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Ultrasound biomicroscopy after vitrectomy in eyes with normal intraocular pressure and in eyes with chronic hypotony

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PURPOSE. *To analyze the ultrasound biomicroscopy (UBM) features of eyes with chronic hypotony after pars plana vitrectomy (PPV) and compare them with the UBM features of eyes with normal intraocular pressure (IOP) after PPV.*
METHODS. *This comparative (nonrandomized) interventional study included 64 eyes of 64 patients who underwent PPV. Group 1 included 20 eyes with less complex vitreoretinal diseases (VRD) that presented with normal IOP after PPV. Group 2 included 44 eyes with severe proliferative vitreoretinopathy (PVR) managed with PPV and silicone oil tamponade that presented with complete retina reattachment and chronic ocular hypotony. UBM was performed to study the anterior segment, ciliary body (CB), and peripheral retina. The UBM findings of the two groups were compared.*
RESULTS. *In Group 1, 19/20 eyes presented with no CB alterations detected by UBM. In Group 2, 43/44 eyes presented with CB alterations that included tractional CB detachment (n=16); exudative CB detachment (n=11); tractional CB detachment/CB atrophy (n=7); CB hypotrophy (n=5); tractional CB detachment/exudative CB detachment (n=3); and CB edema (n=1). There was a strong relationship between IOP and CB findings revealed by UBM.*
CONCLUSIONS. *Eyes with hypotony following PPV have CB abnormalities that can be detected by UBM. These CB alterations were not found in eyes with normal IOP after PPV in this series. (Eur J Ophthalmol 2008; 18: 614-8)*

KEY WORDS. *Chronic hypotension, Intraocular pressure, Vitrectomy, Ultrasound biomicroscopy*

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INTRODUCTION

Chronic ocular hypotony is uncommon after uneventful vitrectomy performed in eyes with less complex vitreoretinal diseases such as macular hole or other maculopathies, but is quite common after vitrectomy for PVR. Ocular hypotony after vitrectomy for the treatment of PVR has been reported in 24% of cases (1). The potential complications of hypotony include decreased visual acuity, corneal opacification, membrane proliferation, and retina detachment (2) and eventually phthisis. The pathophysiology of ocular hypotony is not well understood. Ocular hypotony may be due to increased fluid outflow occurring after ciliary body (CB) detachment or reduced aqueous humor production. Inadequate aqueous humor production can be caused by anatomic changes, such as CB detachment and injuries to the nonpigmented CB epithelium. These changes may be due to proliferative tissue present after trauma, inflammatory debris, or surgical manipulation (3-6). High-frequency ultrasound biomicroscopy (UBM) allows for detailed in vivo examination of the anterior segment, including the CB. The literature pro-

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vides only a few case reports of UBM evaluation of eyes with chronic hypotony after vitrectomy (6, 7). In the present study, we analyze the UBM features of eyes with previous severe PVR that presented chronic hypotony after PPV and silicone oil tamponade and compare them with the UBM features of eyes with previous less complex VRD that presented with normal intraocular pressure (IOP) after PPV.

METHODS

This study was carried out in the Department of Ophthalmology of Federal University of Minas Gerais Medical School and Institute of Vision, Brazil. Ethics Committee approval was obtained. Eyes that had previously undergone pars plana vitrectomy between January 2001 and December 2005 were examined. The study comprised two distinct groups: Group 1 included 20 eyes of 20 consecutive operated patients (15 women, 5 men; age range 12–77 years; mean 58) with less complex VRD that had undergone only one previous standard three-port PPV. This group included eyes that, at the time of surgery, did not require 1) any type of scleral buckle, either radial or circumferential; 2) the use of silicone oil as an internal tamponade; or 3) any other associated surgical procedure, such as lensectomy or intraocular lens implantation. Eyes with previous intraocular surgery (with the exception of cataract extraction with intraocular lens); anterior segment laser therapy; a history or signs of intraocular acute, chronic, or resolved inflammatory conditions; and eyes of patients using topical or systemic steroids or nonsteroidal anti-inflammatory medications for less than 2 weeks before UBM examinations were excluded. The preoperative diagnosis included eyes with complications of proliferative diabetic retinopathy (n=7); macular holes (n=4); subfoveal neovascular membranes (n=4); nondiabetic vitreous hemorrhage (n=3, including 1 with central retinal vein occlusion, 1 with branch retinal vein occlusion, and 1 secondary to an arterial macroaneurysm); and idiopathic macular epiretinal membranes (n=2). Fifteen eyes were phakic and five were pseudophakic.

