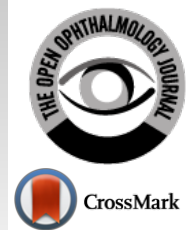




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REVIEW ARTICLE

Review of Corticosteroid Use in Pediatric Cataract Surgery

Dian E. Yulia^{1,*}, Indra M. Pambudy¹ and Lia Amanda¹

¹Department of Ophthalmology, Faculty of Medicine Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia

Abstract:

Introduction:

Following pediatric cataract surgery, an intense inflammatory response is related to various complications, including posterior capsule opacification (PCO), which is a visually threatening incidence that can lead to visual axis opacification (VAO). Although corticosteroids are essentially effective in reducing inflammation, potential ocular side effects are a remaining concern.

Objective:

This study aimed to review the efficacy and safety of corticosteroid drugs and their administration routes in pediatric patients who underwent cataract surgery

Methods:

A literature search was conducted from four electronic databases using keywords selected *a priori*. Identified articles were sorted according to the type of corticosteroid used, route of administration, and outcome measures, including inflammatory response and ocular side effects.

Results:

Five studies were included with one case series, one retrospective case-control, and three clinical trials. The total number of subjects was 311 patients, with an age range of six weeks to 15 years old. Four studies analyzed the use of triamcinolone acetonide intracamerally, which was superior to topical steroids. Most of the studies reported a decrease in inflammatory parameters. The outcome of PCO and VAO varied between studies. Nearly all the studies observed elevated intraocular pressure (IOP) as an ocular side effect.

Conclusion:

Various corticosteroids and different delivery routes can be used to ameliorate inflammation in pediatric cataract surgery. However, there is promising evidence suggesting intracameral steroids as substantially beneficial in reducing inflammatory parameters. Due to the limited number of studies reviewed, no firm conclusion regarding the superior steroid preparation or route of administration can be inferred. This review highlights the need for further studies.

Keywords: Pediatric cataract surgery, Corticosteroid, Inflammation, Posterior capsular opacification, Drug administration, Ocular side effect.

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1. INTRODUCTION

Pediatric cataract remains the largest contributor to a preventable cause of childhood blindness. It is estimated that 200,000 children are bilaterally blind from cataracts, and more are disabled due to partial visual impairment as they age [1]. A systematic review by Sheeladevi *et al.* stated that the global prevalence of childhood and congenital cataract is 0.32 to 22.9

per 10,000 of the pediatric population [2, 3]. With its high prevalence and treatable nature, proper management of pediatric cataracts will significantly lower the number of childhood blindness [1].

Aside from its more difficult surgical technique, post-operative complications are more prominent in the pediatric population. These complications include pupillary membrane formation, fibrinous uveitis, as well as posterior capsule opacification (PCO). One of the most sight-threatening complications is PCO that leads to Visual Axis Opacification (VAO), which has a greater amblyogenic effect compared to

* Address correspondence to this author at Department of Ophthalmology, Faculty of Medicine, University of Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia, Jl. Kimia No.8, Jakarta, Indonesia; Tel: +6281310568817; E-mail: dianestu.dianestu@gmail.com

the adult population. Post-operative severe inflammation reaction is correlated pathophysiologically and contributes significantly to the formation of PCO. This is due to children's immature blood ocular barrier and higher uveal reactivity [4 - 6].

The growth factors are upregulated as a response to tissue injury and inflammation, promoting tissue repair and fibrosis formation that compromises visual rehabilitation. Certain discernible signs of intraocular inflammation include the increased number of anterior chamber cells, precipitates on the intraocular lens, and formation of synechia [4, 5, 7 - 9].

Thus, minimizing the risk of PCO development is of paramount importance in the management of pediatric cataracts. Mitigation of inflammation response is a routine practice in post-operative care [10]. Various modalities have been used to manage post-surgery inflammation in the pediatric cataract, including corticosteroid use as an anti-inflammatory agent with specific receptor proteins in target tissues [11 - 14]. This mechanism thus makes corticosteroids an ideal agent to prevent PCO formation.

