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Report on Ph. D. thesis „ The anterior eye surface: age accommodation and contact lens wear (Wpływ wieku, akomodacji oraz użytkowania soczewek kontaktowych na przedni odcinek oka”) by Ms. Alejandra Consejo

The thesis submitted by Ms. Consejo for the degree of Doctor of Physics is based on extensive measurements to determine the influence of age, accommodation and contact lens wear on the shape of the anterior eye surface. All measurements were performed by the Eye Surface Profiler— a device developed with the participation of prof. Iskander and recently introduced to the market by the company Eaglet Eye.

The construction of this thesis is clear and comprehensive. The thesis spans 145 pages and consists of six chapters. Each chapter (besides the first one) is organized according to the rules of scientific publication in the Journal of Cataract&Refractive Surgery and includes its own list of references. Detailed conclusions are presented at the end of each key chapter. I very much enjoy such a neat structure.

The first chapter presents a brief overview of the eye structures which will be studied in the next chapters. It provides the necessary background information to understand the rest of the paper.

The following chapter is devoted to the instrument – the Eye Surface Profiler. This device, in contrast to previous ones which are based on different principles, determines the shape not only of the cornea but also of the adjacent sclera. This enables location of the transition point between both structures – the limbus.

The content of this chapter is based on a publication co-authored by Ms. Consejo (“*Principles of operation, accuracy and precision of an Eye Surface Profiler*” by D. Robert Iskander, Pawel Wachel, Patrick N. D. Simpson, **Alejandra Consejo** and Danilo A. Jesus in *Ophthalmic & Physiological Optics* 36 (2016) 266–278). Although Ms. Consejo provided independently and additionally very informative illustrations on the working principle of this instrument, it is a pity that she has not revealed this publication neither in figure captions (Figs 2.4, and 2.5) nor in the references following this chapter. Several paragraphs of the journal publication and this chapter overlap without citing the former one. Both texts contain the same inconsistency relating to the angle θ as marked in Fig 2.4 and described in the text as the angle “between optical axes of both projectors and the optical axis of the camera” (p. 33). In my opinion the erratum should be included into all copies of the thesis.

The third chapter deals with a problem of demarcation of the transition from the cornea to the sclera. Two automated methods to determine a limbus shape from a corneo-scleral profile were proposed. The limbal radiuses obtained via these methods were compared with

traditional white-to-white distance (divided by 2). There is no significant difference between these results. The obvious advantage of automated measurements is that they are less dependent on an operator and the complete contour of the limbus is determined from the eye surface data. The shape of the limbus will be essential for investigations described in the next chapters.

The subsequent chapter takes advantage of the fact that the Eye Surface Profiler is able to measure the real shape of limbus. As much as 75 participants took part in the study. Within this group measured limbal shapes were neither circular nor even symmetrical. Ms. Consejo used a 6-parameter fit of a sum of four periodic functions according to formula (4.2) in order to obtain an analytical expression which describes the contour of the limbus. I suspect that in the methodology section something is missing, because to the best of my knowledge it is not possible to fit the more and less circular shape of the limbus with formula (4.2): $y = a_0 + \sum (a_i \cos(iwx) + b_i \sin(iwx))$ $i=1,2$, at least if x and y have their standard meaning as Cartesian coordinates.

In order to quantify non-circularity of the limbus Ms. Consejo presents radial distances in every quadrant of the eye. I suppose that they are determined with respect to the apex of cornea. If yes, what is the precision and accuracy of determination of the position of the apex and how does it affect the distances presented in Table 4.2? That might affect statistical conclusions on the asymmetry of the limbus.

In chapter 5, Ms. Consejo aims to find out what structures beyond the crystalline lens change their shape during accommodation. An interesting finding is that the sclera deforms during accommodation and this effect is more visible in younger subjects. To support this finding several statistical tests were conducted, and care was taken to exclude tilt due to eye convergence during accommodation.

During my reading I found inconsistencies in some findings contained in the result section and passed them to Ms. Consejo and her supervisor. I hope the appropriate erratum correcting errors will be attached to all copies of the thesis.

The last chapter presents interesting results of a study of short-term soft contact lens wear on limbal radius. The study shows that limbal radius increases but after 60-90 minutes returns to a basal value. The results seem to be unequivocal. However, if Subject 1 and 2 are the same in both Table 6.4 and Figure 6.7 (page 115), the values at $t=0$ in the figure should be the same as in the table.

The final chapter contains the main conclusions of the study. It points out the main findings very clearly.

The thesis is very well composed. The parts describing the state of the field are very well written and contain numerous references to the literature. Ms. Consejo showed that she is able to plan and organize measurements with participation of 100 patients and exploit a whole range of possibilities offered by the SPSS package. Although most of my reservations may be answered during the defense, the erratum dealing with the auto-plagiarism must be

added prior the defence. With this correction the thesis fulfils the provisions of Art. 13, par. 1, of "Ustawa o stopniach naukowych i tytule naukowym oraz o stopniach i tytule w zakresie sztuki (Dz. U. z 2016 r. poz. 882, 1311.)".

Tomí 30.03.2017

Andrzej Krowallek