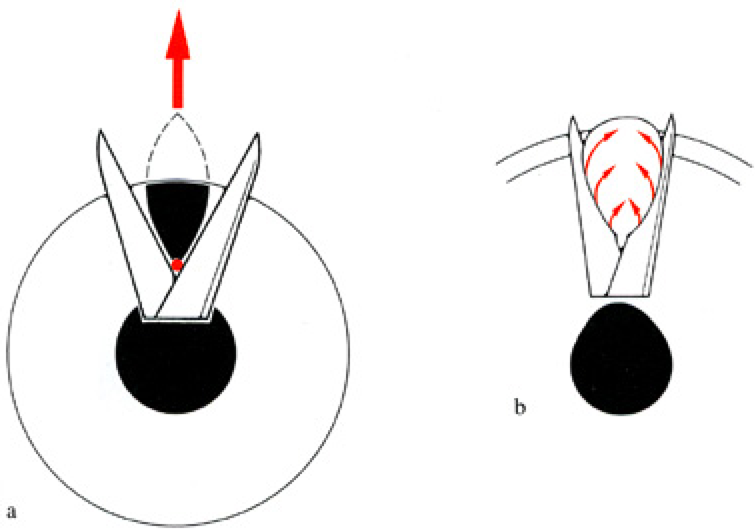


Fig. 7.15. **Directing the scissors toward the iris root**

a Cutting toward the iris root produces a narrow iridectomy with a radially oriented longitudinal axis. The maximum pupillary extent is determined by the site where the cutting point is applied (*red*).

b The lateral extent depends on the mobility of the tissue gathered toward the cutting point from both sides. This mobility is constrained by the lamellar structure of the trabeculae (see Fig. 7.12a) and the peripheral fixation

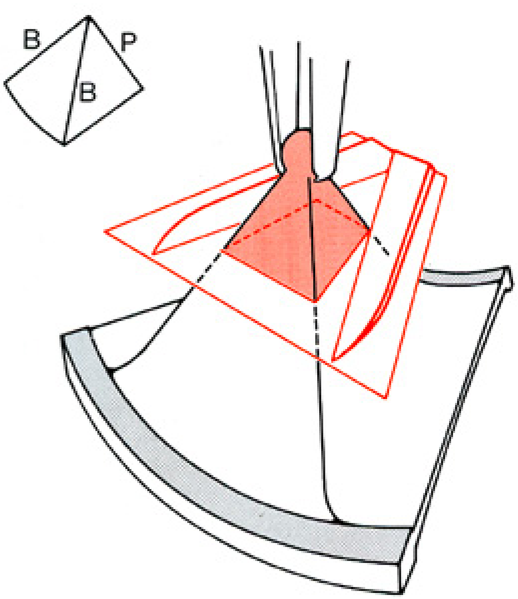
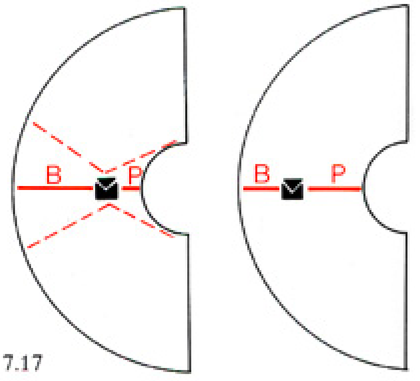


Fig. 7.16. **Forming and sectioning the "iris pyramid."** Traction on the grasping forceps raises the iris into the shape of a pyramid. All tissue located above the guidance path of the scissor blades (*red*) is excised. If the pyramid were composed of firm, noncompliant material, either raising the forceps or lowering the plane of the scissor guidance path would yield the same result. But the iris is compliant, resilient, and is fixed unilaterally at its root; therefore each of these actions produces a different result.
B: Peripheral (basal) portion of pyramid
P: Pupillary portion

distance of the excision from the iris root (Fig. 7.17), the minimum peripheral width of an iridectomy directed toward the iris root (Fig. 7.18), and the minimum size of the iridectomy (Fig. 7.19). *Variables* in the procedure relate to the force and direction of the traction that is applied. Changing the *strength of the traction* alters the tension on the *basal side* of the pyramid but does not affect the amount of tissue there; meanwhile the tension on the *pupil side* remains low, but the amount of tissue in that area is affected. Changing the *direction of traction* draws different portions of the iris across the plane of the scissors and incorporates them into the excision. Thus, traction toward the pupil draws more peripheral tissue into the excision, whereas céntrifugal traction incorporates more of the central portion (Figs. 7.20, 7.21). The same effects can be achieved without moving the forceps simply by *changing the inclination of the scissors* (Fig. 7.22).



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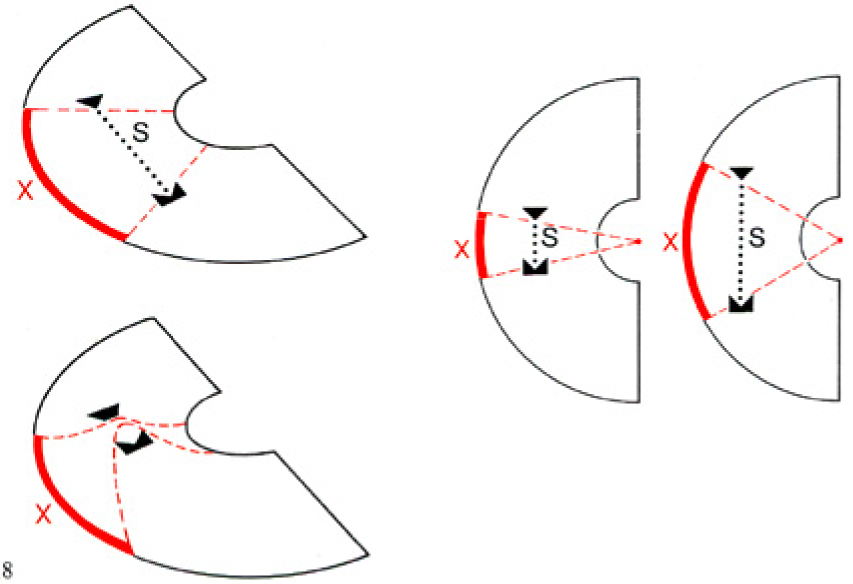

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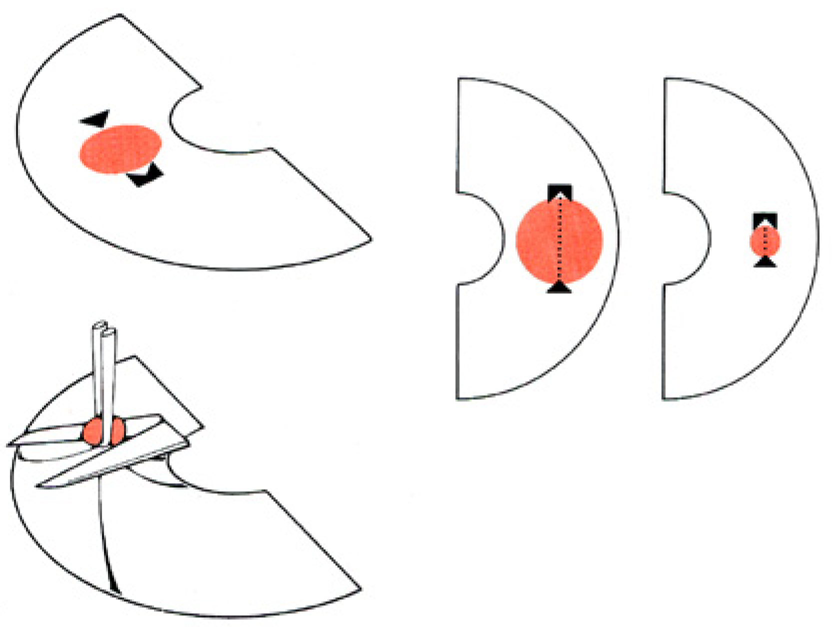


7.19

Fig. 7.17. **Fixed quantities determined by application of the forceps**. The forceps placement determines the *distance from the pyramid apex to the iris root* (*B*) and to the pupil (*P*). Because the application site is always included in the excision, it determines the minimum distance of the excision from the anatomic boundaries of the iris

Fig. 7.18. **Fixed quantities determined by application of the forceps: Peripheral width of the iridectomy**. At a given distance from the iris root, the separation of the forceps blades (*S*) determines the peripheral width (*X*) of the iris "pyramid" and thus the maximum peripheral width of the iridectomy (*left*) that can be achieved by sectioning the pyramid with one snip of the scissors. *Right*: Examples of basal widths for different blade separations

Fig. 7.19. **Fixed quantities determined by application of the forceps: Minimum size of the iridectomy**. *Left*: The blade separation determines the minimum size of the iridectomy (*top*), which can be no smaller than the area grasped between the blades (*bottom*). *Right*: Examples of minimum iridectomy size for various blade separations

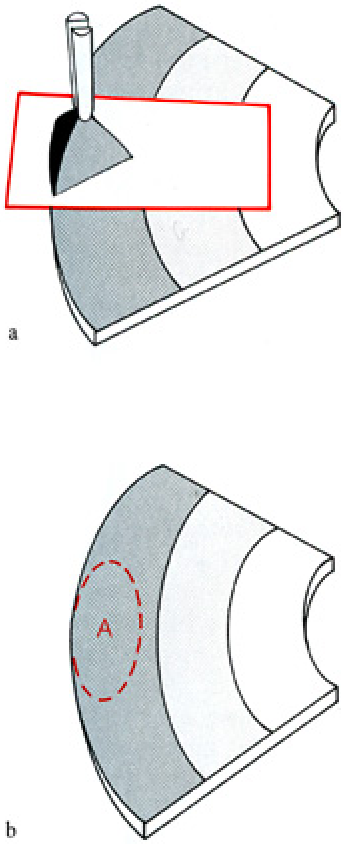
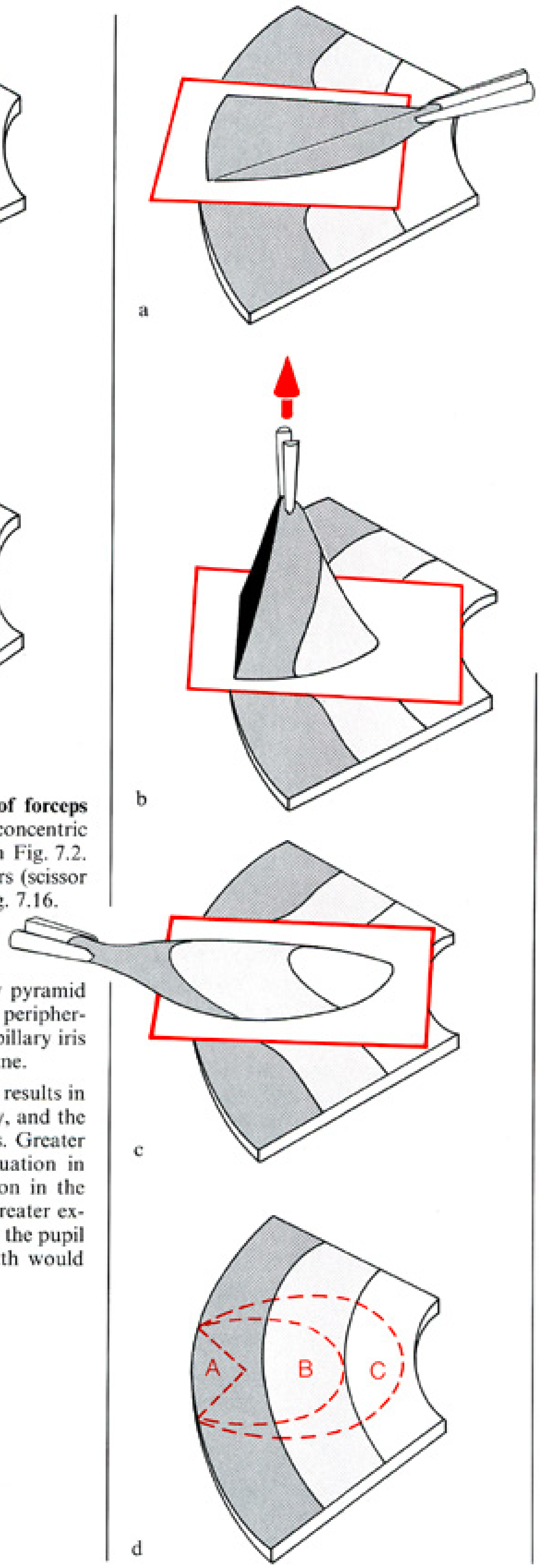


