

## ORIGINAL ARTICLE

# Analysis of Vision Development in Patients after Childhood Cataract Surgery

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## Summary

**Introduction.** Childhood cataracts have different morphologies and different presentation time. If clouding of the lens interferes with visual development, the only type of treatment is lens extraction surgery in order to prevent low vision or blindness development. Intraocular lens implantation is also successfully used in children to correct eye refraction after lens extraction surgery. After surgery combined correction using spectacles or contact lenses is frequently carried out.

**Aim of the Study.** To analyze paediatric cataract morphology and cataract presentation time. To compare patients with different morphological types of cataract, as well as patients with different onsets of lens clouding. To compare vision outcomes in these two classification groups.

**Materials and methods.** There was performed a retrospective analysis of 83 childhood cataract eyes, with the surgery being performed in the time period from 2006 -2013. Visual acuity, contrast-sensitivity, binocular functions, and refraction were measured third month, 6<sup>th</sup> month, and 9<sup>th</sup> month after surgery, and then later once a year. Postoperative complications such as secondary cataract and secondary glaucoma were diagnosed. Visual development in different cataract groups was compared.

The patients were divided into groups depending on cataract presentation time and the type of cataract morphology thus creating five major morphological groups and 12 sub-groups. Established groups were compared to each other by analysing visual development. Results. Pearson's chi-square statistical analysis showed that there is a statistically significant correlation ( $p < 0.05$ ) between morphological classification and cataract presentation over time. The analysis of variance (ANOVA) reveals that postoperative visual abilities (visual outcome) ( $p < 0.001$ ) differ across morphological and cataract presentation groups.

**Conclusions.** Visual development of childhood cataract patients is dependent on the onset of cataract and its morphology, it is affected by cataract surgery timeliness, quality of surgery, postoperative refractive correction possibilities and tolerability; myopic deviation; close patient monitoring; early diagnosis, and treatment of postoperative complications. Further research is required in order to conduct mathematical modelling of the visual outcome after paediatric cataract surgery.

**Key words:** childhood cataract, cataract morphology, cataract age at onset, visual outcome

## INTRODUCTION

Childhood cataracts are significant cause of treatable blindness and visual impairment in children worldwide. There are estimated 130 000 children blind as a consequence of congenital cataract or aphakia (25). Bilateral congenital cataract is the most common cause of potentially treatable blindness in infancy (24). Incidence of paediatric cataracts is 1-15/10.000 births, 60% of cataracts are bilateral (23).

Paediatric Cataract is highly heterogeneous condition with different morphology and cataract presentation time. It is possible to grade cataract density subjectively or objectively. Cataracts with minor obstructions are not candidates for surgery or for early surgery (3). If clouding of the lens interferes with visual development, the only type of treatment is lens extraction surgery in order to prevent low vision or blindness development. The literature on childhood cataract treatment, visual outcomes in different parts of the world shows very different results (7, 16, 27, 30). The visual prognosis depends on the cataract type and whether the treatment

was undertaken during the critical period of the fixation reflex development (15, 29).

Although there are several controversies, intraocular lens implantation is also successfully used to correct children eye refractions after lens extraction operations (2, 6, 12, 13, 14, 15, 18, 20, 27, 28, 30). After cataract surgery it is combined with correction using monocular or bifocal spectacles or contact lenses.

## MATERIALS AND METHODS

There was performed a retrospective analysis of 83 congenital cataract cases with cataract management being performed in Children's Clinical University Hospital and Pauls Stradiņš Clinical University Hospital in Riga (Latvia) in the time period from 2006 -2013.