There are various routes of administration for steroids in pediatric patients following cataract surgery. Steroids can be given via topical, regional, or systemic administration, where systemic use of corticosteroids is often linked to unwanted systemic effects. Regionally administered corticosteroids are given via intracameral or sub-conjunctival injection. Intracameral administration of preservative-free triamcinolone acetonide can be preferred as it does not rely on patient compliance in comparison to topical corticosteroids. Triamcinolone acetonide is a type of prolonged glucocorticoid, which potentially allows minimal injections to have sufficient anti-inflammatory effects. A randomized-controlled trial previously reported that the group of patients given intracameral triamcinolone acetonide had significantly less incidence of PCO as compared to the group only given corticosteroid eyedrops. Moreover, the study reported no incidence of fibrinous exudate in the group given intracameral triamcinolone acetonide, as opposed to 14.3% found in the control group. Apart from its anti-inflammatory effects, intracameral triamcinolone acetonide has also been previously recognized as a beneficial aid in visualizing the vitreous during surgery, allowing for a complete anterior vitrectomy. This is due to the fact that its granules get visibly trapped on the surface of the vitreous, easing visualization and removal by the ophthalmologist. Its role as a visual aid can also explain the lower incidence of cellular reaction [15 - 17].

Despite its potential benefit, short and long-term use of steroids is associated with ocular side effects especially elevated IOP, which still raises concerns. However, it must be noted that most data regarding steroid treatment in cataract surgery were obtained from the adult population [6, 7, 10, 18, 19].

To our knowledge, there is no previous literature review that specifically compared treatments between various modalities or types of corticosteroids given to the pediatric population. Therefore, we aim to review the efficacy and safety between various corticosteroid drugs and routes of

administration in order to control post-surgery inflammation and PCO formation in pediatric patients who underwent cataract surgery.

2. METHODS

A comprehensive literature search was conducted from the following electronic databases: PubMed/Medline, ophthalmologyadvance.com, Scopus, and clinicalkey.com. The search strategy involved the use of these keywords: "cataract surgery," "steroid," "pediatric," "triamcinolone," "prednisolone," "methylprednisolone," "posterior capsular opacification," and "PCO." The search results were then screened by evaluating the title and abstract with regards to the inclusion and exclusion criteria of this review. The inclusion criteria were as follows: English language full-text publication, primary interventional or observational studies about the use of steroids in pediatric cataract surgery in terms of reducing the inflammatory response and its sequelae (PCO formation), with or without safety profile. Articles were excluded on the following basis: 1) they were not in English, 2) they used animal subjects, adult patients, or any patient with a history of trauma, 3) they were single case reports or review articles, or from a non-ophthalmology journal. All relevant studies were reviewed based on the Oxford Center for Evidence-Based Medicine.

The included articles were processed through a data sheet. The extracted details are as follows: study characteristics including study design, level of evidence, sample size, subject characteristics including mean age and gender, treatment and control, and follow-up duration. The outcomes of this review are efficacy in terms of inflammation parameters (*e.g.*, cells, conjunctival injection, corneal clarity, and posterior synechiae), PCO and VAO formation, as well as ocular side effects.

3. RESULTS

The initial search of four electronic databases using the aforementioned terms yielded 110 potentially relevant studies, from which 82 duplicate articles or reprints of the same studies were removed. The remaining 28 studies were assessed for eligibility with regards to inclusion and exclusion criteria. From this, a total of 23 studies were excluded: 20 were review articles, two included patients with a history of trauma, and one used adult subjects. Thus, a total of five studies were considered eligible in the qualitative synthesis of this review, and the characteristics of each study and its findings are summarized in Table 1, with one case series, one retrospective case-control, and three clinical trials.

The total number of subjects from the included studies was 311, including neonates and children (ranging from six weeks to 15 years of age). The largest group of studies was by Dixit *et al.* that included 124 subjects [20]. The types of cataracts in the subjects of each study were similar, in which congenital cataracts were included in Dixit *et al.* [20], Wilson *et al.* [21], and Ventura *et al.* [21], while Gupta *et al.* [22] included both congenital and developmental cataracts, and Cleary *et al.* [23] studied all types of cataracts. Characteristics of the reviewed studies are summarized in Table 1.

Table 1. Characteristic of reviewed studies.

