Morphological changes of eye tissues after the influence of high-frequency electric current welding with suprachoroidal approach to induce chorio-retinal adhesion

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Background: High-frequency electric current welding **(**HFECW) has been recently shown to be a suitable technique for the colligation of biological tissues [1,2]. Application of HFECW in retinal detachment surgery aims to develop a method:

- for instant and effective tissue adhesion with minimal damage to the retina.
- that does not require pigment epithelium (RPE) to form adhesions (relevant for high myopia and repeated operations).
- that omits the use of long-term tamponade.

Purpose: to determine the morphologic changes in eye tissues in an experiment on rabbits under the influence of HFECW with different modes using suprachoroidal and transvitreal approaches.

Methods: The study was carried out according to the guidelines for the care and use of experimental animals and according to the Association for Research in Vision and Ophthalmology (ARVO) for the use of animals in ophthalmic and visual research. The experiments were conducted on 54 adult chinchilla rabbits in the operating room (**Fig.1A**) under intravenous general anesthesia. A modified EK-300M1 generator (Kyiv, Ukraine) was used for electric welding (**Fig.1B**). Parameters used: frequency 66 kHz, voltage 10-12 volts (V), 12-14 V, 14-16 V with a current of 0.1 ampers (A). A gold hemispheric 25-gauge tip served as the working surface of the instrument (**Fig.1C,D**). After euthanasia, a histological analysis of the tissues affected by HFECW using the suprachoroidal and transvitreal approach with different modes was performed (**Fig.1E,F**)

