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Efficacy of Preoperative versus Intraoperative Dexamethasone Implantation in Pars Plana Vitrectomy Combined with Phacoemulsification for Idiopathic Epiretinal Membrane

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Abstract

Background/Objectives

In this study, the clinical efficacy of preoperative and intraoperative dexamethasone (DEX) implantation for postoperative macular oedema (ME) after pars plana vitrectomy (PPV) was compared in patients with idiopathic epiretinal membrane (iERM). The potential impact of DEX implantation on intraoperative complications was also evaluated.

Subjects/Methods

This prospective randomized controlled study included 72 eyes with stage 3–4 iERM complicated by cataracts, with 53 eyes included in the final analysis. Patients were assigned to the preoperative DEX, intraoperative DEX, or control group (no DEX implantation). All patients underwent PPV, ERM peeling, and phacoemulsification. The primary outcomes were changes in CMT and BCVA; the secondary outcomes were IOP and intraoperative complications.

Results

Visual acuity improved significantly in all patients at 3 months compared with baseline ($P < 0.001$). At 1, 2, and 3 months postoperatively, CMT was significantly lower in the preoperative DEX group than in the control group (all $P < 0.05$). At 2 months postoperatively, CMT was significantly lower in the preoperative DEX group than in the control and intraoperative DEX groups (both $P < 0.05$). The ERM peeling time was significantly shorter in the preoperative DEX group than in the intraoperative DEX and control groups (both $P < 0.05$).

Conclusions

Compared with no DEX treatment, DEX implantation 7–14 days before surgery may reduce early postoperative CMT more rapidly, shorten ERM peeling duration, and reduce the extent of intraoperative bleeding; however, no clear advantage over intraoperative DEX was observed for BCVA or CMT at 3 months.

Plain Language Summary

In this study, the clinical value of DEX implantation was investigated at different perioperative time points for surgical outcomes and postoperative prognosis in patients with iERM. Currently, no standardized regimen has been established for the management of postoperative ME after iERM surgery. Previous studies have evaluated DEX delivery mainly at the end of PPV, whereas the potential role of preoperative intervention remains insufficiently explored, particularly with respect to intraoperative challenges such as difficult ERM peeling and haemorrhage. In this study, patients were assigned to preoperative DEX, intraoperative DEX, and no-DEX control groups. These findings show that DEX implantation 7–14 days before PPV may provide potential clinical advantages for patients with advanced-stage or tightly adherent iERM. Preoperative DEX implantation was associated with reduced intraoperative haemorrhage and surgical trauma, attenuation of early postoperative ME, and faster CMT regression and macular structural recovery. These findings indicate that preoperative DEX implantation may provide a more pronounced early anti-inflammatory response with an acceptable safety profile and may inform individualized perioperative anti-inflammatory strategies for patients with iERM.

Summary Box

What was known before

Idiopathic epiretinal membrane (iERM) frequently causes postoperative macular edema after pars plana vitrectomy (PPV) and impairs visual recovery.

Intravitreal dexamethasone (DEX) implant effectively reduces macular edema after vitreoretinal surgery.

Intraoperative DEX application has been widely reported, while evidence for preoperative DEX administration remains limited.

What this study adds

Preoperative DEX implantation significantly reduces postoperative central macular thickness at multiple follow-up time points compared with intraoperative and blank control treatment.

Preoperative DEX shortens intraoperative membrane peeling time and reduces surgical trauma during iERM vitrectomy.

Summary Box

Idiopathic epiretinal membrane (iERM) frequently causes postoperative macular oedema after pars plana vitrectomy (PPV) and impairs visual recovery. Intravitreal dexamethasone (DEX) implantation effectively reduces macular oedema after vitreoretinal surgery. Intraoperative DEX application has been widely reported, but evidence for preoperative DEX administration remains limited. What this study adds

Preoperative DEX implantation significantly reduced postoperative central macular thickness at multiple follow-up time points compared with that in the intraoperative and no-DEX control groups. Preoperative DEX shortened the intraoperative ERM peeling time, reduced the severity of intraoperative haemorrhage and shortened the ERM peeling time.

Introduction

Idiopathic epiretinal membrane (iERM) is a fibrocellular membrane that forms on the surface of the retina in or around the macular; it consists primarily of glial cells but also includes retinal pigment epithelial cells, fibroblasts, and vascular endothelial cells[1][2]. Its prevalence increases gradually with age, with a prevalence of approximately 28% among people aged 63–74 years and as high as 53% among those aged 85 years and older [3]. Imaging studies based on optical coherence tomography (OCT) staging have shown that stage 3 iERM is characterized by continuous ectopic inner foveal layers crossing the central foveal area with loss of foveal depression, whereas stage 4 iERM shows marked anatomical disruption of the fovea and distortion of the retinal layers [4]. PPV with ERM peeling remains the mainstay of treatment for symptomatic iERM [1]. It is currently the standard surgical procedure for treating iERM. It effectively relieves the mechanical traction caused by iERM, and studies have shown that approximately 70% to 90% of patients experience improved vision following surgery[5]. However, postoperative OCT follow-up has shown that the incidence of ME can reach as high as 64% one month after surgery [6], which significantly affects patients' postoperative visual recovery. Further studies have indicated that patients with iERM who have preoperative ME are at a higher risk of developing ME after surgery, thereby affecting visual recovery[6][7]. Dexamethasone intravitreal implant (DEX; Ozurdex®, Allergan/AbbVie) is a potent synthetic glucocorticoid with strong anti-inflammatory activity that may reduce oedema and fibrosis-related responses by suppressing the activity of cytokine- and growth factor-mediated pathways[8][9]. Previous studies have shown that intravitreal DEX implantation can significantly reduce macular oedema and improve visual outcomes in eyes with persistent postoperative macular oedema after ERM peeling, with a generally acceptable safety profile[5][7][10].