S.No.	Authors	Place of Study	Level of Evidence	Total Patients	Follow up	Mean Age (Range)	Gender (M/F)	Types of Cataract
1.	Cleary, 2010 [23]	Ireland	4	26	8 months	5 (6 weeks–15 years old)	10/16	All types
2.	Wilson <i>et al.</i> [21]	United States	2	79	3 months	n/a (0–47 months)	37/42	Congenital
3.	Gupta, 2014 [22]	India	2	20	6 months	4.1 (2–7 years old)	18/2	Congenital and developmental
4.	Ventura, 2014 [24]	United States	2	62	1 year	0.83 (2–23 months)	35/25	Congenital
5.	Dixit, 2010 [20]	India	3	124	11 months	0.7 (2–21 months)	N/A	Congenital

N/A = data not available; M: male; F: female.

Four out of five studies analyzed the use of triamcinolone acetonide intracamerally. The studies used slightly different preparations of intracameral triamcinolone. Gupta *et al.* [22], Dixit *et al.* [20], and Cleary *et al.* [23] used triamcinolone acetate (4 mg/0.1 mL). However, they differed in frequency of application. Gupta *et al.* [22] used 0.1 mL in 2 standardized applications (first injection after posterior capsulorhexis, and the second after IOL implantation), Dixit *et al.* [20] used 0.1-0.2 mL in 3 standardized applications (first application was after PCCC, the second after completion of anterior vitrectomy, and third after the residual viscoelastic was removed from the eye). Ventura *et al.* [21], on the other hand, used triamcinolone acetate (1.2 mg/0.03mL) injected once at the end of surgery. Three of the studies used intraoperative intracameral triamcinolone acetonide in combination with post-operative corticosteroid eye drops as the intervention and compared it to a control of solely using topical corticosteroid post-operatively where Gupta *et al.* [22] used betamethasone 0.1% eye drops 8-10 times per day tapered over 6-8 weeks, Ventura *et al.* [21] used prednisolone acetate 1% eye drops 8 times per day and tapered over the next 6 weeks, and Dixit *et al.* [20] used prednisolone acetate 1% eye drops tapered over 12 weeks. The study by Cleary *et al.* [23] was the only one that did not include a control group and only evaluated the use of intracameral triamcinolone acetonide with post-operative prednisolone acetate 1% eyedrops (12 times a day for 1 week and taper over 6 weeks). The study by Wilson *et al.* [21] evaluated the use of difluprednate eye 0.05% eyedrops in comparison to prednisolone acetate 1% eye drops as the control, both given 1 drop after surgery and 1 drop 4 times a day for 14 days and then tapered over 14 days. The intervention and control used in

each study are summarized in Table 2.

Each study evaluated efficacy in terms of the inflammatory response. However, the inflammatory parameters that were reported in each study were quite varied (Table 3). Cleary *et al.* only studied intracameral triamcinolone acetonide and reported that 3% of the patients had +2 cells two weeks post-surgery. Conjunctival injection, posterior synechiae, and fibrin formation were also reported in 3% of the study population [23]. Meanwhile, the study by Gupta *et al.* evaluated intracameral triamcinolone along with post-operative bethametasone eyedrops and compared it to the sole use post-operative bethametasone eye drops as the control. It was found that 20% of patients in the control group had anterior chamber cells that did not clear after two weeks after surgery, while the group that received intracameral steroids had zero incidences of cells. However, the author also mentioned that 5% of those that received intracameral steroids developed posterior synechiae, whereas the control group did not [22]. This finding contrasts to that of Ventura *et al.*, where they found that the incidence of posterior synechiae to be greater in the control group that received prednisolone eye drops alone (17.2%) in comparison to the intervention group that received a combination of intracameral triamcinolone and post-operative prednisolone eye drops (6.4%) [22, 24]. Furthermore, this finding is similar to Dixit *et al.*'s study that reported the incidence of posterior synechiae to indeed be higher in the control group that received post-operative prednisolone eye drops (21%) in comparison to those who received both intracameral triamcinolone and prednisolone eye drops (9.8%) [20].

Table 2. Intervention and control group of reviewed studies.

