British Journal of Ophthalmology 1995; 79: 934–938

ORIGINAL ARTICLES – Laboratory science

Effect of the cytokines on the prostaglandin E_2 synthesis by lens epithelial cells of human cataracts

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Accepted for publication 24 May 1995

Abstract

***Background*—Lens epithelial cells (LECs) derived from human cataracts have been reported to produce various cytokines and prostaglandin E_2 (PGE_2) in culture. The effects of IL-1, TGF-β, and b-FGF on the PGE_2 synthesis by LECs have been studied.**

***Methods*—A circular piece of the anterior capsule with attached LECs was obtained by capsulotomy during cataract surgery and cultured. The primary, almost confluent, cultures were used for the study. The PGE_2 concentration of the culture media for 24 h was measured after the addition of recombinant human IL-1 α, TGF-β 2, or b-FGF at various concentrations. The PGE_2 concentration was also measured in the media to which each cytokine and rabbit polyclonal anti-human antibodies against the corresponding cytokine had been added.**

***Results*—The PGE_2 concentration of the culture media after addition of IL-1 α at the concentration of 100 or 500 pg/ml (1765 (768) and 3071 (1121) pg/10^4 cells) or TGF-β 2 at the concentration of 10 or 100 ng/ml (689 (264) and 750 (189) pg/10^4 cells) was significantly increased compared with that in the controls (67 (20) pg/10^4 cells). These effects were suppressed by the corresponding anti-cytokine antibodies. Basic FGF and anti-human b-FGF showed no significant effect on the PGE_2 concentration. IL-1 and TGF-β increased but b-FGF did not affect the PGE_2 synthesis by LECs in culture.**

***Conclusion*—IL-1 and TGF-β may participate in postoperative inflammation after cataract surgery by increasing PGE_2 synthesis by residual LECs.**

(*Br J Ophthalmol* 1995; **79:** 934–938)

We previously reported that residual lens epithelial cells (LECs) participate in postoperative inflammation[1] including fibrin reaction,[2] a fibrinous, non-infectious inflammation seen 4 to 10 days after intraocular lens (IOL) implantation. The aqueous flare intensity, which was decreasing after the initial peak owing mainly to surgical trauma, increased again forming a second peak, when the LECs came in contact with the IOL and began to undergo fibrous proliferation. Since this second flare peak was not seen when residual LECs were removed, this flare spike – that is, the renewed breakdown of the blood-aqueous barrier, was thought to be caused by residual LECs. Thus, residual LECs can disrupt the blood-aqueous barrier after IOL implantation, enabling them to participate in the production of postoperative inflammation after cataract surgery. Some reports have corroborated this finding. The prostaglandin E_2 (PGE_2) concentration in the aqueous humour has been found to be significantly higher in eyes with IOL implanted in the capsular bag than in those without it.[3] The permeability across the blood-aqueous barrier to fluorescein was found to be significantly higher in the in the bag fixations than in the out of the bag fixations.[4] In these reports, the significant increase in blood-aqueous barrier disruption was attributed to proliferated residual LECs.

We have proposed the hypothesis[5] that residual LECs synthesise cytokines and PGE_2, which may be responsible for this disruption of the blood-aqueous barrier. We cultured the LECs of human cataracts and detected interleukin-1 (IL-1),[5] IL-6,[6] IL-8, transforming growth factor (TGF)-β 1 (unpublished data), basic fibroblast growth factor (b-FGF),[7] and PGE_2[5] in the incubation medium.

Cytokines function as intercellular signals that regulate locally in an autocrine or paracrine manner and, at times, systemically, inflammatory host response.[8] The present study describes our subsequent research performed to ascertain the effects of IL-1, TGF-β, and b-FGF on PGE_2 synthesis by human cataract LECs in culture.

Materials and methods

To determine the effects of each substance on PGE_2 synthesis, we measured the PGE_2 concentration in primary cultures of human cataract LECs to which recombinant human IL-1 α, TGF-β 2, or b-FGF was added at various concentrations and that in cultures in which a cytokine and its neutralising antibody were added.

