

**SHORT THESIS FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY (PHD)**

**Examination of the vitreolenticular interface, with special
regard to the changes occurring during
phacoemulsification**

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Abbreviations

AS-OCT – anterior segment optical coherence tomography

BS – Berger's space

ECCE – extracapsular cataract extraction

AHM – anterior hyaloid membrane

AVD – anterior vitreous detachment

iOCT – intraoperativ optical coherence tomography

HA – hyaluronic acid

LM-BS – lens material in Berger's space

OCT – optical coherence tomography

SS-AS-OCT – swept-source anterior segment optical coherence tomography

1. Introduction and literature review

Our study examines the anterior hyaloid membrane (AHM), the anterior vitreolenticular interface, as well as the behaviour of the surrounding tissues of AHM before and after uncomplicated phacoemulsification during one year postoperative period. The AHM is an integral part of the vitreous body, and therefore the behavior of the AHM may affect both the anterior and posterior vitreous body.

1.1. Macromolecular structure and biochemistry of the vitreous

The vitreous is a transparent gel-like substance. It consists mainly of water, collagen and hyaluronic acid (HA), with a dry matter content of 2%. The vitreous accounts for about 80% of the eye volume, with a cubic capacity of about 4.0 ml. 75% of the collagen content of the vitreous is type II collagen and 15% is type IX collagen. One of the minor collagens of the vitreous is type XVIII, the progenitor of endostatin, which is a potent inhibitor of angiogenesis. HA is a hydrophilic glycoprotein that, by forming a complex with other glycoprotein blocks, chondroitin sulfate and collagen fibrils, acts as a “scaffold” in the vitreous, playing a crucial role in maintaining the molecular morphology of the vitreous. HA attracts the so-called counter ions and water, which also contribute to the formation of distances and the maintenance of the three-dimensional structure. Of the proteins in the vitreous proteome, 278 were detected only in the anterior vitreous space, 322 in the cortex, 128 in the vitreous base, and 136 in the vitreous nucleus, suggesting that different substructures of the vitreous have different roles and interact differently with surrounding tissues. Oxygen enters the vitreous by diffusion from the choroid and retinal circulation. Most of this is consumed by hyalocytes, thereby limiting the amount of oxygen reaching the lens and anterior segment.

1.2. Anatomy of the vitreous body

The vitreous body in adulthood is divided into two main topographic areas: the central part, called the vitreous gel, and the peripheral vitreous cortex. The vitreous body is surrounded by the hyaloid membrane. The posterior hyaloid membrane adheres to the retina and the ciliary body, while the AHM is connected to the suspensory fibers and the posterior capsule of the lens. The anterior part of the cortical vitreous body is the so-called vitreous base, where the collagen fibers are particularly dense, and the vitreous body adheres so firmly to the anterior retina that it cannot be detached without tissue destruction. The Berger's space (BS), named after Emil Berger, is a virtual space between the posterior surface of the lens and the AHM, often limited by the ligamentum hyaloideocapsulare, also known as the Wieger ligament. The Wieger's band forms a ring 8-9 mm in diameter 1 mm from the lens edge and attaches the vitreous to the posterior lens. The vitreous adheres to the retinal surface, the membrana limitans interna, via the adhesion molecules fibronectin and laminin. This connection - in addition to the vitreous base - is particularly strong along the retinal vessels, at the edge of the papilla, in the area of the macula and on the posterior lens. Anterior the macula the posterior vitreous forms the bursa praemacularis (16).

