High-frequency electric welding of biological tissues versus diode laser photocoagulation as intraoperative retinopexy in vitrectomy for rhegmatogenous retinal detachment

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Background: *It is important to find an alternative retinopexy technique allowing for the exclusion of silicone oil (or gas) tamponade of the vitreous cavity from the vitrectomy procedure for rhegmatogenous retinal detachment (RRD).*
Materials and Methods: *A retrospective non-randomized study was conducted and included 112 patients (112 eyes) with uncomplicated RRD. Retinopexy in the study group (53 patients, 53 eyes) and in controls (59 patients, 59 eyes) was performed using high-frequency electric welding of biological tissues (HFEWBT) and 810-nm laser irradiation, respectively.*
Results: *Mean visual acuity increased to higher levels in the HFEWBT group than in controls at 2 months (0.29 versus 0.21, P = 0.035; this is due to the fact that we managed to avoid intraoperative tamponade in 30% of patients of the study group, thus enabling maintenance of clarity of the posterior lens capsule) and 12 months (0.41 versus 0.39, P > 0.05).*
Conclusions: *High-frequency electric welding of biological tissues (a) is a safe and efficient method for obtaining a firm chorioretinal adhesion, (b) can be used in the clinical practice for intraoperative retinopexy at the time of vitrectomy in patients with uncomplicated RRD, and (c) can ensure retinal re-attachment at the long-term follow-up in as much as 96% of such cases.*

Key words: high-frequency electric welding of biological tissues, retinal detachment, vitrectomy

Introduction

Retinal detachment is a severe ocular disorder resulting in a loss of visual function. Rhegmatogenous retinal detachment (RRD) incidence has been reported to be between 6.3 and 17.9 per 100,000 [1]. Vitrectomy is the most efficient treatment for RRD, and involves the removal of the altered vitreous gel, flattening the retina, performing retinopexy to prevent retina from tearing away, and filling the vitreous cavity with a tamponading agent [2-4]. The most common type of retinopexy is laser photocoagulation [5]. Given the fact that formation of a firm chorioretinal scar requires approximately 10 days after laser photocoagulation, a tamponade of the vitreous cavity is essential for the creation of chorioretinal adhesion [6-8].

In current clinical practice, expansile gas/air mixtures of various concentrations and silicone oils of different densities are used as an ocular endotamponade [9-10]. Although the tamponade force exerted by the gas against the retina is high, its effect is limited in time, and any re-detachment will require an urgent surgical treatment. The use of gases is limited in children and in patients with severe systemic diseases having difficulties with maintaining a specific position of the body for a long postoperative period. In addition, flying or traveling to high altitudes is contraindicated while the gas bubble is present in the eye [11]. Silicone oil as a tamponade agent in RRD patients, however, also has some disadvantages. Not only the tamponade force exerted by silicon oil against the retina is comparatively low, but the patient requires an additional procedure for the removal of this oil from the eye [12]. Moreover, perisilicone proliferation, secondary ocular hypertension, cataract progression and degenerative ocular changes are frequent following silicone oil endotamponade [13].

Therefore, it is important to find an alternative retinopexy technique allowing for an immediate and firm chorioretinal adhesion as well as for the exclusion of silicone oil (or gas) tamponade of the vitreous cavity from the vitrectomy procedure. We have previously found experimentally that (1) high-frequency electric welding of biological tissues (HFEWBT) with upgraded high-frequency current generator EK- 300M1 can be used for retinopexy, and (2) exposure of the chorioretinal complex to electric current (voltage, 14-16 V; current, up to 0.1 A; frequency, 66.0 kHz; exposure time, 1.0-2.0 s) results in a two times higher chorioretinal adhesion compared that achieved with diode endolaser photocoagulation in the presence of the vitreous [14-15]. In addition, we have established optimal current patterns for achieving similar effects in the clinical setting in the presence of various substances (air, perfluorodecalin) in the vitreous cavity [16].