Fig. 7.20. **Effect of the degree of forceps traction on the iridectomy.** The concentric gray zones follow the pattern in Fig. 7.2. The guidance path of the scissors (scissor plane) is outlined in *red* as in Fig. 7.16.

a Mild traction produces a low pyramid which places little tension on the peripheral iris and draws little of the pupillary iris (*dark gray*) across the scissor plane.

b Excised area. The low tension results in a strong lateral shifting tendency, and the iridectomy has rounded margins. Greater traction would produce the situation in Fig. 7.21 b, with increased tension in the peripheral iris (*dark gray*) and greater extension of the iridectomy toward the pupil (*light gray*). The peripheral width would remain unchanged



◄ Fig. 7.21. **Effect of the direction of forceps traction on the iridectomy.** Changing the direction of the traction without changing its magnitude does not affect the peripheral iris tension but does affect the amount of tissue drawn from the pupillary portion above the plane of the excision.

a Traction toward the pupil yields the smallest iridectomy (includes only the *dark gray* zone). Because the peripheral iris is very tense (in contrast to Fig. 7.20a), the iridectomy is narrower and has straight margins (see **d**).

b Upward traction draws part of the central iris into the iridectomy (*light gray* zone).

c Traction toward the iris root draws more pupillary tissue above the scissor plane (*white* zone).

d Iridectomies *A*, *B* and *C* obtained in situations **a**, **b** and **c**

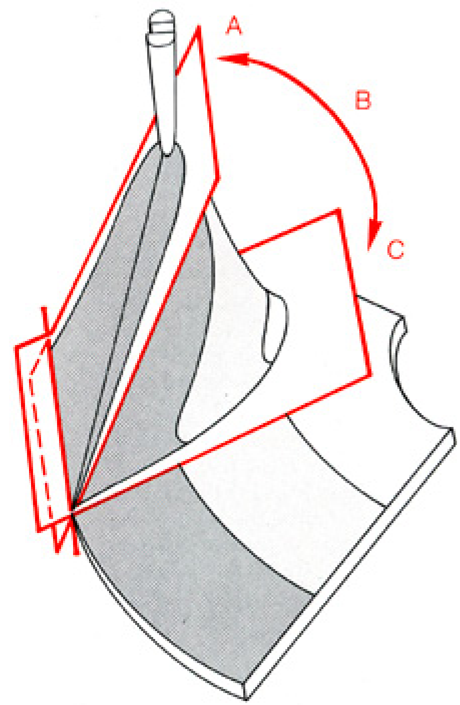


Fig. 7.22. **Effect of the angle of scissor application on the iridectomy.** By changing the inclination of the scissors while holding the forceps stationary, the surgeon can tailor the iridectomy just as he can by changing the direction of forceps traction while holding the scissors stationary. The iridectomies resulting from scissor positions *A* and *B* correspond to those in Fig. 7.21 d

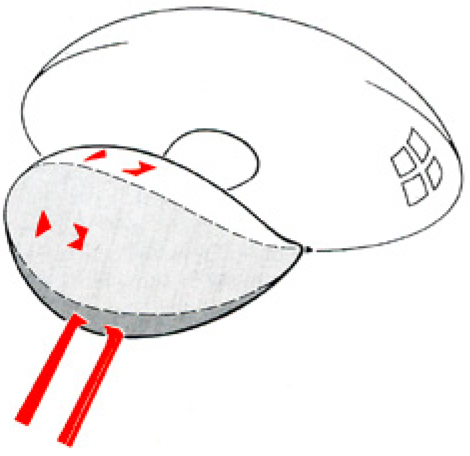


Fig. 7.23. **Extrabulbar iridectomy**. Because the tissue in the prolapse is stretched, it is difficult to estimate the true distance between the site of forceps application (*red*) and the iris root. An iridectomy of minimum size is obtained by grasping the prolapse as close as possible to the basal lip of the incision (*dark gray* zone). Grasping at sites higher on the bleb yields larger iridectomies. The maximum width of the iridectomy at the root is limited by the width of the incision

Fig. 7.24. **Effect of the direction of traction on intrabulbar and extrabulbar iridectomies**

a In an intrabulbar iridectomy, changing the direction of traction brings new tissue above the guidance plane of the scissors (*red*); this alters the shape of the iridectomy as in Fig. 7.21.

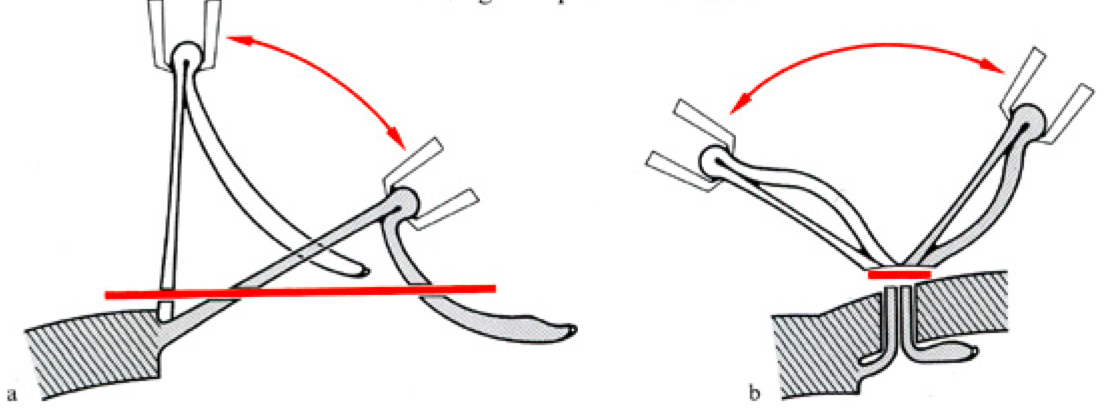
b In an extrabulbar iridectomy, changing the *direction* of traction does not affect iris lying above the guidance plane. Thus the shape of the iridectomy depends on the *degree* of traction rather than its direction

Performing an **extrabulbar** iridectomy changes the distribution of tension on the iris tissue and alters its topography. When the iris is **grasped** with a forceps, it is more difficult to estimate the distance between the site of forceps application and the anatomic boundaries of the iris (root, pupil margin) (Fig. 7.23). The maximum *peripheral width* of the extrabulbar iridectomy is no longer determined by the separation of the forceps blades (see Fig. 7.18) but depends chiefly on the width of the corneoscleral incision, for only tissue lying directly below the opening can be sectioned close to the root (tissue drawn into the prolapse from the side is not divided at the root). As in the intrabulbar procedure, the *amount of tissue* that is drawn *across* the scissor blades depends on the *degree* of traction. The *direction* of the traction is of lesser importance, because friction at the lips of the incision creates a new fixation zone that hinders tissue movement from the pupillary zone (Fig. 7.24).

The main difficulty in **cutting** is to get close to the iris root. If this is attempted by pressing the scissor blades firmly against the ocular surface, there is a danger of raising the intraocular pressure and enlarging the prolapsed bleb. If the planned *size of the iridectomy* just equals the quantity of prolapsed tissue, enlargement of the bleb can be prevented by cutting the iris quickly with a single snip of the scissors. Alternatively, if the iridectomy is to be *smaller* than the prolapsed tissue, the bleb is incised and allowed to collapse before the excision is performed.

Although many factors influence the excision of freely mobile iris, there are several **practical guidelines** for the technique of iridectomy: The best precision is achieved by cutting *toward the iris root*. The maximum pupillary extent of the iridectomy is then determined by the site of scissor application, and lateral shifting is reduced by the high tension in the peripheral part of the pyramid and by cutting parallel to the trabeculae (Fig. 7.15). If the cut is made *parallel to the root*, however, the shifting tendencies of the tissue will tend to make the iridectomy larger than planned. In this case the pupillary extent of the iridectomy is not limited by the site of scissor application, but depends chiefly on iris mobility. The tissue will tend to shift continuously from the lax pupillary part of the pyramid toward the forceps or the root, this tendency being reinforced by the cross-trabecular trajectory of the cut (Fig. 7.14). The result of this may be an unintended sector iridectomy if the cut crosses the pupil margin.

The following practical examples serve to illustrate how the above tendencies can be utilized to achieve specific goals:



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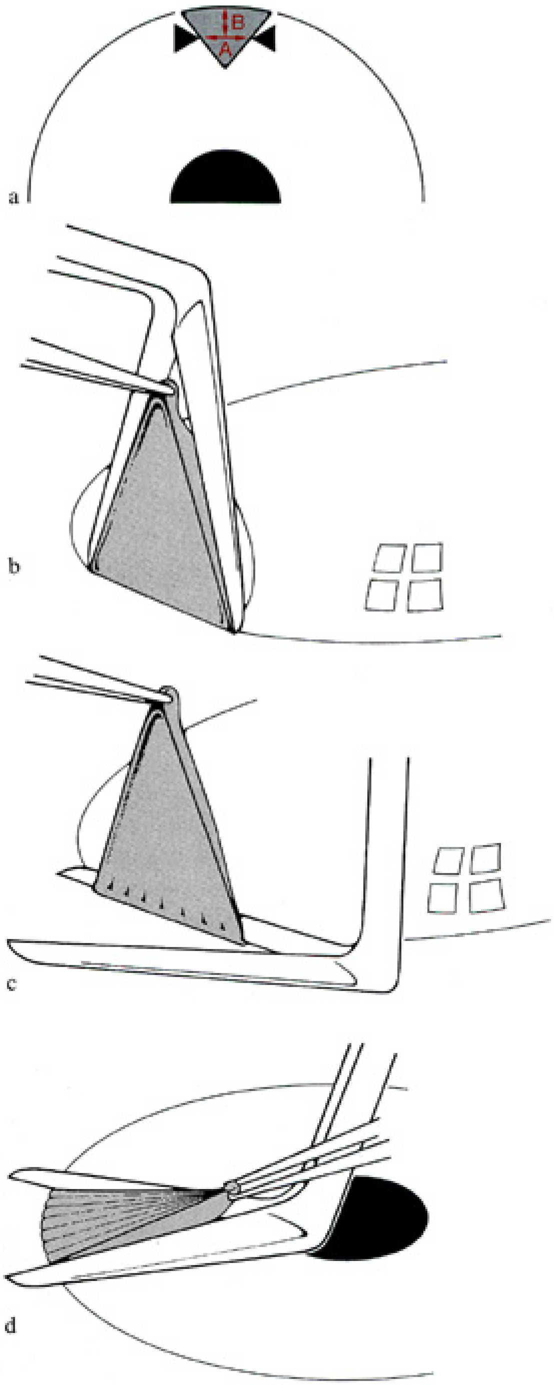

Fig. 7.25. **Objective**: **Peripheral iridectomy of minimal size**.
Grasping: Small blade separation (*A*) and short distance from iris root (*B*).
Traction: Firm in the direction of the cutting point.
Cutting: Position of guidance plane: In tense part of pyramid (i.e., just below forceps), close to traction fold, close to iris root. Guidance direction: Toward iris root.

a Diagram of planned shape of iridectomy.

b *Extrabulbar* iridectomy: Selection of tense portion by inclining the scissors.

c Excision of the incised triangle by cutting along the iris root.

d *Intrabulbar* iridectomy: Selection of tense portion by directing traction just above the scissor blades. Since the scissor blades are parallel to the iris plane, they may extend beyond the base. The excision is done with one snip of the scissors

A **peripheral iridectomy** of *minimum size* (Fig. 7.25) is obtained by cutting mostly in the tense portion of the pyramid. This places the iridectomy closer to the root by exploiting the retractile tendency of the iris tissue. Additionally, the cut is directed toward the root to define the maximum pupillary extent of the excision from the outset and reduce lateral shifting (see Fig. 7.15).

