Indications and Techniques of Iris Reconstruction

Essay

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Abstract

The Iris is the anterior part of uveal tract, the intermediate coat of the eyeball. It is a pigmented circular diaphragm which is present between the lens and the cornea. It has a central hole: The pupil, the window to the inner eye, through which light passes to reach retinal photoreceptors. It controls amount of light entering the eye and prevents chromatic aberrations of the light passing through lens periphery.

Being the anterior diaphragm that controls light entrance to the eye, iris defects as cases of aniridia, coloboma of the iris, albinism, tumors of the iris as naevi, melanomas and leiomyomas and penetrating, blunt or surgical traumas may manifest damage to iris tissue and all need surgical repair.

Surgical management of iris defects may involve alterations to the cornea as corneal tattooing, reconstruction or manipulation of the iris, or insertion of an opaque barrier in the lenticular plane.

Corneal tattoing is practiced by staining or inserting a variety of substances into the corneal tissue by either needle puncture or corneal lamellar dissection.

Iridopexy is addressed to repair iris defects with at least two thirds normal tissue. It involves repairing sector iridectomy, localized colobomas and sphincteric rupture with pupilloplasty using McCannel suture technique, repairing of iridodialysis using single or double-armed closed system techniques and Iris cerclage suture technique for traumatic mydriasis.

When significant amounts of iris tissue are damaged or missing, iris repair may be impossible and we had no means of restoring the diaphragmatic function of the iris. In these eyes, artificial iris implants can augment the iris diaphragm.There are different prosthetic iris devices available involving the Morcher single-piece iris-diaphragm IOL styles 67F and 67G, the Morcher endocapsular ring prosthetic iris devices styles 96G and 50C and The Ophtec model 311 lens and Iris prosthetic system (IPS).

Iris reconstruction is under continuous progress to achieve the best visual outcome.

Key Words **:** Iridopexy- iris prosthesis- iris repair- corneal tattoo- aniridia**.**

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Introduction

The elegant anatomy of the iris has captured the fancy of soothsayers and poets throughout the ages, but, in early modern ophthalmic history, the iris has received surprisingly little attention. In our enlightened age of small incision, closed-system anterior segment surgery, surgical control have been increased over the intraocular environment and the skills have been developed for more sophisticated iris repair. The confluence of increased awareness and surgical abilities set the stage for the new era in iris surgery.[1]

The function of the iris as a light-limiting diaphragm has been recognized for several thousand years. The primary function of the iris is to act as a diaphragm regulating the amount of light entering the eye. Because light enters through the entire area of the pupillary aperture, enlarging the pupil diameter (diameter = 2r) results in exponential increase in the area through which light enters the eye (area = ttr^2).Stated simply the amount of light entering an aniridic eye (limbal diameter 12.0 mm) is about 4-fold greater than the amount of light entering an eye with a 6.0 mm pupil. Besides reducing the amount of light entering the eye, the iris diaphragm promotes depth of focus and limits spherical and chromatic aberrations related to the edge of the lens.[2]

Iris absence or deficiency can be a result of congenital anomalies such as aniridia, anterior segment dysgenesis, or coloboma. Iris tissue loss is also common after penetrating ocular trauma and occurs rarely as a sequela of ophthalmic surgery. Other congenital and acquired conditions reduce the effectiveness of the iris diaphragm; ie, ocular albinism, irido-corneal-endothelial syndrome, herpetic iris atrophy, and traumatic mydriasis.[3]

The management of patients with iris deficiency is often challenging because of the underlying ocular problems. Repair of the iris is indicated in three clinical situations. The first, and by far the most common, is functional difficulties associated with glare and/or diplopia. These optical symptoms are caused by an enlarged pupillary opening secondary to trauma, surgery, or a congenital defect. Traumatic or congenital aniridia is the ultimate example of pupil enlargement. A symptomatic paracentral or peripheral iridotomy or iridectomy would constitute the opposite extreme. The second indication for repair is restoration of the iris diaphragm as part of a multifaceted surgical reconstruction. A large iris defect might require closure to support an anterior chamber intraocular lens. If a posterior chamber lens is implanted, the edges of an iris defect might be drawn together in an effort to reduce postoperative glare or diplopia (caused by the enlarged pupillary opening itself or light striking the edge of the lens). The removal of an iris lesion might be combined with iris reconstruction if enough iris is left to facilitate a primary repair. Corneal transplant surgeons will surgically tighten a loose, floppy iris diaphragm during penetrating keratoplasty to reduce the risk of the iris shifting forward, thereby adhering to the endothelial surface and producing a broad peripheral anterior synechia and secondary glaucoma. The third clinical situation, and by far the rarest, is repair of an iris defect for cosmetic purposes as patients may experience negative psychosocial repercussions from unaesthetic quality of abnormal iris.[4]

Various methods have been used to overcome the disabling effects of iris deficiency, including repair of reminant iris tissue, if possible, corneal tattooing, and implantation of artificial irides. Among researchers throughout the world, an intraocular approach recently enjoyed the greatest interest, in particular for creating an artificial iris-lens diaohragm to serve the optical function of the lens and diaphragm function of the iris simultaneously.[5]

Aim of work

To highlight surgical methods and techniques of iris reconstruction in different situations and to determine the efficacy of surgical implantation of artificial iris-lens diaphragm in patients with anatomic and functional iris deficiencies, aphakia or cataract.