S.No.	Authors	Intervention	Control
1.	Cleary <i>et al.</i> [23]	Intracameral triamcinolone acetonide 4 mg/0.1 mL (intraoperative – 1 application at the end of surgery) + prednisolone acetate 1% eye drops (post-operative – 12 times a day for 1 week, tapered over 6 weeks)	N/A
2.	Wilson <i>et al.</i> [21]	Difluprednate 0.05% eye drops (post-operative – 1 drop after surgery, 1 drop 4 times for 14 days then tapered over 14 days)	Prednisolone acetate 1% eye drops (post-operative – 1 drop after surgery, 1 drop 4 times for 14 days then tapered over 14 days)
3.	Gupta <i>et al.</i> [22]	Intracameral triamcinolone 4 mg/0.1 mL (intraoperative – 2 standardized applications, 0.1 mL) + bethametasone 0.1% eye drops (post-operative – 8-10 times a day, tapered over 6-8 weeks)	Bethametasone 0.1% eye drops (post-operative – 8-10 times a day, tapered over 6-8 weeks)
4.	Ventura <i>et al.</i> [24]	Intracameral triamcinolone acetonide 1.2 mg/0.03 mL (intraoperative – 1 application at the end of surgery) + prednisolone acetate 1% eye drops (post-operative – 8 times per day, then tapered over 6 weeks)	Prednisolone acetate 1% eye drops (post-operative – 8 times per day, tapered over 6 weeks)

(Table 2) *contd....*

S.No.	Authors	Intervention	Control
5.	Dixit, 2010 [20]	Intracameral triamcinolone 4 mg/0.1 mL (intraoperative – 3 standardized applications, 0.1-0.2 mL)	Prednisolone acetate 1% eye drops (post-operative – tapered over 12 weeks)

Table 3. Inflammatory parameters observed.

S.No.	Authors	Treatment	Inflammation Parameters							
			Cells		Conjunctival Injection		Corneal Clarity		Posterior Synechiae	
			Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
1.	Cleary <i>et al.</i> [23]	T	3%*	no comparison	3%	no comparison	3%	no comparison	3%	no comparison
2.	Wilson <i>et al.</i> [21]	D vs. P(ed.)	21.1%**	22.5%**	11.3%	7.5%	5.1%	10%	N/A	N/A
3.	Gupta <i>et al.</i> [22]	T	0%**	20%**	N/A	N/A	N/A	N/A	5%	0%
4.	Ventura <i>et al.</i> [24]	T	N/A	N/A	N/A	N/A	N/A	N/A	6.4%	17.2%
5.	Dixit <i>et al.</i> [20]	T	N/A	N/A	N/A	N/A	N/A	N/A	9.8%	21%

*cells +2 after 2 weeks; **cells not clearing after 2 weeks
 N/A: data not available; D: difluprednate; P: prednisolone

On the other hand, the study by Wilson *et al.* compared the use of two different eye drops (difluprednate 0.05% eye drops in comparison to prednisolone 1% eye drops as the control) and observed similar trends in both the treatment and control group, where 21.1% of the former and 22.5% of the latter were reported to have cells that did not clear after two weeks of treatment. Furthermore, the author also reported that 5% of those who received difluprednate eye developed posterior synechiae, whereas no cases were found in those who received prednisolone eye drops [21].

Outcomes of PCO and VAO greatly differed between the included studies (Table 4). Cleary *et al.* found that 26% of patients receiving intracameral triamcinolone in the case series developed VAO that required surgical or Nd:YAG (Neodymium-doped Yttrium Aluminium Garnet) treatment [23]. Ventura *et al.*'s study, on the other hand, found no cases of PCO nor VAO formation in both the intracameral triamcinolone group as well as in the prednisolone eyedrop group [24].

Contrastingly, Gupta *et al.* found that PCO was found in 10% of those who only received prednisolone eye drops. Meanwhile, none were found in the intracameral triamcinolone

group. Despite this, none of the patients in the study developed VAO, and thus further treatment was not required [22]. Dixit *et al.*'s study reported that none of those who received intracameral triamcinolone developed VAO, whereas 10.8% of those who received prednisolone eye drops alone (control group) developed VAO [20]. Meanwhile, Wilson *et al.* reported that PCO developed in 7.7% of those who received difluprednate eye drops, but none in that given prednisolone acetate. However, this difference was not found to be statistically significant [21].