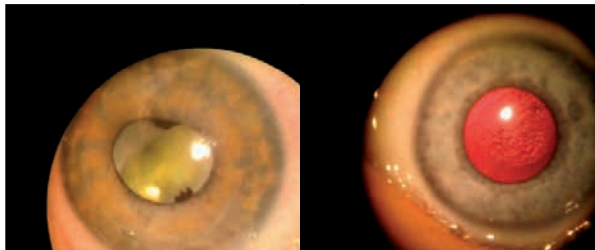
There were excluded traumatic cataracts, complicated cataracts and operated cataracts without intraocular lense (IOL) implantation. Visual acuity, contrast-sensitivity, binocular functions, and refraction were measured third month, 6<sup>th</sup> month, and 9<sup>th</sup> month after surgery, and then later once a year. Postoperative

complications such as secondary cataract and secondary glaucoma were diagnosed. The given article describes and compares the obtained visual outcomes of different paediatric cataract classifications.

Patients were divided into groups depending on cataract presentation time and the type of cataract morphology. Cataract morphology was determined with slit lamp examination for children older than 2 years and with operation microscope examination under general anaesthesia for children under 2 years old. Slit lamp cataract images were later analysed. Cataract presentation time was determined based on the history (anamnesis) of cataract identification or by the first clinical investigation record in the medical history. Established groups were compared.

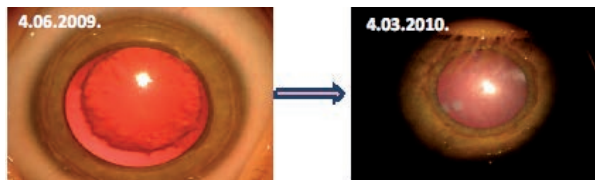
All treated and research inclusive paediatric cataracts were classified depending on the age at cataract onset thus subdividing them into following groups (8, 29):

1. congenital cataracts, which may be present at birth or may go unnoticed until an effect on child's visual function is noticed or a white pupil reflex develops, but based on the anamnesis it is possible to conclude that the cataract started to develop at birth(Fig.1.),



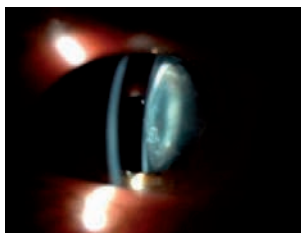
**Fig. 1. Congenital Total Cataract and Congenital Posterior Capsule Cataract.**

2. Infantile cataracts, what developed in the first 2 years of life(Fig.2.),



**Fig. 2. Infantile Progressive Cataract.**

3. Juvenile cataracts with onset within the first or second decade of life(Fig.3.).

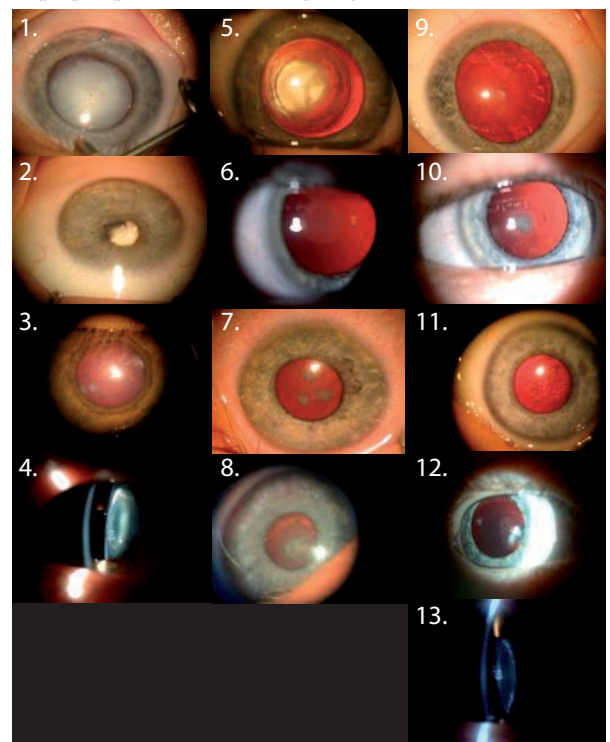


**Fig. 3. Juvenile Progressive Cataract.**

Other important and useful classification is based on cataract morphology (8,29). There were distinguished 5 big morphological groups, such as:

1. Total diffuse cataracts;
2. Lamellar cataracts;
3. Nuclear cataracts;
4. Posterior capsule cataracts;
5. Cortical cataracts.