To obtain a peripheral iridectomy that is somewhat *larger than a given excised corneal opening*,[8] surrounding iris tissue must be drawn into the area between the scissor blades (Fig. 7.26). The blades are directed along the longitudinal axis of the corneal opening (Fig. 7.14).

A **sector iridectomy** made with a *single snip* of the scissors (Fig. 7.27) will always have rounded edges, because much of the excision is performed in lax tissue.[9] If the goal is a sector iridectomy with straight margins, the excision must be performed in *several steps* (Fig. 7.28).

[8] E.g., in an antiglaucomatous fistula made with a trephine or scissors (trabeculectomy), the iridectomy may be made larger than the corneal opening to avoid synechiae with the wound margin.
[9] If the forceps is applied at the pupil margin to make the tissue tense, the resulting iridectomy will be triangular in shape, i.e., narrower peripherally than at the pupil.

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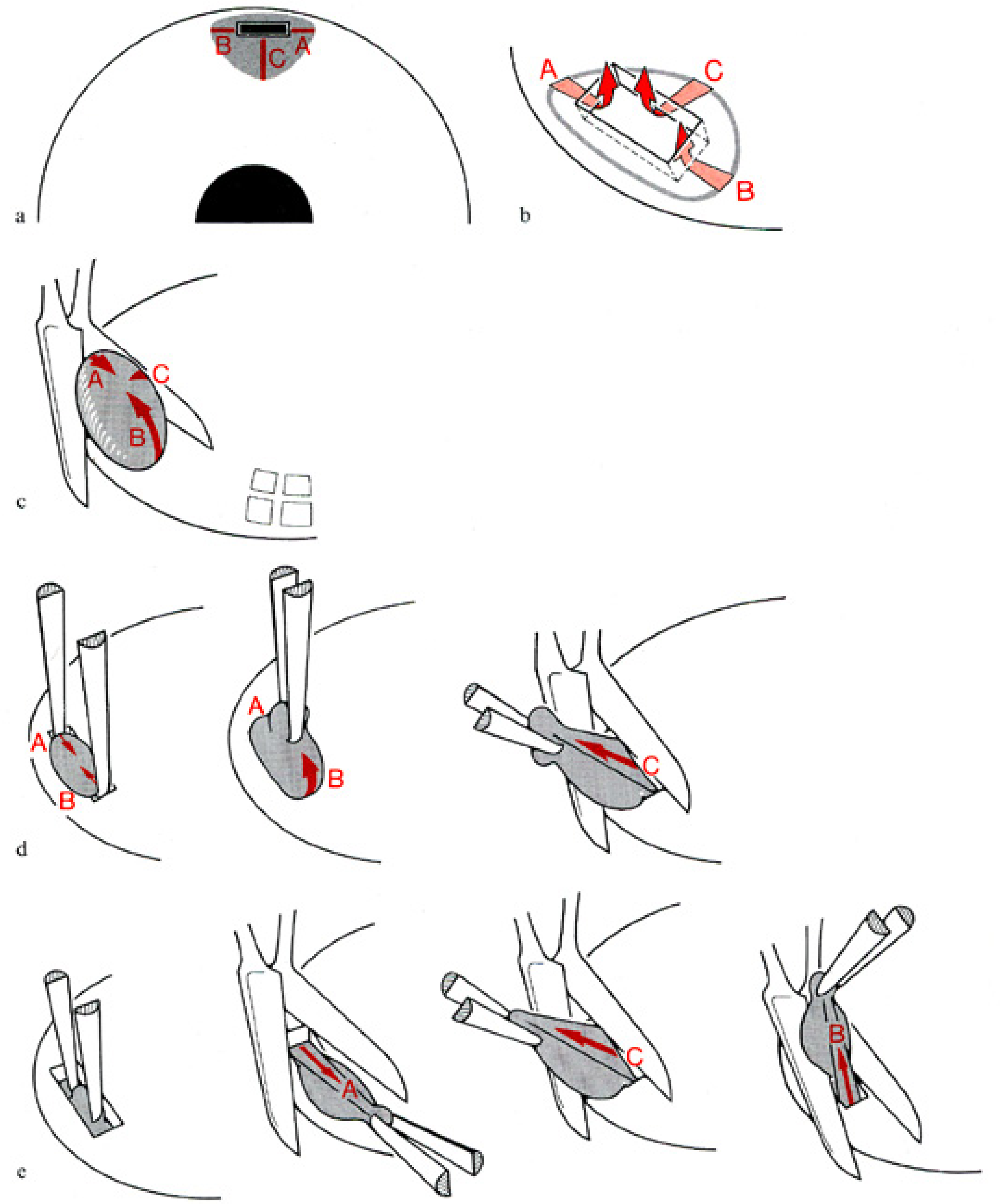

7.26. **Objective: Peripheral iridectomy larger than a given corneal opening**

a Diagram of the planned shape of the iridectomy: The margins of the iridectomy are to lie at distance ABC from the margins of the corneal opening (black rectangle).

b *Task*: Iris tissue must be exteriorized from the areas corresponding to ABC.

c *First method*: Segments *ABC* are exteriorized by spontaneous prolapse. Control is difficult, and the effect is hard to judge due to stretching of the tissue (see Fig. 7.2).

d *Second method*: Segments *A* and *B* are exteriorized by closure of the forceps. If the forceps grasp the edges of a small spontaneous prolapse, segments A and B are both exteriorized by closure alone. Segment *C* is exteriorized by additional forceps traction toward the iris root.

e *Third method*: Segments *ABC* are exteriorized purely by forceps traction. If the iris is grasped with a small blade opening, forceps closure effects very little tissue displacement. Segments *A*, *B* and *C* are exteriorized by consecutive traction toward the scissors tip, iris root, and cutting point

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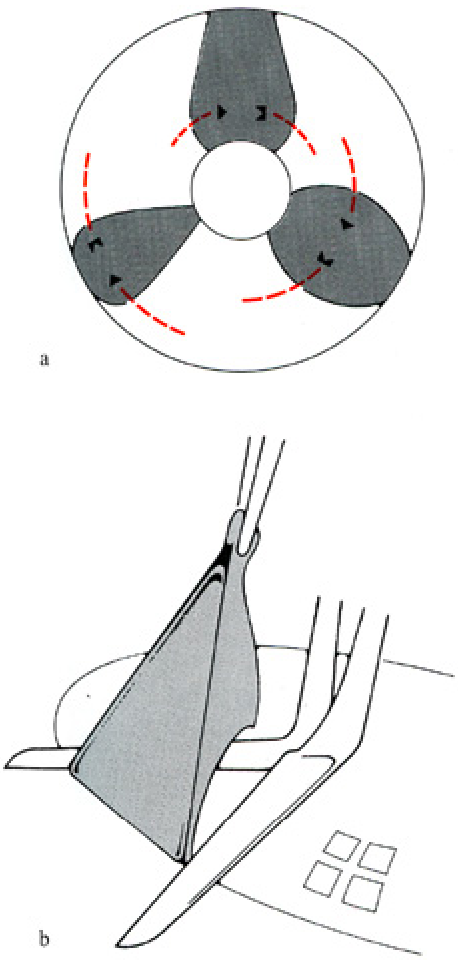
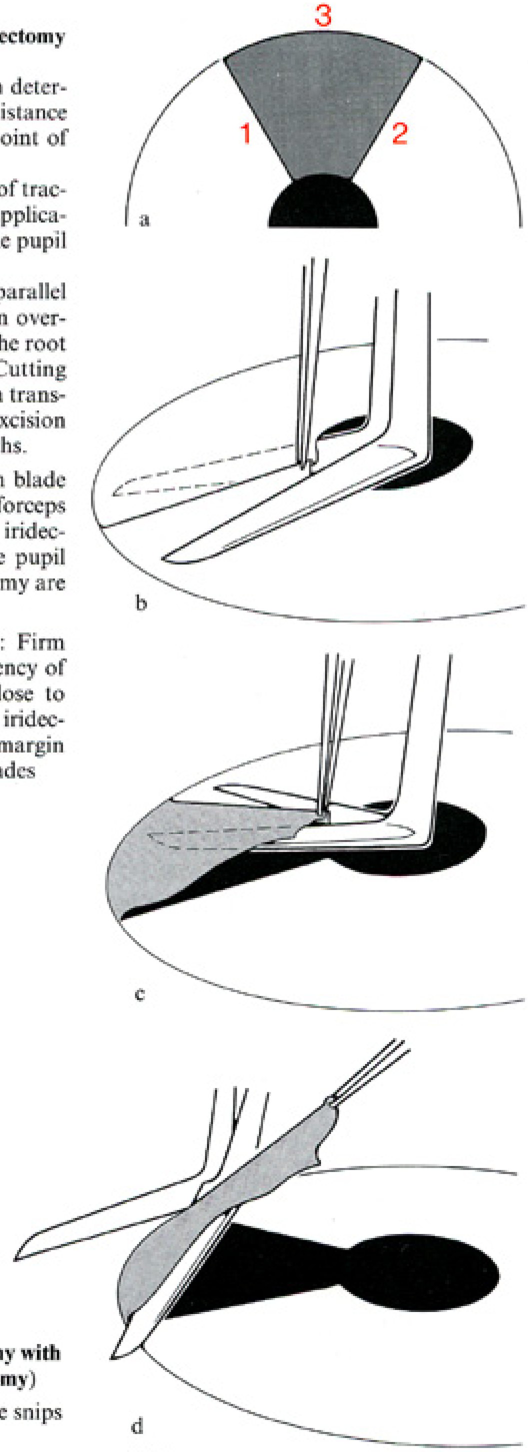


7.27

Fig. 7.27. **Objective: Sector iridectomy with a single snip of the scissors**
Grasping: Forceps blade separation determines the minimum width. The distance from the iris root determines the point of greatest width.
Traction: The direction and degree of traction depend on the site of forceps application. The traction serves to bring the pupil margin above the scissor blades.
Cutting: The blades are directed parallel to the iris plane so that the tips can overhang the iris root. Cutting toward the root produces upright ellipses as in **a**. Cutting parallel to the root would produce a transverse ellipse with a large stromal excision for similar pupillary and basal widths.

a Shape of iridectomy: For a given blade separation, the distance of the forceps from the iris root determines the iridectomy width at the root and at the pupil margin. The margins of the iridectomy are rounded.

b Criteria for controlling traction: Firm traction exploits the retractile tendency of the iris to place the iridectomy close to the iris root. In a single-snip sector iridectomy, it is essential that the pupil margin be drawn above the plane of the blades



7.28

Fig. 7.28. **Objective: Sector iridectomy with straight margins ("keyhole" iridectomy)**

a Diagram of iridectomy (with three snips of the scissors).

b Step 1: The pupil margin is grasped at one corner of the planned iridectomy. The cut is made along the traction fold (for minimum deviation).

c Step 2: A similar cut is made from the other corner.

