Ultrasound biomicroscopy in the comparison of the anterior segment morphometry before and after pars plana vitrectomy

Biomicroscopia ultra-sônica na comparação da morfometria do segmento anterior antes e após vitrectomia "pars plana"

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ABSTRACT

Purpose: To determine if pars plana vitrectomy induces long-term changes in the anterior segment anatomy by means of ultrasound biomicroscopy. **Methods:** A prospective case series study was undertaken of consecutive patients referred to a tertiary eye care centre for pars plana vitrectomy as the only procedure. Twenty eyes of 20 patients undergoing pars plana vitrectomy alone were studied by ultrasound biomicroscopy. Silicone oil or scleral buckle was not used in any of the included cases. The following morphometric parameters were compared before and after 3 months of surgery: anterior chamber depth, angle-opening distance at 500 µm from the scleral spur, trabecular-ciliary process distance, ciliary body thickness at 1, 2 and 3 millimeters from the scleral spur and measurement of the supraciliary space thickness, when fluid was detected. **Results:** No statistically significant differences were found between the preoperative and the postoperative morphometric parameters. **Conclusions:** Uncomplicated pars plana vitrectomy does not induce any long-term change on anterior segment morphometry. Based on these findings, the normal long-term pattern to be expected after pars plana vitrectomy is the conservation of the preoperative morphometry.

Keywords: Anterior eye segment/ultrasonography; Ultrasonics; Anatomy, cross-sectional/methods; Ciliary body/ultrasonography; Vitrectomy; Microscopy/instrumentation

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INTRODUCTION

Pars plana vitrectomy (PPV) is considered the standard surgery to approach a large number of vitreoretinal disorders. Ultrasound biomicroscopy (UBM) has demonstrated that anterior segment changes can be associated to complications in the early postoperative period after the procedure[1-5]. Such changes include shallowing of the anterior chamber[1], narrowing of the anterior chamber angle[1] and ciliary body detachment[1,3-5]. These changes may determine transient complications like glaucoma[2] or hypotony[3].

Although early postoperative changes after vitrectomy have already been detailed, little is known about the long-term anatomical changes of the anterior segment anatomy after PPV. Such a study would provide useful information about the influence of PPV on the stability of the anterior segment in the postoperative period. Based on this information, unexpected

anatomical changes that may determine later complications like persistent ocular hypotony can be detected more easily.

The aim of the present study is to compare the anterior segment morphometry before and after PPV to determine if this procedure is capable of determining long-term changes in the anterior segment anatomy.

METHODS

Ultrasound biomicroscopy was used to prospectively evaluate 20 eyes of 20 consecutive patients in the preoperative and late postoperative period of PPV as the only procedure. The patients were referred to Instituto da Visão, in Belo Horizonte, Brazil, a tertiary eye care centre. The following situations were excluded: patients who had previous intraocular surgery (except cataract surgery); cases of PPV which required associated surgical procedures like scleral buckling, internal tamponade, lensectomy or intraocular lens implantation; previous anterior segment laser therapy; history of uveitis, trauma or glaucoma and use of any topical or systemic drugs that might affect pupil or accommodation.

The preoperative diagnosis included 7 eyes with complications of proliferative diabetic retinopathy (PDR) (4 with vitreous hemorrhage (VH), 2 of which also having tractional retinal detachment (TRD); two with chronic clinical significant macular edema (CSME) and 1 with a macular pucker (MP); 4 eyes with stage III or IV macular holes (MH); 4 eyes with subfoveal neovascular membranes (SNVM); 3 eyes with non-diabetic vitreous hemorrhage (one secondary to a central retinal vein occlusion (CRVO), one secondary to branch retinal vein occlusion (BRVO) and another secondary to an arterial macroaneurysm (AM); and 2 eyes with idiopathic macular epiretinal membranes (IERM). Fifteen eyes were phakic and 5 were pseudophakic.