The study purpose was to compare the efficacy (i.e., anatomic and visual outcomes) of vitrectomy with HFEWBT retinopexy versus vitrectomy with diode endolaser photocoagulation for rhegmatogenous retinal detachment.

Materials and Methods

A retrospective non-randomized study was conducted and included 112 patients (112 eyes) with uncomplicated RRD. Retinopexy in the study group (53 patients, 53 eyes) and in controls (59 patients, 59 eyes) was performed using high-frequency electric welding of biological tissues (HFEWBT) and 810-nm laser irradiation, respectively. Exclusion criteria were single eye patients, presence of giant retinal tears, disinsertion from the ora serrata, or retinal detachment in both eyes. The mean duration of RRD was two weeks. Baseline visual acuity was accurate projection of light to 0.1. Pneumotonometry readings ranged from 16.0 to 20.0 mmHg.

Patients were divided into two groups, Group 1 (HFEWBT retinopexy) involving 53 patients (53 eyes; 33 women (62.3%) and 20 men (37.7%); mean age, 55.1±10.9 years) and Group 2 (810 nm endolaser retinopexy; controls) involving 59 patients (59 eyes; 31 women (52.5%) and 28 men (47.5%); mean age, 57.7±10.3 years).

Preoperative examination included autokeratorefractometry, pneumotonometry, visual acuity assessment (using the modified Shevalev's Charts), biomicroscopy, ophthalmoscopy, and perimetry.

Each patient underwent a 20G three-port subtotal pars plana vitrectomy with the use of a wide-field OMS-800 OFFISS (Topcon, Japan) operating microscope.

Surgical technique

After subtenon anesthesia (5.0 mL of 2% lidocaine hydrochloride), conjunctivotomy was placed in the superior temporal, superior nasal, and inferior temporal quadrants of the ciliary body, and sclerotomy was performed. An irrigation cannula was inserted through the inferotemporal sclerotomy and secured in place with a "U" suture. A core vitrectomy was performed at 1500-2500 cuts/min and at vacuum level of 400-600 mm Hg. This was followed by excision of the posterior hyaloid over 360є. Subsequently, a peripheral vitrectomy was performed (2500-5000 cuts/min; vacuum level, 150-250 mm Hg) with scleral depression.

Pneumohydraulic reattachment of the retina was achieved in the control eyes. Two or three rows of endolaser photocoagulation burns were placed around the retinal tear in a confluent fasion. Gas/air mixture (20% SF6 or 30% C3F8) was used for endotamponade of the vitreous cavity. In the HFEWBT retinopexy group, our proprietary retinal flattening method (patent of Ukraine) with perfluorodecalin was used intraoperatively to facilitate complete drainage of subretinal fluid. Intraoperative retinopexy was performed by applying spot burns of up to 1 mm sequentially in two rows along the edge of the retinal tear. Thereafter, perfluorodecalin was removed and replaced for a balanced salt solution. The adequacy of the chorioretinal adhesion formed along the edge of the retinal tear was examined intraoperatively. If the adhesion was adequate, no intraoperative endotamponade of the vitreous cavity was performed. Otherwise, fluid-gas exchange and tamponade of the vitreous cavity was performed at the site of a break in the adhesion, with sterile air, and either 30% SF6 or 20% C3F8, depending on the break location, used as a tamponade agent.

Results

Patients of Group 1 were comparable to those of Group 2 in terms of baseline clinical and functional status, with best corrected visual acuity ranging from accurate projection of light to 0.1. Given a substantial difference in baseline visual acuity among patients, they were divided into four visual acuity categories as follows: (1) accurate projection of light (8 patients of Group 1 and 9 patients (15.1%) of Group 2); (2) accurate projection of light to 0.1 (23 patients (43.4%) of Group 1 and 31 patients (52.5%) of Group 2); (3) 0.1 to 0.3 (13 patients (24.5%) of Group 1 and 9 patients (15.3%) of Group 2); and (4) 0.3 to 1.0 (9 patients (17.0%) of Group 1 and 10 patients (16.9%) of Group 2).