These 5 groups were subdivided into 13 smaller groups. Minor morphological signs allow to foresee the progress of operation, postoperative vision development, postoperative refraction changes, and complications. Detailed morphological division of cataracts, photodocumentation and description allows in a different diagnostic steps to identify, evaluate and select predictive treatment tactics. For this reason, 13 smaller morphological groups are displayed photodocumentally (Fig.4.).



|                              |                                                                                                                                                  |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Total diffuse cataracts      | 1 Total, diffuse, from the birth<br>2 Total, diffuse, from the birth, with calcificates or/and sinechies<br>3 Total semitransparent, progressive |
| Lamellar cataracts           | 4 Lamellar                                                                                                                                       |
| Nuclear cataracts            | 5 Nuclear dense<br>6 Nuclear pulverulent<br>7 Nuclear with visible sutures<br>8 Nuclear with posterior capsule plaque                            |
| Posterior capsulae cataracts | 9 Posterior polar<br>10 Posterior lenticonus<br>11 Posterior capsule plaque<br>12 Posterior capsulae plaque with PFV                             |
| Cortical cataracts           | 13 Cortical(coronary)                                                                                                                            |

**Fig. 4. Morphological Classification.**

Visual acuity was determined by preferential looking technique, using the Cardiff Acuity Card (CAC) for children up to 2 years of age (the results were adjusted to the log-MAR charts), the visual tables for log-MAR tables in the distance (E alpha test, numeral test), near visual acuity was measured with the LEA table in 40 cm distance.

The resulting visual activity after the surgery and the best adjustments were divided into 5 groups assessing the obtained vision as very good, good, medium, low and very low (Table1.).

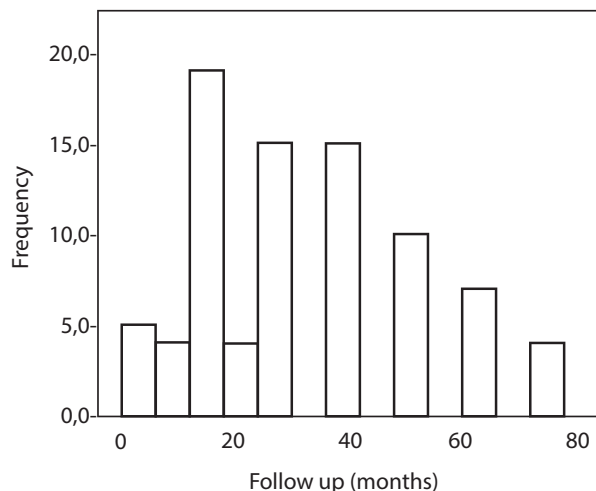
| Vision acuity | Vision assessment grading | Rating    |
|---------------|---------------------------|-----------|
| 20/25-20/20   | 5                         | very good |
| 20/40-20/30   | 4                         | good      |
| 20/60-20/50   | 3                         | middle    |
| 20/200-20/100 | 2                         | low       |
| till 20/200   | 1                         | very low  |

**Table 1. Distance Vision Assessment Using Visual Acuity (VA).**

## RESULTS

There were 12 unilateral cataracts and 71 bilateral operated cataract eyes, 21 from them were bilaterally asymmetric, 50 - symmetric.

