Prognostic factors and imaging procedures in postoperative endophthalmitis and in severe eye injuries

Doctoral thesis

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Introduction

Postoperative endophthalmitis (POE) is still one of the most dangerous complications after cataract surgery. With pars plana vitrectomy performed at an early stage and with the standard procedures recommended by the Endophthalmitis Vitrectomy Study (EVS) this severe inflammation of the eye can be treated successfully. To better understand the structural changes in post cataract endophthalmitis we need imaging data about the changes in vitreous cavity and other parts of the posterior eyewall. The structural changes in the retina and choroid in different degenerative, proliferative and inflammatory diseases of the eye have been studied and described, however, it is still unknown, how postoperative endophthalmitis after cataract surgery influences the microstructure of the retina and choroid after full recovery from this severe complication. In addition, the presence of structural retinal and choroidal changes due to post cataract endophthalmitis may help to predict the long term clinical outcomes after performed vitrectomy as first choice treatment.

Endophthalmitis is also a severe complication after open globe injuries with intraocular foreign bodies. Accurate imaging procedures are fundamental for the diagnosis, treatment and the prognosis of these severe eye injuries. Therefore, the examination of clinical data using a specific classification of the eye injuries would provide information about clinical outcomes and help to establish a prognosis. Numerous authors have shown different imaging procedures and established important recommendations for the early management of these injuries in order to guarantee the best possible postoperative outcomes. CT, x-ray radiography, ultrasonography and OCT are standard procedures in the diagnostics and clinical management of eye injuries with IOFBs. Especially advanced technologies in CT such as CT volumetry may help to better localize IOFBs and help to plan the surgical treatment of these open globe injuries.

In the last decade, imaging technologies in ophthalmology have undergone an enormous development and thus provide an indispensable help for the management of postoperative endophthalmitis and open globe injuries with intraocular foreign bodies.

Aims

1) **Evaluation of data on endophthalmitis in Hungary**

To collect and analyse data related to the current incidence and treatment of POE in Hungary

2) **Ultrasound examination in POE**

To evaluate the ultrasonographic features in patients with POE following cataract surgery

3) **SD-OCT examination in patients after successful management of acute POE**

To analyze the retinal and choroidal microstructure imaged by SD-OCT in patients after PPV due to post cataract endophthalmitis.

To study the correlation between central retinal thickness and choroidal thickness in eyes after post cataract endophthalmitis.

4) **Clinical outcomes (prognostic factors) and imaging evaluation in patients with IOFB**

To retrospectively analyse clinical features as well as the visual results of open globe eye injuries with IOFB.

To determine the prognostic factors after the removal of retained intraocular foreign bodies.

5) **Accuracy of CT volumetry for measurement of IOFB**

To evaluate the three dimensional reconstruction of CT imaging volume of intraocular foreign bodies (IOFB) using CT volumetry as a prognostic factor for clinical outcomes in open globe injuries.

Materials and methods

1) Evaluation of data on endophthalmitis in Hungary

We retrospectively collected data on 2678 patients with endophthalmitis from the database of the National Health Insurance Fund in Hungary covering the 8-year period between 1st of January 2000 and 31th of December 2007. we analysed the type of endophthalmitis, we compared the registered data on vitrectomy with the effective performed and reported surgical approaches to treat the endophthalmitis.

2) Ultrasound examination in POE

At the Department of Ophthalmology of Semmelweis University, Budapest, Hungary, a retrospective analysis of data and ultrasound findings of 81 patients with endophthalmitis following cataract surgery was conducted during a 6 year period from 1st of January 2000 and 31th of December 2005. We evaluated the type of cataract surgery, time of onset of endophthalmitis, and different ultrasonographic findings such as opacities in vitreous cavity, membrane formations, detachment of posterior hyaloid, detachment of the choroid and /or of the retina, formation of abscess or granulomas, swelling of optic nerve and thickness of the posterior eye wall (PEWT).