At baseline, the mean visual acuity in Group 1 was 0.16 (0.06), and in Group 2 was 0.17 (0.04), with no statistically significant intergroup difference (P = 0.63). The extent of detachment was 1, 2, 3 and 4 quadrants in 6 patients (11.3%), 16 patients (30.2%), 17 patients (32.1%), and 14 patients (26.4%), respectively, of Group 1, and in 3 patients (5.1%), 14 patients (23.7%), 9 patients (15.3%), and 33 patients (55.9%), respectively, of Group 2 (P = 0.011). Macula detachment was present in 37 patients (69.8%) of Group 1 and 47 patients (79.7%) of Group 2 (P = 0.22). Retinal breaks were located superiorly and anteriorly in 26 patients (49.1%) and 27 patients (50.9%), respectively, of Group 1 and in 39 patients (66.1%) and 20 patients (33.9%), respectively, of Group 2 (P = 0.068). Mild lens opacity, aphakia and IOL were present in 49 patients (92.5%), 1 patient (1.9%), and 3 patients (5.7%), respectively, of Group 1, and in 48 patients (81.4%), 2 patients (3.4%), and 9 patients (15.3%), respectively, of Group 2 (P = 0.21).

Vitrectomy resulted in a complete retinal attachment in all cases (112 eyes), and no intraoperative complications were observed in any patients treated. Operating time ranged from 30 minutes to 50 minutes. It is noteworthy that we managed to exclude intraoperative tamponade in 19 patients (35.8%) of Group 1. During postoperative days 1-3, local retinal detachment secondary to adhesion failure was observed in 2 of these cases, which required for fluid-gas exchange with 20% C3F8. The adhesion failure along the edge of the retinal tear was observed intraoperatively in 34 patients (64.2%), which required the tamponade with sterile air, 20% C3F8 and 30% SF6 in 4 eyes (7.5%), 20 eyes (37.7%), and 10 eyes (18.9%), respectively. At day 1 after surgery, the visual acuity in non-endotamponade patients and endotamponade patients of Group 1 was 0.1 to 1.0 and accurate projection of light, respectively.

At the end of vitrectomy, tamponade of the vitreous cavity with a gas-air mixture, including either 20% C3F8 or 30% SF, was performed in all patients of Group 2 (47 eyes (74.5%) and 12 eyes (25.5%), respectively); in these eyes, mean visual acuity at the discharge was accurate projection of light.

At the 2 month follow-up, retinal re-attachment and recurrent retinal detachment was observed in 51 eyes (96.2%) and 2 patients (3.8%), respectively, of Group 1, and in 53 eyes (89.8%) and 6 patients (10.2%), respectively, of Group 2, with no statistically significant intergroup difference (P = 0.18) (Table 1).

Table 1. Rates of recurrent rhegmatogenous retinal detachment (RRD) in study group (high-frequency electric welding of biological tissues) and controls at two months after vitrectomy

Retinopexy type	Recurrent RRD		Attachment		Total (patients/ eyes)
	Incidence (patients/ eyes)	Rate (%)	Incidence (patients/ eyes)	Rate (%)	
Diode laser photocoagulation	6	10.2%	53	89.8%	59
High-frequency electric welding of biological tissues	2	3.8%	51	96.2%	53
$\chi 2$ =1.721975, p=0.18944					

Table 2. Rates of phacoemulsification in study group (high-frequency electric welding of biological tissues) and controls at twelve months after vitrectomy

Retinopexy type	Phaco with IOL implantation was performed		Phaco with IOL implantation was not performed		Total (patients/ eyes)
	Incidence (patients/ eyes)	Rate (%)	Incidence (patients/ eyes)	Rate (%)	
Diode laser photocoagulation	42	87.5%	6	12.5%	48
High-frequency electric welding of biological tissues	33	67.5%	16	32.5%	49
$\chi 2$ =5.62, p=0.0178					

Patients with recurrent RRD underwent reoperation for RRD, with removal of epiretinal membranes, flattening the retina with sterile air, and diode endolaser photocoagulation of the edges of retinal tears with subsequent tamponade of the vitreous cavity with 20% C3F8. Subsequently, at the follow-up visits over a 12-month period, consistent improvement in anatomic outcome was demonstrated in 52 patients (98.1%) of Group 1, and in 59 patients (98.3%) of Group 2.