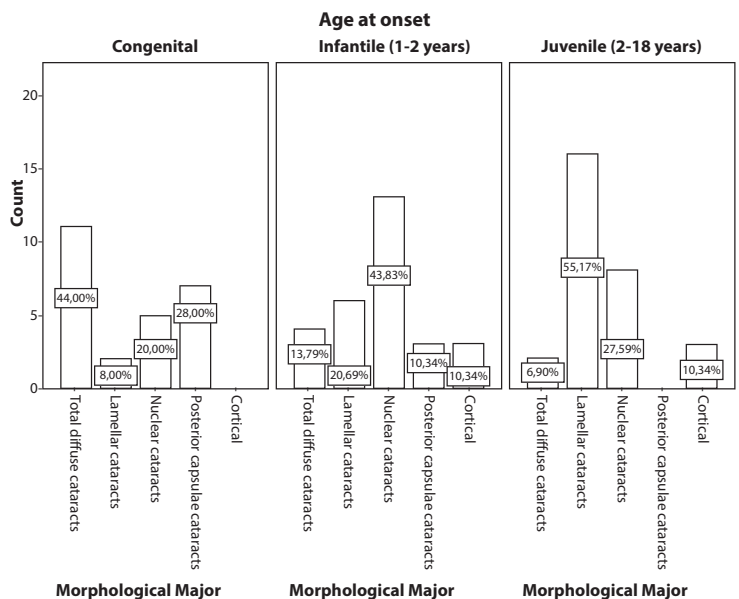
The average follow-up period for patients was 29, 24 months (SD=19,22) with minimum follow-up period of 3 months and maximum 72 months. Patient follow-up histogram is depicted in Figure 5.



**Fig. 5. The Follow-up Period of the Researched Patients.**

A number of studies have looked at morphological types of paediatric cataracts and their impact on postoperative visual outcome(3, 6, 9, 10, 12, 15, 17, 19, 20, 22, 26). Cataract morphology and potential amblyogenic potential varies(15).Statistical analysis showed that the most important factor in forecast of long-term visual outcome and complications is a cataract type (19).The given study compared morphological types of paediatric cataractsand the age at cataract onset.

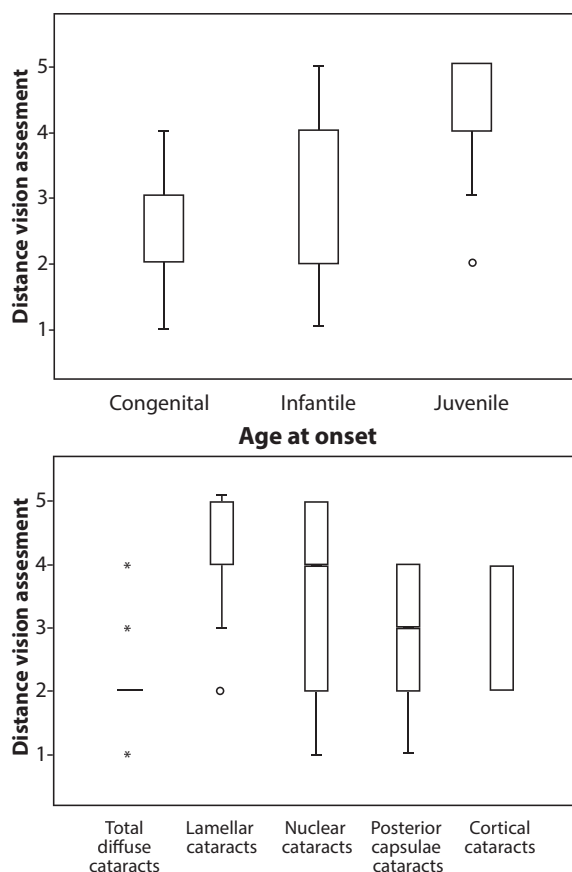
The statistical analysis of Pearson's chi-square showed that there is astatistically significant association ( $p < 0.05$ ) between morphological classification and the age at cataract onset.



**Fig. 6. Percentual Comparison of Major Morphological Classification with the Classification According to the Age at Cataract Onset.**

In the congenital group, 44% of cataracts were total diffusions; in the infantile group, 44,83% of the patients had nuclear cataracts; in the juvenile group, 55,17% of the cases were associated with lamellar cataracts. In the given study, the patents of congenital group did not have cortical cataract while in the infantile group, cortical and posterior capsule cataracts constituted the smallest proportion - 10,34% (Figure 6.).

There was carried out the analysis and comparison of distance visual acuity and aligned distance visual acuity in both patient groups.Besides that, both groups were compared as well (Figure 7. a) and b)).



