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# Objective assessment of the inflammatory reaction in foldable heparin surface-modified hydrophilic acrylic intraocular lens

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## 肝素表面修饰可折叠亲水性丙烯酸酯人工晶状体对白内障术后炎症反应影响的评测

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**摘要**

**目的**:调查使用激光房水闪光细胞仪评测肝素表面修饰的和无肝素表面修饰的可折叠亲水性丙烯酸酯人工晶状体对前房炎症反应的影响。

**方法**:研究组22例22眼被植入肝素表面修饰的可折叠亲水性丙烯酸酯人工晶状体,对照组21例21眼被植入无肝素表面修饰的的可折叠亲水性丙烯酸酯人工晶状体。分别在术后1、7和28d,使用激光房水闪光细胞仪检测其前房房水细胞密度和闪光数值。

**结果**:在术后1,7d,肝素表面修饰的可折叠亲水性丙烯酸酯人工晶状体组的患者前房房水的细胞密度数值和闪光数值显著低于无肝素表面修饰人工晶状体组患者的检测数值。在术后28d,两者间细胞密度数值和闪光数值无明显差别。

**结论**:肝素表面修饰的可折叠亲水性丙烯酸酯人工晶状体与无肝素表面修饰人工晶状体相比,可以降低白内障术后早期炎症反应。激光房水闪光细胞仪可以安全、客观地评测前房炎症反应。

**关键词**:肝素表面修饰人工晶状体;白内障;炎症反应

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## Abstract

• AIM: To investigate the inflammatory reaction in the anterior chamber after cataract surgery for the heparin surface modified foldable hydrophilic acrylic intraocular lens (HSM-IOL) by laser flare-cell meter.

• METHODS: The test group consisted of 22 patients (22 eyes) in whom a HSM-IOL was implanted in the capsular bag (HSM-IOL group). There was one control group including 21 patients (21 eyes) who received a normal foldable hydrophilic acrylic IOL (uncoated IOL group). Anterior chamber flare and cell values were measured, using laser flare-cell meter preoperatively and 1, 7, 28d postoperatively.

• RESULTS: In the HSM-IOL group, the flare and the cells values were significantly lower than those in the uncoated IOL group 1d and 7d postoperatively. Between the two groups, there were no significant differences in cells and the level of flare on the 28d postoperative.

• CONCLUSION: HSM-IOL can decrease inflammation in early postoperative stage, compared with the uncoated IOL. The laser flare-cell meter provides a safe and objective technique for measuring inflammation in anterior chamber.

• KEYWORDS: heparin surface-modified intraocular lens; cataract; inflammatory reaction
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## INTRODUCTION

The inflammation induced by surgical trauma and intraocular lens (IOL) implantation is inevitable even with modern small-incision cataract surgical techniques. To address the potential inflammatory effects of IOL, different materials and designs have been introduced to improve the biocompatibility of the implant and to decrease the postoperative inflammation. We used laser flare-cell meter to observe inflammatory reaction in the anterior chamber after phacoemulsification and respective implantation of the two kinds of IOL including the heparin surface modified foldable hydrophilic acrylic IOL (HSM-IOL) and the foldable hydrophilic acrylic IOL (uncoated IOL).

## SUBJECTS AND METHODS

Patient selection criteria preoperative: senile cataract patient

**Table 1 Mean values for ocular humor flare and cells** $\bar{x}\pm s$

| Groups | Flare (pc/ms) | | | | Cells(num/mm$^3$) | | | |
|---|---|---|---|---|---|---|---|---|
| | Preoperative | Postoperative | | | Preoperative | Postoperative | | |
| | | 1d | 7d | 28d | | 1d | 7d | 28d |
| HSM-IOL group | 2.0±1.4 | 11.6±5.8 | 5.6±3.0 | 2.4±1.6 | 0.4±0.4 | 9.4±3.7 | 3.6±2.9 | 1.1±1.0 |
| Uncoated IOL group | 1.9±1.3 | 17.0±6.7 | 8.8±5.0 | 2.8±1.8 | 0.5±0.5 | 13.7±5.8 | 6.4±2.9 | 1.1±1.0 |

with nuclear opacity below grade 4 (Lens Opacities Classification System Ⅲ[1]). Exclusion criteria: no other ophthalmopathy history, no diabetes, no autoimmue diseases, no high myopic eye, no severe angiocardiopathy, no history of using corticotrophin partly or systemly. Intra-operative: phaco time limited to less than 60s, no posterior capsular rupture, no obvious corneal edema, no incision leak, no discoria, no shallow anterior chamber, no hyphema, no dislocated lens, and no IOL membrane.

**Methods** The test group consisted of 22 patients (22 eyes, 10 male, mean age 63±7.9y) in whom HSM-IOL was implanted in the capsular bag and the control groups included 21 patients (21 eyes, 9 male, mean age 65±4.8y) who received uncoated IOL. The two IOL types are all sharp-edged and single-piece design, biconvex. The optic diameter of HSM IOL is 6.0 mm and another's optic diameter is 5.75 mm.