The prevalence of iERM increases with age, with most patients presenting after 50 years of age, and the peak prevalence occurs in the seventh decade [1]. Because cataract progression is common after vitrectomy in phakic eyes, cataract phacoemulsification is frequently performed in combination with PPV in elderly patients with iERM [11]. However, cataract surgery itself may induce pseudophakic cystoid macular oedema, also known as Irvine–Gass syndrome, and a preexisting epiretinal membrane is a recognized risk factor for cystoid macular oedema following cataract surgery[12][13]. At present, most domestic and international studies have focused on the intraoperative implantation of DEX during PPV combined with ERM peeling to evaluate its efficacy in reducing postoperative ME; however, research on the preoperative use of DEX to treat iERM-related ME remains insufficient, particularly with a lack of controlled studies examining preoperative DEX implantation in the perioperative period of PPV combined with phacoemulsification in elderly patients with iERM.

Materials (Subjects) and Methods

This study is a prospective randomized controlled trial conducted at the Second Affiliated Hospital of Harbin Medical University. It strictly adheres to the principles of the Declaration of Helsinki to ensure ethical compliance. This study was approved by the Ethics Committee of Harbin Medical University (Approval No.:YK2025-435). All the enrolled patients were fully informed of the risks associated with the study and voluntarily signed informed consent forms.

Participants were randomized using Research Randomizer software. Allocation sequences were sealed in numbered opaque envelopes; an assessor who was blinded to the screening assigned participants sequentially.

Sample size estimation

Three groups were formed: Preop (n = 18, DEX 7–14 days preoperatively), Intraop (n = 20, DEX at surgery end), and Control (n = 15, no DEX).

The sample size was calculated for controlled trials with $\alpha = 0.05$ and power $(1 - \beta) = 0.8$. Expected intergroup differences were derived from published mean and SD data. After adjusting for dropout, the final sample sizes guaranteed adequate power for cross-group comparisons of continuous and categorical outcomes during follow-up, ensuring reliable clinical results.

Patient eligibility

The inclusion criteria were as follows: (1) patients aged ≥ 60 years with iERM confirmed by OCT; (2) OCT staging consistent with stages 3–4, characterized by marked disruption of the retinal architecture, the appearance of inner retinal folds, and the disappearance or severe disruption of the foveal structure; (3) best-corrected visual acuity (BCVA) ranging from 20/30 to 20/200; (4) central macular thickness (CMT) ≥ 300 μm; (5) axial length < 26.00 mm; and (6) significant cortical or nuclear lens opacity. (7) Consent to participate in this study.

The exclusion criteria were as follows: (1) Patients complicated with or a previous history of macular diseases that may interfere with visual recovery, such as age-related macular degeneration, retinal vein occlusion, diabetic macular oedema (DME), lamellar macular hole or full-thickness macular hole; (2) Patients with a history of vitreoretinal surgery or intravitreal injections; (3) Patients with affected eyes requiring additional treatments such as intravitreal injections or retinal laser photocoagulation during the follow-up period; (4) Patients with concurrent uncontrolled systemic or infectious diseases; (5) Patients with coagulation dysfunction; (6) Patients with poorly controlled blood pressure or blood glucose (systolic blood pressure > 140 mmHg or diastolic blood pressure > 90 mmHg despite standard medication; fasting blood glucose > 8.0 mmol/L, random blood glucose > 10.0 mmol/L, or HbA1c > 8.0%); (7) Patients taking medications that may cause ocular side effects, such as glucocorticoids or hydroxychloroquine; and (8) Patients with poor compliance who are unable to attend long-term follow-up appointments on schedule.

In this study, data were collected from patients with iERM who received treatment at our hospital from January 2026 to March 2026. A total of 72 patients were admitted during this period. After screening for compliance with the inclusion criteria and excluding patients who were lost to follow-up or whose data were incomplete, 53 patients were ultimately included in the statistical analysis.