All patients were submitted to the same surgical protocol and were operated on by the same surgeon (MBN). In brief, after routine three-port sclerotomies, vitrectomy was executed using a 20-gauge vitrector. During vitrectomy the intraocular pressure (IOP) was maintained at a level of approximately 20 mmHg. The superior sclerotomies were closed with a 9-0 nylon "X" suture and the infusion sclerotomy with a 7-0 absorbable "U" suture.

One or two days before each UBM all eyes were submitted to a complete ophthalmologic examination consisting of visual acuity and refraction applanation tonometry, conventional slit-lamp biomicroscopy, and indirect ophthalmoscopy.

UBM was performed using a commercial version of the ultrasound biomicroscope (Humphrey-Zeiss model 840, San Leandro, CA) with a 50 MHz transducer that provides a maximal lateral resolution of 50 μm and a maximal depth penetration of 4-5 mm. The scanner produces a 5x5 mm image at a scanning rate of 8 Hz. Scanning was performed with the patient in supine position using the standard technique which has been described elsewhere[6]. After instillation of topical 0.5% proparacaine, a polymethyl-methacrylate eye cup was inserted between the lids and filled with physiological saline as a coupling agent. Accommodation was kept constant by asking the patient to fix on targets at the ceiling about 3 meters from the eye. Room illumination was controlled at 50 lux. Gain was set at 80 dB. The scanner was positioned perpendicular to the structure to be examined. The UBM images were obtained axially and radially on the superior, nasal, inferior and temporal quadrants. Measurements were performed in a masked way by one of us (MZ) using the internal electronic caliper of the instrument and were recorded in micrometers. The preoperative examinations were performed not more than 48 hours before surgery. Since the aim of this study was to detect the late postoperative morphometric changes produced by PPV, all postoperative examinations were performed 8 weeks after surgery (range: 60-183 days, mean±standard deviation [SD] 92 ± 33 days, median 90 days).

For quantitative analysis five standard UBM morphometric parameters[6-7] were compared before and after surgery. These parameters (measured in micrometers) were: central anterior chamber depth (ACD); angle opening distance 500 μm from the scleral spur (AOD); trabecular meshwork – ciliary process distance (TCPD); ciliary body thickness (CBT) 1, 2 and 3 millimetres from the scleral spur (CBT1, CBT2 and CBT3) and the thickness (perpendicular to the sclera) of supraciliary fluid (SF) if present. Except for ACD, all other morphometric parameters were measured at the 3:00, 6:00, 9:00 and 12:00 o'clock meridians and the average of the measurements between meridians was used to compare the preoperative and late postoperative morphometric parameters.

Student's *t* test for paired samples was used for statistical analysis, with the level of significance established at $p<0.05$ using a commercial statistic software package (SAS version 5, SAS Institute, Cary, NC, USA).

RESULTS

The mean age ± standard deviation (SD) was 58 ± 17 years (range: 12-77). 15 (75%) women and 5 (25%) men were included. All patients were caucasians. There were twelve right eyes (60%) and eight (40%) left eyes.

The preoperative and postoperative morphometric parameters obtained from the 20 eyes are summarized in table 1. For each patient, the average of the measurements of the four quadrants studied by UBM was used to compare the preoperative and postoperative morphometry. There were no statistically significant differences in the morphometric parameters before and after vitrectomy. Only one eye showed a small circumferential exudative ciliary body detachment (with a maximum thickness of 142 μm), on the postoperative UBM examination. This eye had a fall in IOP from 13 mmHg (preoperative) to 7 mmHg (postoperative) without any signs of clinical hypotony.