Anatomy of iris

The iris is the most anterior portion of the uveal tract. It lies in the frontal plane of the eye between the anterior and posterior chamber and is bathed on both surfaces by the aqueous. It acts as a diaphragm that is continuous peripherally with the anterior aspect of the mid point of the ciliary body and its central opening, the pupil, is the aperture that regulates the amount of light entering the eye. Although seemingly simple in structure, iris function is related to image clarity.[6]

Embryology:

Prior descriptions of the embryology of the iris were largely based on the classical theory of development, which described three germ layers in the developing embryo: endoderm, mesoderm, and ectoderm. It is now known that the majority of the ocular mesenchyme is derived from neural crest cells. Neural crest cells are defined as those cells of primitive ectoderm that proliferate from the crest (peak) of the neural folds at about the time the folds fuse to form the neural tube. During embryogenesis, the iris arises from both the optic cup and the periocular mesenchyme.The posterior and anterior layers of the iris pigment epithelium are embryologically derived from the anterior tip of the optic cup. The iris stroma is derived from the neural crest, and vascular endothelium is derived from mesoderm.[7] fig.(1)[8]. At about six weeks gestational age, the neural ectodermal derivatives (iris epithelium, muscle) begin to rapidly proliferate and extend anteriorly, vascular channels of tunica vasculosa lentis extend into mesenchymal cells of the anterior surface of the lens and are incorporated into iris stroma..The two layers of neuroepithelium become the anterior and posterior iris pigment epithelium. Pigmentation of these layers begins at ten weeks, proceeds from the margin of the optic cup toward the ciliary region and is completed by seven months' gestation. The iris sphincter muscle first appears as basal infoldings in the cells

of the anterior layer of the neuroepithelium and can be seen by light microscopy at about three months.Dilator muscle fibers are first identified in the sixth month as fine fibrils in the anterior iris epithelium.[9]

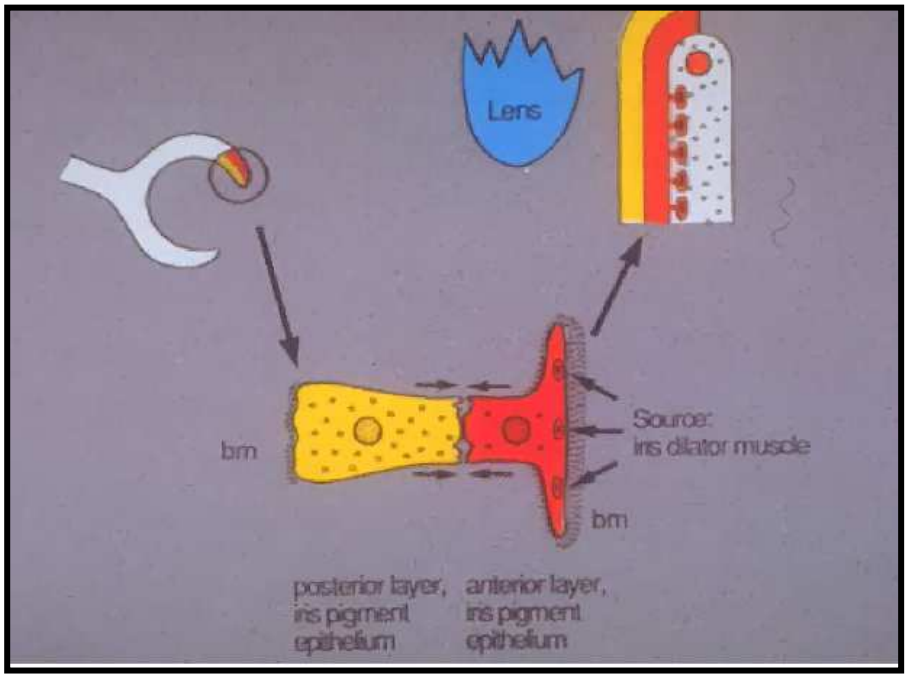

Fig.1.