Examinations

The complete preoperative clinical records of each subject, including sex, age, blood pressure, serum glucose and coagulation profiles, were documented. All patients underwent complete preoperative ophthalmic evaluations performed by two senior ophthalmologists. Discrepancies between the two examiners' measurements were resolved by averaging the

two values to obtain the final result. BCVA was measured using an international standard visual acuity chart, recorded as a decimal, and further converted to the logarithm of the minimum angle of resolution (LogMAR). Under dilated conditions, fundus examinations were performed using a slit-lamp biomicroscope, and a comprehensive assessment of retinal structure was conducted using B-scan (Tianjin Maida Medical Technology Co., Ltd., Tianjin, China) ultrasound and a scanning laser ophthalmoscope (SLO, Optos plc, Dunfermline, UK). Intraocular pressure (IOP) was measured using a noncontact tonometer. An OCT platform (Heidelberg Engineering GmbH, Heidelberg, Germany) was used to measure CMT within a 1-mm diameter area and to assess for abnormalities in macular structure.

Surgical technique

All operations were performed by a single senior surgeon via 25-gauge three-port PPV combined with ERM peeling, phacoemulsification and IOL implantation. In the preoperative DEX group, patients received intravitreal DEX implantation 7–14 days before PPV. During surgery, the implant was visible within the vitreous cavity under the wide-angle viewing system. The surgeon carefully avoided inadvertent aspiration or mechanical damage to the implant during vitrectomy. When necessary, the implant was gently repositioned or maintained in the inferior vitreous cavity, away from the vitreous cutter and infusion port, to preserve implant integrity while allowing standard ERM staining and peeling procedures to proceed.

After standard disinfection and retrobulbar anaesthesia (3 mL 2% lidocaine + 1 mL 2% bupivacaine), phacoemulsification was completed first before three standard 25-gauge sclerotomies were created. Complete posterior vitreous detachment was induced using a vitrectomy probe. The macular was stained with 0.0625% ICG for 20–30 s for meticulous ERM peeling; intraoperative OCT (Carl Zeiss Meditec AG, Jena, Germany) was used to assess residual ILM and membrane tissue. An IOL was implanted thereafter.

For patients who underwent intraoperative DEX implantation, the implant was injected 3.5 mm behind the limbus at surgery completion under indirect ophthalmoscopic guidance to avoid retinal trauma. All patients received the same topical antibiotics, which were discontinued four weeks after surgery.

Subsequent visits

All patients underwent follow-up examinations at 1 week, 1 month, 2 months, and 3 months after surgery. The examinations included BCVA, IOP, slit-lamp examination, SLO, and OCT. The “follow-up” function of the SD-OCT was utilized to ensure that the same macular region was evaluated at each examination. If the IOP exceeded 25 mmHg during the follow-up period, appropriate pharmacological interventions were administered.

Outcome measures

To minimize the risk of assessment bias associated with subjective outcome measures, all outcome assessors in this study were masked and evaluated according to standardized criteria; in cases where the assessors’ scores differed, the mean value was used as the final assessment result. Additionally, the assessors were not involved in patient randomization. The primary endpoints were BCVA and CMT at 1, 2, and 3 months after surgery. The secondary endpoints were IOP measured at 1, 2, and 3 months after surgery; the need for intraoperative ICG restaining; the degree of difficulty of ERM peeling during surgery; and the duration of peeling and the occurrence of foveal surface haemorrhage after membrane stripping. The outcome grading criteria were as follows: the degree of ERM peeling difficulty was graded according to intraoperative membrane adhesion and retinal traction: Grade 0, easy stripping without retinal displacement and complete removal in one pass; Grade 1, difficult stripping with retinal traction or displacement due to tight ERM adhesion, requiring more than one peeling attempt. Retinal haemorrhage after membrane peeling was graded as follows: Grade 0, no haemorrhage; Grade 1, punctate foveal haemorrhage; and Grade 2, patchy foveal haemorrhage. Peeling duration was defined as the time from the

initial grasp of the membrane to complete membrane removal, as previously reported in studies evaluating ERM peeling time, grasping manoeuvres, and intraoperative haemorrhage[14][15].

Statistical analyses

Statistical analyses were performed with SPSS 26.0. Normality was checked via the Shapiro–Wilk test. Normally distributed data are reported as the mean (SD) and were compared using independent/paired t-tests and one-way ANOVA. Non-normal data are presented as medians (IQRs) and were analysed with Mann–Whitney U, Wilcoxon and Kruskal–Wallis tests. Categorical data are summarized as n (%) and were compared by the χ^2 test or Fisher's exact test. Spearman's test was used for correlation analysis. Between-group effect sizes are reported as the mean differences with 95% CIs; binary outcome differences were calculated by the Newcombe method, and continuous median differences were calculated by the Hodges–Lehmann estimator. Bonferroni correction was applied for multiple comparisons. All tests were two-sided, with $\alpha = 0.05$; $P < 0.05$ indicated statistical significance.

Results

Basic characteristics

The baseline data for all the enrolled patients are summarized in Table 1. No statistically significant differences were observed in the demographic characteristics, such as age, sex, or operative eye, among the three groups (all $P > 0.05$). No statistically significant differences were observed among the three groups in terms of preoperative ocular parameters, including CMT, BCVA, IOP, and ERM stage (all $P > 0.05$), indicating good baseline comparability.

Table 1. Baseline demographic characteristics of patients.