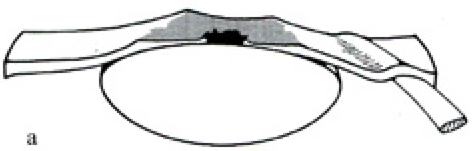
d Step 3: Excision is completed along the iris root. Firm tension is applied to exploit the retractile tendency of the tissue

7.4 Synechiolysis

When a **solid spatula** is used for the blunt division of synechiae, it is directed in a way that maximizes tissue sectility (by increasing the tissue tension) and minimizes resistance (by applying the spatula at right angles to the adhesions) (Fig. 7.29).

When **viscoelastic material** is applied as a "soft spatula," the material will flow along the path of least resistance. Thus, if the resistance at the pupil margin is high in the presence of posterior synechiae, the injected material may rupture the zonule and subluxate the lens rather than divide the synechiae (Fig. 7.30). This is avoided by preliminary synechiotomy with a *solid spatula* (this may be the injection cannula itself), creating a *path of low resistance* leading to the pupil. After preparation of this route of escape, synechiolysis with a soft spatula can begin.

Visual confirmation that the synechiolysis is proceeding well relies on an absence of concomitant motion in the rest of the iris stroma. Such motion is a warning sign that potentially damaging forces are being transferred to sites other than the synechiae. Thus, for example, if the synechial attachment is stronger than the anatomic attachment of the iris root,[10] any attempt to divide the synechiae would most likely cause an iridodialysis. Firm synechiae of this kind are better excised altogether and the resulting defect repaired by an iridoplastic procedure.



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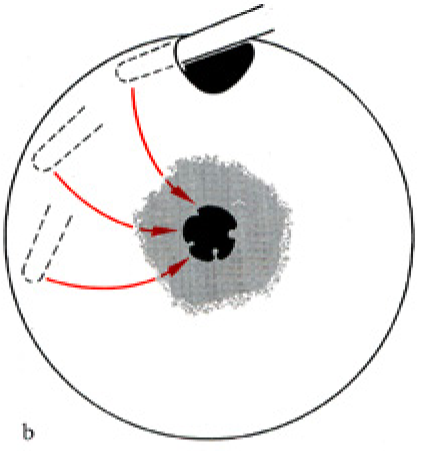
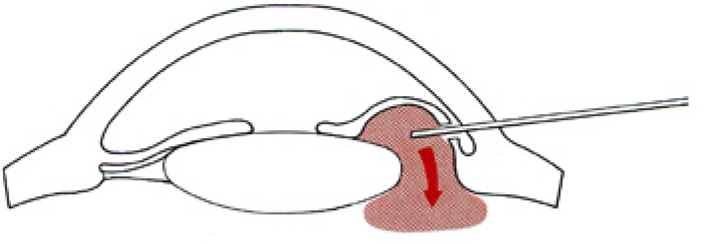


b

Fig. 7.29. **Separation of posterior synechiae**

a The spatula is inserted into an area presumed to contain no adhesions (i.e., the space peripheral to the lens margin). For visual control, the spatula position is indicated by a bulge in the iris (which can be accentuated by raising the spatula slightly without advancing it).

b The synechiae are cleared by sweeping the spatula in a centripetal direction, i.e., the direction in which the greatest tissue tension is produced (shortest path to fixation point at iris root) and resistance is minimal (smallest diameter of adhesion zone, *gray*)



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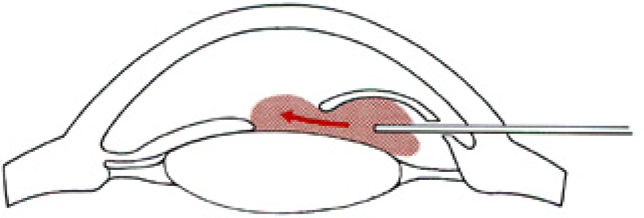

b

Fig. 7.30. **Separation of posterior synechiae with a viscoelastic spatula**

a If the resistance of the synechiae is higher than that of the zonule, the injected material may penetrate the zonule and cause an unintended zonulolysis.

b This is avoided by dividing the synechiae at one site with the tip of the injection cannula to allow surplus material to escape toward the pupil

7.5 Surgical Enlargement of the Pupil

The technique for enlarging the pupil depends on whether the pupil is incapable of dilating because of *nonresponse to mydriatics* or as a result of *pathologic structural changes* (Fig. 7.31).

If the *tissue structure is normal*, localized short-term dilatation can be effected with small hooks or contact retractors. **Iris hooks** pass around and engage the pupil margin. They are removed by pushing the hook slightly toward the center of the pupil (Fig. 7.32). **Contact retractors** retract the pupil margin by establishing direct contact with the lens surface and are easy to remove (Fig. 7.33). Soft *sponge swabs* effect temporary iris retraction by establishing direct contact with the lens (mechanical blocking action) and with the iris trabeculae (friction) (Fig. 7.34). Global mydriasis of longer duration can be produced by

[10] Most adhesions with the lens capsule or corneal endothelium are easily divided with a blunt spatula, but adhesions with cortical remnants or corneal stroma may be too firm for this.

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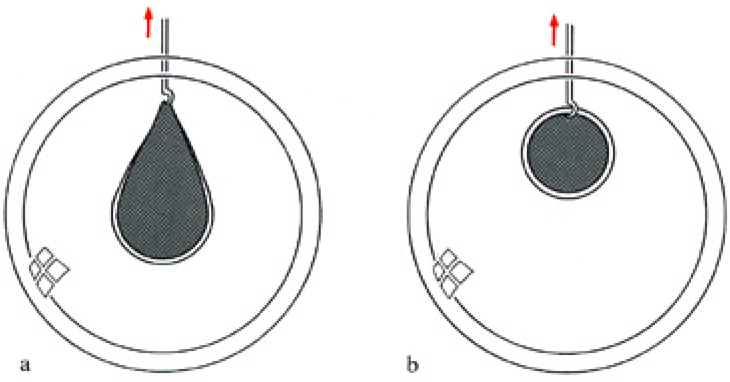
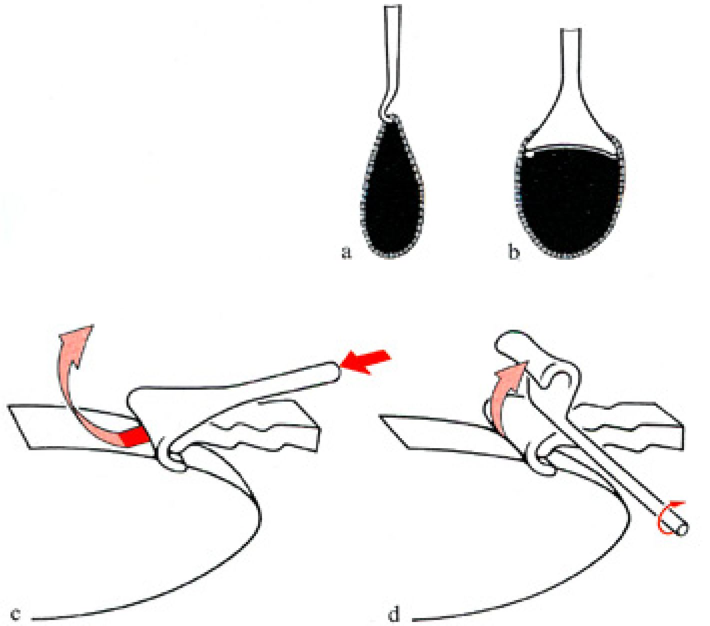


7.31

Fig. 7.31. **Visual assessment of the ability of the pupil to dilate**

a If the pupil is dilatable, locally applied forces tend to deform the pupil rather than displace it.

b The opposite effect is seen in a rigid, nondilatable pupil, which is displaced rather than deformed



7.32

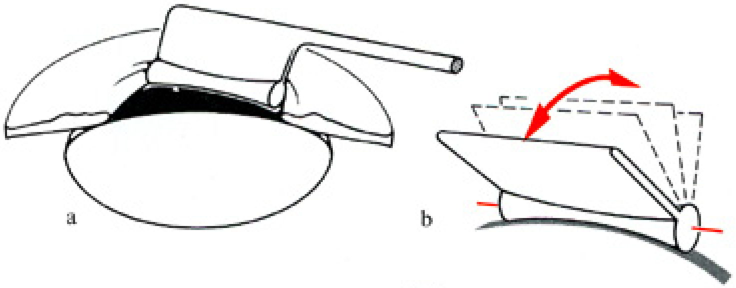
Fig. 7.32. **Iris hooks as retractors**

a Narrow hooks have small areas of contact with the lens and expose only a small field.

b Broad hooks expose a larger field. The large contact area with the lens increases the risk of capsule injury, but this can be reduced by shaping the hook surface to conform to the front surface of the lens (equal radii of curvature). This distributes the force evenly over the contact area and reduces pressure on the lens.

c Handle at right angles to the axis of curvature of the hook. To remove, the hook must be pushed back toward the pupil.

d Handle parallel to axis of curvature: The hook is removed by simple rotation of the handle

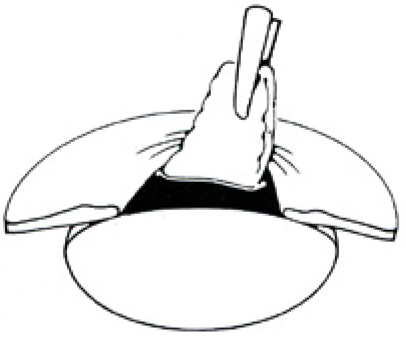


7.33

Fig. 7.33. **Rigid instruments as contact retractors**

a The lower surface of the rigid retractor conforms to the curvature of the anterior lens surface, ensuring full, uniform contact with the lens.

b Shaping the blade like a concave cylinder satisfies this condition at any angle of application



7.34

Fig. 7.34. **Sponge swab as an iris retractor.** Sponge swabs conform to the anterior lens surface when moist. They also adhere to iris tissue by suction and therefore can function as retractors. If the sponge absorbs aqueous, it expands and may endanger the corneal endothelium. If it becomes soft, its efficiency as a mechanical tool decreases

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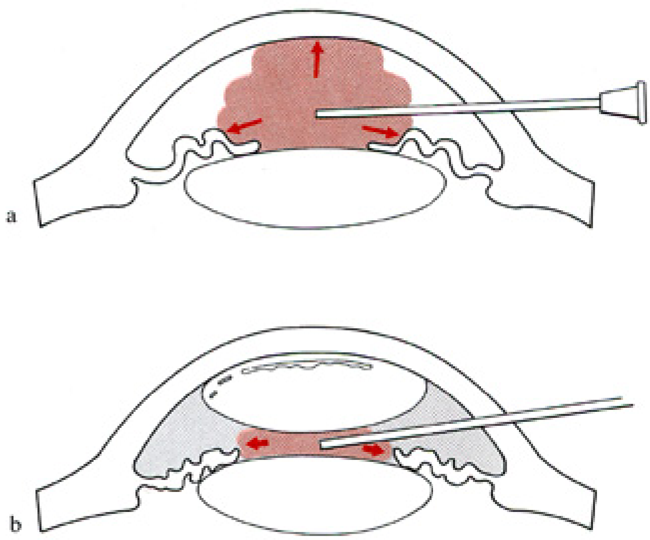
Fig. 7.35. **Viscomydriasis**. A "soft spatula" can be used to enlarge the iris aperture.

a The injection is directed toward the collarette rather than the pupil margin to ensure that viscoelastic material does not get behind the iris. *Note*: Because viscoelastic material may flow in all directions, a large amount may have to be injected, depending on the depth of the anterior chamber.

b The preliminary injection of an air bubble will reduce the amount of viscoelastic material needed. Once mydriasis has been accomplished, the air can be removed and replaced with watery fluid



applying *viscoelastic material* as a soft, permanent spatula (Fig. 7.35).