Table 1. Anterior segment morphometry in the pre- and late postoperative period of pars plana vitrectomy

Demographic data					Morphometry (Micrometers)†											
					ACD		AOD		TCPD		CBT1		CBT2		CBT3	
No.	Age	Sex	Eye	Diagnosis	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	77	F	L	SNVM	3964.00	3953.00	380.75	327.25	923.00	752.50	736.75	897.75	424.00	470.25	246.00	294.50
2	63	F	R	IERM	2928.00	3148.00	196.75	276.50	939.25	881.00	809.25	889.00	436.25	468.25	227.00	318.75
3	12	F	R	SNVM	2569.00	2685.00	258.50	259.50	823.75	800.75	1025.25	844.50	354.00	416.25	215.00	246.25
4	55	F	L	IERM	2425.00	2581.00	96.25	149.50	654.25	766.50	763.25	744.50	358.75	394.25	199.75	233.00
5	64	F	R	MH	2425.00	2459.00	180.00	238.75	530.50	697.25	621.00	634.75	339.25	321.75	229.25	199.25
6	26	M	L	PDR (VH+TRD)	2697.00	2593.00	392.75	347.25	714.25	691.00	747.50	718.75	388.50	363.25	276.25	241.25
7	65	M	R	SNVM	2535.00	2500.00	359.25	421.75	848.00	794.00	847.50	843.25	429.50	454.50	268.00	276.75
8	66	M	L	PDR (VH)	2506.00	2558.00	301.50	291.75	862.25	882.75	689.00	743.00	431.50	392.50	243.00	244.00
9	68	F	R	MH	2413.00	2459.00	313.75	412.00	881.50	1051.50	695.75	856.50	423.50	516.50	299.25	305.25
10	76	M	L	VH (CRVO)	2737.00	2824.00	181.00	239.50	833.00	852.25	759.75	745.50	403.00	433.00	224.50	245.50
11	76	F	R	VH (AM)	4363.00	4172.00	350.75	363.25	690.00	743.25	697.00	626.50	334.00	325.00	238.25	231.25
12	61	F	R	MH	2465.00	2448.00	221.00	226.75	762.50	808.00	702.75	726.50	356.25	327.00	213.25	210.25
13	46	F	R	SNVM	2815.00	2801.00	245.25	246.75	820.25	807.25	720.00	730.75	421.50	414.25	282.50	281.00
14	63	M	R	VH (BRVO)	2668.00	2790.00	330.00	342.00	866.75	839.50	913.25	843.00	446.75	444.50	293.75	280.00
15	67	F	L	PDR (CSME)	2760.00	2766.00	277.75	275.00	956.50	930.25	808.25	816.75	486.50	539.00	290.50	264.00
16	56	F	L	MH	2633.00	2639.00	301.25	327.50	942.00	883.75	930.50	903.75	430.25	470.75	262.00	300.25
17	68	F	R	PDR (VH)	3501.00	3576.00	361.00	355.00	1152.50	1124.00	865.25	886.75	564.25	559.75	330.75	337.50
18	35	F	L	PDR (VH+TRD)	2662.00	2650.00	460.75	429.00	845.50	836.00	811.75	812.00	532.00	519.25	362.25	361.25
19	66	F	R	PDR (MP)	3403.00	3443.00	380.25	319.50	1088.00	1091.00	1211.25	1068.00	648.25	574.25	334.75	335.00
20	60	F	R	PDR (CSME)	3605.00	3600.00	339.25	336.00	1249.00	1227.25	799.00	803.75	447.25	477.25	282.25	287.00
Ave					2903.70	2932.25	296.39	309.23	869.14	872.99	807.70	806.76	432.76	444.08	265.91	274.60
SD					558.96	528.06	89.38	71.69	166.78	145.29	135.10	102.47	78.16	76.00	44.36	43.84
P					0.174		0.210		0.829		0.960		0.221		0.203	

Note: Student *t* test for paired samples comparing preoperative and postoperative measurements.

†For all parameters (except of ACD), numbers represent the average of measurements taken at the 3:00, 6:00, 9:00 and 12:00 o'clock positions.