3) SD-OCT examination in patients after successful management of POE

Between 1st of July 2012 and 31th of January 2013, a cross sectional, observational study was carried out at the Department of Ophthalmology, Semmelweis University, Budapest, Hungary. Patient charts were evaluated retrospectively where pars plana vitrectomy was performed in the period between 2008 and 2012 due to severe acute endophthalmitis following cataract surgery and obtained clear optic media after recovery. All patients underwent phacoemulsification and posterior chamber intraocular lens implantation in both eyes. The average time for the SD-OCT assessment performed after the vitrectomy was 48 ± 34 months. SD-OCT examinations were performed in all eyes using Spectralis (Heidelberg Engineering, Heidelberg, Germany) SD-OCT. We measured central retinal thickness, macular volume, peripapillar RNFL. For the measurement of choroidal thickness patients underwent enhanced depth imaging spectral-domain optical coherence tomography which was obtained

by positioning the device close to the eye and employing the automatic EDI mode of the device. Pairwise comparisons were made between the post-endophthalmitis eye (study eye) and the fellow healthy eye (control eye). The statistical analyses were performed using the Statistica 8.0 software (Statsoft Inc., Tulsa, USA). Data were expressed as mean values ± standard deviation. Wilcoxon nonparametric test was used for the comparison of thickness data between the study and control eyes. The occurrence of epiretinal membranes was compared by Fisher exact test. Spearman rank order correlation test was performed between central retinal thickness and subfoveal choroidal thickness. The level of significance was set at $p < 0.05$.

4) Clinical outcomes (prognostic factors) and imaging evaluation in patients with IOFB.

At the Department of Ophthalmology of Semmelweis University Budapest, Hungary, we conducted a non-randomised, non-comparative retrospective analysis of records of 31 patients with intraocular foreign bodies treated by pars plana vitrectomy and other conventional surgical techniques during a 3-year period between January 2006 and December 2008. We evaluated the age of the patients, gender, the size of the IOFBs, the pre- and postoperative best corrected visual acuity (BCVA), the time between injury and performed removal of the IOFBs, the type of surgery, the follow-up and the clinical outcome. We classified the ocular injury using the OTS (Ocular Trauma Score) classification for ocular injuries (United States Eye Injury Registry [USEIR]). The calculation of the OTS grade considers the visual acuity at the time of admission, the evidence of eye rupture, endophthalmitis, the presentation of penetrating wounds, detachment of the retina and the presence of relative afferent pupillary defect (RAPD). The main point of interest was to evaluate the differences in the clinical outcome between eye injuries of lower and of higher OTS score. For statistical evaluation we used the non parametric Student T-test (Statistica 8.0 Statsoft Inc, Tulsa, OK, USA), $p<0.05$ was considered significant.

5) Accuracy of CT volumetry for measurement of IOFB

We compared the volume of 11 IOFBs over 5 mm3 based on CT volumetry, with the real size also determined by in-vitro volume measurement. For volume calculation we used the following software: Philips Extended Brilliance Workspace, Brilliance 3.5 (Koninklijke

Philips Electronics N.V.). For the pairwise statistical analyses we used the comparative Wilcoxon Test (Statistica 8.0, Stasoft, Tusla, USA), $p<0.05$ was considered significant.

For the correlation between visual outcome and IOFB size, we performed a retrospective evaluation of documented clinical data, medical history, visual acuity, complications, relation to size of IOFBs, and clinical outcomes of 33 patients (mean age 41.0 ± 13.5 years). We compared the initial visual acuity with the postoperative BCVA. For statistical analysis, we converted the decimal values in logMAR values for visual acuity to obtain a linear correlation. We used the Student T-test and the Mann-Whitney-U-test to evaluate significant differences (Statistica 10.0, Stasoft Inc., Tusla, OK, USA).

Results

1) Evaluation of data on endophthalmitis in Hungary

Between 2000 and 2007, 1660 cases of endophthalmitis cases were registered in Hungary. The calculated incidence of endophthalmitis in Hungary was 2.19 per 100,000 in 2000, which decreased to 1.65 per 100,000 population in 2007. The number of postoperative endophthalmitis cases decreased from 103 in 2000 to 40 in 2007. In this 8-year period, cataract surgery was the most common cause of postoperative endophthalmitis (381 cases; 74%), followed by vitrectomy (90 cases; 17.9%), perforating keratoplasty (20 cases; 3.8%) and trabeculectomy (8 cases; 1.6%). The incidence of endophthalmitis following cataract surgery was estimated to be 0.058 %, and decreased over the study period. We noted that in 2000, PPV was performed in 71 % of these severe postoperative complications, and it increased in the following years (100% in 2007).