In *pathologic tissue* that is inelastic and immobile, the pupil must be enlarged by surgical incision. A *sphincterotomy* is sufficient when changes are confined to the iris sphincter.[11] **Multiple partial sphincterotomies** leave a portion of the muscle intact. They decrease but do not abolish its function (Fig. 7.36), so the pupil responds postoperatively to pupillomimetics and retains its normal shape.

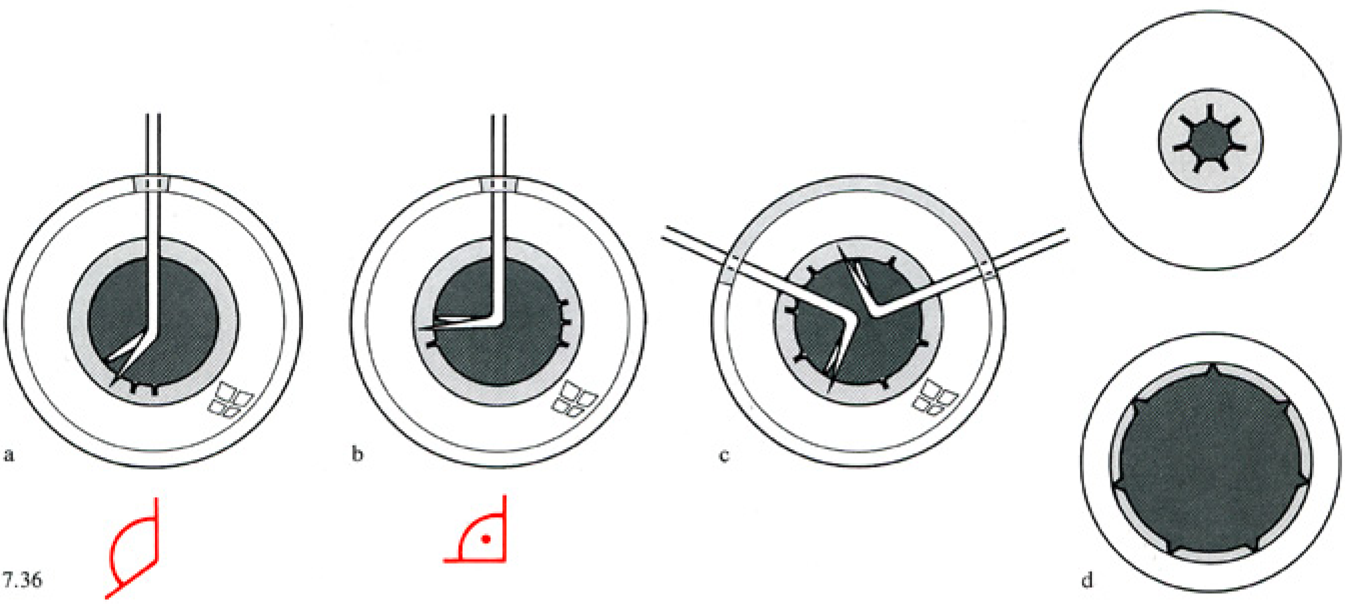
If pathologic changes affect the *whole iris*,[12] the stroma must be incised to create an adequate opening. This will abolish pupillary function unless the incision is sutured. **Inferior iridotomies** (Fig. 7.37) are easy to perform but difficult to suture; they are used in cases where an unsutured iridotomy is acceptable.

Superior iridotomies are started from a peripheral iridectomy or parabasal iridotomy. The width of the initial iridectomy or iridotomy determines the width of the area that can be exposed by reflection of the iris flaps (Fig. 7.38).

When combined with iridotomy, multiple partial sphincterotomies may serve as relaxing incisions to aid in restoring a satisfactory pupil shape after suturing (Fig. 7.38e).

[11] As in senile or postinflammatory sclerosis or pseudoexfoliation syndrome.

[12] E.g., following iritis, acute glaucoma, or previous glaucoma surgery.



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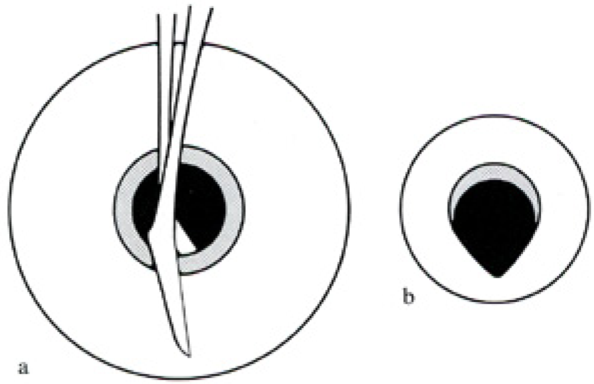

Fig. 7.37. **Inferior iridotomy**

a The iridotomy is cut downward from the pupil margin.

b The area exposed by a single incision is relatively small. Its width depends mainly on the retractility of the tissue

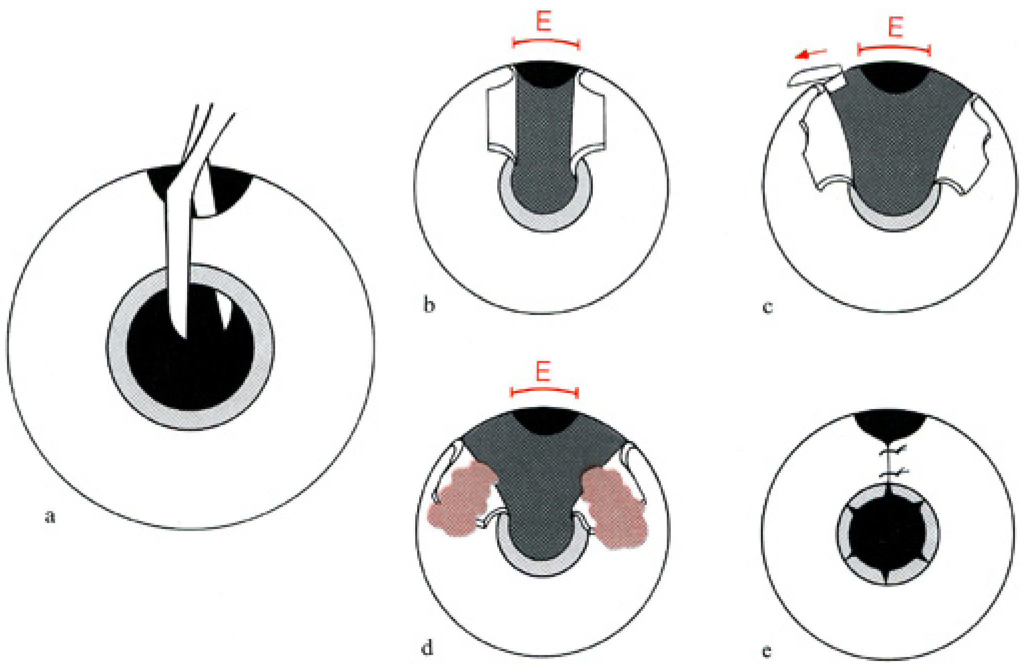

Fig. 7.36. **Multiple partial sphincterotomies**

a, b Sphincterotomies through a small corneal incision: Because the small opening makes it difficult to angle the instrument, the angulation of the microscissors determines the portion of the circumference that can be incised. Incisions at other sites require scissors with different angulations.

c With a large chamber opening, all the sphincterotomies can be made with a single instrument.

d Partial sphincterotomies preserve pupillary function while enabling mydriasis and miosis

Fig. 7.38. **Superior iridotomy**

a The deep scissor blade is introduced through a peripheral iridectomy, and the cut is made from there to the pupil.

b The width of the preliminary iridectomy (*E*) determines the exposure obtained by reflecting the iris flaps.

c In case of insufficient exposure the iris is incised along its root (*arrow*).

d Viscoelastic material can be used to effect and maintain reflection of the iris flaps.

e Closure of the iridotomy, shown here in conjunction with multiple partial sphincterotomies. *Note*: If the pupil is to retain a mydriatic response postoperatively, sutures should be placed only in the stroma, not in the sphincter itself

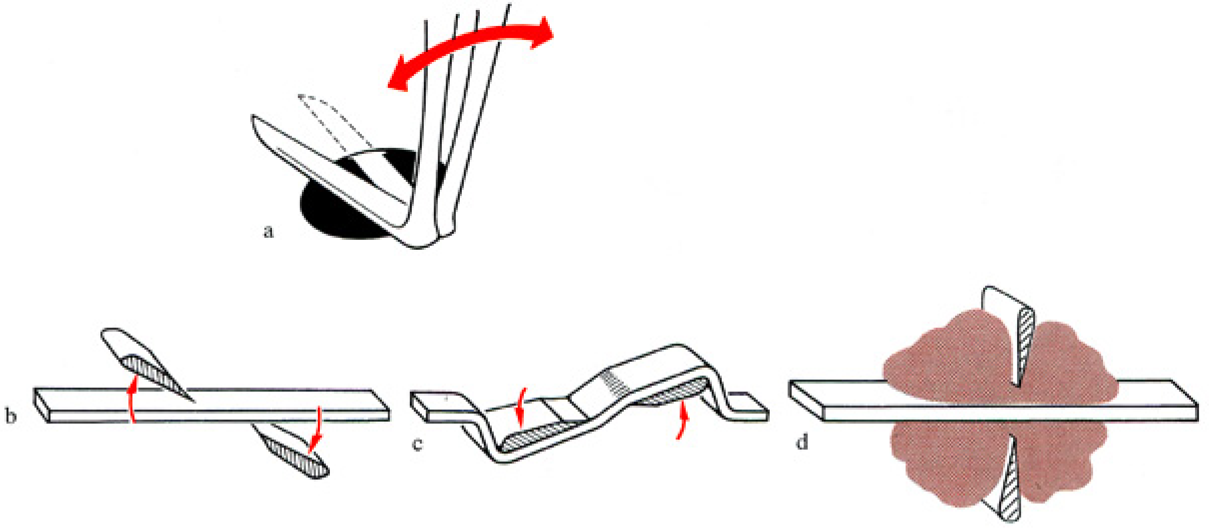

Fig. 7.39. **Controlling sectility in sphincterotomies and iridotomies**

a Iris mobility (friction between the scissor blades and tissue) as well as tissue tension can be controlled by tipping the scissors laterally.

b Friction is eliminated by holding the blades so that their sides are not in contact with the tissue. The blades are held in this position when advanced to the point of incision, their blunt edges leading to avoid tissue damage.

c Tipping the blades laterally brings their sides into contact with the tissue. This makes the tissue tense and increases friction. The blades are held in that position during the working motion (closure).

d Iris mobility can be reduced by embedding the tissue in viscoelastic material. The effect does not depend on the scissor position. Because forward shifting is neutralized, short microscissor blades can be used

The precision of iridotomies and especially of partial sphincterotomies is enhanced by applying techniques that minimize iris shifting by the advancing cutting point of the scissors (see Fig. 2.81). This can be accomplished by making the cut swiftly to exploit tissue *inertia*, by tilting the blades to fixate the tissue by *friction* (Fig. 7.39a–c), or by *viscoelastic immobilization* (Fig. 7.39d).