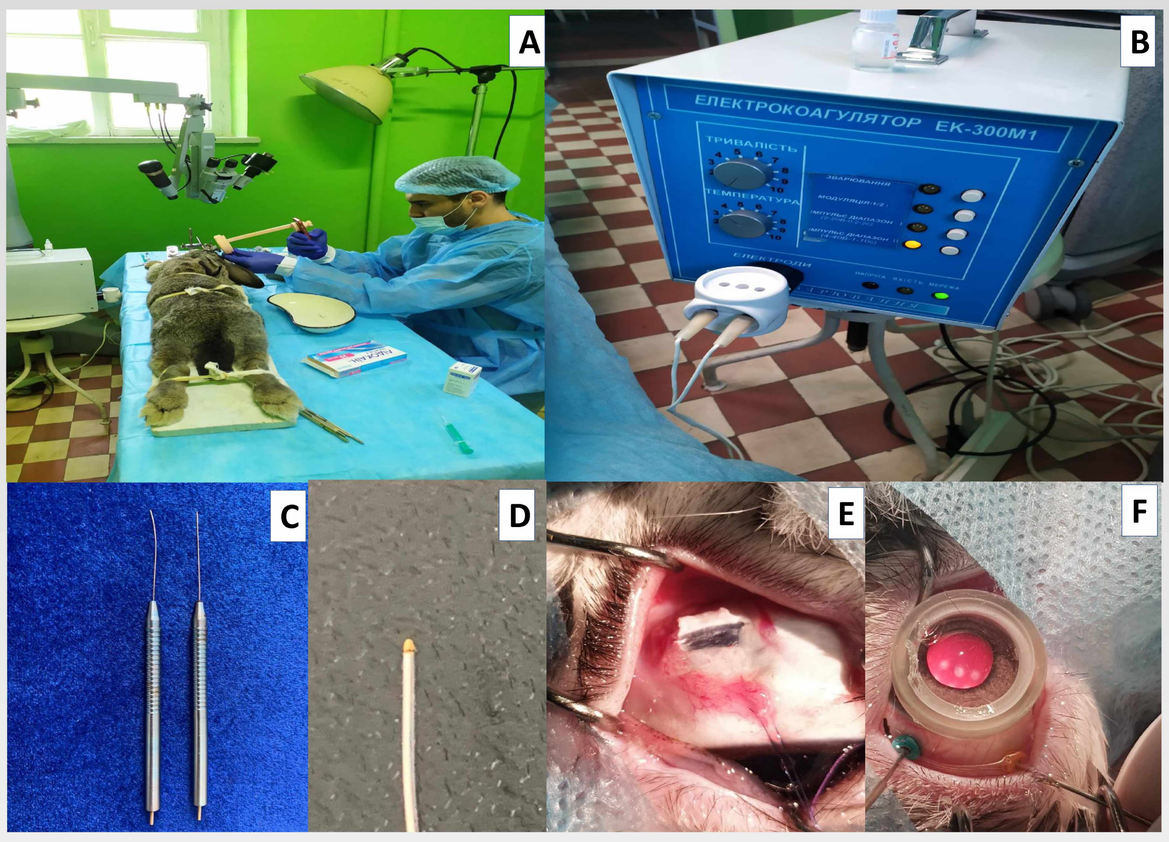

Figure 1. Experimental settings for the study of HFECW-induced chorio-retinal adhesion using transvitreal and suprachoroidal approach (see details in the text).

Results: In all treated eyes, the monopolar HFECW induced an increased tissue adhesion in the area of electrode application, which strengthened with time. The retina responded by apparent destruction of rods, cones, loss of bipolar, amacrine, horizontal and ganglion cells, development of cysts and migration of RPEs (**Fig.2,3**). The choroid showed damage and migration of melanocytes. By 30 days, a tissue thinning with partial cell regeneration and connective tissue degeneration were apparent (**Fig.4A,B**). Application of the voltage from 10 to 16 V caused a shift from active exudation without significant tissue damage to acute retinal necrosis, respectively (**Fig.2,3**). The nearby retinal layers and vitreous remained intact.