Note: Data are presented as the mean (SD), median (IQR), or n (%); comparisons between groups were performed using Pearson's chi-square test; ANOVA; Kruskal–Wallis H test; pairwise comparisons were performed with Bonferroni correction; CMT: central macular thickness; BCVA: best-corrected visual acuity; IOP: intraocular pressure

Visual acuity measurements

No significant between-group difference in baseline BCVA was observed ($P = 0.103$). BCVA improved significantly from baseline in all three groups at postoperative month 3 (all $P < 0.001$), whereas no significant between-group differences were detected at postoperative months 1, 2, or 3 ($P = 0.336$, 0.138, and 0.083, respectively).

Central macular thickness measurements

No significant difference in baseline central macular thickness (CMT) was detected among the three groups ($P = 0.996$). At postoperative months 1, 2, and 3, the CMT significantly decreased from baseline in all three groups (all $P < 0.001$). Throughout follow-up, the greatest reduction in CMT occurred in the preoperative group, followed by the intraoperative group, whereas the control group showed the slowest reduction.

A significant overall between-group difference in CMT was observed at postoperative month 1 (overall $P = 0.008$). Pairwise comparisons revealed that CMT was significantly lower in the preoperative group than in the control group [439.5 (402,476.25) vs. 520 (472,542), 95%CI: -113.000~-25.000; adjusted $P_{13} = 0.006$]. At postoperative month 2, a significant overall between-group difference was also observed (overall $P = 0.004$). CMT was significantly lower in the preoperative group than in the control group [396.1 (48.8) vs. 458.8 (41.0), 95%CI: -107.600~-17.770 adjusted $P_{13} = 0.003$]. CMT was also lower in the intraoperative group than in the control group [412.1 (60.9) vs. 458.8 (41.0), 95%CI: -90.500~-2.820, adjusted $P_{23} = 0.033$]. At postoperative month 3, CMT remained significantly lower in the preoperative group than in the control group

[370.7 (41.9) vs. 414.4 (36.6), 95%CI: -86.360~-0.990, adjusted P_{13} =0.043]. These findings are summarized in Figure1 and Table 2 and.

Figure1. CMT across the three groups at baseline and postoperative follow-up.

Note: * indicates $P < 0.05$, ** indicates $P < 0.01$, and *** indicates $P < 0.001$; differences are statistically significant.

Figure 2. Representative preoperative, intraoperative, and postoperative OCT images of patients with iERM in the three treatment groups.

Note: (a–c) A representative case from the preoperative DEX group. (a) Preoperative OCT image showing advanced iERM with macular thickening and retinal surface traction. (b) Intraoperative fundus image and intraoperative OCT image during membrane peeling; the yellow arrow indicates the intravitreal DEX implant. (c) OCT image at 3 months after surgery showing relief of macular traction and partial restoration of the foveal contour. (d–f) A representative case from the intraoperative DEX group. (d) Preoperative OCT image showing iERM-associated retinal thickening and distortion of the foveal architecture. (e) Intraoperative fundus image and intraoperative OCT obtained during ERM peeling. (f) OCT image at 3 months after surgery showing a reduction in retinal thickening and improved macular morphology. (g–i) A representative case from the control group. (g) Preoperative OCT image showing iERM with macular thickening and tractional retinal deformation. (h) Intraoperative fundus image and intraoperative OCT during ERM peeling. (i) OCT image at 3 months after surgery showing postoperative anatomical improvement after membrane removal. DEX, dexamethasone implant; ERM, epiretinal membrane; iERM, idiopathic epiretinal membrane; OCT, optical coherence tomography.

Intraocular pressure measurements

No significant difference in baseline IOP was detected among the three groups (P =0.061). In the preoperative group, IOP significantly increased at 1 week, 1 month, 2 months, and 3 months postoperatively compared with baseline (P =0.001, $P <$ 0.001, P =0.011, and P <0.001, respectively). In the intraoperative group, IOP differed significantly from baseline only at 2 months postoperatively (P =0.007). In the control group, IOP differed significantly from baseline at 1 week, 1 month, and 3 months postoperatively (P=0.001, P =0.018, and P=0.003, respectively). A significant between-group difference was observed at postoperative month 1 (overall P =0.022). Pairwise comparisons revealed a significant difference between the preoperative and intraoperative groups [18.2 (2.2) vs. 15.7 (2.9), 95%CI: 0.265~4.769, adjusted P_{12}=0.024]. A significant between-group difference was also observed at postoperative month 2 (overall P =0.003). Pairwise comparisons revealed significant differences between the preoperative and control groups [17 (13.8, 20.2) vs. 13 (13, 17), 95%CI: 0.000~6.000, adjusted P_{13} =0.018], as well as between the intraoperative and control groups [17 (16.3, 18) vs. 13 (13, 17), 95%CI: 1.000~5.000, adjusted P_{23} =0.005]. No statistically significant intergroup differences in IOP were observed at 1 week or 3 months postoperatively (P=0.241 and P =0.075, respectively). Although the postoperative intraocular pressure increased from baseline in all three groups during follow-up, the elevations observed in eight patients remained below 25 mmHg and returned to normal following medical treatment. No cases of glaucoma or optic atrophy occurred. These changes are summarized in Table 2.