2) Ultrasound examination in POE

We examined data of 218 patients with endophthalmitis of different etiologies, 137 cases of them were POE, in 86 cases after cataract surgery. During the study period, calculated incidence of POE (23 cases) after a total volume of 13803 cataract surgeries amounted to 0.16%. Eighty-one patients have reported ultrasonographic data. Ultrasonographic findings such as membrane formation were detected in 23 eyes (28%); dense vitreous opacities were detected in 9 eyes; detachment of the choroid was reported in 3 eyes and of the retina in 4 eyes. Two findings of initial echography were associated with acute and subacute endophthalmitis: dense vitreous opacities and detachment of posterior hyaloid membrane.

3) SD-OCT examination in patients after successful management of acute POE

Mean postoperative BCVA was 63± 30 ETDRS letters in the study eye group and 75± 21 ETDRS letters in the control group ($p = 0.1$). Mean retinal thickness in the study eyes was 320.6 ± 28.83 μm and 318.4 ± 18.8 μm in the control eye group ($p = 0.767$). In the endophthalmitis study eye group, the mean RNFL thickness was 92.2 ± 15.1 μm, while it was 97.8 ± 18.4 μm in the control eye group, the difference was not significant ($p = 0.31$).

Choroidal thickness in the central, temporal superior, temporal inferior, nasal superior and nasal central region was found significantly lower in the study eyes (p = 0.03, 0.007, 0.09, 0.02 and 0.049, respectively). In other regions, choroidal thickness was also decreased, but the difference was insignificant (p = 0.33, 0.36). In the study eyes, mean choroidal thickness was significantly lower compared to the control eyes (195.14 ± 23.19 μm and 221.86 ± 28.47 μm, respectively, p = 0.018). There was no significant correlation between central retinal thickness and choroidal thickness of the study and fellow eyes in the foveal region (p > 0.05).

4) Clinical outcomes (prognostic factors) and imaging evaluation in patients with IOFB.

Almost all patients (96.8%) were male with a mean age of 32.29 years ± 13.38 SD. In all 31 cases, an open globe injury with intraocular foreign bodies was diagnosed. In 27 cases, the IOFB was magnetic. The average value according to the OTS scale was 2.45 ± 0.78 SD. The mean preoperative visual acuity for all patients in decimals was 0.3 ± 0.4 SD (logMAR 0.5 ± 0.36 SD). After 2.5 months, the best postoperative visual acuity for all patients was 0.6 ± 0.4 SD (logMAR 0.24 ± 0.37). Regardless of OTS score, good preoperative visual acuity (20/200 or better) (83 %) was connected with postoperative visual acuity of 20/40 or better (p = 0.002). We found that in the case of injuries with small foreign bodies (< 4 mm ^{2}) the postoperative visual acuity was significantly better than in injuries with larger intraocular foreign bodies (p = 0.002948).

5) Accuracy of CT volumetry for measurement of IOFB

The CT - volumetric values of 11 IOFBs were in average 68.03 ± 90.1 mm ^{3}. The measurements determined by water displacement amounted to an average of 64.1 ± 87.5 mm ^{3}. However, no significant differences were found between in vitro measurement and CT volumetric size (Wilcoxon, p=0.07). During study period, we evaluated data of 33 patients with open globe injuries and IOFBs, that had been treated at our department. The 33 present intraocular foreign bodies were divided into 3 groups: (<15 mm ^{3},16-35 mm ^{3}, > 35 mm ^{3}). Clinical outcomes were significantly better in injuries with small IOFBs measuring <15 mm3 (p=0.0098).

Conclusions

In our work we aimed for the understanding of the morphological changes in postoperative endophthalmitis following cataract surgery using modern imaging techniques. Furthermore, our aim was to understand the clinical findings and the follow-up in open globe lacerations with intraocular foreign bodies to be able to make a better prognosis after these severe eye injuries.

We have shown the importance of ultrasound in the diagnostics of POE. Our findings not only confirm typical clinical signs known previously, but we also described ultrasonographic differences between acute and chronic post cataract endophthalmitis in a very exact manner. Two findings detected by initial echography were associated with acute and subacute endophthalmitis: dense vitreous opacities and detachment of posterior vitreous limiting membrane.

We have shown the usefulness of high resolution spectral domain Optical Coherence Tomography to detect morphological changes in the choroid after vitrectomy due to postoperative endophthalmitis. We found that choroidal thickness decreased significantly after endophthalmitis, but there was no functional correlation with the changes in choroidal microstructure. Furthermore, the development of epiretinal membranes may have been associated with either vitrectomy or endophthalmitis in the history. However, these structural findings have no influence on the visual acuity and clinical outcome and showed, that successful treatment may guarantee good clinical results even long after this severe postoperative complication.