Group 2 included 44 eyes of 44 consecutive patients (15 women, 29 men; age range 10–78 years; mean 47.8) with severe PVR that had undergone more than one PPV and presented with a complete retina reattachment and chronic ocular hypotony. In all eyes, the last surgery included a standard three-port PPV, with a complete vitreous shaving, and silicone oil tamponade for treatment of recurrent retinal detachment. All eyes had an IOP of no more than 5 mm Hg for at least 8 weeks. The primary diagnosis, before the first vitrectomy, included retinal detachment (n=24), ocular trauma (n=15), diabetic retinopathy (3), and endophthalmitis (n=2). Thirty-one eyes (70.5%) had a scleral buckle. An ophthalmologic examination, consisting of best-corrected Snellen visual acuity, pupillary and external motility testing, slit lamp biomicroscopy, applanation tonometry, dilated indirect binocular ophthalmoscopy with scleral depression, and posterior segment biomicroscopy with a contact lens, was administered to all patients. All eyes included in the study were examined by UBM on the same or day following the ophthalmologic examination. Patients were not using systemic steroids or nonsteroidal anti-inflammatory medications when UBM was performed. Twelve patients from Group 2 were using topical steroids. The retina of each eye was reattached at the time the UBM was performed. All patients were operated on by the same surgeon.

UBM was performed with the patients in a supine position using a 20-mm eye cup filled with saline (50 MHz, 50 µm maximum resolution, and tissue penetration depth 4–5 mm). The probe was moved perpendicular to the structure to be scanned. To explore the whole circumference of the anterior ocular segment, the perilimbal area was divided into eight sectors: 12:00, 1:30, 3:00, 4:30, 6:00, 7:30, 9:00, and 10:30. Each sector was scanned radially with the ultrasound probe. To examine the circumference to the fullest possible extent, the clinician asked patients to gaze in the direction opposite to the probe. All UBM scans were performed by the same examiner. The ciliary body changes imaged by UBM were defined according to previous published articles (5-9): 1) tractional ciliary body detachment was diagnosed when an anterior proliferative traction sheet of membrane was found connected to the ciliary body (5); 2) exudative ciliary body detachment is imaged as an anechoic enlargement of the supraciliary space containing fluid (5-9). It is frequently crossed by medium-echoic strands that correspond with the connective fibers which connect the sclera to the uvea; 3) ciliary body atrophy was characterized by reduction of the ciliary body volume; 4) ciliary edema or ciliary congestion is defined by ciliary body thickening (8).