Nearly all the studies reported an elevation in IOP in each respective population (Table 5), be it in terms of mean IOP or in the form of intraocular hypertension. Gupta *et al.*, Ventura *et al.*, and Dixit *et al.*'s studies did not find any significant difference in IOP between the groups who received intracameral steroids compared to those who received topical steroids only [20, 22, 24]. Wilson *et al.* observed intraocular hypertension in 5.1% population who received difluprednate eye drop compared to 2.5% in the population who received prednisolone acetate eye drop [21]. However, Cleary *et al.* reported no IOP increase in all patients receiving triamcinolone acetate intracamerally [23].

Table 4. PCO and VAO study results.

S.No.	Authors	PCO		VAO	
		Treatment	Control	Treatment	Control
1.	Cleary <i>et al.</i> [20]	N/A	N/A	26%	N/A
2.	Wilson <i>et al.</i> [18]	7.7%	0%	N/A	N/A
3.	Gupta <i>et al.</i> [19]	0%	10%	0%	0%
4.	Ventura <i>et al.</i> [21]	0%	0%	0%	0%
5.	Dixit <i>et al.</i> [17]	N/A	N/A	0%	10.8%

N/A: data not available.

Table 5. IOP after treatment

S.No.	Authors	IOP	
		Treatment	Comparison
1	Cleary <i>et al.</i> *	0%	No comparison
2	Wilson <i>et al.</i> *	5.1%	2.5%
3	Gupta <i>et al.</i>	13.75 mmHg	13.35 mmHg
4	Ventura <i>et al.</i>	8.16 mmHg	8.03 mmHg
5	Dixit <i>et al.</i>	12.64 mmHg	14.29 mmHg

*Increase above 21 mmHg

4. DISCUSSION

The use of steroids as a part of the management in pediatric cataract surgery is vital in preventing post-operative complications by making suppression from inflammatory cytokines that are known to play a role in PCO formation. VAO formation after pediatric cataract surgery is most visually threatening.

However, considering the variety of choices in terms of steroid types and route of administration and the considerable occurrence of ocular side effects, the issue of its safety and efficacy needs to be explored in the pediatric population. The pediatric population included in this review was comparable as all five included congenital cataracts, although Gupta *et al.* also included developmental cataracts and Cleary *et al.* included all types of cataracts. The mean age of each study population varied slightly, with Cleary *et al.* having the widest age range and also included older children (the oldest being 15 years).

The studies included in this review investigated several types of steroids. The majority of the studies evaluated intracameral triamcinolone in conjunction with topical steroid eye drops. In contrast, the other two studies investigated intracameral triamcinolone alone without a control group, and the other study compared two different topical steroid eye drops. Four out of five studies discussed the use of intracameral triamcinolone. Therefore, we were able to draw a general understanding of intracameral triamcinolone. Each study evaluated inflammatory response using varying outcome measures, and some evaluated either PCO or VAO, with only two studies reporting both. The IOP of subjects was measured in all the studies.

Inflammatory reactions in pediatric patients can be assessed in a variety of ways. However, it is relatively difficult to measure exact quantitative inflammatory parameters due to the challenge of patient compliance at a young age, and this is reflected in the use of objective, observable parameters in the included studies. Four [20, 22 - 24] out of five studies evaluated posterior synechiae as a measure of inflammation and three [21 - 23] out of five studies used anterior chamber cells in their analysis. Only two studies [21, 23] evaluated conjunctival injection and corneal clarity.

In terms of anterior chamber cells, Wilson *et al.*'s study highlighted better rates of anterior chamber cell clearing in the population given difluprednate eye drops (51.3%) in comparison to those given prednisolone eye drops (75%) at day eight post-surgery. However, the proportion between the two

groups become comparable on day 15 (21.1% and 22.5%, respectively) [21]. Gupta *et al.* reported that anterior chamber cells were not found in all patients of the intracameral triamcinolone acetate group, whereas 20% of patients in the prednisolone acetate eye drop group had anterior chamber cells (+1) that did not clear two weeks post-surgery [22]. This suggests that intracameral triamcinolone may be superior in clearing cells in comparison to topical steroids.