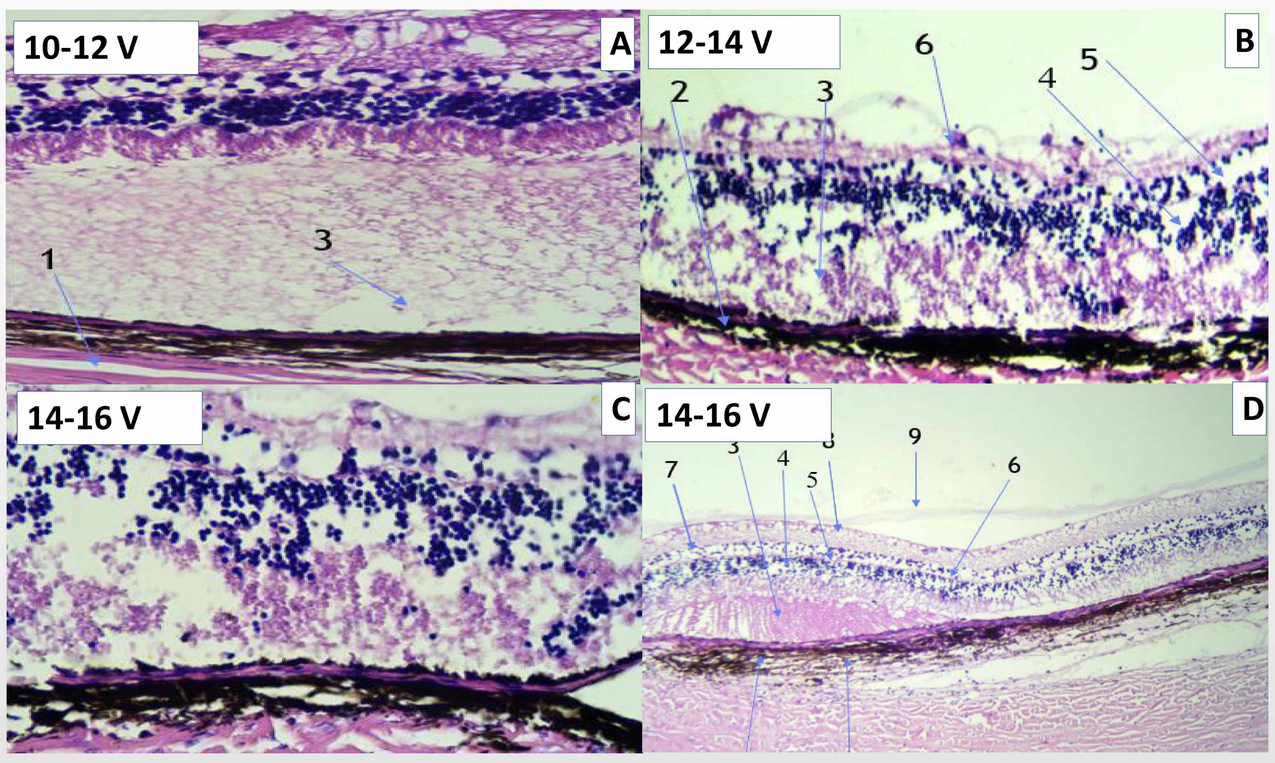

Figure 2. Morphology of the chorio-retinal adhesion in the rabbit's eye 3 days after suprachoroidal exposure to HFECW with 10-12V (**A**), 12-14V (**B**) and 14-16V (**C,D**). **A,B:** 1- swelling of the interstitium in the sclera; 2 - coagulation of large vessels in the choroid; 3 - swelling of the interstitium and destruction of rods and cones of the photoreceptor layer; 4 - focal swelling of the interstitium in the outer nuclear layer; 5 - focal edema of the interstitium in the inner nuclear layer; 6 - detachment of the internal Limiting membrane. **C,D:** 1 - coagulation of large vessels in the choroid; 2 - swelling of the interstitium in the choroid; 3-swelling of the interstitium of the photoreceptor layer of the retina; 4 - focal swelling of the interstitium in the outer nuclear layer; 5 - external plexiform layer; 6 - focal swelling of the inner nuclear layer; 7 - ganglion cell layer; 8 –nerve fibers layer; 9 - detachment of the vitreous body.