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PRIMARY CULTURE OF HUMAN CATARACT LECS

Human cataract LECs were cultured as previously described.[5] Briefly, a circular piece of the anterior capsule with LECs attached was obtained by capsulotomy during cataract surgery and cultured directly without dispersion of the cells. After circular capsulorhexis, the section of anterior capsule, about 5 mm in diameter, was touched with an irrigation/aspiration tip and withdrawn from the eye by aspiration. Each section was held with fine forceps and washed thoroughly with irrigating solution, then placed immediately into a well of a 48 well, multiwell plate containing 0·5 ml of Eagle's minimum essential medium (MEM) containing 10% fetal calf serum, penicillin G at 100 U/ml, and streptomycin sulphate at 100 μg/ml, and cultured in 100% humidity at 37°C in 5% carbon dioxide atmosphere. The culture medium was replaced once a week.

PGE_2 CONCENTRATION IN THE CULTURE MEDIUM

The cell cultures that became almost confluent after 3 to 4 weeks were used for the study.

PGE_2 concentration in the culture to which IL-1 α, TGF-β 2, or b-FGF was added

An aliquot of the culture medium was replaced with 0·5 ml of culture medium containing human recombinant IL-1 α (500 ng/ml, Genzyme, Cambridge, MA, USA) at the concentrations of 10 pg/ml (n=5), 100 pg/ml (n=5), or 500 pg/ml (n=5), TGF-β 2 (1 mg/ml, Austral Biologicals, San Ramon, CA, USA) at 1 ng/ml (n=5), 10 ng/ml (n=6), or 100 ng/ml (n=5) or b-FGF (1 mg/ml, UBI, Lake Placid, NY, USA) at 1 ng/ml (n=5), 10 ng/ml (n=5), or 100 ng/ml (n=6). The PGE_2 concentration in cultures with untreated medium served as the controls (n=16).

PGE_2 concentration in the culture to which the rabbit polyclonal anti-human cytokine antibody was added to neutralise the cytokine added

An aliquot of culture medium was replaced with 0·5 ml of culture medium containing recombinant human IL-1 α at 500 pg/ml and rabbit polyclonal anti-human IL-1 α and β antibodies (1 mg/ml, Genzyme, Boston, MA, USA) at 10 μg/ml (n=6), recombinant human TGF-β 2 at 10 ng/ml and rabbit polyclonal anti-human TGF-β 1 and TGF-β 2 antiserum (1 mg/ml, King Brewing Co Ltd, Hyogo, Japan) at 10 μl/ml (n=7), or recombinant human b-FGF at 10 ng/ml and rabbit polyclonal anti-human b-FGF antibody (1 mg/ml, Collaborative Research Inc, Bedford, MA, USA) at 10 μg/ml (n=5).

In the control plates for IL-1 α and b-FGF, an aliquot of culture medium was replaced with 0·5 ml of culture medium containing rabbit IgG (1 mg/ml, Sigma, St Louis, MO, USA) at the concentration of 10 μg/ml (n=5). In the control plates for TGF-β, an aliquot of culture medium was replaced with 0·5 ml of culture medium containing rabbit serum (NHT, Tokyo) at the concentration of 10 μl/ml (n=5), or 0·5 ml of culture medium containing rabbit polyclonal anti-human TGF-β 1 and TGF-β 2 antiserum at 10 μl/ml (n=5).

SAMPLE COLLECTION

Twenty four hours after treatment in each culture, the incubation medium was withdrawn and frozen immediately at −70°C and kept at this temperature until the measurement of PGE_2. Thus, the amount of PGE_2 which had accumulated in the incubation medium during the 24 h period after treatment was measured. At the end of culture, the number of viable cells was determined according to the previously reported procedure[5] (as described below), and the PGE_2 concentration was expressed as picograms of PGE_2 per 10^4 viable cells.

PGE_2 EXTRACTION AND MEASUREMENT

The PGE_2 concentration in the culture medium was measured with a radioimmunoassay (RIA) kit containing ^{125}I labelled PGE_2 (New England Nuclear Corp, Boston, MA, USA) according to the assay procedure described in the kit manual, with modifications as reported elsewhere.[9,10] Briefly, 0·5 ml of culture medium at 4°C was acidified with 0·05 M citrate to pH 3·5. C-18 extraction cartridge columns (each containing 200 mg of Bond Elut, Analytichem International Inc, Harbor City, CA, USA) were first treated with 2 ml of methanol followed by 4 ml of 0·05 M citrate. The acidified medium was then passed through the cartridge and eluted with 2 ml of distilled water, 2 ml of 10% methanol, 2 ml of cyclohexane, and 2 ml of ethylacetate, in that