Table 2. Comparison of BCVA, CMT, and IOP between the three groups at baseline and sequential postoperative visits.

Note: Data are presented as the mean (SD) or median (IQR); comparisons between groups were performed using ANOVA and the Kruskal–Wallis H test; pairwise comparisons were performed with Bonferroni correction; CMT: central macular thickness (μm); BCVA: best-corrected visual acuity (LogMAR); IOP: intraocular pressure (mmHg); P_{12}: comparison between the preoperative group and intraoperative group; P_{13}: comparison between the preoperative group and control group. P_{23}: comparison between the intraoperative group and control group.

Intraoperative parameters

Membrane rupture time

ILM peeling time differed significantly among the three groups (overall P <0.001). Post hoc pairwise comparisons revealed that the ILM peeling time was significantly shorter in the preoperative group than in the intraoperative group [217 (177.50, 285.25) vs. 354 (269.50,419.50), 95%CI:-192.000~-60.000, adjusted P_{12} =0.001], as well as a significant difference between the preoperative group and the control group [217 (177.50,285.25) vs. 356 (278.000,479.000), 95%CI:-246~-45, adjusted P_{13} =0.002].

Haemorrhage on the retinal surface following detachment of the anterior hyaloid membrane

Dot-like haemorrhages were observed in 61.11% of patients in the preoperative group, without any patchy haemorrhages detected. In contrast, 68.47% of patients in the intraoperative and control groups presented with dot-like haemorrhages, and 25.71% developed patchy haemorrhages. The overall intergroup differences in the severity of intraoperative haemorrhage across the three groups were statistically significant (P = 0.002). Pairwise comparisons demonstrated that intraoperative bleeding was markedly milder in the preoperative group than in the intraoperative group (95%CI: 0.004~0.008; P =0.020) and the control group (95%CI: 0.000~0.001; P =0.004). All haemorrhages occurring in the preoperative group were limited to punctate macular lesions and did not hinder surgical manipulation.

Difficulty of epiretinal membrane peeling

There were 13 (72.2%) patients with easy internal limiting membrane peeling in the preoperative group, 8 (40.0%) in the intraoperative group, and 8 (53.3%) in the control group, with no statistically significant overall intergroup differences (P = 0.136).

Repeated intraoperative staining

Thirteen patients (72%) in the preoperative group, 12 patients (60%) in the intraoperative group, and 9 patients (60%) in the control group required restaining, and no statistically significant intergroup difference was detected across the three groups (P =0.677).

Table 3. Comparison of intraoperative findings among the three groups

Notes: Data are presented as the mean (SD), median (IQR), or n (%); comparisons between groups were performed using Pearson's chi-square test or the Kruskal–Wallis H test; pairwise comparisons were performed with Bonferroni correction; P_{12}: comparison between the preoperative group and the intraoperative group; P_{23}: comparison between the intraoperative group and the control group.

Discussion

This study is the first to compare the efficacy of preoperative and intraoperative intravitreal DEX implantation combined with PPV and phacoemulsification for iERM. We found that DEX implantation 7–14 days before surgery accelerated macular structural recovery and that preoperative DEX was associated with a shorter ERM peeling time and milder intraoperative haemorrhage; however, the difference in subjective peeling difficulty did not reach statistical significance.

Postoperative ME after iERM vitrectomy restricts visual recovery[6], and no unified perioperative anti-oedema regimen exists for this condition [9]. Previous work has confirmed that intraoperative DEX implantation at surgery completion accelerates the reduction in residual retinal oedema after ERM peeling and is reliable and safe [8][16]. All three groups achieved significant BCVA gains at 3 months versus baseline, with no intergroup differences in visual improvement magnitude. This is related to the sustained intravitreal release of DEX lasting 3–4 months [8]; as the drug clears, anti-inflammatory effects fade and vision plateaus, which is consistent with reports that visual acuity stabilises 3 months after DEX treatment [8][17].

The combination of PPV and intraoperative DEX implantation has been associated with greater postoperative CMT reduction and improved macular anatomical restoration in eyes with advanced ERM [7]. Compared with stage III iERM, stage IV iERM shows more severe anatomical disruption of the fovea and distortion of retinal layers, suggesting more advanced tractional macular damage [4][18]. Persistent traction disrupts the macular tissue architecture and may even cause limited or incomplete visual recovery [4][14]. Moreover, PPV combined with ERM peeling may induce postoperative intraocular inflammation, which is considered an important contributor to postvitrectomy macular oedema because it promotes inflammatory fluid accumulation within the retinal layers[6][9]. Postoperative ME typically peaks at 4–6 weeks after surgery and delays visual rehabilitation[6][8].

