Role of Scheimpflug imaging for assessment of posterior lens capsule in pediatric traumatic cataract

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Purpose: To find the accuracy of Scheimpflug imaging for the evaluation of posterior lens capsule and to assess the incidence of pre-existing posterior capsular tear (PCT) in pediatric traumatic cataracts. Methods: It was a prospective, non-randomized, and interventional study. Scheimpflug imaging was done preoperatively to detect pre-existing PCT in pediatric traumatic cataracts after blunt trauma. All patients underwent cataract extraction with intraocular lens implantation. Intraoperatively, the posterior capsule status was noted and compared with the preoperative Scheimpflug images. Results: Forty-seven eyes of 47 children having traumatic cataracts following closed-globe injury were included. There were 32 males and 15 females with a mean age of 10.91 ± 2.75 years. The mean duration of performing the Scheimpflug imaging from injury was 41.7 ± 7.78 days. Preoperative Scheimpflug imaging showed intact posterior lens capsule in 36 eyes and PCT in 11 eyes. Intraoperative, 37 eyes had an intact posterior lens capsule and 10 eyes had PCT. The Scheimpflug imaging did not detect the PCT in three eyes (false-negative), and in four eyes, PCT was detected falsely on Scheimpflug imaging (false-positive). The sensitivity and specificity of the Scheimpflug imaging were 70 and 89.18%, respectively. The accuracy of the technique was 85.11%. Conclusion: Scheimpflug imaging is a useful modality for the detection of PCT preoperatively in cases with doubtful posterior lens capsule integrity.

Key words: Closed-globe injury, pentacam, posterior capsular tear, Scheimpflug imaging, traumatic cataract

Scheimpflug imaging is a non-invasive technique and easily reproducible. The non-invasive nature and ability to perform the test in a sitting position makes this technique more suitable to be used in children. However, only a single case report is available in a child following closed-globe injury detecting posterior capsule rupture. Studies involving larger cases are required to determine sensitivity, specificity, and its applicability in pediatric patients. Hence, the objective of this study was to evaluate the accuracy of the Scheimpflug imaging for the assessment of posterior lens capsule in pediatric traumatic cataracts after closed-globe injury. The incidence of PCT after blunt trauma was also calculated.

Methods

This was a prospective, non-randomized study that included 47 pediatric traumatic cataracts that were scheduled to undergo cataract extraction at our institute between February 2018 and July 2018. Informed written consent was taken from their parents before enrolling the children in the study. This study was initiated after taking approval from the Institutional Review Board/Institutional Ethics Committee on 8th January, 2018. The study was conducted in accordance with the tenets of the Helsinki Declaration.

We included all consecutive cases of pediatric traumatic cataracts following closed-globe injury (age group <16 years)
Figure 1: Pentacam 25 Scheimpflug images at 360° of a patient showing increased density of edges of posterior capsule surrounding the traumatic posterior capsule rupture.
after obtaining the necessary consent. The patients having an open-globe injury, significant irregularity of globe contour and corneal scarring, associated vitreoretinal injuries, remarkable discomfort, or inability to cooperate for imaging were excluded from the study.

The demographic information, history related to the trauma was obtained and detailed anterior and posterior segment evaluations were performed. The visual acuity was measured using age-appropriate vision charts. An ultrasound B-scan was performed to detect any posterior segment complication.

In all the cases, detailed visualization of the posterior lens capsule and its tear by slit-lamp biomicroscopy was not possible. So, the patients underwent Scheimpflug imaging to know the status of the posterior lens capsule. The rotating Scheimpflug images (OCCLUS, Wetzlar, Germany) of the anterior segment were taken. Twenty-five pictures per second at 360° were taken of the involved eye [Fig. 1].

PCT was detected in the form of increased lens density at the cortex-vitreous interface and/or white dots on the posterior capsule. A characteristic bulging whitish lesion was also seen at the level of the posterior capsule in some of the cases—‘sinking lens-matter’ sign [Fig. 2]. The contour of this increased density at the cortex-vitreous interface correlated to the edge of the PCT.

Preoperatively, the guardians of the patients were informed about the findings of the Scheimpflug imaging and counseled about the surgical plan and choice of either a single-piece or three-piece intraocular lenses (IOL) according to the status of the posterior capsule.