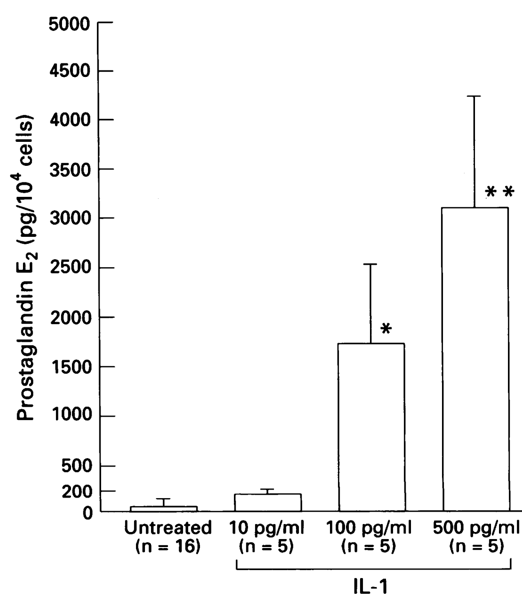

*Figure 1 Effect of IL-1 α on the PGE_2 concentration in culture medium containing LECs. The mean PGE_2 concentrations 24 hours after the addition of IL-1 in concentrations of 100 pg/ml and 500 pg/ml were significantly increased. * and ** indicate significant difference at $p<0·05$ and $p<0·01$, respectively (multiple comparisons according to Scheffe's method).*

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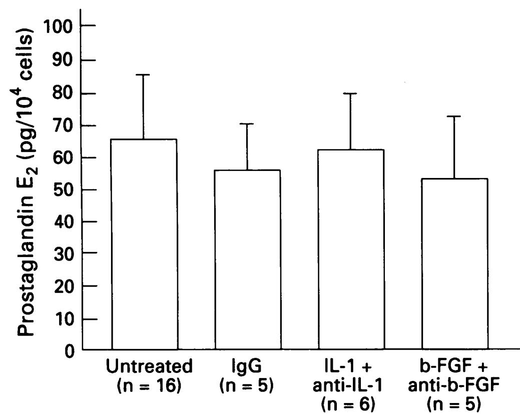

Figure 2 Effect of neutralising anti-IL-1 and anti-b-FGF antibodies on the PGE_2 concentration in culture medium. No significant difference was observed between the PGE_2 concentrations in the experimental and control cultures.

order. The last solvent was evaporated at 37°C under a stream of nitrogen. The minimum detectable amount of PGE_2 by this method was 0·25 pg per tube.

COUNT OF VIABLE CELLS

Without disturbing the cells, the incubation medium was removed from each well, followed by a wash with 0·5 ml of calcium-free and magnesium-free PBS. The cells in each well were then incubated with 0·4 ml of a mixture of 0·25% trypsin and 0·02% ethylene diaminotetra-acetic acid (EDTA) 2 Na for 10 minutes at 37°C. After repeated pipetting to remove the cells from the capsule and the plastic wall of the well, the entire cell suspension was transferred into a small glass test tube, taking care to leave as few cells as possible in the well. The cells were stained by adding 0·1 ml of a mixture of 0·05% crystal violet and 2·1% citric acid, followed by one drop of formalin. Only viable cells could be stained by this procedure. The number of viable cells in the cell suspension from each well was determined, in triplicate, in a Fuchs-Rosenthal cell chamber for counting erythrocytes, and the mean value was used to express the total number of viable cells in each sample.

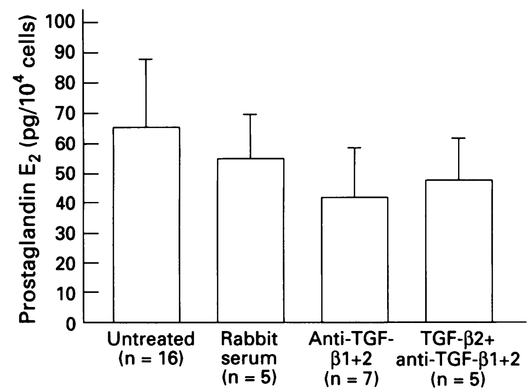

Figure 4 Effect of neutralising anti-TGF-β antiserum on the PGE_2 concentration in culture medium containing LECs. There is no significant difference between the PGE_2 concentration in the experimental and control cultures.

Results

CULTURE OF HUMAN CATARACT LECS

After 3 to 4 weeks, the cells were still proliferating and had become almost confluent in the well. The mean number of viable cells in the untreated cultures and in the treated cultures was 4·25 (0·9)$\times10^4$ (mean (SD)) cells (n=16) and 4·07 (1·1)$\times10^4$ (n=47), respectively, at the end of culture.