SNVM= subfoveal neovascular membrane; IERM= idiopathic macular epiretinal membrane; MH= macular hole; PDR= proliferative diabetic retinopathy; VH= vitreous hemorrhage; TRD= tractional retinal detachment; CRVO= central retinal vein occlusion; AM= arterial macroaneurysm; BRVO= branch retinal vein occlusion; CSME= clinical significant macular edema; MP= macular pucker; ACD= anterior chamber depth; AOD= angle opening distance; TCPD= trabecular meshwork-ciliary process distance; CBT1/2/3= ciliary body thickness at 1/2/3 mm from the scleral spur; Ave= Average; SD= Standard deviation.

DISCUSSION

UBM has been investigated concerning reproducibility, accuracy and precision of the measurements[8-12]. Intraobserver reproducibility is considered adequate[8-9,12] but interobserver reproducibility is thought to be variable[8-9]. Therefore to appropriately compare the preoperative and postoperative data, all measurements were performed in this study by the same masked observer.

It has been demonstrated that the best UBM morphometric parameters are those related to immutable landmarks such as the scleral spur[10]. For this reason, considering the myriad of available anterior segment morphometric parameters, we selected to be included in this study only those of interest to vitreoretinal surgery that have been previously demonstrated to be reliable and reproducible.

Anterior segment changes in the first postoperative weeks after posterior segment surgery like vitrectomy and retinal detachment surgery have been described[1-4,7,13-16] but little is known about the long-term effects of vitrectomy on anterior chamber anatomy. If vitrectomy would determine permanent changes in anterior segment morphology, such changes might predispose the eye to complications. For example, if vitrectomy would cause permanent narrowing of the angle, it would cause narrow-angle glaucoma in predisposed eyes. This information would be useful in order to anticipate possible complications of the surgery in such eyes. Our results showed no statistically significant differences between the preoperative and postoperative periods of PPV concerning any of the studied morphometric parameters. Only one eye presented an image suggestive of a ciliary body detachment. The maximum thickness of the supraciliary space in this case was 142 μm and it affected only one quadrant. This patient had an IOP of about 7 mmHg with no clinical or angiographic signs of hypotony. These results suggest that PPV alone does not affect the long-term stability of the anterior segment anatomy.

CONCLUSION

In conclusion, UBM demonstrated that there is no significant difference of the anterior segment morphometric parameters bet-

ween the preoperative and postoperative periods after PPV. Based on these findings, the normal long-term pattern to be expected after PPV is the conservation of the preoperative morphometry.

RESUMO

Objetivos: O objetivo do presente estudo foi determinar, por meio da biometria ultra-sônica (UBM), se a vitrectomia via "pars plana" pode induzir alterações permanentes na anatomia do segmento anterior. **Métodos:** Foi realizado estudo prospectivo, analisando-se uma série consecutiva de pacientes, encaminhados para um centro de referência terciário para serem submetidos a vitrectomia via "pars plana" como único procedimento. Vinte olhos de 20 pacientes a serem submetidos a vitrectomia como único procedimento foram estudados pela biomicroscopia ultra-sônica. Óleo de silicone ou introflexão escleral não foram usados em nenhum dos casos incluídos. Os seguintes parâmetros morfométricos foram comparados antes e após 3 meses da cirurgia: profundidade da câmara anterior, abertura do ângulo a 500 µm do esporão escleral, distância trabéculo-processos ciliares, espessura do corpo ciliar a 1, 2 e 3 milímetros do esporão escleral e medida da espessura do espaço supraciliar, quando fluido foi detectado. **Resultados:** Não foram encontradas diferenças estatisticamente significativas entre os períodos pré e pós-operatório para os parâmetros morfométricos estudados. **Conclusões:** A vitrectomia via "pars plana" não-complicada não induz alterações permanentes na morfometria do segmento anterior. Com base nestes achados, o padrão normal esperado após a vitrectomia via "pars plana" é a conservação da morfometria pré-operatória.

Descritores: Segmento anterior do olho/ultra-sonografia; Ultra-som; Anatomia seccional/métodos; Corpo ciliar/ultrasonografia; Vitrectomia; Microscopia/instrumentação

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