All surgeries were performed under topical anesthesia by a single experienced surgeon using the same technique. The irrigating solution, viscoelastic and phacoemulsification system and setup parameters such asultrasound power (maximum 50%) were equivalent for every patient. A 3.8 mm long incision within limbus of cornea located at about ten or two clock hour was made and then the IOL was implanted into the capsular bag. After IOL implantation, the ophthalmic viscoelastic was aspirated thoroughly from the anterior chamber as well as retrolentally to ensure complete removal. The wounds were not sutured. All operations were processed successfully. There were no complications during or after any of the operations. Postoperatively, the patients were treated with tobramycin and dexamethasone (TobraDex) drops 6 times per day for two weeks and slow tapering was done within the next two weeks.

The quantitative values of patients' anterior chamber flare and cells were measured by a single experienced doctor, using a laser flare-cell meter (Kowa FC 2000, Kowa Co. Ltd.) preoperatively and 1, 7, 28d postoperatively. The mean of four replicate measurements was determined and reported. The unit for anterior chamber flare is optical photon counts per millisecond (pc/ms) and the unit for cells is number/mm$^3$ (num/mm$^3$).

**Statistical Analysis** Two independent statistical tests were used to compare the values of flare and cell between the test and control groups. $P<0.05$ were deemed statistically significant. The data was analyzed by the software SPSS 11.5 (SPSS Inc. Chicago, Illinois, USA).

**RESULTS**

The result was summarized in Table 1. The values of all groups' flare and cells obviously increased on the first day postoperatively and then decreased gradually. At 1d and 7d postoperatively, the values of HSM-IOL group were significantly lower than uncoated IOL group in terms of flare values and cells values and the $P$ values were 0.011 and 0.014 respectively. The differences were not statistically significant preoperatively ($P=0.900$) and 28d postoperatively ($P=0.991$).

**DISCUSSION**

The agents of early inflammatory reaction after phacoemulsification and IOL implantation include disruption of the blood-aqueous barrier and release of prostaglandin, exudation of fibrin, adhesion of macrophages, and deposition of fibroblasts. The inflammatory response is manifest in the increased aqueous flare intensity and cell density in the anterior chamber. A strong inflammatory response can delay recovery of vision and increase the rate of such complications as iris synechiae, abnormal intraocular pressure, after-cataract, and cystoid macular edema[2]. There are many correlation factors of inflammatory reaction including the surgical technique, surgical trauma, IOL location, material and design of IOL, and lens cortical residue.

The material biocompatibility of IOL is an important factor in postoperative inflammation. Heparin surface modification on IOL has been used many years in order to improve IOL biocompatibility. Studies[3-4] have shown that the postoperative inflammatory reaction using HSM-IOL is milder than normal IOL. HSM can reduce breakdown of the blood-aqueous barrier and attenuate the foreign body response by interfering with the adhesion of macrophages and fibroblasts, the deposition of plastocytes by hindering the activation of leukocytes, by reducing the effusion of fibrin, and by inhibiting the release of mediators of inflammation such as prostaglandins[5]. The surface of HSM-IOL is in the state of persistent molecular movement. Besides, it has the same negative charge as cells and bacterium. All these factors make the inflammatory mediators, inflammatory cells and bacteria relatively non-adherent to HSM-IOL surface therefore reducing the postoperative inflammatory reaction and complications[6]. Our study also concluded that HSM-IOL showed a significantly lower inflammatory reaction in the early postoperative stage.

The technology of heparin surface modification was originally used to poly methyl methacrylate (PMMA) lenses in the early 1990s and they had shown their advantages in diminishing the postoperative inflammation[4,6]. Acrylic IOL was first

implanted into the human eye in 1990 in an effort to find more biocompatible IOL materials and began to be used in 1994. A number of clinical and experimental studies showed that acrylic IOL has superior biocompatibility over PMMA IOL[7]. The new generation of foldable IOL requires a considerably smaller self-sealing incision, minimal trauma by which the inflammation induced is slight. Eyes with foldable hydrophobic acrylic IOL were even associated with lower, although not statistically significant, flare values than those with HSM PMMA lenses[8]. Thus, the anti-inflammatory effect of HSM PMMA IOL disappeared. If the surface of acrylic IOL that has superior biocompatibility were coated with heparin, theoretically, it could be considered to be an ideal IOL. The HSM foldable acrylic IOL were presented in the mid-2000s. The studies which used the laser flare-cell meter to compare HSM acrylic IOL and un-coated acrylic IOL are seldom. Krall *et al*[9] had observed the inflammation of HSM acrylic IOL and un-coated acrylic IOL at only 1d and 1mo but 7d postoperatively. They concluded the mean flare value was statistically significantly lower in the HSM-IOL group than in the uncoated IOL group at 1d postoperatively, and there was no statistically significant difference between groups 1mo postoperatively. Another similar study was also lack of the 7d postoperative data[10]. We believe ours for the first time reported this inflammation difference is at least up to 7d postoperatively by comparing the flare and cells values of the inflammation.

In our study, we used a laser flare-cell meter, an objective proven method to determine aqueous flare in the anterior chamber. The laser flare-cell meter is composed of laser system, light-amplification and computer control systems. A beam of He-Ne laser (energy 25 μW, diameter 20 μm) is projected to anterior chamber by the machine and the diffusion of the laser within sample window ($0.3 \times 0.5$ mm$^2$) is detected by light-amplification. The aqueous flare and number of cells is acquired by computing the intensity of diffusion. The instrument is developed for quantitative determinations of the flare and number of cells in the anterior chamber[11]. The laser flare-cell meter provides great practical advantages for rapid, noninvasive, sensitive, repeatable and relatively easy measurement for the inflammatory reaction of anterior chamber[12].

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