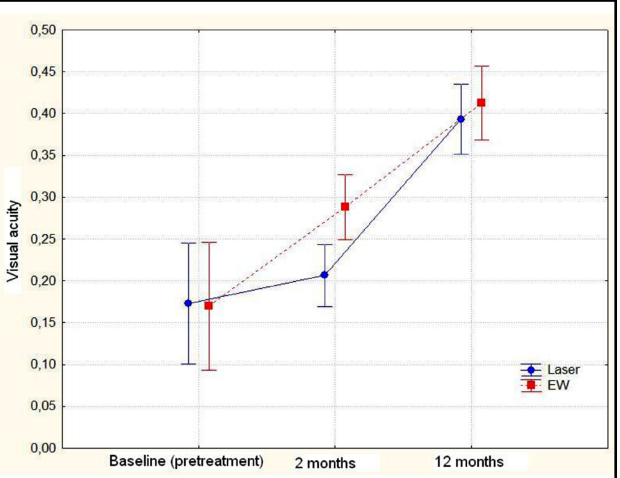

Figure 1. Mean visual acuities in study group (high-frequency electric welding of biological tissues) and controls (diode laser irradiation) at 2 months and 12 months after vitrectomy

Mean visual acuities (vision of light perception or better) in two RRD groups at baseline (preoperatively), at 2 months and at 12 months after vitrectomy are presented in Fig. 1. Fig. 1 demonstrates that, in spite of similar baseline visual acuities among the two groups, at 2 months after vitrectomy, the mean visual acuity in Group 1 was 0.29±0.02, and in Group 2 was 0.21±0.02, with a statistically significant intergroup difference (P = 0.035). At 12 months, visual acuity in Group 1 and in Group 2 improved to 0.41±0.02 and 0.39±0.03, respectively, and the improvement was statistically significant, although the intergroup difference at this time point was not statistically significant (P = 0.61). Most probably, the intergroup difference in visual acuity at 2 months was associated with a lower rate of cataract in eyes undergoing high-frequency electric welding of biological tissues. As it was mentioned, we managed to exclude intraoperative tamponade in 30% of patients of Group 1, thus enabling maintenance of clarity of the posterior lens capsule.

We analyzed the frequency of performing phacoemulsification in the study groups (Table 2). Table 2 demonstrates that during 12 months of follow-up, phacoemulsification was performed in patients of Group 2 more often than in those of Group 1 (42 eyes (87.5%) versus 33 eyes (67.5%)), and the difference was statistically significant (P = 0.017).

Conclusions

First, high-frequency electric welding of biological tissues (a) is a safe and efficient method for obtaining a firm chorioretinal adhesion, (b) can be used in the clinical practice for intraoperative retinopexy at the time of vitrectomy in patients with uncomplicated RRD, and (c) can ensure retinal re-attachment at the long-term follow-up in as much as 96% of such cases.

Second, at 2 months and 12 months after vitrectomy with high-frequency electric welding of biological tissues for RRD, mean visual acuity improved to 0.29 and 0.41, respectively, which is better than after vitrectomy with diode laser photocoagulation (0.21 and 0.39, respectively), although the intergroup difference at 12 months was not statistically significant.

Last, the use of with high-frequency electric welding of biological tissues for retinopexy provided for the exclusion of gas/air mixture tamponade of the vitreous cavity from the vitrectomy procedure in 30% of RRD cases, thus enabling a 20% reduction in the frequency of performing phacoemulsification.

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