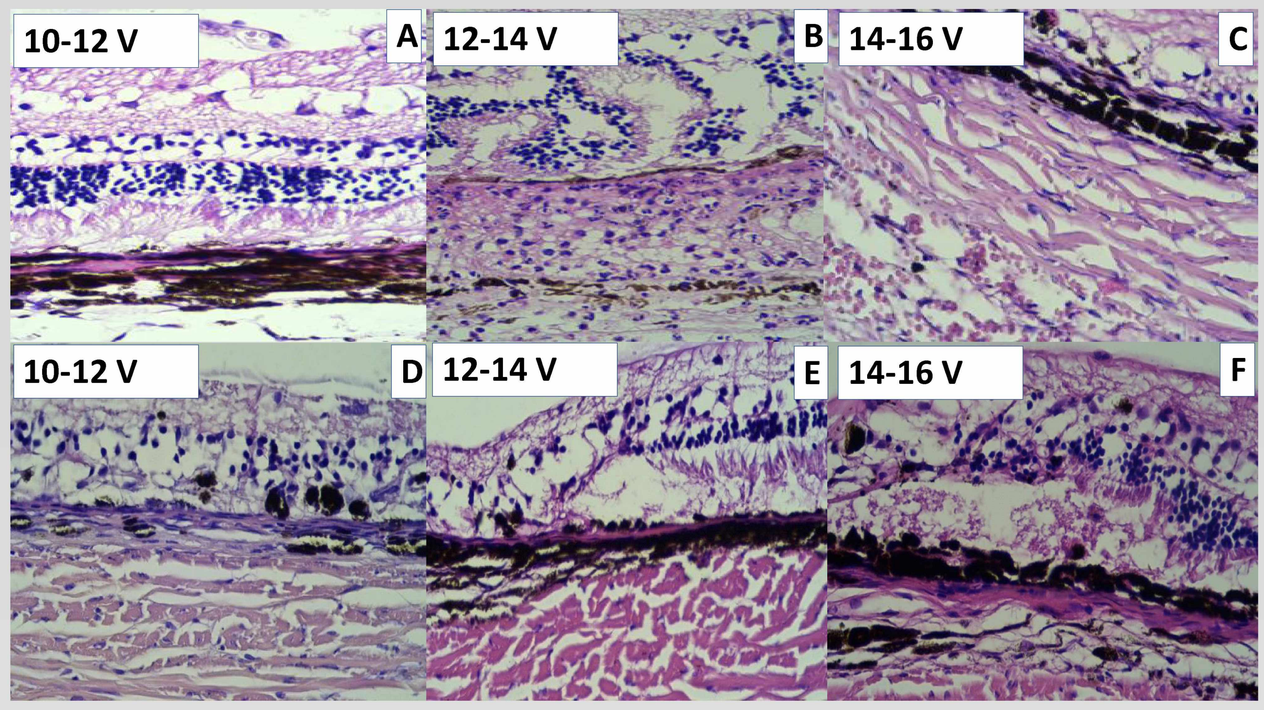

Figure 3. Morphology of the chorio-retinal adhesion in the rabbit's eye 7 days (**A,B,C**) and 30 days (**D,E,F**) after suprachoroidal exposure to HFECW.

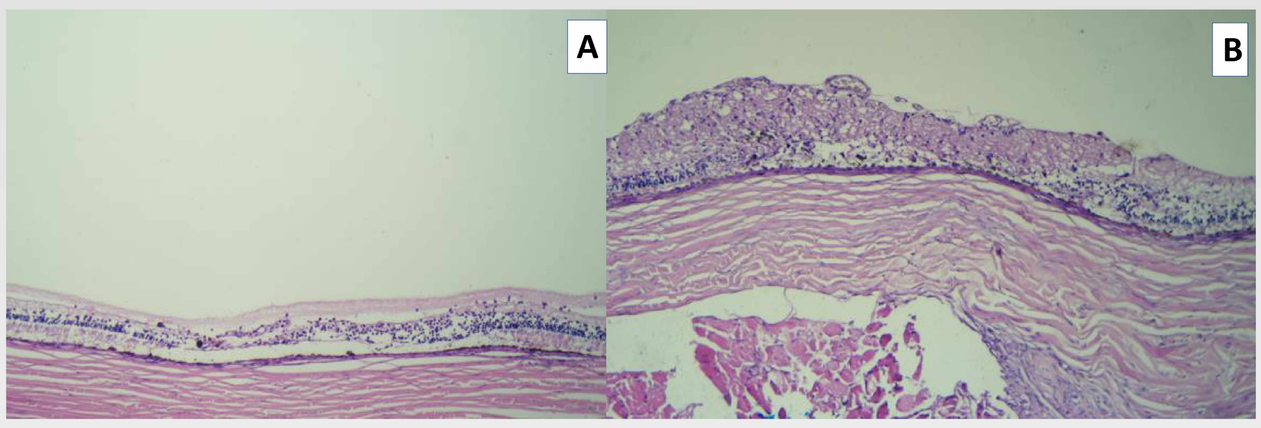

Figure 4. Morphology of the chorio-retinal adhesion in the rabbits eye 30 days after surgery using transvitreal (**A**) and suprachoroidal (**B**) approach.

Conclusions:

- Application of HFECW with suprachoroidal approach induces a chorio-retinal adhesion within 1 hour from treatment, and it strengthens within first weeks.
- The extent of atrophic changes strongly depends on the voltage and is less pronounced when using a voltage of 10-12 V.
- The transvitreal approach demostrates pronounced retinal changes compared to the suprachoroidal one, where the retina adjacent to the focus of electric welding remained histologically less damaged.
- Implementation of HFECW as an alternative method to treat retinal detachment could reduce the need of endotamponade and the associated risks of complications.

References: **1.**Zadorozhnyy O, Pasyechnikova N, Naumenko V, Lazar Y (2012)Experimental application of high-frequency electric welding of biologicaltissues for iridoplasty and trabeculectomy. Acta Ophthalmologica 90:0. doi:10.1111/j.1755-3768.2012.F043.x. **2.** Pasyechnikova N, Umanets N, Artemov A (2012) High-frequency electro-welding of the tissues of the eyeball posterior part (modifiedgenerator EC-300 M1) with the application of the original mono and bipolar set of instruments. Journal of Ophthalmol 2:45–49.

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