**Surgical technique**

Surgeries were done by multiple but equally experienced surgeons. Special care was taken in all the cases irrespective of the absence or presence of PCT on Scheimpflug imaging. Hydrodissection was avoided. Lens-matter aspiration was done using bimanual irrigation aspiration cannulas (I/A) at low parameters in cases with intact posterior capsule. Vitrector in I/A cut mode was used when PCT was suspected preoperatively or detected intraoperatively to prevent vitreous traction to the retina. A single-piece acrylic hydrophobic IOL (Acrysof, model SA60AT, Alcon) was implanted in the bag with an intact posterior capsule or in the eyes with a small central PCT, whereas a three-piece acrylic hydrophobic IOL (Acrysof, model MA60AC, Alcon) was implanted in the sulcus with or without the posterior optic buttonholing (POBH) in the cases of a ruptured large PCT. The IOL power was reduced by 0.5 sphere whenever the IOL was implanted in the sulcus without POBH. Intracameral triamcinolone was used whenever there was a doubt regarding prolapsed vitreous strands in the anterior chamber. The keratome entry was sutured with 10-0 nylon/polyglactin suture in cases having PCT.

**Statistical analysis**

The data were analyzed on SPSS version 17.0 (SPSS Inc., Chicago, IL). The quantitative variables were recorded as number (\( n \)), percentage (%) and mean±SD. Statistical analysis and graphs were generated using the Microsoft Office Excel software 2017. Intraoperative posterior lens capsule findings were compared with the preoperative findings of the Scheimpflug images to evaluate the accuracy of the method in detecting a posterior lens capsule rupture. The sensitivity, specificity, positive

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**Table 1: Incidence of PCT diagnosed on Scheimpflug imaging and its comparison with true incidence of intraoperative findings**

| Results on Scheimpflug imaging | PCT present | \( n \) | PCT absent | \( n \) | Total |
|-------------------------------|-------------|---------|------------|---------|-------|
| Positive                      | True-positive (a) | 7       | False-positive (c) | 4       | \( a + c = 11 \) |
| Negative                      | False-negative (b) | 3       | True-negative (d) | 33      | \( b + d = 36 \) |
| Total                         | \( a + b \) | 10      | \( c + d \) | 37      | \( a + b + c + d = 47 \) |

**Table 2: Accuracy of Scheimpflug imaging to detect posterior capsular tear in traumatic cataract**

| Statistic                     | Formula                  | Value    | 95% CI              |
|-------------------------------|--------------------------|----------|---------------------|
| Sensitivity                   | \( a/a + b \)            | 70.00%   | 34.75-93.33%        |
| Specificity                   | \( d/c + d \)            | 89.19%   | 74.58-96.97%        |
| Positive likelihood ratio     | Sensitivity/1-specificity| 6.47     | 2.36-17.79          |
| Negative likelihood ratio     | 1-specificity            | 0.34     | 0.13-0.87           |
| Disease prevalence            | \( a + b/a + b + c + d \)| 21.28%   | 10.70-35.66%        |
| Positive predictive value     | \( a/a + c \)            | 63.64%   | 38.91-82.78%        |
| Negative predictive value     | \( d/b + d \)            | 91.67%   | 80.92-96.61%        |
| Accuracy                      | \( a + d/a + b + c + d \)| 85.11%   | 71.69-93.80%        |

\( a = \) true positive, \( b = \) false-negative, \( c = \) false-positive, \( d = \) true-negative
predictive value, negative predictive value, and accuracy of the Scheimpflug imaging were determined using MedCalc for Windows, version 15.0 (MedCalc Software, Ostend, Belgium). All the variables were expressed as percentages.\textsuperscript{[10,11]}

**Results**

The series consisted of 47 eyes of 47 patients having total cataracts following closed-globe injury. The mean age of the cohort was 10.91 ± 2.75 years (range 5–15 years). There were 32 males and 15 females. The right eye was involved in 25 (53.2%) patients while the left eye was involved in the remaining 22 (46.8%) cases.

Trauma by wooden objects was responsible for the traumatic cataract in the majority of the cases ($n = 31, 65.9\%$). The traumatic cataract developed after falling on solid ground in seven eyes. Three eyes each developed cataracts after firecracker and finger injuries. In the remaining three cases, a proper history could not be elicited.