PGE_2 CONCENTRATION IN THE CULTURE MEDIUM

PGE_2 concentration in the culture medium to which IL-1, or IL-1 and its neutralising antibody, was added

The mean PGE_2 concentration in the cultures to which IL-1 α had been added at the concentration of 10 pg/ml was not significant, but at the concentrations of 100 pg/ml ($p<0·05$) and 500 pg/ml ($p<0·01$) significantly, increased (multiple comparisons according to Scheffe's method) compared with that in the control cultures (Fig 1). There was no significant difference between the PGE_2 concentration in the cultures to which IL-1 α 500 pg/ml and the neutralising anti-IL-1 α and β antibodies (10 μg/ml) were added and that in the untreated, or rabbit IgG treated controls (Fig 2).

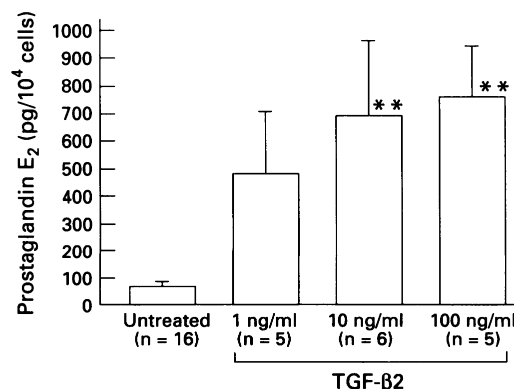

Figure 3 Effect of TGF-β 2 on the PGE_2 concentration in culture medium containing LECs. The mean PGE_2 concentrations after the addition of TGF-β 2 in concentrations of 10 ng/ml and 100 ng/ml were significantly increased.

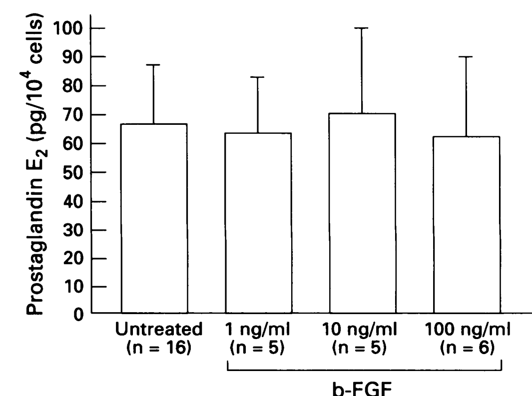

Figure 5 Effect of b-FGF on the PGE_2 concentration in culture medium containing LECs. There is no significant difference between the PGE_2 concentration in the experimental and the control cultures.

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PGE_2 concentration in the culture medium to which TGF-β, or TGF-β and its neutralising antibody, was added

The mean PGE_2 concentration in the cultures to which TGF-β 2 had been added at the concentration of 1 ng/ml was not significantly, but at 10 ng/ml ($p<0.01$) and 100 ng/ml ($p<0.01$) significantly, increased (Fig 3). There was no significant difference between the PGE_2 concentration in the cultures treated with TGF-β 2 (10 ng/ml) and its neutralising TGF-β antiserum (10 μl/ml) and that in the control cultures treated with rabbit serum, or anti-TGF-β antiserum alone (Fig 4).

PGE_2 concentration in the culture medium to which b-FGF or b-FGF and its neutralising antibody, was added

There was no significant difference between the mean PGE_2 concentration in the medium treated with b-FGF at any concentration and that in the controls (Fig 5). There was no significant difference between the PGE_2 concentration in the cultures to which b-FGF (10 ng/ml) and its neutralising anti-b-FGF antibody (10 μg/ml) were added and that in the untreated, or rabbit IgG treated controls (Fig 2). That the b-FGF preparation used was biologically active was demonstrated by our other experimental studies, in which the same preparation significantly increased the uptake of ^{3}H-thymidine or ^{3}H-proline by LECs of human cataracts in culture (manuscript submitted).