1.3. Clinical significance of the vitreolenticular interface

Congenital pathological changes of the vitreolenticular junction and anterior vitreous: persistent hyaloid artery, primary hyperplastic persistent vitreous, and some forms of congenital cataract - Mittendorf point, posterior lenticonus, and posterior polar cataract - affect the lens capsule itself to varying degrees and complicate cataract surgery and/or pars plana vitrectomy. Morsman summarized the biomicroscopic features of the retrolental space in 1929, emphasizing its clinical significance in anterior and posterior segment inflammation. Other authors have reported blood deposits in the posterior capsule in proliferative

diabetic retinopathy, highlighting another clinical significance of BS. In the era of intracapsular cataract surgery, a crucial question was how the surgeon could delicately dissect the zonular fibers and Wieger's ligament and remove the lens without loss of vitreous. When extracapsular cataract extraction (ECCE) became a common practice, the dice turned, and preservation of the lens capsule and AHM became one of the main goals. However, in some special cases of ECCE, the BS had to be addressed separately. In the case of a membranous lesion of the posterior lens capsule, Weidle opened the posterior capsule in a point-wise manner, filling the retrolental space with sodium hyaluronate, which widened the BS and facilitated the performance of the posterior capsulorhexis.

It is well known that phacoemulsification fundamentally changes the state of the lens, and the surgery affects the integrity of the entire eye. The behavior of the vitreolenticular compartment and AHM during phacoemulsification was first described by Tassignon and Dhubhghaill in 2016 using real-time intraoperative optical coherence tomography (iOCT). Other authors have used anterior segment optical coherence tomography (AS-OCT) to visualize changes in the posterior capsule and AHM. It has been shown that after phacoemulsification, the BS enlarges in most of the cases after surgery, or the preoperatively fixed AHM even detaches from the posterior capsule in some cases. It has been shown that the patient's age, axial length of the eye, the presence of lens materials in the BS (LM-BS), weakness of the zonular fibers, and corneal curvature affect the behavior of AHM. Some surgical parameters of phacoemulsification, such as total surgical time, cumulative dissipated energy (CDE), ultrasound time, average longitudinal power, total aspiration time, fluid consumption, infusion pressure, aspiration flow rate, bottle height, and vacuum, affect the development of BS. In addition to the above, we examined the degree of cataract, the number of hydrodissections, and the size of the capsulorhexis, which parameters could also be assumed to influence the development of BS. Previous studies have shown that LM-BS

correlates with certain anatomical features, and that there may be a relationship between LM-BS and certain surgical parameters of phacoemulsification. We ourselves have extensively analyzed the cases of LM-BS in our studies. Analyzing the development of phacoemulsification, we can conclude that one of the key points is perhaps that the surgery should be as atraumatic as possible and should spare the vitreolenticular border as much as possible.

1.4. The importance of AS-OCT in the examination of the vitreolenticular interface

AS-OCT allows visualization and evaluation of the tear film, cornea, conjunctiva, sclera, rectus muscles, anterior chamber, anterior chamber angle, and lens. OCT technology has advanced rapidly over the past two decades, moving from time-domain OCT to Fourier-domain OCT and then swept-source AS-OCT (SS-AS-OCT). The SS-AS-OCT we used, an Anterion (Heidelberg Engineering, Heidelberg, Germany), uses a 1300 nm light source and produces 50,000 A-scans per second.

The Anterion provides good visualization of the cornea, anterior chamber, anterior chamber angle, iris, and lens, but the retrolental space is very limited in phakic eyes, so the detection of BS is only incidental. We found that the AHM detachment (AVD) can be safely visualized only in manual mode, allowing deep and clear images of the vitreolenticular interface. In contrast, we found that the automatic mode of the Anterion can be very well used postoperatively to visualize the AHM and even to measure the distance between the AHM and the posterior lens capsule.

2. Objectives

1. To develop a routine procedure using SS-AS-OCT that does not rely solely on incidental detection of AVD and can reliably show AVD preoperatively.
2. To follow the change in AHM and vitreolenticular interface prospectively for 1 year in a large group of patients after uneventful phacoemulsification.
3. To analyze the postoperative status of AHM in the light of surgical parameters in the early and late postoperative period.
4. To examine the preoperative conditions and surgical parameters that may be related to lens materials appearing in the Berger space after phacoemulsification.