In the present study, CMT gradually decreased, and best-corrected visual acuity continuously improved in all three groups. Compared with the control group, the preoperative DEX group exhibited suppressed early ME peaks, with remarkable macular thinning and no secondary elevation of CMT at postoperative month 1. Although no statistically significant difference was detected compared with the intraoperative DEX group, the preoperative DEX group demonstrated a faster resolution rate of macular lesions. At postoperative month 2, the CMT in the preoperative group remained significantly different from that in the other two groups. DEX is a potent synthetic glucocorticoid with sustained intravitreal release that may reduce postoperative macular oedema by suppressing inflammatory cytokines and growth factors involved in retinal fluid accumulation [8][9]. Preoperative DEX may attenuate surgery-induced inflammatory responses and help stabilize the retinal microenvironment, thereby contributing to earlier CMT reduction. In the present study, DEX implantation 7–14 days before surgery was associated with the attenuation of early postoperative ME and faster macular anatomical recovery. These findings suggest that preoperative DEX may represent a potential perioperative anti-inflammatory adjunct for selected iERM patients with preoperative ME. Foveal intraoperative haemorrhage may reflect peeling-related retinal trauma and was therefore analysed as a potential intraoperative factor associated with postoperative visual recovery[15][19]. ERM peeling may be associated with peeling-related retinal microtrauma, including intraoperative haemorrhage, even when performed with careful surgical manipulation[15]. The three groups differed significantly in terms of haemorrhage incidence; notably, the severity distribution of intraoperative haemorrhage differed significantly among the three groups. No patchy haemorrhage occurred in the preoperative DEX group, whereas patchy haemorrhage was observed in 25% of the intraoperative group and 27% of the control group. Preoperative DEX may improve early anatomical recovery by suppressing perioperative inflammation and stabilizing the blood–retinal barrier; however, whether it directly alters the strength of ERM–ILM adhesion requires further validation through histological or biomarker studies.

Perioperative DEX implantation during PPV for ERM appears to be effective and generally safe, with transient IOP elevation being the most commonly monitored adverse event[8][16]. Consistent with previous clinical observations, transient IOP elevation occurred in 4 eyes in the preoperative group, 1 eye in the intraoperative group, and 3 eyes in the control group. No eye had an IOP > 25 mmHg or required long-term glaucoma treatment. Transient IOP spikes occurred in eight participants in total; notably, all abnormal readings resolved spontaneously without sustained pressure elevation. Cataract surgery may induce pseudophakic cystoid macular oedema, also known as Irvine–Gass syndrome, whose reported incidence varies according to diagnostic criteria; one spectral-domain optical coherence tomography study reported a 2.3% rate of significant macular oedema and a 9% overall incidence of Irvine–Gass syndrome after phacoemulsification[20], and in phakic eyes, intravitreal DEX implantation may induce cataract formation or cataract progression, including posterior subcapsular cataract[21][22]. Because postoperative ME after iERM surgery may involve both traction-related structural damage and inflammation-mediated fluid accumulation, perioperative DEX may serve as an adjunctive anti-inflammatory treatment to accelerate early oedema resolution after mechanical traction has been relieved by ERM peeling[8][9]. All participants received combined vitrectomy and phacoemulsification, which counteracts DEX-related lens opacity and avoids secondary cataract surgery costs. Distinct OCT morphological features distinguish Irvine–Gass oedema from ERM tractional oedema [23], and no cystoid ME developed in any subject during follow-up.

Compared with no treatment, both preoperative and intraoperative DEX implantation accelerated postoperative recovery, enabling faster ME clearance and earlier macular and visual restoration. Preoperative DEX administration 7–14 days before

surgery was associated with a reduced severity of intraoperative haemorrhage and a shorter ERM peeling time, suggesting a potential role in improving intraoperative conditions in selected patients.

However, two-stage management increases hospital visits, financial burden and patient anxiety, limiting routine use. Intraoperative single-shot DEX streamlines clinical workflows and improves patient acceptance, which is suitable for most mild, loosely adherent stage III iERM cases. For tight-adherent stage IV iERM with a high bleeding risk, preoperative DEX is recommended to optimize intraoperative conditions and postoperative recovery.

This single-centre, single-surgeon study with a limited sample size lacks multi-centre validation, restricting generalisability. We also did not measure aqueous humour inflammatory biomarkers to clarify the molecular regulatory mechanisms of DEX. Future large-scale multi-centre trials should include biomarker testing to further validate the clinical value of preoperative DEX implantation. Because fluorescein angiography was not performed, we could not completely differentiate between inflammatory cystoid ME and traction-related structural oedema following PPV in patients with iERM.

To our knowledge, this is the first direct comparison of preoperative versus intraoperative DEX implantation for iERM. Preoperative DEX implantation 7–14 days before surgery accelerated CMT recovery, reduced intraoperative bleeding, and shortened the peeling time, whereas the subjective peeling difficulty score did not differ significantly. Thus, DEX improved the overall postoperative prognosis and provided reliable clinical evidence for perioperative anti-inflammatory protocols.

Declarations

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Conflict of Interest

The authors declare no competing financial interests.

Author Contribution Statement

Yuege Zhang collected clinical data and drafted the manuscript.

Haomin Lu completed patient follow-up and sorted experimental records.

Xingguo Zhang and Yi Peng performed statistical analysis of all study indicators.

Yanan Shen, Chenyang Xue and Sibo Wang assisted in case screening and data sorting.