Development of neuroepithelium of iris from anterior tip of optic cup, iris stroma from neural crest and vascular endothelium from mesoderm.[8]

Gross anatomy:

The iris is continuous peripherally with the midpoint of the ciliary body (the root of the iris).This attachment is thinnest part of the iris 0.6 mm where it is readily torn away from ciliary body by contusion, injury or as surgical procedure. The central opening of the iris is the pupil, its margin rests lightly on the anterior surface of the lens, slightly pushed forward by it, so that the pupil lies in a plane anterior to iris root. The pupil, is normally displaced somewhat inferiorly and nasally. It regulates the entry of light into the eye:it is pinpoint in bright sunlight and widely dilated in the dark.The range of pupil

diameter lies between 1.2and 9 mm in youth; in old age the pupil size is often smaller.[6] Table(1)[10]

Diameter	12 mm
Circumference	37.5 mm
Thickness of iris root	0.2 mm
Thickness of collarette	1.0 mm
Pupillary diameter	1.2-9.0 mm
Width of sphincter muscle	0.6-0.9 mm
Thickness of pigment epithelium on miosis	12 um
Thickness of pigment epithelium on mydriasis	50-60 um

Table 1 : Standard measurements of iris.[10]

Vascular supply:

Blood supply to the iris originates in the major arterial circle, which lies in the stroma of the ciliary body near the iris root. The vessels have a slight corkscrew shape to accommodate iris dilation and contraction. Branches travel in the anterior iris stroma extending toward the collarette where they form an incomplete minor arterial circle. Venous channels follow a similar course and eventually drain into the vortex system and ciliary plexus.[11]

Nerve supply:

The trigeminal nerve provides sensory and vasomotor function to the iris. Sensory nerves are diffusely distributed in the stroma, terminating as unmyelinated fibers. Sympathetic and parasympathetic fibers enter the iris with the sensory nerves and serve

the pupillary dilator and constrictor muscles.[11] A report describing the receptorial distribution of human iris musculature has shown alpha-exciting and beta-2-relaxing receptors, and the absence of cholinergic, serotonergic, dopaminergic, and histaminergic receptors on the iris dilating muscle. Muscarinic cholinergic receptors was found on the pupillary sphincter muscle without any adrenergic receptors.[12]

Macroscopic picture:

The anterior surface of the iris is generally richly textured, but in darker races, where iris pigment is increased, the surface is smooth and velvety and the texture is masked. The collarette of the iris is located about 1.5 mm from the pupillary margin, represents the thickest portion of the iris (1.0 mm) and divides the iris into two zones: the pupillary zone and the ciliary zone. The pupillary zone begins at the margin of the pupil, known as the pupillary ruff which is a series of small ridges formed by continuation of the pigmented epithelium from the posterior surface. The collarette overlies an incomplete vascular circle (circulus vasculosus iridis minor). In blue irides or where stroma is atrophic, the iris sphincter is visible as a flat circular strap-like muscle, encircling the pupil. The central part of the ciliary zone is smooth, but peripherally several contraction furrows occur, concentric with the pupil, which deepen as the pupil dilates. The crypts of Fuchs are a series of openings located on either side of the collarette on both its pupillary and ciliary sides. These crypts are focal defects in the anterior layer of the iris stroma allowing iris tissues to be bathed in the aqueous humor.[13] fig.(2)[6].

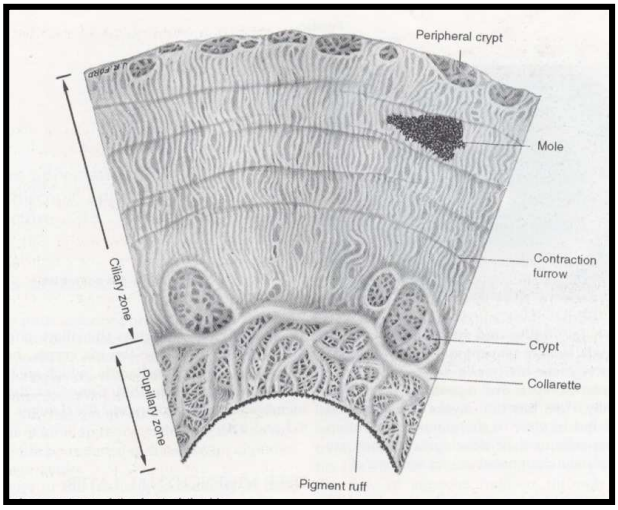

Fig.2.
Anatomy of the front surface of iris.[6]

The posterior surface of the iris is dark brown, much smoother and more uniform than its anterior counterpart.It is a smooth surface that is broken by relatively shallow furrows. Two types of radial folds are identified: contraction folds of Schwalbe are small sulci that run for a distance of 1 mm bending over the pupillary aperture and forming the crenations on its anterior surface, and structural folds of Schwalbe which begin about 1.5 mm from the pupillary border and extend between the ciliary processes. Circular contraction furrows are also present.[14] fig.(3)[8].

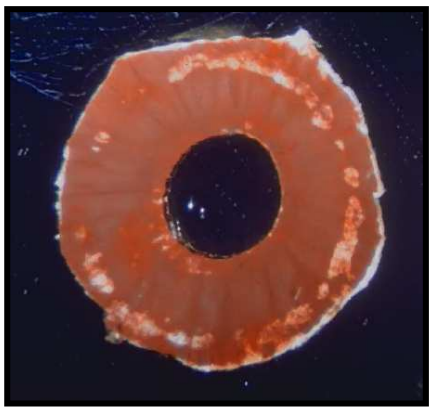

Fig.3.

The posterior surface of the iris is smoother than the anterior surface.Radial folds are present.[8]