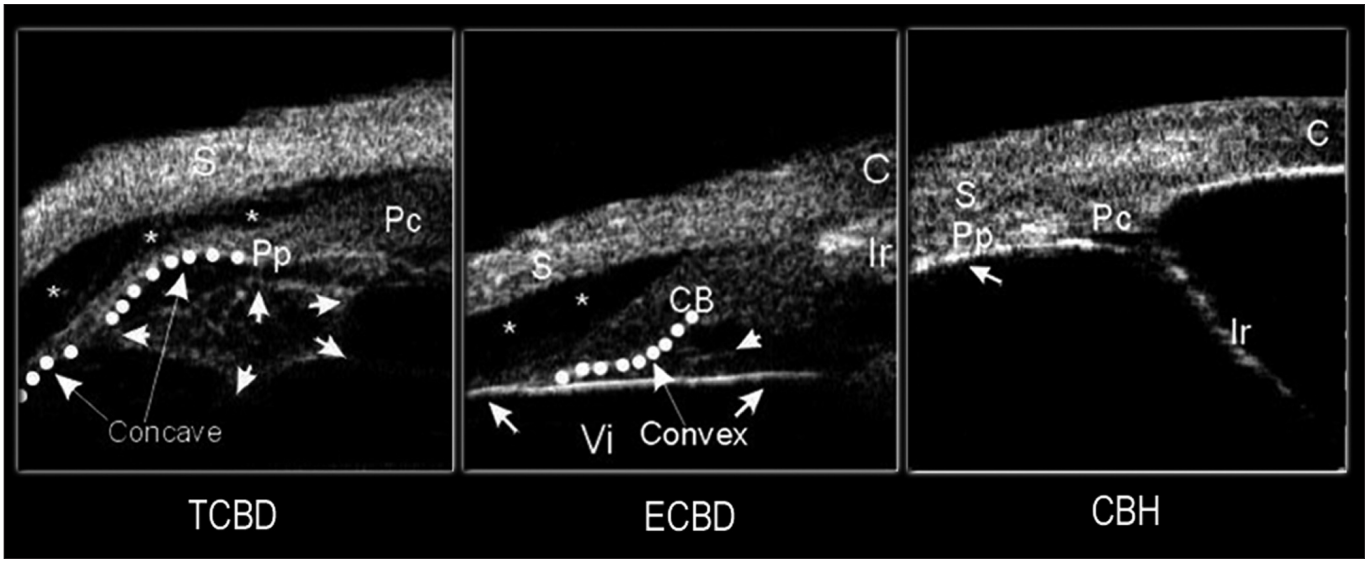

Fig. 1 - *Ultrasound biomicroscopic findings of the three main types of ciliary body alterations.* Left: *Tractional ciliary body detachment (TCBD) is recognized by its tent-like shape, with the apex connected to a tractional membrane. Note the concave profile to the vitreous cavity assumed by the ciliary surface.* Center: *Exudative ciliary body detachment (ECBD) presents as an echolucent space, crossed by strands that represent the conjunctival fibers connecting the choroid to the sclera.* Right: *Ciliary body hypotrophy (CBH) is characterized by significant decrease of the ciliary body processes. CB = ciliary body; Pc = pars plicata; Pp = pars plana; S = sclera; C = cornea; * = detached ciliary body; white dot circles = ciliary body surface.*

RESULTS

In Group 1, the time interval between vitrectomy and UBM examination varied from 2 to 6 months (mean 3 months). When UBM was performed, the mean IOP was 14.5 mmHg (7–19 mmHg). Nineteen eyes (95%) presented with no CB alterations on UBM. Only one eye presented with a subtle exudative CB detachment. In this eye the IOP was 7 mmHg. In Group 2, the time interval between vitrectomy and UBM examination varied from 3 to 32 months (mean 15.2). When UBM was performed, the mean IOP was 3.7 mmHg (0–5 mmHg). In this group, 43 eyes (98%) presented with CB changes. More than one CB alteration was frequently observed in the same eye. The most frequent findings were as follows: tractional CB detachment (TCBD; n=16), exudative CB detachment (ECBD; n=11), tractional CB detachment/CB hypotrophy (TCBD/CBH; n=7), CB hypotrophy (CBH; n=5), tractional CB detachment/exudative CB detachment (TCBD/ECBD; n=3), CB edema (CBE; n=1), and normal CB (NCB; n=1). The Figure shows the three main types of CB alterations: TCBD, ECBD, and CBH.

DISCUSSION

UBM has been used to evaluate transient anterior segment changes in the first several postoperative weeks after vitrectomy (7, 10-12). Some transient anterior segment changes have also been described after retinal detachment surgery (8, 9, 13-15), including a shallow anterior chamber, narrowing of the anterior chamber angle, and CB detachment (7, 10, 12, 15, 16). A transient shallow anterior chamber with narrowing of the anterior chamber angle is associated with the accumulation of fluid in the supraciliary space that usually remains for up to 4 weeks after vitrectomy (5,10). As many as 42% (46/109) of eyes may have transient CB detachment after PPV, but the detachment resolved within 6 weeks in all cases (16).

To our knowledge, there are only a few case reports of UBM evaluation of eyes with chronic hypotony after PPV (6, 7). We are not aware of reports which include comparison to eyes with normal IOP. In one study (7) there were 15 eyes that had previous vitreoretinal surgery with a history of hypotony (≤8 mmHg) lasting more than 28 days. Because the objective of our study was to evaluate long-term changes of the CB and the peripheral retina, all eyes in the present study were examined after the eighth postoperative week. The criterion for ocu-

lar hypotony in our large retrospective case series was also different (IOP ≤5 mmHg). We selected these two criteria because eyes in this situation carry a significant risk of atrophy if the silicone oil is removed, even if the retina is completely reattached as it was in the eyes included in this case series. Modern vitreoretinal surgical techniques have improved the prognosis of eyes with complex retinal detachment. Eyes with advanced PVR, such as most of the cases included in this series, usually present with major anatomic changes not only in the posterior segment, but also in the vitreous base, peripheral retina, pars plana, and CB. Although the retina can be reattached in most of these eyes, there are still some important challenges to be resolved. Chronic hypotony after vitrectomy is a well recognized complication in the treatment of PVR and one of the most difficult situations to manage. In the Silicone Study, chronic hypotony occurred in 24% of the operated eyes, and was more prevalent in eyes randomized to C_3F_8 than in those randomized to silicone oil (31% versus 18%) (1). The prevalence of chronic hypotony in this study was 16% when the retina is attached (1).