Dawei Sun and Bo Jiang designed the trial protocol, carried out all surgeries and revised the full manuscript.

All authors read and approved the final version of this article.

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Tables

Table 1. Baseline demographic characteristics of patients.

Baseline characteristics	Preoperative group (n=18)	Intraoperative group (n = 20)	Control group (n = 15)	*P*
Age (years)	69.06 (4.905)	68.00 (5.140)	66.87 (5.975)	0.504
Sex (Male/Female)	8/10	9/11	4/11	0.48
Eye Deviation (OD/OS)	11/7	11/9	8/7	0.889
CMT(μm)	561.5 (67.0)	561.5 (84.0)	568 .0(50.7)	0.996
BCVA(LogMAR)	0.52(0.4,0.7)	0.7(0.4,0.96)	0.52(0.4,0.7)	0.103
IOP(mmHg)	15.5(13,18)	16.5(15,17)	14(13,16)	0.061
ERM Classification (Percentage of Level 3)	8(44.4%)	10(50.0%)	10(66.7%)	0.422

Table 2. Comparison of BCVA, CMT, and IOP between the three groups at baseline and sequential postoperative visits.

Time	Preoperative group (n=18)	Intraoperative group (n = 20)	Control group (n = 15)	Overall *P*	Adjusted P_{12}	Adjusted P_{13}	Adjusted P_{23}
BCVA							
Baseline	0.52(0.4,0.7)	0.7(0.4,0.96)	0.52(0.4,0.7)	0.103	-	-	-
Postop 1 M	0.4(0.3,0.52)	0.52(0.33,0.66)	0.4(0.22,0.7)	0.336	-	-	-
Postop 2 M	0.22(0.20,0.3)	0.3(0.22,0.49)	0.4(0.22,0.52)	0.138	-	-	-
Postop 3 M	0.22(0.15,0.22)	0.22(0.22,0.38)	0.3(0.15,0.4)	0.083	-	-	-
CMT							
Baseline	561.5 (67.0)	561.5 (84.0)	568 .0(50.7)	0.996			
Postop 1 M	439.5(402,476.25)	472.5(392.5,527)	520(472,542)	**0.008**	-	**P_{13}=0.006**	**-**
Postop 2 M	396.1(48.8)	412.1(60.9)	458.8(41.0)	**0.004**	-	**P_{13}=0.003**	**P_{23}=0.033**
Postop 3 M	370.7(41.9)	374.5(61.9)	414.4(36.6)	**0.027**	-	**P_{13}=0.043**	-
IOP							
Baseline	15.5(13,18)	16.5(15,17)	14(13,16)	0.061	-	-	-
Postop 1 W	17.78(2.58)	16.45(2.06)	17.33(2.47)	0.221	-	-	-
Postop 1 M	18.2 (2.2)	15.7 (2.9)	16.2 (3.3)	**0.022**	**P_{12}=0.024**	-	-
Postop 2 M	17(13.8,20.2)	17(16.3,18)	13(13,17)	**0.003**	-	**P_{13}=0.018**	**P_{23}=0.005**
Postop 3 M	18.1 (2.4)	16.3 (1.9)	17.1 (2.9)	0.075	-	-	-

Table 3. Comparison of intraoperative findings among the three groups

Intraoperative parameters	Preoperative group (n=18)	Intraoperative group (n = 20)	Control group (n = 15)	Overall *P*	$P_{1.2}$	$P_{1.3}$	$P_{2.3}$
Peeling time(s)	217(177.5,285.25)	354(269.5,419.5)	356(278,479)	<0□001	0.001	0.002	-
ERM peeling was easy, n(%)	13(72%)	8(40%)	8(53%)	0.136	-	-	-
Restaining, n(%)	13(72%)	12(60%)	9(60%)	0.677	-	-	-
Intraop haemorrhage, n(%)				0.002	0.020	0.004	-
0	7(39%)	2(10%)	0(0%)				
1	11(61%)	13(65%)	11(73%)				
2	0(0%)	5(25%)	4(27%)				