3. Patients and Methods

3.1. Changes in the vitreolenticular interface after uneventful phacoemulsification for 1 year, using SS-AS-OCT

We performed a prospective study on 102 eyes of 102 patients preoperatively and at 1-day, 1-week, 1-month, 3-month, 6-month and 1-year follow-ups. In addition to the routine ophthalmological examination, SS-AS-OCT examinations were performed in pupil dilatation before surgery and at all follow-ups. Preoperatively, on phakic eyes, deep and clear images of the vitreolenticular interface were obtained using the Anterior Metrics App and Imaging App. Postoperatively, in eyes with intraocular lenses (IOL) we used the automatic mode of the Metrics App, the measured distances were given in microns at all follow-ups. Behind the IOL, centrally, in the area not shaded by the iris, the AHM was clearly visible and suitable for measurements. For the measurements, we used 90-270 degree vertical and 0-180 degree horizontal sections. On each section, we measured the distance between the posterior capsule and the AHM at three points. For the measurements, we chose two clearly visible points on both sides of the IOL: 1 mm in the middle from the optic edge, and we measured the width of the detachment at the deepest point. On the SS-AS-OCT images, the posterior capsule appeared as a more hyperreflective, continuous line following the shape of the IOL, while the AHM was a thinner, less reflective, slightly irregular line than the posterior capsule.

3.2 The effect of surgical parameters of phacoemulsification on the vitreolenticular interface.

We included 82 eyes of 82 patients in our study. Preoperatively, the severity of the cataract was classified based on the Lens Opacity Classification System III (LOCSIII) grade 1–6 scale. After an uneventful, standard phacoemulsification, the following intraoperative data were recorded: capsulorhexis size (to the nearest 0.5 mm),

number of hydrodissections, CDE, ultrasound time, total operative time, LM-BS (yes or no), and fluid consumption (to the nearest 20 ml). Zonular weakness was scored on a semi-quantitative scale from 1 to 4. Preoperatively, as well as postoperatively at 1 day, 1 week, 1 month, 3 months, 6 months, and 1 year, the examinations described in the previous subsection were performed, thus obtaining an accurate picture of the status of the AHM.

All studies were conducted in accordance with the Declaration of Helsinki, with approval from the local Research Ethics Committee, and with informed consent from the patients.

4. Statistical analysis

For quantitative variables, the valid N, mean, standard deviation, minimum, 25th percentile, median, 75th percentile and maximum values were given, while for qualitative variables, the number of cases and percentages were used. For qualitative variables, Fisher's test or Pearson's chi-square test was used. To select the appropriate statistical test, the normality of the variables was checked with the Shapiro–Wilk test and the equality of error variances with the Levene test. The Mann–Whitney U-test was used to test for differences between groups when the Shapiro–Wilk test was significant ($p < 0.05$) and the independent t-test (comparison of two groups) or the one-way ANOVA with Bonferroni post-hoc test (comparison of three groups) was performed for variables where the Shapiro Wilk test did not show a significant deviation from normal distribution. To test for differences between groups over time, a Friedman test was performed for variables where the Shapiro–Wilk test showed significant deviations from normal distribution, and a Levene test rejected the null hypothesis that the error variance of the variable was equal in the studied groups. Spearman correlation analysis was performed to compare groups. The significance

level was set at $p < 0.05$. During the processing of surgical parameter data, linear-linear association was also examined for ordinal qualitative variables. Binary regression was tested for LM-BS before applying backward Wald characteristics; then a Hosmer–Lemeshow test was performed. All statistical tests were performed using IBM SPSS version 25.

5. Results

5.1. Changes in the vitreolenticular interface after uneventful phacoemulsification over 1 year

In the study series, eyes were divided into two groups. Group 1 included those eyes in which an AVD was seen before surgery ($N=19$), and Group 2 included those eyes in which no AVD was seen ($N=83$). Group 2 was divided into two subgroups depending on the postoperative outcome: Group 2A ($N=50$) included those eyes in which BS was visible on at least one follow-up in the postoperative period. Group 2B included those eyes in which BS was not seen on any of the one year follow-ups ($N=33$). AHM was detectable preoperatively in 19 cases in the manual mode, while AVD was detected in only 8 cases in the automatic mode images, examining the same eyes. Based on this finding, we can state that in more than half of the cases we would have come to the wrong conclusion without the examination method we introduced.