Discussion

The PGE_2 concentration was significantly increased by 24 hours after the addition of human recombinant IL-1 α or TGF-β, and these effects were significantly suppressed by the addition of neutralising anti-human IL-1 or anti-human TGF-β antibodies. The results demonstrate that IL-1 α as well as TGF-β 2 increased PGE_2 synthesis in the primary culture of human cataract LECs. The induction of PGE_2 synthesis by IL-1 in various cells or cell lines has been widely reported. Seckinger *et al*[11] reported that PGE_2 production was increased by IL-1 in cultured neonatal mouse calvariae and inhibited by recombinant human IL-1 receptor antagonist. Leizer and Hamilton[12] found that PGE_2 synthesis was increased by IL-1, but that goat anti-IL-1 antiserum significantly inhibited PGE_2 synthesis in the supernatants of human synovial cell cultures. A number of very recent studies[13–16] have indicated that IL-1 induces PGE_2 synthesis in various kinds of cells.

The mechanism of the increase in PGE_2 concentration by IL-1 or TGF-β may be accounted for by the observations presented in several reports. IL-1 is known to activate in vitro phospholipase A_2,[17] cyclo-oxygenase,[18] and lipoxygenase[19] in the arachidonic acid cascade. Some reports indicate that TGF-β increases PGE_2 synthesis by activating cyclo-oxygenase and phospholipase A_2 in lung fibroblasts and endothelial cells in culture,[20] and by activating phospholipase A_2 in rat mesangial cells.[21] Our results are consistent with these reports. On the other hand, Bry *et al*[22] reported that TGF-β inhibits the cytokine (IL-1 and tumour necrosis factor) induced PGE_2 production by cultured amnion cells. However, Kniss *et al*[23] reported that TGF-β increased the cytokine (epidermal growth factor) induced PGE_2 synthesis in mesangial cells. These apparently contradictory findings may be the result of the different cell types or the presence of other modulating cytokines. It would therefore be of interest to study the effect of anti-IL-1 antibodies on TGF-β 2 induced PGE_2 or anti-TGF-β 2 antibodies on IL-1 induced PGE_2 with our culture model of LECs. This might clarify the cytokine context.

We observed no apparent effect of b-FGF on PGE_2 synthesis by human cataract LECs, although there are some reports,[24–26] that b-FGF increases PGE_2 synthesis. Goddard *et al*[27] observed a significant increase of PGE_2 synthesis by b-FGF, which they suggested to activate phospholipase A_2. This discrepancy appears again to be the result of the different cell types and the cytokine context. However, we should take into consideration that in the present study, the investigation was performed at only one time point, which might be the reason that there was no effect of b-FGF observed.

Recent reports have described the detection of IL-1[28] in the aqueous humour of rabbit eyes and of IL-6[29] in that of human eyes after intraocular lens implantation. IL-6 was observed to cause acute inflammation subsequent to intravitreal injection[29] and is known to be induced by IL-1[30,31] in inflammatory host response. TGF-β[32–34] as well as b-FGF[35] have been detected in the aqueous humour obtained from patients undergoing cataract surgery and in the aqueous humour of the rabbit after IOL implantation.[36] Basic FGF was identified immunohistochemically in the proliferated LECs around the lens capsule after cataract surgery.[37] Prostaglandin E_2 plays a major role in postoperative inflammation after IOL implantation.[3,38] Lens epithelial cells can be a source of these cytokines and PGE_2 that are present in the aqueous humour in vivo. Lens epithelial cells disrupt the blood-aqueous barrier, when they come in contact with the IOL and proliferate after IOL implantation.[1,2–4] Our results suggest that endogenous IL-1 and TGF-β produced by LECs act in an autocrine or paracrine manner on PGE_2 synthesis by LECs, which disrupts the blood-aqueous barrier. However, the present study indicates that TGF-β 2 did not significantly alter PGE_2 synthesis at the concentrations present in the normal eye.

In conclusion, IL-1 and TGF-β significantly increased, but b-FGF did not affect PGE_2 synthesis by LECs in culture. The present study clarifies an aspect of our hypothesis regarding postoperative inflammation caused by residual LECs.

The authors have no proprietary interest in the methods and products mentioned in this paper.