**Fig.7. Comparison of Distance Vision a) in Paediatric Cataract Groups with Various Age at Onset, b) Various Major Morphological Cataract Classification Groups.**

In the congenital group, the distance vision assessment of 50% of the patients is 1 to 2 and in 50% of the cases it is between 2 and 4, thus these patients have a higher concentrations in group 1-2. In the infantile group, the distance vision assessment of 50% is 1 to 4 and 50% - 4-5, hence these patients concentrate around group 4-5. In the juvenile group, postoperative visual abilities starts from 3 and 50% of patients have a very good visual outcome.

Analysing the morphological cataract classification, the worst visual outcomes were by total diffuse cataracts, the best visual outcomes were by lamellar cataracts.

Based on an analysis of variance (ANOVA), it was found that the mean distance vision assessment statistically significantly differ for 3 age at cataract onset groups ( $F(2,78)=33,40$ ;  $p<0,001$ ). The estimated result using eta squared=0,46 (i.e. 46% of the distance vision assessment changes can be explained by the influence of age and the statistical effect is of significant importance).

Based on the analysis of *Spearman's* correlation coefficient, it was concluded that there is a strong and statistically significant correlation between the age at onset and distance vision assessment ( $r_s=0,68$ ;  $p<0,001$ ).

## DISCUSSION

Lens opacities in infancy have a wide spectrum of presentations. The nucleus can be the primary structure affected in some eyes. In others, the fetal nucleus remains clear but the cortex is involved, displaying different patterns of opacities. Abnormalities in or near the posterior capsule are common in infants with cataract. The visual prognosis may vary according to the morphological type of cataract (3, 9, 10, 11, 12, 15, 17, 19, 20, 22, 26, 30). In order to accurately determine the morphological type of paediatric cataract, several studies have used video documentation during the cataract extraction surgeries (17, 26). As accurate as possible preoperative examination with slit lamp, hand biomicroscope or surgery microscope makes it possible to predict the likely visual development for cataract patients with or without cataract surgery. It is also proven by statistical analysis of the data obtained in the present study. Paediatric ophthalmology and paediatric cataract management textbooks provide a classification depending on the age at cataract onset (1,8,29). In everyday life, there are problems related to classification and distinguishing between cataracts present at birth and the ones which develop in first two years of life and those which develop in first decade of life. The morphology of congenital cataracts reflect a combination of the timing and nature of the cause; the anatomy of the lens, including its capsule, its development, and changes that take place with time. Morphology may variably affect prognosis, give a clue to the aetiology and the age of onset and, in an isolated case, sometimes suggest heritability (1).

Findings of the study showed that cataract morphology and age at onset together can theoretically and mathematically describe vision assessment variations in 78%.

If cataract is diagnosed at a later stage, as it frequently happens in practical life, it is essential to identify the age at cataract onset based on cataract morphology in everyday practice. Consequently, there can be drawn conclusions regarding time of visual deprivation, depth of amblyopia, thus usefulness of lens extraction and IOL implantation surgery as well (1). This is especially important in case of various translucent cataracts where preoperative visual acuity could be better than postoperative visual acuity, even in case of a perfect cataract surgery, due to preoperative visual deprivation and possible post-operative complications.

## CONCLUSIONS

The results of cataract analysis show heterogeneity of paediatric cataracts. This can be explained by different cataract onset time and morphology.

Vision development in paediatric cataract patients is closely related to the age at cataract onset and its morphology. Earlier cataract onset age and especially the presence of a cataract at birth will cause problems for the successful development of vision. According to the data of the given research and the literature, almost in a half of the cases, cataracts present at birth were associated



with a total diffuse cataract and comparatively worse vision development.

Further research is required in order to conduct mathematical modelling of the outcome of the cataract surgery. Mathematical modelling will allow to calculate probability of every patient's operation outcome and to define statistically relevant factors which influence clinical probability of the outcome. Certainly, elaboration of the mathematical model will require high quality analysis of numerous patients and their factors, therefore, the necessity of collaboration between many countries and clinics is of utmost importance in joint analysis and mathematical modelling of the results.

**Conflict of interest:** None

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