7.6 Repair of Iris Defects

The closure of iris defects is indicated not only on cosmetic or optical grounds[13] but also for surgical tactics. The tactical reason is to restore tension to the diaphragm to prevent anterior synechiae.

In iris tissue with normal mobility and compliance, most defects can be satisfactorily repaired by **approximating the margins** of the defect with simple interrupted sutures. Defects in rigid iris tissue must be repaired with **sliding flaps** mobilized by means of **relaxing incisions**. Relaxation may pose a dilemma, however, for it is antithetical to the goal of restoring diaphragmatic tension (Fig. 7.40). Thus, disinsertion from the iris root, while very effective for relaxation, should be avoided whenever possible. The peripheral iris suspension is preserved by placing the relaxing incisions at the pupil margin and in the iris stroma (Fig. 7.41). It is easier to control the degree of tissue advancement with multiple small incisions than with a few larger incisions.

[13] Optical indications include the prevention of glare and monocular diplopia.

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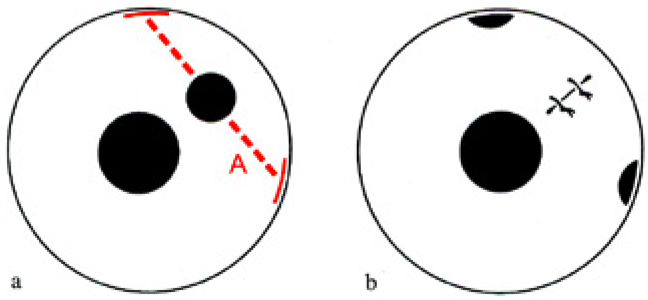

Fig. 7.40. **Closure of a stromal defect** (e.g., following excision of an anterior synechia)

a The stroma is mobilized by small peripheral iridotomies placed at the points where the imaginary transverse axis through the defect (*A*) intersects the iris root.

b Adjacent stroma is approximated over the defect with sutures. Compensatory defects are left at the iris root, but these cause no optical disturbances if in a very peripheral location

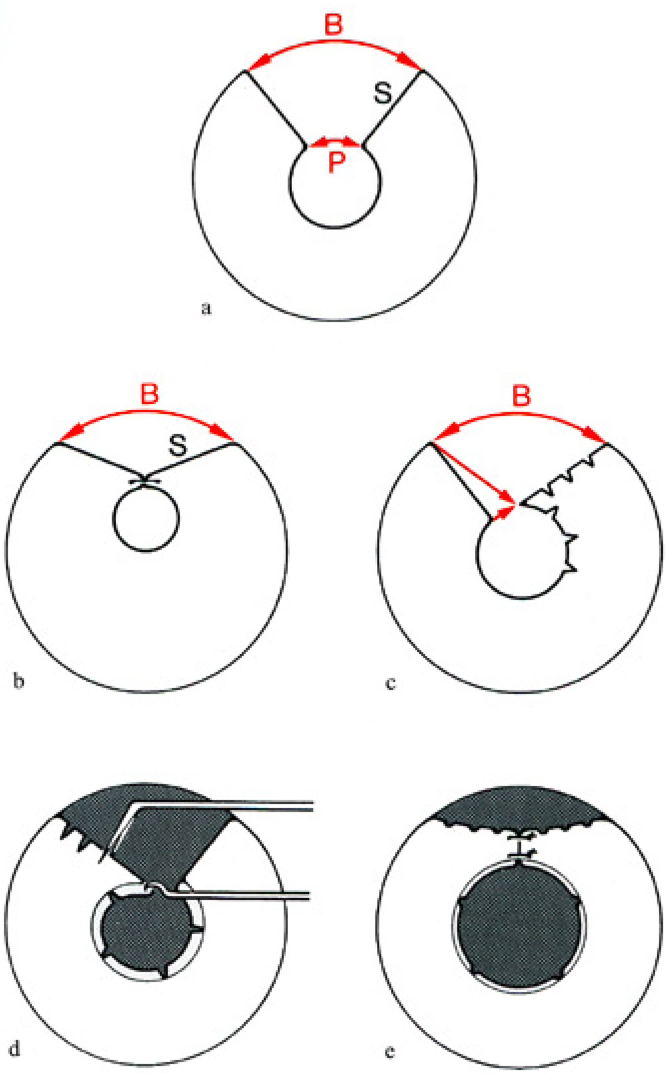

Fig. 7.41. **Closure of a sector iridectomy**

a Sector iridectomy in which a segment *B* has been removed from the base of the iris and a segment *P* from the pupil margin. For closure, the tissue advancement must compensate for these missing segments.

b An attempt to close the iridectomy directly with a suture at the pupil margin redirects the borders of the iridectomy (*S*) and shifts the pupil upward. Also, the pupil circumference is reduced by the distance *P*.

c If a rotation flap is created by lengthening S and the pupil margin, the pupil remains centered, and its suspension at the diaphragm remains intact. The tension is adjusted by using microincisions to lengthen the distance *S*.

d The necessary degree of relaxation is determined empirically by drawing the iris into the desired position with a small hook and making microincisions until the desired advancement is obtained.

e Closure with sutures

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7.7 Suturing the Iris

Iris sutures are used for attaching

- *iris to iris* (closure of iridotomies or traumatic lesions; Fig. 7.45);
- *iris to iris root* (repair of iridodialysis; Fig. 7.47);
- iris to *foreign material* (e.g., fixation of implants; Fig. 7.44).

In a **transcorneal suture** the needle pierces the cornea in addition to the iris, so it must be very sharp and strong enough to overcome the corneal resistance.

In an **intracameral suture** the needle pierces only the delicate iris tissue, so a fine atraumatic needle with a round cross-section may be used.

The selection of suture type is influenced by the *width of the opening* in the anterior chamber. Transcorneal sutures can be placed as an independent procedure where otherwise no entry into the anterior chamber is planned; intracameral sutures are suitable only in cases where the anterior chamber has been widely opened. Suture selection is also influenced by the *condition of the iris tissue*. Sharp, heavy-gauge needles (i.e., for transcorneal sutures) can be used in normal tissue, for the defect produced by the needle will be smaller than the needle cross-section (owing to the centrifugal mobility of the resilient tissue). However, needles of this type will produce large defects in less mobile, pathologically altered tissue. Then, the size of the defect will at least equal the needle cross-section, and any lateral needle motion during suturing will cause an even larger rent. Thus, extremely fine needles (e.g., vascular needles) should be used to minimize trauma in pathologically altered iris tissue (i.e., intracameral sutures).

Sufficient *space* for suturing must be provided both anterior and posterior to the iris. *Air* injected into the anterior chamber may displace the iris posteriorly, obliterating the retroiridal space (Fig. 7.42a–c). *Viscoelastic material* placed behind the iris can expand and maintain the retroiridal space by displacing deeper tissues away from the danger zone (Fig. 7.42d).

The main *technical* difficulty in suturing the iris is the extreme *mobility* of the tissue. In practice this means that the *site of needle insertion* can be precisely defined by the surgeon, but the exact *site of emergence* is indeterminate, and this uncertainty must be allowed for in the suturing technique (Fig. 7.43). In the *transcorneal* suture, the insertion site is defined by an incision, while the site of emergence may lie anywhere on the cornea (Fig. 7.44). The needle for the *intracameral* suture, following its own trend of travel, is left to emerge into an undetermined portion of the anterior chamber and is then withdrawn from the chamber in a second step (Fig. 7.45).

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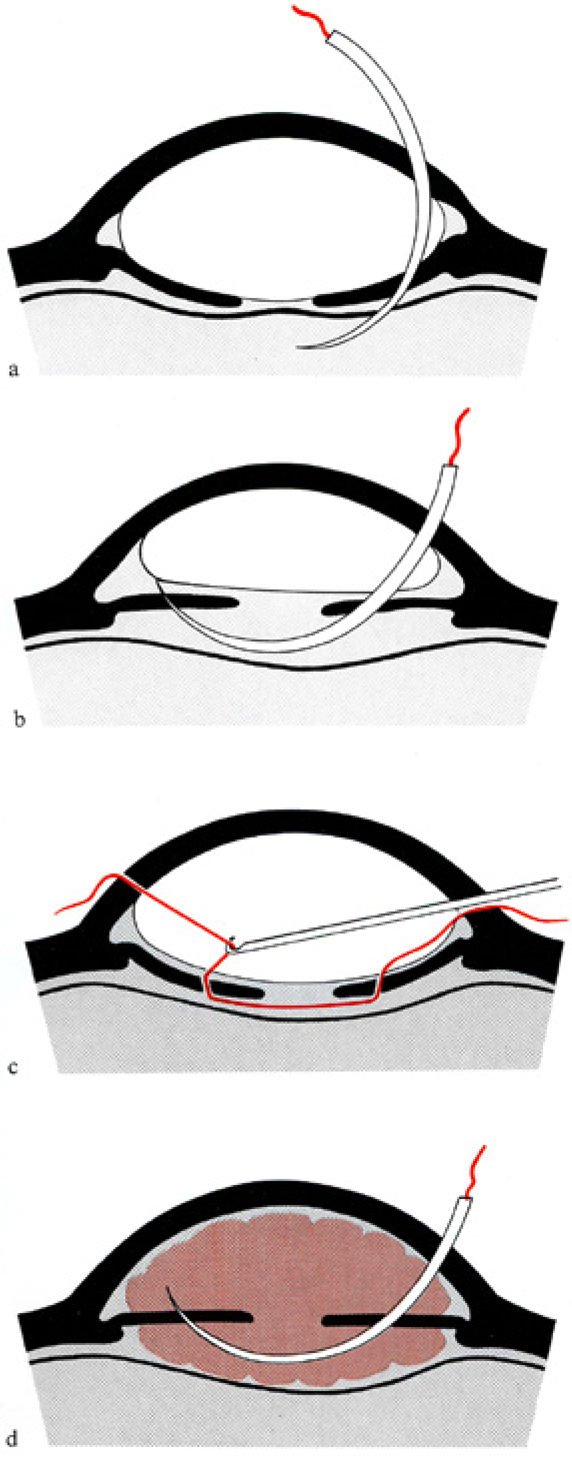