- We retrospectively analysed data of patients affected by open globe injuries with intraocular foreign bodies. Using OTS classification we confirmed that postoperative BCVA was significantly better for ocular injuries with a higher OTS score, so that acceptable visual results could be achieved after the removal of posterior segment IOFBs by vitrectomy.

- We demonstrated that the use of CT volumetry is an accurate method for the measurement of IOFBs. Exact data about the size and measurement of volume are also an important factor for the prognosis of clinical outcome in open ocular injuries with IOFBs, and CT volumetry can also provide important information about the localization of IOFBs.

11. Publications of the author

11.1. Publications of the author in the scope of the present work

Papers

1) Németh J, **Maneschg O**, Kovács I: „Az endophthalmitis magyarországi adatai 2000 és 2007 között - Data on endophthalmitis in Hungary between 2000 and 2007"; *Szemészet* 148:(2) pp. 42-45. (2011)
2) **Maneschg O**, Csákány B, Németh J: „Ultrasonographische Befunde bei Endophthalmitis nach Kataraktoperationen- Rückblick auf 81 Fälle (Ultrasonographic findings in Endophthalmitis following cataract surgery: a review of 81 cases)"; *Ophthalmologe* 106:(11) pp. 1012-1015. (2009) **(IF: 1.0)**
3) **Maneschg OA**, Resch M, Papp A, Németh J: „Prognostische Faktoren und klinische Ergebnisse in der Behandlung von offenen Augenverletzungen mit intraokularen Fremdkörpern (Prognostic factors and visual outcome for open globe injuries with intraocular foreign bodies)"; *Klinische Monatblätter für Augenheilkunde* 228:(9) pp. 801-807. (2011) **(IF: 0.51)**
4) **Maneschg OA**, Volek É, Németh J, Somfai GM, Géhl Z, Szalai I, Resch MD: "Spectral domain optical coherence tomography in patients after successful management of postoperative endophthalmitis following cataract surgery by pars plana vitrectomy", *BMC Ophthalmol*ogy 14: Paper 76. 8 p. (2014) **(IF: 1.02)**
5) **Maneschg OA**, Volek É, Lohinai Z, Resch MD, Papp A, Korom C, Karlinger K, Németh J: "Genauigkeit und Relevanz der CT Volumetrie bei offenen Bulbusverletzungen mit intraokularen Fremdkörpern (Accuracy and relevance of CT volumetry in open globe injuries with intraocular foreign bodies)", *Ophthalmologe* 112:(4) pp. 359-363. (2015) **(IF 2014 0,504)**

11.2. Publications of the author outside the scope of the present work

Papers Papers

1) Resch M, Seres A, **Maneschg O**, Pregun T, Papp A, Szabó A, Németh J: "Nehéz szilikonolaj a retinaleválás sebészetében - Haevy silicon oil in retinal detechment surgery"; *Szemészet* 147:(3-4) pp. 155-161 (2010).
2) Marsovszky L, **Maneschg O**, Németh J, Resch MD: „Hornhaut Konfokal-Mikroskopie bei einer bilateralen Augenverletzung mit multiplen kornealen Fremdkörpern (Confocal microscopy after multiple corneal foreign body injury)" *Spektrum der Augenheilkunde* 25:(3) pp. 231-233 (2011) **(IF: 0,274)**
3) Resch MD, Takáts J, Csákány B, Szabó A, **Maneschg O**, Papp A, Németh J: "Retinal thickness measurements with optical coherence biometry and optical coherence tomography" *Spektrum der Augenheilkunde* 28:(3) pp. 121-125 *(*2014)
4) Géhl Z, Kulcsár K, Kiss HJM, Németh J, **Maneschg OA**, Resch MD:" Retinal and choroidal thickness measurements using spectral domain optical coherence tomography in anterior and intermediate uveitis", *BMC Ophthalmology* 14:(1) Paper 103. 7 p. (2014) **(IF: 1.02)**
5) Géhl Z, **Maneschg OA**, Nagy ZZ. Progressive Bilateral Chorioretinitis. *Klinische Monatblätter für Augenheilkunde* Klin Monbl Augenheilkd. In press (2015 Sep 14) (**IF 2013/2014**; **0,504)**