Furthermore, Cleary *et al.*'s study reported a particular case where the patient developed severe inflammation despite being given intracameral triamcinolone intra-operatively and topical steroids post-operatively. It was thought that the patient's narrow palpebral fissure hindered the proper administration of topical steroids. The patient was then given intracameral triamcinolone and cefuroxime, and the inflammation resolved within three weeks. This case further highlights the potential use of intracameral triamcinolone as it is effective in achieving rapid resolution of the inflammation, especially in cases where topical steroids cannot be administered properly. The use of intracameral triamcinolone also prevents the need for high-dose oral steroids, which might be warranted in the aforementioned case [23].

Corneal edema is one of the early post-operative complications of pediatric cataract surgery. Causes of corneal edema include surgical trauma, inflammation, or ocular hypertension. Inflammation can lead to pump dysfunction and ultimately lead to endothelial apoptosis. The study by Wilson *et al.* implies that difluprednate eye drops promote resolution of corneal edema at a faster rate than prednisolone acetate, with 5.1% and 10% of the respective groups having persistent edema on day 15 post-surgery [21]. In addition to this, Cleary *et al.* stated that when patients with severe inflammation after cataract removal were treated with intracameral triamcinolone acetate, the edema resolved within three weeks post-treatment [23].

Posterior synechiae occurs as a result of inflammatory responses following ocular surgery. Two studies included in this review that observed adjunctive use of intracameral triamcinolone compared to the sole use of steroid eyedrops had contrasting results regarding the patients that developed posterior synechiae; while Dixit *et al.*'s findings indicated intracameral triamcinolone to be superior with this group having fewer cases of posterior synechiae than the control group [20], Ventura *et al.*, instead, found the control group to have lesser cases of posterior synechiae [24]. In another study that included traumatic cataracts, where the inflammation is

considered to be more prominent, the group given triamcinolone acetonide seemed to have lesser cases of posterior synechiae [25]. This differs, however, from a study that compared intracameral triamcinolone with systemic steroids, in which no difference between the two groups was found [26].

The formation of PCO in the studies was reviewed. However, the numbers were quite varied in each study. Cleary *et al.*'s study showed that roughly a quarter of patients receiving intracameral triamcinolone developed VAO that required treatment. The study did not have a control group, and thus a comparison in the population cannot be made [2]. Contrastingly, the study by Gupta *et al.* showed that PCO was found in the control group, whereas no cases of PCO developed in the group that received intracameral triamcinolone, thus implying that the latter group has a lower risk of developing PCO in comparison to those who were solely administered bethamethasone eye drops [22]. Moreover, Dixit *et al.*'s study reported that while cases of VAO were found in the control group, no cases of VAO were found in the group that received intracameral triamcinolone, also implying that the intracameral method is superior in prevention of VAO in comparison to prednisolone eye drops alone [20]. The study that compared the two steroid eyedrops insinuated that prednisolone acetate was superior in preventing PCO in comparison to difluprednate. However, no statistical significance was found [21]. This shows that the rates of PCO and VAO in each study population vary greatly, and the limited data in these papers are not adequate enough to be comparable due to the varying steroid preparations and parameters used. No definitive conclusion can be inferred from the data because of the variability of results.

One of the most common ocular side effects of using steroids in the pediatric population is increased IOP that might lead to secondary glaucoma. All of the reviewed studies found no difference between the groups in terms of the incidence of ocular hypertension or secondary glaucoma [20 - 26].

This review attempted to discern a consistent pattern or superior method of steroid administration in pediatric cataract surgery by illustrating the findings of 5 relevant primary studies. However, the review's broad scope may be restricted. The study is limited to a singular type of steroid use and includes multiple outcome measures, which may make it difficult to make eye-to-eye comparisons of each steroid individually. Despite this, an inclusive approach was taken to ensure that an adequately thorough exploration of all available data on this topic was conducted.

Another limitation would be the quantity of the high-quality studies, in which we were limited to 3 studies with a level of evidence of 2. This, however, reflects the currently available literature at this time which is still lacking in quantity, and further investigation is needed in order to truly elucidate the drug of choice as well as its safety and efficacy in the pediatric population.

CONCLUSION

Various corticosteroids and different delivery routes can be used to ameliorate inflammation in pediatric patients who have

undergone cataract surgery. From the limited studies available, intracameral triamcinolone was implied to have superior results compared to topical steroids in safely preventing the formation of PCO and VAO. However, because of the limited number of studies reviewed, no strong conclusion or recommendation can be inferred, highlighting the need for further studies to elucidate this subject. Difluprednate eye drops, when compared with prednisolone acetate, showed similar efficacy and can be used safely. Regarding the concern for elevated IOP as an ocular side effect, we can infer that various corticosteroid administration methods and commonly used corticosteroids are safe for the pediatric population.