The mean duration of performing the Scheimpflug imaging from the injury was 41.7 ± 7.8 days. The preoperative Scheimpflug imaging showed an intact posterior lens capsule in 36 eyes, and the rest 11 eyes had PCT. Intraoperatively, 37 eyes and 10 eyes had intact and ruptured posterior lens capsule, respectively. The results of the Scheimpflug imaging were not compatible with the intraoperative findings in 7/47 cases. The Scheimpflug imaging did not detect the PCT in three eyes—false-negative cases. Four eyes had ruptured posterior lens capsule on Scheimpflug imaging but were not found intraoperatively—false-positive cases. The details of the positive and negative results of PCT are shown in Table 1.

The surgery was uneventful in all the cases with no iatrogenic intraoperative complications. The Scheimpflug image finding showed 70.0% sensitivity, 89.2% specificity, 63.6% positive predictive value, and 91.7% negative predictive value. Overall, the accuracy of the procedure was 85.1% (Table 2).

**Discussion**

A cataract may be an early or late complication of a closed-globe injury. The management of traumatic cataracts is challenging and varies in each individual case. The prognosis is variable due to the associated comorbidities. Accurate knowledge of all the comorbidities may help the surgeons to manage such complex scenarios efficiently. All anterior segment comorbidities can be diagnosed on a detailed slit-lamp evaluation except PCT in the presence of an opaque lens.

Though the exact data are not available in the literature, we believe that the incidence of PCT might be more in children compared to adults after blunt trauma. PCT usually occurs due to equatorial elongation leading to the stretching of the posterior capsule. Direct coup injury and countercoup forces may also damage the posterior capsule.\textsuperscript{[13]} In a younger eye, zonules are very strong and can withstand significant pressure before breaking up.\textsuperscript{[14]} Hence, any significant blunt force is likely to be transferred to the weakest part of the lens—the central part of the posterior capsule subsequently leading to its rupture. Contrary to this, zonular dehiscence/subluxation is more common after blunt trauma in adults with increasing age. A capsular injury is likely to occur in adults after open-globe injury than closed-globe injury. Blum et al.\textsuperscript{[13]} did a retrospective analysis in a large study involving 148 eyes having traumatic cataracts. In 85 eyes having blunt trauma (mean age 56.1 years ± 15.6), zonal dehiscence/subluxation was observed in almost one-third (35.2%) of the cases. While lens capsule defect (26.9%) was present only in patients having an open-globe injury.

An accurate diagnosis of PCT helps in preoperative counseling regarding the potential difficulties during the surgery and the choice of IOLs. The surgeon needs to take many precautions if the posterior capsule defect is anticipated preoperatively. One may perform a small anterior capsulorhexis, abandon hydro-procedures, and use a vitrector for lens-matter aspiration in I/A cut mode. The complications of unrecognized PCT are many. Hydrodissection in such cases may enlarge the PCT, through which the lens-matter drop in the vitreous may occur. The consequences include severe intraocular inflammation, glaucoma, corneal edema, and even retinal detachment.\textsuperscript{[14]} Vitreo-retina surgery via pars plana route may also be required to remove the lens-matter. Such complications may also occur if the surgeon has the knowledge regarding the presence of PCT. But then, both the surgeon and patient will be ready to face and accept the complications.

Tabatabaei et al.\textsuperscript{[9]} noted that the incidence of PCT in a cohort of traumatic cataracts was 32.6% (14/43 eyes). However, as postulated earlier, 41 out of 43 cases had an open-globe injury. In our series, the incidence of PCT was 21.1%. However, we have included only the closed-globe injury cases. Thus, it becomes important to assess the posterior capsule status in children not only in open-globe injury but also in closed-globe injury. Such events in adults are rare after blunt trauma as noted in the above-mentioned studies.