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1 Nishi O, Nishi K. Disruption of the blood-aqueous barrier by residual lens epithelial cells after intraocular lens implantation. *Ophthalmic Surg* 1992; **23:** 325–9.
2 Nichi O. Fibrinous membrane formation on the posterior chamber lens during the early postoperative period. *J Cataract Refract Surg* 1988; **14:** 73–7.
3 Miyake K, Mibu H, Horiguchi M, Shirasawa E. Inflammatory mediators in postoperative aphakic and pseudophakic baboon eyes. *Arch Ophthalmol* 1990; **108:** 1764–7.
4 Tsuboi S, Tsujioka M, Kusube T, Kojima S. Effect of continuous circular capsulorhexis and intraocular lens fixation on the blood-aqueous barrier. *Arch Ophthalmol* 1992; **110:** 1124–7.
5 Nishi O, Nishi K, Imanishi M. Synthesis of interleukin-1 and prostaglandin E_2 by lens epithelial cells of human cataracts. *Br J Ophthalmol* 1992; **76:** 338–41.
6 Nishi K, Nishi O, Omoto Y. The synthesis of cytokines by human lens epithelial cells – interleukin-1, tumor necrosis factor, interleukin-6, and epidermal growth factor. *Acta Soc Ophthalmol Jpn* 1992; **96:** 715–20.
7 Nishi K, Nishi O. Basic fibroblast growth factor detected by ELISA during the time course of human cataract lens cell culturing. *Atarashii Ganka* 1994; **11:** 143–5.
8 Oppenheim JJ, Ruscetti FW, Faltineck C. Cytokines. In: Stites DP, Terr AI, eds. *Basic human immunology.* East Norwalk: Appleton and Lange, 1991: chapter 7.
9 Powell WS: Rapid extraction of oxygenated metabolites of arachidonic acid from biological samples using octadecylsilyl silica. *Prostaglandins* 1980; **20:** 947–57.
10 Imanishi M, Kawamura M, Akabane S, Matsuohima Y, Kuramochi M, Ito K, *et al.* Aspirin lowers blood pressure in patients with renovascular hypertension. *Hypertension* 1989; **14:** 461–8.
11 Seckinger P, Klein-Nulend J, Alander C, Thompson RC, Dayer JM, Raisz LG. Natural and recombinant human IL-1 receptor antagonists block the effects of IL-1 on bone resorption and prostaglandin production. *J Immunol* 1990; **145:** 4181–4.
12 Leizer T, Hamilton JA. Plasminogen activator and prostaglandin E_2 levels in human synovial fibroblasts. *J Immunol* 1989; **143:** 971–8.
13 Peterson CM, Hales HA, Hatasaka HH, Mitchell MD, Rittenhorse L, Jones KP. Interleukin-1β (IL-1β) modulates prostaglandin production and the natural IL-1 receptor antagonist inhibits ovulation in the optimally stimulated rat ovarian perfusion model. *Endocrinology* 1993; **33:** 2301–6.
14 Kent AS, Sun My, Sullivan MH, Elder MG. The effects of interleukins 1 alpha and beta on prostaglandin production by cultured fetal membranes. *Prostaglandins* 1993; **41:** 51–9.
15 Inoue T, Fukuo K, Morimoto S, Koh E, Ogihara T. Nitric oxide mediates interleukin-1-induced prostaglandin E_2 production by vascular smooth muscle cells. *Biochem Biophys Res Commun* 1993; **194:** 420–4.
16 Jacobs AL, Carson DD. Uterine epithelial cell secretion of interleukin-1 alpha induces prostaglandin E_2 (PGE_2) and PGE_2 alpha secretion by uterine stromal cells in vitro. *Endocrinology* 1993; **132:** 300–8.
17 Chang J, Gilman SC, Lewis AJ. Interleukin 1 activates phospholipase A_2 in rabbit chondrocytes: a possible signal for IL-1 action. *J Immunol* 1986; **136:** 1283–7.
18 O'Neill LAJ, Barett ML, Lewis GP. Induction of cyclooxygenase by interleukin-1 in rheumatoid synovial cells. *FEBS Lett* 1987; **212:** 35–9.
19 Farrar WL, Humes JL. The role of arachidonic acid metabolism in the activities of interleukin 1 and 2. *J Immunol* 1985; **135:** 1153–9.
20 Jackson BA, Goldstein RH, Roy R, Cozzani M, Taylor L, Polgar P. Effects of transforming growth factor beta and interleukin-1 beta on expression of cyclooxygenase 1 and 2 and phospholipase A_2 mRNA in lung fibroblasts and endothelial cells in culture. *Biochem Biophys Res Commun* 1993; **197:** 1465–74.