There was no statistically significant correlation between the distribution of groups and gender. However, in terms of mean age, the difference between 1 and 2B (Bonferroni corrected $p = 0.01$) and 2A and 2B (Bonferroni corrected $p = 0.001$) was statistically significant in the pairwise comparison. Therefore, in those groups where the AHM was depicted preoperatively (group 1) or postoperatively (group 2A), the mean age was higher. In Group 1, the mean axial length was 22.98 ± 0.77 mm, while in Group 2 it was 24.38 ± 2.22 mm. The difference between the two groups was statistically significant (independent t-test; $t = -4.629$; $p < 0.001$). In Group 2A, the mean

axial length was 23.79 ± 1.67 mm, while in Group 2B it was 25.26 ± 2.66 mm. A statistically significant difference was observed between the three groups (ANOVA, $F: 9.670$, $p < 0.001$). In the pairwise comparison, the difference between Groups 1 and 2B (Bonferroni corrected $p < 0.001$) and between Groups 2A and 2B (Bonferroni corrected $p = 0.003$) was also statistically significant. Thus, in those groups where AHM was visualized, the mean axial length was smaller. There was no significant difference between the groups regarding the preoperatively measured anterior chamber depth and lens thickness.

The deepest point of BS in the horizontal meridian on the 1st postop. day was on average 782.5 ± 324.1 μm in Group 1 and 184.1 ± 220.1 μm in Group 2A. The difference between the two groups was statistically significant at all control times ($p = 0.001$). The deepest point was most often nasally in Group 1 and centrally in Group 2A. Examining the temporal progression within Group 1, first day data was statistically significantly different from all subsequent follow-up data ($p = 0.031$). In contrast, in Group 2A there was no statistically significant change in BS depth over 1 year at the different follow-ups. The deepest point of BS in the vertical meridian was measured on the 1st postop day. On day 1, the mean BS depth was 711.3 ± 332.5 μm in Group 1 and 231.7 ± 310.4 μm in Group 2A. There was a significant difference between the two groups at all time points (Mann–Whitney test, Bonferroni corrected $p < 0.008$). The deepest point was most often in the lower region in Group 1 and centrally in Group 2A. During the 1-year follow-up, we did not see a statistically significant change in the depth of BS in either group. When examining the mean BS values in the nasal, temporal, inferior or superior regions in Group 1, the Friedman test did not show a statistically significant change during the 1-year follow-up period compared to the 1st postoperative day. In Group 2A, there was a significant change from baseline in the nasal and temporal regions ($p = 0.002$ and $p = 0.008$), while the change was not significant in the lower and upper regions.

5.2. The effect of surgical parameters of phacoemulsification on vitreolenticular interface

Intraoperative data collection during uneventful phacoemulsification demonstrated in several cases a significant correlation with some phacoemulsification parameters and preoperative conditions, as well as with AVD. At the postoperative 1-day follow-up, a significant linear trend was observed between AVD and increasing degrees of zonular weakness ($p=0.023$). CDE was significantly higher in the post-op. AVD group (t-test: $p=0.005$). At the 1-month follow-up, a significant linear trend was observed between AVD and high degrees of nucleosclerosis ($p=0.011$) and with increasing intraoperative zonular weakness ($p=0.001$). CDE (t-test: $p=0.001$) and higher fluid consumption (t-test: $p=0.012$) were significantly higher in the 1-month post-op AVD group. A significant correlation was observed between the presence of AVD at 1 month and intraoperative LM-BS ($p=0.026$). At the 3-month follow-up, a significant linear trend was observed between AVD and high grade nucleosclerosis ($p=0.014$), and between AVD and increasing zonular weakness ($p=0.004$). We observed a correlation between AVD and higher CDE (t-test: 0.001), long total surgical time (t-test: 0.028), and high fluid consumption (t-test: 0.021). At the 1-year follow-up, a significant linear trend was observed between AVD and high grade of nucleosclerosis ($p=0.015$), and increasing zonular weakness ($p=0.024$). Higher CDE (t-test: 0.002) and high fluid intake (t-test: 0.014) were also correlated with 1-year AVD.