A number of authors have speculated that chronic traction of the anterior vitreous base results in shallow detachment of CB, hyposecretion, and subsequent hypotony (3, 17-19). Alternative theories relating to the cause of hypotony in PVR include 1) mechanical blockage of the ciliary processes by the formation of a thin sheet of fibrous tissue from recurrent PVR; 2) traction on the CB resulting in small cyclodialysis clefts; and 3) mechanical damage of repeated surgery to the ciliary processes (1). UBM is a noninvasive examination that allows for a detailed in vivo examination of the anterior segment, including the CB. Therefore, UBM is helpful for studying tissue structures likely to be involved or associated with chronic hypotony.

In this study, only one eye in Group 1 had an image suggestive of CB detachment. The maximum thickness of the supraciliary space in this case was 142 mm and it affected only one quadrant. This patient had an IOP of 7 mmHg with no clinical or angiographic signs of hypotony. The other 19 eyes in this group presented no CB alteration that could be detected by UBM. These results suggest that a normal CB at UBM might be the expected feature in eyes with uneventful PPV and normal IOP. These normal UBM findings also seem to confirm previous clinical observations that PPV does not induce long-term changes in the anterior segment anatomy (16). In contrast, in this study, 98% of the eyes with previous severe PVR that underwent PPV and silicone oil tamponade and demonstrated complete retina reattachment but chronic ocular hypotony showed alterations in the CB detected by UBM. These findings suggest that such CB alterations are related to ocular hypotony.

Hypotonus eyes have an increased risk of retinal redetachment, reproliferation of membranes, and phthisis (2). For these reasons, many retina specialists believe that it is necessary to keep the silicone oil in these eyes to maintain retinal reattachment and to prevent ocular atrophy (6). Due to the possible long-term complications, however, it is recommended that silicone oil not be kept indefinitely in the vitreous cavity. It is therefore important to treat the ocular hypotony before removing the silicone oil. To treat ocular hypotony effectively, it is necessary to know the cause or pathophysiology of hypotony. Evaluation of the CB, as well as the vitreous base region by UBM, can help surgeons to understand the mechanisms involved in ocular hypotony and, therefore, can provide a rational basis for its treatment or prevention. In this study, 98% of the cases that presented chronic ocular hypotony after a successful vitrectomy with silicone oil facilitated reattachment of the retina presented with anatomic CB changes. TCBD was the most frequently observed change and occurred in 26 eyes (59.1%). More than one CB alteration was frequently observed in the same eye. Although it is not possible to establish the primary change–ocular hypotension or CB alterations–it is our impression that CB alterations appear first and might have a significant role in the pathophysiology of the observed ocular hypotony.

Some reports have shown that eyes with chronic ocular hypotony associated with PVR may present an increase in IOP when treated by means of periciliary proliferative tissue dissection (20-22), topical ibopamine (23), intravitreous triamcinolone (24), and laser trabecular sclerosis (25). These reports showed quite variable results (with some eyes demonstrating increase and others showing no elevation in IOP). UBM was not used to evaluate the status of the CB in any of these reports, to attempt to individualize the treatment. The present study showed that chronic ocular hypotony may be associated with different CB alterations. This could provide a rational basis for the selection of one or more of these treatments. For instance, eyes with TCBD would be initially treated with periciliary membrane dissection; eyes presenting ECBD or CBE would be preferentially treated with intraocular corticosteroids; and eyes with CBH could be primarily treated by laser trabecular sclerosis or topical ibopamine. We also speculate that eyes with CB detachment could receive an additional aliquot of silicone oil. Additional silicone oil might cause a temporary increase in IOP, sufficient to reapply the CB, which could result in a decrease in the fluid outflow and an increase in the aqueous humor production. These treatments could also be combined in order to get an effective and consistent increase in IOP.

This study demonstrated that most of the eyes with previous

PVR that presented retina reattachment but chronic hypotony after PPV have CB alterations detected by UBM, and most of the eyes with less severe VRD that present with a normal IOP after PPV have no CB changes detected by UBM. These findings shed light on the pathophysiology of hypotony and provide anatomic findings to consider as we search for new treatments of this challenging complication.

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