21 Schaltwijk CG, de Vet E, Pfeilschifter J, van den Bosch H. Interleukin-1 beta and transforming growth factor beta 2 enhance cytosolic high-molecular-mass phospholipase A_2 activity and induce prostaglandin E_2 formation in rat mesangial cells. *Eur J Biochem* 1992; **210:** 169–76.
22 Bry K, Lappalainen U, Hallman M. Interleukin-1 binding and prostaglandin E_2 synthesis by amnion cells in culture: regulation by tumor necrosis factor-alpha, transforming growth factor-beta, and interleukin-1 receptor antagonist. *Biochem Biophys Acta* 1993; **1181:** 31–6.
23 Kniss DA, Zimmerman PD, Fertel RH, Iams JD. Transforming growth factor-beta potentiates epidermal growth factor-induced prostaglandin E_2 production in amnion cells. *Prostaglandins* 1993; **45:** 27–33.
24 Candela M, Barker SC, Ballou LR. Fibroblast growth factor increases TNF alpha-mediated prostaglandin E_2 production and TNF alpha receptor expression in human fibroblasts. *Mol Cell Biochem* 1993; **120:** 43–50.
25 Goddard DH, Grossman SL, Newton R. Polypeptide growth prostaglandin E_2 by rheumatoid arthritis synovial cells in vitro. *Cytokine* 1990; **2:** 294–9.
26 Chin JE, Hatfield CA, Krzesicki RF, Herblin WF. Interactions between interleukin-1 and basic fibroblast growth factor on articular chondrocytes. Effects on cell growth, prostanoid production, and receptor modulation. *Arthritis Rheum* 1991; **34:** 314–24.
27 Goddard DH, Grossman SL, Newton R, Clark MA, Bomalaski JS. Regulation of synovial cell growth: basic fibroblast growth factor synergizes with interleukin-1 beta stimulating phospholipase A_2 enzyme activity, phospholipase A_2 activating protein production and release of prostaglandin E_2 by rheumatoid arthritis synovial cells in culture. *Cytokine* 1992; **4:** 377–84.
28 Yokoyama T. Interleukin-1β in the aqueous humor in aphakic and pseudophakic eyes of rabbits. *Acta Soc Ophthalmol Jpn* 1992; **96:** 67–73.
29 Malecaze F, Chollet P, Cavrois E, Vita N, Arne J-L, Ferrara P. Role of interleukin 6 in the inflammatory response after cataract surgery. An experimental and clinical study. *Arch Ophthalmol* 1991; **109:** 1681–3.
30 May LT, Torua C, Cozzolino F. Interleukin 6 gene expression in human endothelial cells: RNA start sites, multiple IL-6 proteins and inhibition of proliferation. *Biochem Biophys Res Commun* 1989; **159:** 991–9.
31 Planck SR, Dang TT, Graves D, Tara D, Ansel JC, Rosenbaum JT. Retinal pigment epithelial cells secrete interleukin-6 in response to interleukin-1. *Invest Ophthalmol Vis Sci* 1992; **33:** 78–82.
32 Jampel HD, Roche N, Stark WJ, Roberts AB. Transforming growth factor-beta in human aqueous humor. *Curr Eye Res* 1990; **9:** 963–9.
33 Granstein RD, Staszewski R, Knisely EZ, Zeira E, Nazareno R, Latina M, *et al.* Aqueous humour contains transforming growth factor-β and a small (<3500 daltons) inhibitor of thymocyte proliferation. *J Immunol* 1990; **144:** 3021–7.
34 Cousins SW, McCabe MM, Danielpour D, Streilein JW. Identification of transforming growth factor-beta as an immunosuppressive factor in aqueous humor. *Invest Ophthalmol Vis Sci* 1991; **32:** 2201–11.
35 Tripathi RC, Millard CB. A molecule resembling fibroblast growth factor in aqueous humor. *Am J Ophthalmol* 1988; **106:** 230–1.
36 Namiki M. Quantification of basic fibroblast growth factor (bFGF) and transforming growth factor (TGF β) in rabbit aqueous humor after intraocular lens implantation. *J Jpn Ophthalmol Soc* 1994; **98:** 334–9.
37 Hayashi N, Kato H, Kiyosawa T, Hayashi H, Oshima K, Yamaoka M. The change of immunohistochemical localization of basic fibroblast growth factor around the lens capsule after extra capsular extraction. *Acta Soc Ophthalmol Jpn* 1991; **95:** 621–4.
38 Törngren L, Rolfsen W, Lundgren B. PGE_2 and leukocyte levels in aqueous humor after lens extraction and intraocular lens implantation. *Ocular Immunol Inflamm* 1993; **1:** 151–7.

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