Figures

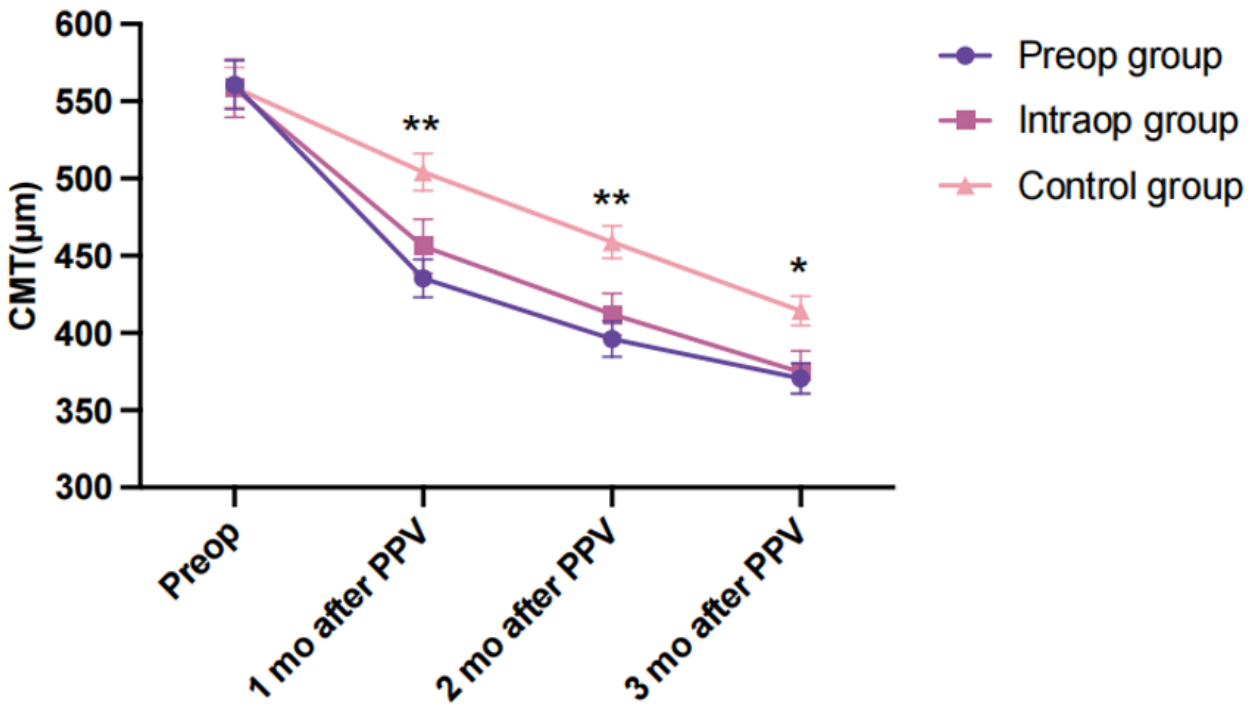

Figure 1

CMT across the three groups at baseline and postoperative follow-up.

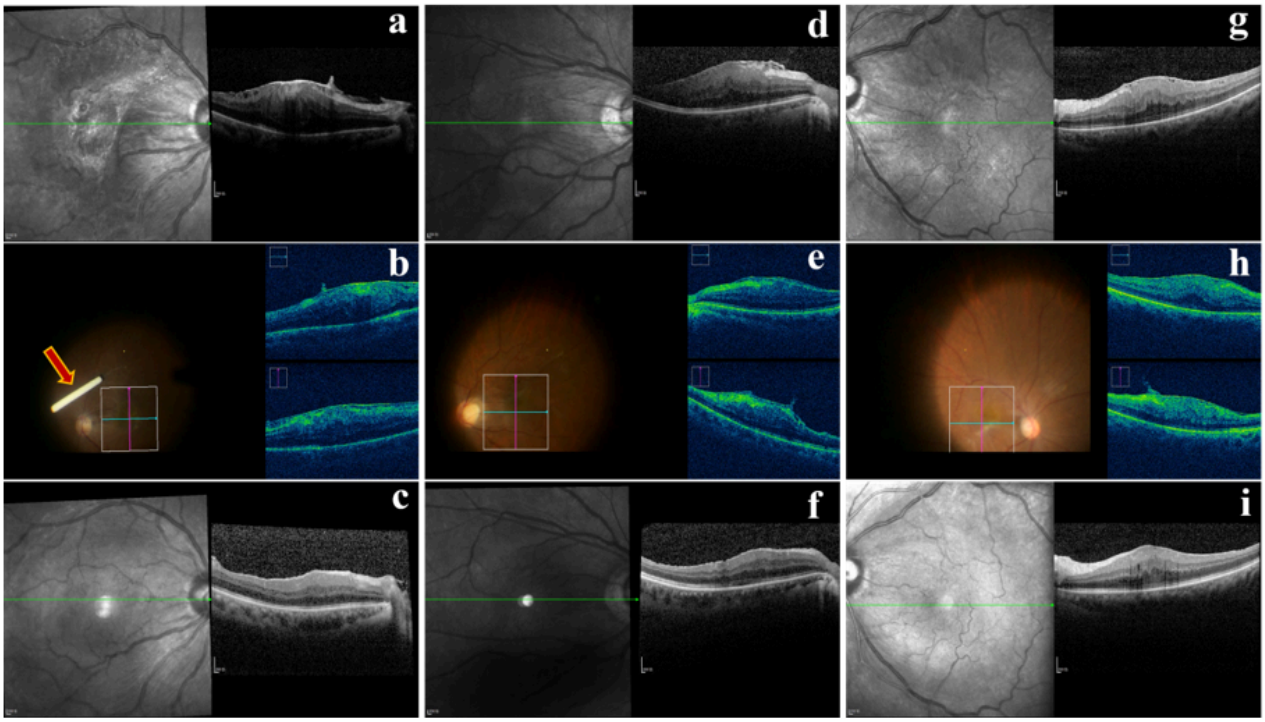

Figure 2

Representative preoperative, intraoperative, and postoperative OCT images of patients with iERM in the three treatment groups.