The role of imaging to assess the posterior capsule status was noted by Grewal et al.\textsuperscript{[9]} in a single case report in 2007. They used the Scheimpflug imaging to detect the PCT in an 11-year-old boy. They suggested the term ‘posterior pseudo-lenticous’ as the lens-matter was bulging into the vitreous cavity through a ruptured posterior capsule. In 2012, Tabatabaei et al.\textsuperscript{[9]} published one of the largest series comprising 43 patients (mean age 35.6 ± 15.3 years) having traumatic cataracts. They performed echography using a 20-MHz probe to detect the PCT. It was noted in 14 eyes (32.6%). The sensitivity and specificity of the procedure were high, 93 and 86%, respectively. In 2014, Tabatabaei et al.\textsuperscript{[9]} did a comparison of UBM, AS-OCT, and Scheimpflug imaging in 21 patients. Again, the open-globe injury was associated in 17 (81%) eyes with the mean age of 31.5 ± 4.5 years. Choudhary et al.\textsuperscript{[14]} reported a case of traumatic cataract after blunt trauma in a 15-year-old boy. The B-scan findings were suggestive of a PCT. An MRI was done which confirmed the presence of PCT.

All the above-mentioned techniques have certain advantages and limitations. A B-scan with a 10-MHz probe permits limited visualization of the anterior segment structures and smaller PCTs are likely to be missed. A 20 MHz UBM probe has a good balance between resolution and depth of penetration. However, UBM requires to be performed by a skilled and experienced observer. It is a contact procedure; hence, it cannot be performed in patients having an open-globe injury or significant lid edema. Cooperation from the patient is mandatory, hence, often the procedure is unsuitable for pediatric patients. Nevertheless, UBM uses ultrasound waves. And, it can produce good resolution images even in the presence of significant media opacities. An MRI is difficult to perform in smaller children, and also, the presence of a foreign body might prove disastrous for the patient.

The Scheimpflug imaging and AS-OCT are non-contact procedures and multiple photographs can be taken within a short period. Hence, they are useful even in small children with lesser cooperation. Being optical methods, some inherent limitations are expected. The presence of media opacities and conditions which interfere with the path of rays like corneal scar, very dense cataract, hyphema, and inability to open eyes can affect the quality
of the images markedly. However, we could reliably image the posterior capsule in all our cases. The main reason could be the absence of the nuclear sclerosis component in children. Also, patients with significant media opacities (except lenticular) were excluded from the study. We analyzed the patients after a mean duration of 41.7 ± 7.8 days, which may be an important factor as well. The PCT margin becomes thick and fibrous approximately after 6 weeks. The fibrous margins are easier to be picked in such imaging techniques. Any imaging method performed soon after trauma may miss such subtle changes.

Tabatabaei et al. noted that the sensitivity and specificity to detect PCT were 62 and 57% for the Scheimpflug imaging, 80 and 86% for 20 MHz echography, 71 and 77% for AS-OCT, respectively. The accuracy of the Scheimpflug imaging was 42.9%, which was the least among all. However, in our study, the Scheimpflug imaging had a good sensitivity of 70%. The accuracy of the technique was also very high at 85%. Thus, it is safe to say that the Scheimpflug imaging is as good as UBM at least in children, provided the posterior capsule can be imaged properly. Tabatabaei et al. also noted to consider such non-invasive techniques in the eyes with blunt trauma.

In our study, the false-negative and false-positive results were seen in three eyes and four eyes, respectively. The false-negative results could be due to the small size of the PCT without any significant changes at the level of the posterior capsule and adjacent structures. One case report highlighted the utility of a 35 MHz echography to detect even sub 1 mm of PCT. The false-positive results were obtained due to uneven and irregular posterior border with changes in the anterior vitreous face causing irregular echoes mimicking PCT. Our reasons for obtaining the false results were similar to those mentioned by Tabatabaei et al.

The current study broadens the knowledge of the use of Scheimpflug imaging for the evaluation of the posterior capsule in pediatric traumatic cataracts. The strength of our study is the large sample size and inclusion of children with closed-globe injury only. Probably, this is the first largest case series in the pediatric age group demonstrating the role of Scheimpflug imaging in traumatic cataracts. We did not use multiple imaging techniques to have a comparison among all. However, it is important to note that not all patients are suitable to undergo all the imaging modalities as discussed earlier. We have not evaluated the duration of injury and its correlation with a positive or negative result. The comparison of the location and size of PCT detected by the Scheimpflug imaging with intraoperative findings should also be noted in future studies.

Conclusion

This study showed that the Scheimpflug imaging is a useful modality for the detection of posterior lens capsule rupture preoperatively in doubtful cases of capsular integrity. By employing this imaging technique, the surgeon will be ready to manage the potential complications during cataract surgeries.

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Conflicts of interest

There are no conflicts of interest.

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