Intraoperative LM-BS was found in 12 eyes (14.6%). Among the surgical parameters examined, zonular weakness and fluid intake showed a statistically significant correlation with LM-BS using multiple regression. Zonular weakness was significantly correlated with LM-BS status, i.e. the looser the zonular fibers, the more likely LM-BS was to occur (odds ratio: 0.085 (95% confidence interval: $0.017-0.420$; $p=0.002$)). Fluid consumption was significantly higher in the presence of LM-BS (odds ratio: 1.049 (95% confidence interval: $1.003-1.096$; $p=0.037$)). However, high degree of nucleosclerosis, CDE, total operative time, size of capsulorhexis, number of

hydrodissections and ultrasound time did not show a significant association with the intraoperative presence of LM-BS.

6. Discussion

6.1. Changes in the vitreolenticular interface after uneventful phacoemulsification over 1 year postop period.

The factors known influencing the assessment of the vitreoretinal interface with AS-OCT in phakic eyes, and thus the visibility of BS and AHM, are as follows: circumstances of the AS-OCT image taking, pupil size, age, and axial length. Various authors found preoperatively 0.9-8.2% of BS that could be seen on images, while in our study this rate was 18.6%. By turning off the automatic mode of the Anterior SS-AS-OCT, we performed the examination in manual mode for the first time in the world on phakic eyes before phacoemulsification, and were able to routinely visualize the retrolental space with great certainty. Since the average age of the patients was similar in each publication, this new examination method, as well as the dilated pupil in each case, explains, in our opinion, the fact that we were able to detect BS preoperatively in a higher rate than other authors. While Mori et al. showed that BS was more typical of older age, in our study we did not find a statistically significant difference in the mean age of patients with preoperatively detectable BS (Group 1) and patients with preoperatively non-demonstrable BS (Group 2). However, our own studies have shown that AVD is more likely to occur in older age after uneventful phacoemulsification. According to our current knowledge, the role of axial length in the status of AHM is controversial. Mori et al. found a direct correlation between axial length and AVD. In contrast, our experience suggests that a long eye does not predispose to AVD, and in fact, the longer an eye was

preoperatively, the more likely AHM adhesion was present ($p < 0.001$). This issue requires further investigation.

The postoperative status of BS and the development of possible AVD have been investigated by various authors up to today during a follow-up period of up to 1 month. We followed the changes in the vitreolenticular interface for 1 year after uneventful phacoemulsification. In the images collected over 1 year, a striking difference emerged in the anatomy of the anterior surface of the two study groups. The group with preoperatively visible BS, i.e. Group 1, had a depth of the deepest point around 650-750 μm in all follow-ups, while in Group 2A, where the AVD was detected only postoperatively, the AHM was only 140-180 μm away from the posterior capsule. This difference was statistically significant at all time points, as was the case for all points measured peripherally. In Group 1, the largest distance was measured in the nasal region in most cases, which showed a decreasing trend from month 1 to month 3, and then showed a trend of moving away from the posterior capsule from month 3 until the 1-year follow-up. In addition, the baseline values on the first day were significantly higher in all cases compared to all later loww ups registered during the year. In Group 2A, the deepest point was measured in the central region on the horizontal OCT images. According to our observation, the average distance on the first day gradually decreased to the one-month follow-up, and then gradually moved away again during the one-year period. However, no significant change in the movement of the limiting membrane could be detected here, at most a trend could be observed. The vertical OCT images of Group 2A showed a change with a similar course to the horizontal cross-sectional images.