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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REFERENCES

- [1] Trivedi RH, Wilson ME. Epidemiology of pediatric cataracts and associated blindness. Pediatric cataract surgery techniques, complications, and management. United States of America: Wolters Kluwer Health 2014; pp. 1-8.
- [2] Sheeladevi S, Lawrenson JG, Fielder AR, Suttle CM. Global prevalence of childhood cataract: A systematic review. *Eye (Lond)* 2016; 30(9): 1160-9. [http://dx.doi.org/10.1038/eye.2016.156] [PMID: 27518543]
- [3] Bramantyo T, Roeslani RD, Andriansjah A, Sitorus RS. The efficacy of 1% chloramphenicol eye ointment *versus* 2.5% povidone-iodine ophthalmic solution in reducing bacterial colony in newborn conjunctivae. *Asia Pac J Ophthalmol (Phila)* 2015; 4(3): 180-3. [http://dx.doi.org/10.1097/APO.000000000000070] [PMID: 26065506]
- [4] Trivedi RH, Wilson ME. Intraoperative and postoperative complications. Pediatric cataract surgery techniques, complications, and management. United States of America: Wolters Kluwer Health 2014; pp. 329-46.
- [5] Whitman MC, Vanderveen DK. Complications of pediatric cataract surgery. *Semin Ophthalmol* 2014; 29(5-6): 414-20. [http://dx.doi.org/10.3109/08820538.2014.959192] [PMID: 25325868]
- [6] Gasper C, Trivedi RH, Wilson ME. Complications of pediatric cataract surgery. *Dev Ophthalmol* 2016; 57: 69-84. [http://dx.doi.org/10.1159/000442502] [PMID: 27043393]
- [7] Robbins SL, Breidenstein B, Granet DB. Solutions in pediatric cataracts. *Curr Opin Ophthalmol* 2014; 25(1): 12-8. [http://dx.doi.org/10.1097/ICU.000000000000015] [PMID: 24257246]
- [8] Zang X, Chen X. Postoperative complications and management. *Pediatric Lens Diseases*. Singapore: Springer Nature 2017. [http://dx.doi.org/10.1007/978-981-10-2627-0_23]
- [9] Brookshire HL, English RV, Nadelstein B, Weigt AK, Gift BW, Gilger BC. Efficacy of COX-2 inhibitors in controlling inflammation and capsular opacification after phacoemulsification cataract removal. *Vet Ophthalmol* 2015; 18(3): 175-85. [http://dx.doi.org/10.1111/vop.12159] [PMID: 24636042]
- [10] Nibourg LM, Gelens E, Kuijer R, Hoymans JM, van Kooten TG, Koopmans SA. Prevention of posterior capsular opacification. *Exp Eye Res* 2015; 136: 100-15. [http://dx.doi.org/10.1016/j.exer.2015.03.011] [PMID: 25783492]