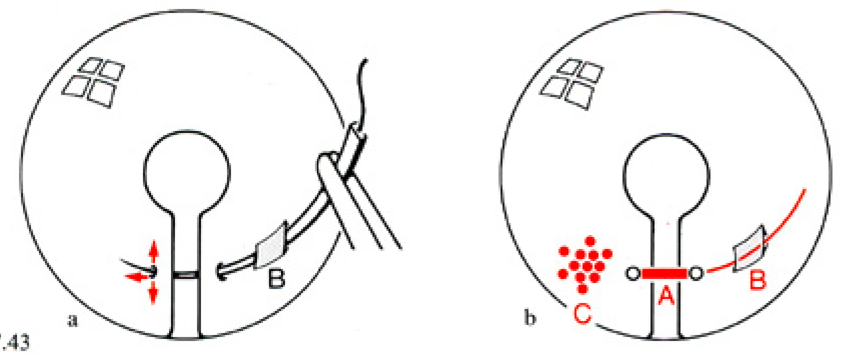
Fig. 7.42. **Space-tactical considerations in iris suturing.** **a–c** air, **d** viscoelastic material

a Maximum inflation of the anterior chamber with air presses the iris firmly against the anterior hyaloid. A suture needle passed behind the iris will enter the vitreous.

b Space for manipulations behind the iris is preserved by injecting just enough air that the bubble does not touch the iris. The remaining space within the chamber contains watery fluid.

c Once manipulations behind the iris are completed, additional air can be injected to make room for manipulations anterior to the iris (here: Retrieving the thread).

d Viscoelastic material can selectively expand the space behind the iris, creating the necessary space for pre- and retroiridal manipulations

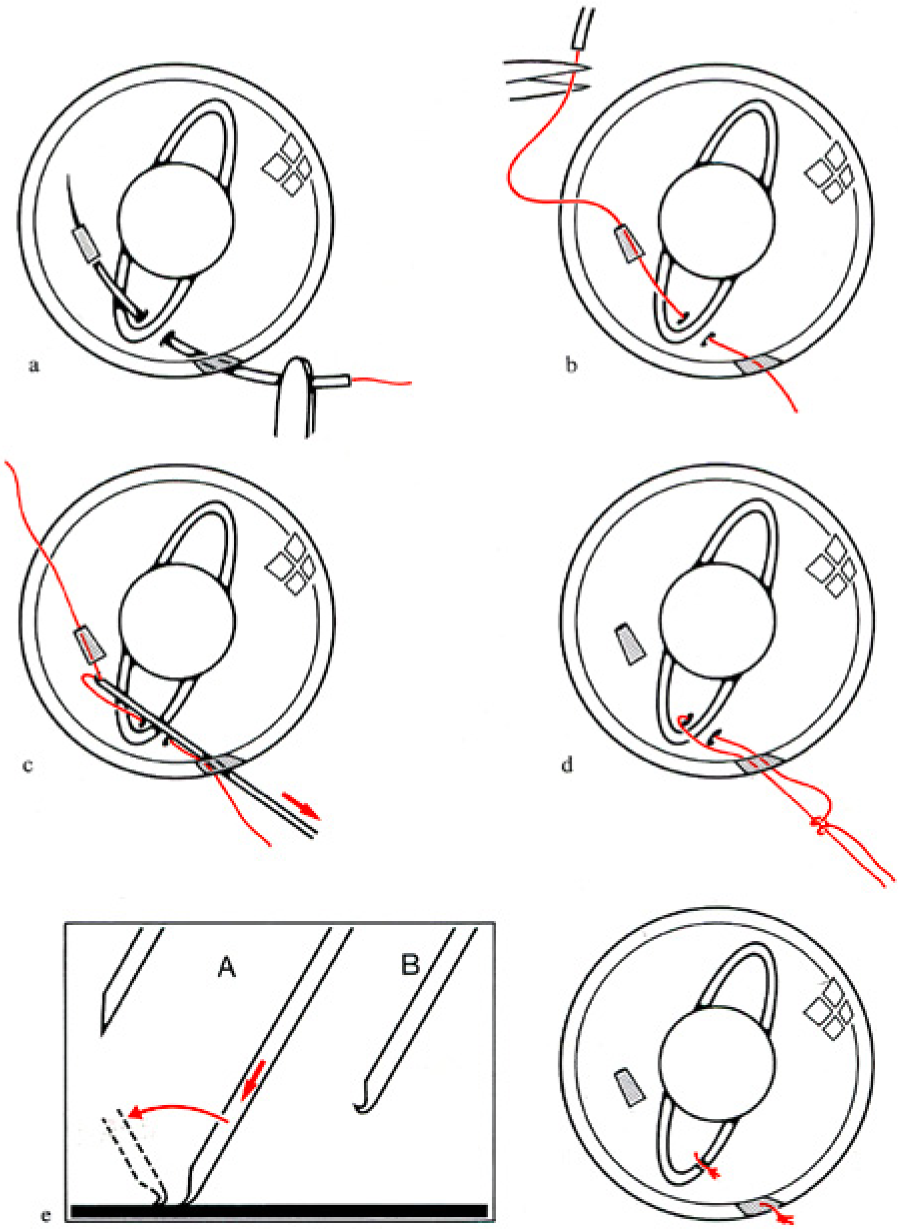


7.43

Fig. 7.43. **Principle of suture technique**

a Due to its extreme mobility, the iris may shift ahead of the tip (*arrows*) and the needle follows an unpredictable path.

b Parameters of the needle pathway: The distance between the planned entry and exit sites in the iris (*A*) is *given*. The site of needle insertion into the anterior chamber (*B*) is *selected* with the aim of reaching A, making proper allowance for the needle curvature. However, the exact site of emergence through the cornea (*C*) cannot be predicted and is *left to chance*



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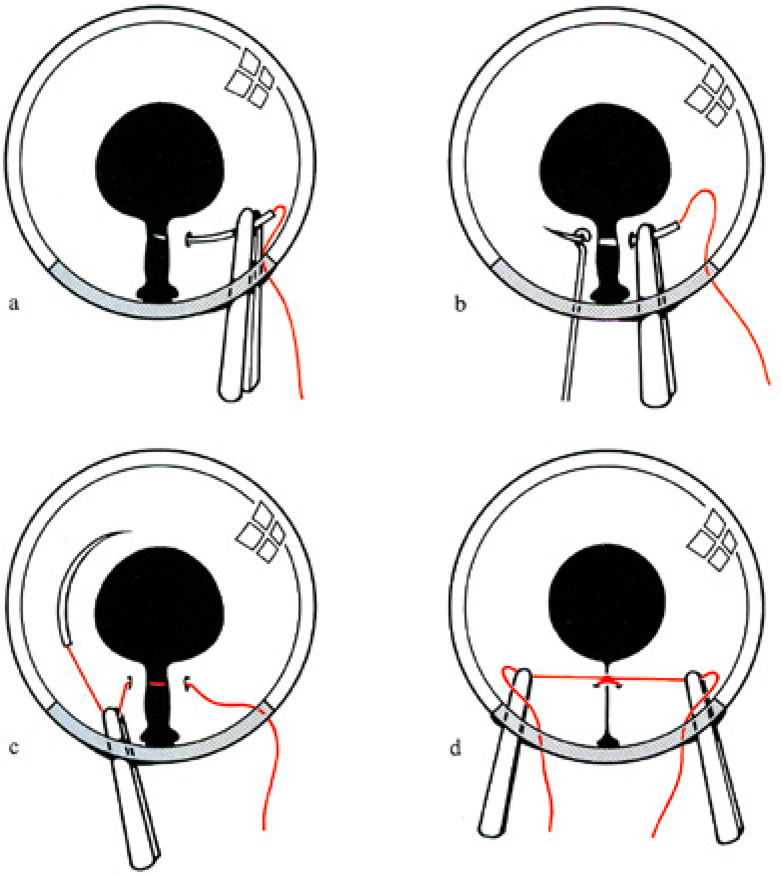

Fig. 7.45. **Intracameral suture** (illustrated for an iridotomy repair)

a Through a large corneal incision, a microneedle is introduced into the anterior chamber on a fine needleholder and passed through the limbs of iris. The anterior chamber is maintained by space-tactical means (e.g., viscoelastic material).

b If the resistance of the tissue and viscoelastic substance is not sufficient to keep the emerging needle tip from pushing the iris aside, additional resistance is provided by a second instrument. An iris hook used for this purpose increases the resistance all around the needle, and it can be easily removed.

c The needle is left in the chamber just as it emerges from the iris; it will stay suspended in the chamber if the latter has been filled previously with viscoelastic material. The thread is then grasped close to the needle eye with the suture forceps, and with the needle it is pulled backward out of the chamber.

d The knot is prepared outside the chamber and tightened inside the chamber

Fig. 7.44. **Transcorneal iris suture (illustrated for the fixation of an IOL haptic to the iris stroma)**

a A small corneal opening that is larger externally than internally (see Fig. 5.18 D) is prepared. A long, heavy-gauge needle with sharp edges is passed through the opening, through the iris, and emerges somewhere on the cornea.

b The thread is cut from the needle.

c The thread is pulled back into the anterior chamber with a small, fine hook, and from there it is retrieved through the corneal incision. *Inset*: A very fine hook can be made by bending the tip of an injection cannula inward; this is done by rolling the tip on a hard surface. The hook is smaller than the diameter of the cannula, so it can be passed into and out of a small incision without snagging.

d The ends of the thread are tied into a slip knot and drawn tight over the haptic of the implant.

e The ends of the thread are trimmed, and the corneal incision is sutured if necessary (see hinge rule, Fig. 5.27)

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7.8 Reposition of a Disinserted Iris

The procedure for repairing an iridodialysis depends on the length of the disinsertion and the compliance of the tissue. With a short iridodialysis and normal tissue structure, the iris can simply be repositioned and held in place with *viscoelastic material* until it becomes fixed in that position through scar formation.[14] With dialysis of rigid iris tissue,[15] greater forces will be needed to effect the reposition (*solid spatulas* and *iris hooks*). The iris may be reattached at its base by incarcerating it in the corneal incision or by using loops of thread. **Incarceration** leads to *shortening* of the intracameral iris surface and will cause *anterior displacement* of the diaphragm, depending on the location of the corneal incision (Fig. 7.46). **Suture loops** allow for precise guidance of the iris back to its normal anatomic position (Fig. 7.47; see examples in Figs. 7.48–7.50).