The data seen and measured on the AS-OCT images detailed above reveal a characteristic vitreolenticular interface dynamics during the 1-year follow-up of the patients. However, this process is slightly different in the two groups. The main reason for this is that the preoperatively detached AHM (Group 1) cannot

reorganize itself in the immediate vicinity of the posterior capsule after surgery. We can therefore reasonably assume that the phenomenon is related to the status of the Wieger ligament. Despite our repeated attempts, we were unable to image the Wieger ligament on AS-OCT due to its delicate structure and peripheral location shaded by the iris. Therefore, we indirectly inferred the position of the ligament from the shape of the prehyaloid space. In Group 1, the typical location of the deepest point was the nasal region on the horizontal section, while on the vertical section the deepest point was found in the inferior region. In the preoperative images, the AHM was mainly seen in the central part behind the lens, as the large diameter cataractous lens prevented accurate peripheral imaging. Thus, we do not know whether the nasal and inferior parts of the AHM were detached preoperatively or not. The identical course of the cases in Group 1 suggests that irreparable damage occurs in the ligament, which was already weakened earlier, during cataract surgery. The location of the deepest point presumably indicates the direction of fluid outflow in the space behind the lens.

This assumption is also supported by the process that took place in Group 2A. In this case, preoperative AVD was not visible. In most of the postoperative cases, a small opened BS was seen, and the distance of the AHM from the posterior capsule was three times smaller than the values measured in Group 1. In the cases of Group 2B the BS remained virtual. We can therefore conclude that if the peripheral supporting structures are intact preoperatively, the „damage“ caused by the surgery will be smaller.

We can rightly assume that the “space” left behind the relatively large removed lens will not assume its final state behind the relatively thin IOL on the first postoperative day, and its depth will not even be definitive for the first month. In the case of Groups 1 and 2A, a residual amount of fluid is likely to be present between the lens capsule and the AHM in the early postoperative period, i.e. in

the prehyaloid space, which will flow out of the space in the late postoperative period. Of course, this theory must also be supported by histopathological analysis.

6.2. The effect of the surgical parameters of phacoemulsification on the state of the vitreolenticular compartment.

In 2016, Tassignon and Ghubhghaill visualized the AHM during phacoemulsification with iOCT. It was assumed that the BS is a real anatomical space that has a physiological role and should be protected. Scarfone et al. demonstrated that high infusion pressure used during phacoemulsification has a detrimental effect on AHM, which can be prevented by the use of so-called “active fluidics” provided by some phacoemulsifiers. These examples also show that it is worth examining as widely as possible which phacoemulsification parameters are prone to causing AVD. The experiences gained during our studies are partly in agreement with the relevant literature, according to which zonular weakness, higher than average ultrasound use, high-pressure infusion, and higher CDE predispose to AVD.

Previous comparisons have not found a significant association between AVD and higher degree of cataract and high fluid intake; however, we found that both parameters were significantly correlated with AVD in the majority of follow-ups. We believe that our data are likely to differ from those previously published due to differences in measurement methods.

According to our current knowledge, it is still not completely clear how important it is to preserve the integrity of the vitreolenticular interface during phacoemulsification, if possible. However, we agree with Tassignon's theory that the fluid collected in the 8-9 mm annular Wieger's band may act as synovium, facilitating lens accommodation. Adherent AHM may also play a role in faster stabilization of postoperative refraction. Disruption of the

vitreolenticular compartment facilitates the diffusion of various microbes and inflammatory mediators through the zonula into the BS, thereby increasing the risk of vitritis, macular edema, and endophthalmitis. According to various sources, 2.0-25.0% of bacteria can be cultured from the anterior chamber after phacoemulsification, although the basic rules of perioperative asepsis and antisepsis were strictly observed. Therefore, we consider it important to know precisely those surgical parameters that influence the state of the vitreolenticular interface. This knowledge facilitates the application of a surgical technique that preserves the integrity of the vitreolenticular interface as much as possible.