- [11] Schimmer BP, Parker KL. Adrenocorticotropic hormone; adrenocortical steroids and their synthetic analogs; inhibitors of the synthesis and actions of adrenocortical hormones. Goodman & Gilman's The Pharmacological Basis of Therapeutic. United States of America: McGraw Hill 2006.
- [12] Kumar V, Abbas AK. Inflammation and repair. Robbins and Cotran Pathologic Basis of Disease. United States of America: Elsevier Saunders 2015.
- [13] Yang H-W, Lee S-A, Shin J-M, Park IH, Lee HM. Glucocorticoids ameliorate TGF- β 1-mediated epithelial-to-mesenchymal transition of airway epithelium through MAPK and Snail/Slug signaling pathways. *Sci Rep* 2017; 7(1): 3486. [http://dx.doi.org/10.1038/s41598-017-02358-z] [PMID: 28615628]
- [14] Sendrowski DP, Jaanus SD, Semes LP, *et al.* Anti-inflammatory drugs. *Clinical ocular pharmacology*. United States of America: Elsevier Saunders 2008; pp. 1044-68. [http://dx.doi.org/10.1016/B978-0-7506-7576-5.50017-3]
- [15] Tsai T-H, Tsai C-Y, Huang J-Y, Hu FR. Outcomes of pediatric cataract surgery with triamcinolone-assisted vitrectomy. *J Formos Med Assoc* 2017; 116(12): 940-5. [http://dx.doi.org/10.1016/j.jfma.2017.01.009] [PMID: 28254265]
- [16] Chou Y-Y, Zhang B-L, Gan L-Y, Ma J, Zhong Y. Efficacy of intracameral preservative-free triamcinolone acetonide in pediatric cataract surgery: A meta-analysis. *Graefes Arch Clin Exp Ophthalmol* 2020; 258(10): 2205-12. [http://dx.doi.org/10.1007/s00417-020-04765-x] [PMID: 32533281]
- [17] Allam G, Ellakkany R, Ellayah A, Mohsen T, Abouelkheir HE, Gaafar W. Outcome of pediatric cataract surgery with intraocular injection of triamcinolone acetonide: Randomized controlled trial. *Eur J Ophthalmol* 2018; 28(6): 633-8. [http://dx.doi.org/10.1177/1120672117754168] [PMID: 29619840]
- [18] Khokhar SK, Pillay G, Dhull C, Agarwal E, Mahabir M, Aggarwal P. Pediatric cataract. *Indian J Ophthalmol* 2017; 65(12): 1340-9. [http://dx.doi.org/10.4103/ijoo.IJO_1023_17] [PMID: 29208814]
- [19] Marcantonio JM, Vrensen GF. Cell biology of posterior capsular opacification. *Eye* 1999; 13: 484-8. [http://dx.doi.org/10.1038/eye.1999.126]
- [20] Dixit NV, Shah SK, Vasavada V, *et al.* Outcomes of cataract surgery and intraocular lens implantation with and without intracameral triamcinolone in pediatric eyes. *J Cataract Refract Surg* 2010; 36(9): 1494-8. [http://dx.doi.org/10.1016/j.jcrs.2010.03.040] [PMID: 20692560]
- [21] Wilson ME, O'Halloran H, VanderVeen D, *et al.* Difluprednate versus prednisolone acetate for inflammation following cataract surgery in pediatric patients: A randomized safety and efficacy study. *Eye* 2016; 30(9): 1187-94. [http://dx.doi.org/10.1038/eye.2016.132] [PMID: 27367745]
- [22] Gupta R, Ram J, Sukhija J, Singh R. Outcome of paediatric cataract surgery with primary posterior capsulotomy and anterior vitrectomy using intra-operative preservative-free triamcinolone acetonide. *Acta Ophthalmol* 2014; 92(5): e358-61. [http://dx.doi.org/10.1111/aos.12375] [PMID: 24730623]
- [23] Cleary CA, Lanigan B, O'Keefe M. Intracameral triamcinolone acetonide after pediatric cataract surgery. *J Cataract Refract Surg* 2010; 36(10): 1676-81. [http://dx.doi.org/10.1016/j.jcrs.2010.04.038] [PMID: 20870112]
- [24] Ventura MC, Ventura BV, Ventura CV, Ventura LO, Arantes TE, Nosé W. Outcomes of congenital cataract surgery: Intraoperative intracameral triamcinolone injection versus postoperative oral prednisolone. *J Cataract Refract Surg* 2014; 40(4): 601-8. [http://dx.doi.org/10.1016/j.jcrs.2013.09.011] [PMID: 24530023]
- [25] Mohamed TA, Soliman W, Fathalla AM. Effect of intracameral triamcinolone acetonide on postoperative intraocular inflammation in pediatric traumatic cataract. *Eur J Ophthalmol* 2016; 26(2): 114-7. [http://dx.doi.org/10.5301/ejo.5000648] [PMID: 26350986]
- [26] Li J, Heinz C, Zurek-Imhoff B, Heiligenhaus A. Intraoperative intracameral triamcinolone injection prophylaxis for post-cataract surgery fibrin formation in uveitis associated with juvenile idiopathic arthritis. *J Cataract Refract Surg* 2006; 32(9): 1535-9. [http://dx.doi.org/10.1016/j.jcrs.2006.04.018] [PMID: 16931268]