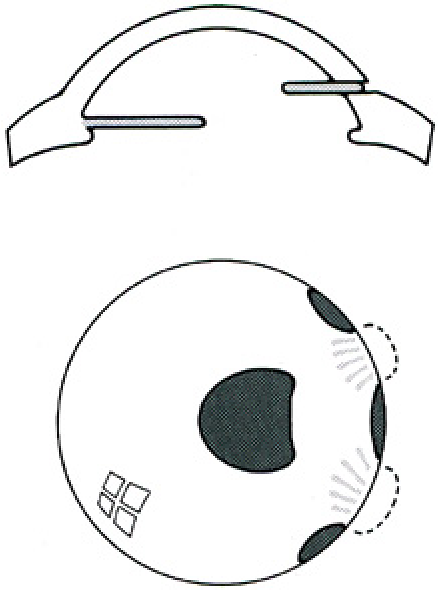

Fig. 7.46. **Reposition by incarceration of the iris root in a corneal incision.** An iris root incarcerated in a corneal incision lies farther peripherally than normal. It also lies far anterior to its natural position if the incision has been placed at the limbus

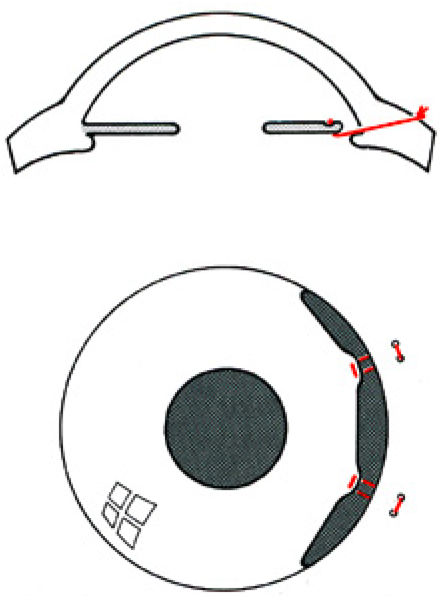

Fig. 7.47. **Iris reposition with sutures.** If the iris root is fixed with loops of thread, an essentially normal pupil shape can be achieved by fine adjustment of the suture tension. The threads can be passed well peripherally through the chamber angle to give an essentially normal anteroposterior iris position

Fig. 7.48. **Simple transcorneal iridodialysis repair**

a After placement of the suture as shown in Fig. 7.44b, a third incision is made at the proposed fixation site behind the limbus. Both ends of the thread above the iris are brought out through the incision with a small hook.

b The iris is reapproximated to the periphery by traction on the protruding threads. Finally the incision is sutured so that the iris threads can be tied around the scleral sutures (*insets*)

Fig. 7.49. **Repair of a longer iridodialysis**

a Two (or more) scleral incisions are prepared as fixation sites. For each fixation one thread loop lying above as well as below the iris are brought out through the incisions.

b One exteriorized loop is cut (*A*) and pulled out through the second incision (*B*). Finally the loops are tied around the scleral sutures (*insets*)

[14] "Viscoreposition" may suffice for a small, accidental iris avulsion occurring during surgery. Here the tissue is structurally normal, and there are no forces that might redisplace the repositioned iris. If this technique is unsuccessful, other obstacles should be suspected (e.g., vitreous prolapse) and managed accordingly.

[15] As in the secondary repair of an inveterate posttraumatic iridodialysis. *Note*: Often there are associated lesions (zonular rupture, retinal detachment, etc.) that must be recognized preoperatively and incorporated into the operating plan.

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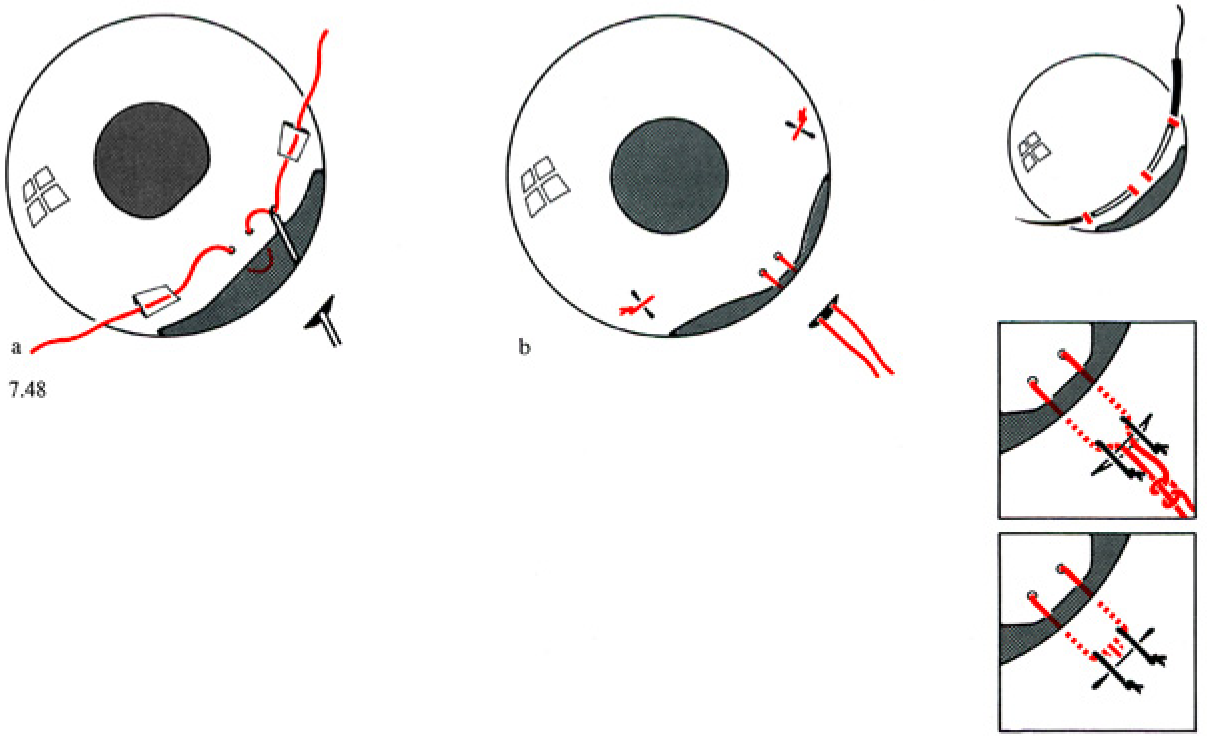
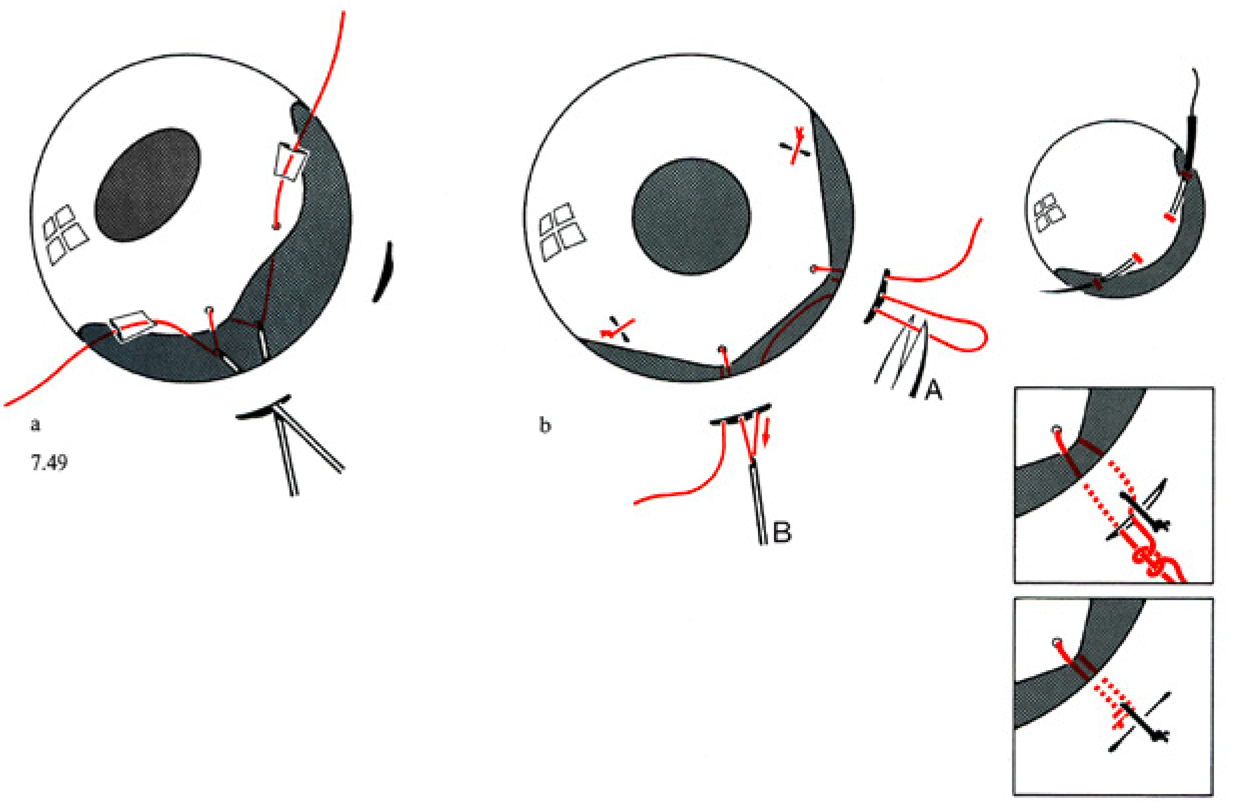


a b

7.48



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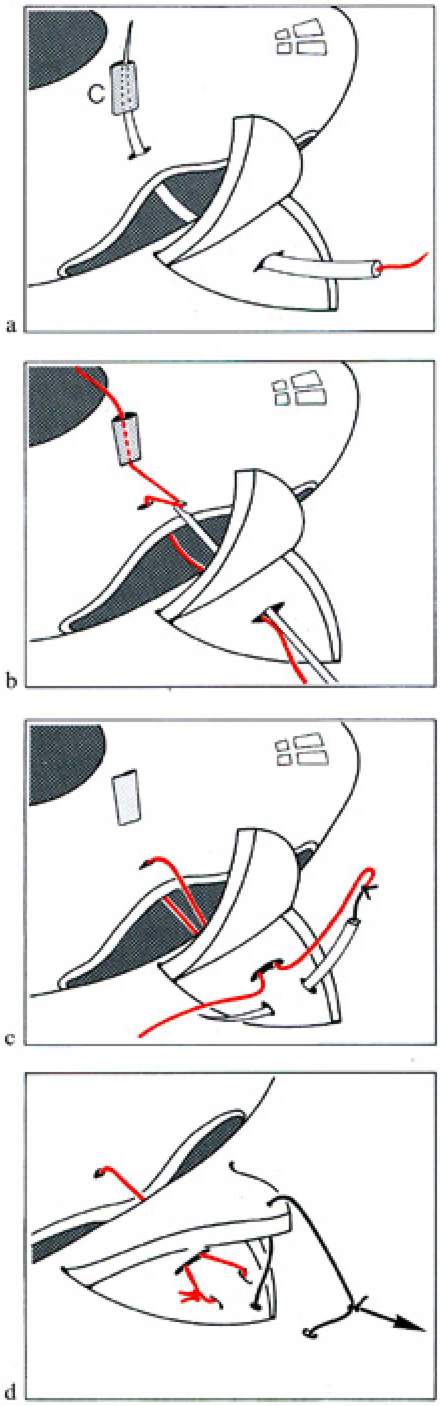

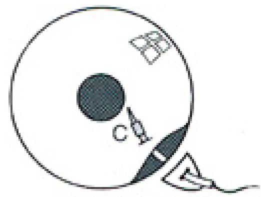

Fig. 7.50. **Transcorneal iridodialysis repair using a partial-thickness scleral flap**. This technique poses little risk of aqueous loss because there is a minimal opening for insertion of the needle and the retrieving cannula hook.

a A partial-thickness scleral flap is dissected at the limbus. The thinning of the tissue layer facilitates needle passage and enables the surgeon to locate the anatomically correct insertion site while visualizing the structures of the chamber angle through the thin scleral bed. The needle passes through the scleral bed, through the iris margin, and emerges somewhere on the cornea (*C*).

b The transcorneal suture segment is brought out through the incision as in Fig. 7.44c.

c With both ends of the suture protruding from the incision, one end is tied to the thread remaining on the needle, and the needle is passed through the floor of the thinned sclera.

d The ends of the iris suture are tied together, and the scleral flap is replaced and sutured

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