According to the literature, LM-BS is a condition when lens material in the BS can be visualized by various methods during cataract surgery. This can be done with iOCT or LM-BS can be easily detected with an operating microscope because of its characteristic appearance. LM-BS can now also be detected postoperatively using AS-OCT. Our findings are consistent with the findings of Anisimova et al. and Lin et al. that phacoemulsification can cause zonular dehiscence, AVD, and Wieger's ligament injury, which can result in lens material entering the BS. Our studies have identified previously unknown risk factors for LM-BS. In the LM-BS group, a significant correlation was observed with increased zonular laxity. Fluid consumption was also significantly higher in the LM-BS group. We believe that if LM-BS is detected intraoperatively, it most likely indicates a desorganization of the integrity of the vitreolenticular anatomy. Therefore, in such cases, it may be worthwhile to implant a capsular tension ring. In this way, the lens capsule can be stabilized; and the postoperative refraction will theoretically stabilize more quickly. This assumption, of course, needs to be supported by further studies.

7. Summary of the new results and their clinical significance

7.1. Changes in the vitreolenticular interface after uneventful phacoemulsification for 1 year using SS-AS-OCT.

A routinely applicable swept source anterior segment OCT protocol was developed, which allowed for more accurate preoperative determination of AHM detachment or adhesion in the phakic eye. For the first time in the field, we prospectively followed the changes in the Berger Space and anterior vitreous membrane in a large group of patients after uneventful phacoemulsification for 1 year in the postoperative period. At all postoperative follow-ups, we found a significant difference in the depth of the Berger Space between the group of patients with preoperative anterior vitreous detachment and the group of patients whose anterior vitreous detachment developed only after phacoemulsification.

7.2. The effect of phacoemulsification surgical parameters on the state of the vitreolenticular compartment.

We demonstrated that the adhesion and detachment of the anterior vitreous detachment after phacoemulsification is highly dependent on certain preoperative anatomical factors, the patient's age, and the surgical parameters used during cataract surgery. We demonstrated that, in addition to other surgical parameters, high degree of cataract and fluid consumption are also significantly correlated with postoperative anterior vitreous detachment in both the early and late postoperative periods. We were the first to describe that in the case of a weak zonula and greater intraoperative fluid use, there is a significantly higher chance of finding intraoperative lens material in the Berger Space.

Based on our observations, we can more consciously choose the surgical parameters of phacoemulsification and refine our surgical technique. Based on our results, we can follow the postoperative state of the vitreolenticular interface, and this can give us a good basis for further functional studies.



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List of publications related to the dissertation

1. **Elekes, Á.**, Németh, G., Lauter, D., Edelmayer, M., Rupnik, Z., Vámosi, P.: Examination of the Vitreolenticular Interface in Relation to Uneventful Phacoemulsification over One-Year Postoperative Period.
J Clin Med. 13 (11), 1-12, 2024.
DOI: <http://dx.doi.org/10.3390/jcm13113219>
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2. **Elekes, Á.**, Vámosi, P.: Examination of Vitreolenticular Interface in Relation to Different Phacoemulsification Parameters in Early and Late Postoperative Period.
J Clin Med. 13 (16), 1-8, 2024.
DOI: <http://dx.doi.org/10.3390/jcm13164855>
IF: 3 (2023)

List of other publications

3. **Elekes, Á.**, Vámosi, P.: Az intracamerális cefuroxim toxicitásáról.
Orv. hetil. 166 (8), 301-306, 2025.
DOI: <http://dx.doi.org/10.1556/650.2025.33245>
IF: 0.8 (2023)
4. **Elekes, Á.**, Vámosi, P.: Ismereteink az elülső üvegtesti határhártyáról, Berger-térről, vitreolenticularis határfelzínről: (Pontszerző továbbképző közlemény tesztkérdésekkel).
Szemész. 162 (1), 2-13, 2025.
DOI: <http://dx.doi.org/10.55342/SZEMHUNGARICA.2025.162.1.2>
5. Vámosi, P., **Elekes, Á.**, Németh, G.: Műlencsetervezés nagyfokú myopiás szemén: (Pontszerző referáló közlemény, tesztkérdésekkel).
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9. **Elekes, Á.**, Vámosi, P.: A vena cava superior szindrómához társuló kétoldali zárt zugú glaucoma.
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Total IF of journals (all publications): 9,2

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The Candidate's publication data submitted to the Tudóstér have been validated by DEENK on the basis of the Journal Citation Report (Impact Factor) database.

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