INTRAOCULAR PRESSURE REDUCTION WITH INTRACAMERAL BIMATOPROST IMPLANTS

CROSS REFERENCE TO RELATED APPLICATIONS

[1] This Application is a continuation in part of US Patent Application Serial No. 10/837,260, filed on April 30, 2004 in the names of Hughes et al, incorporated entirely by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention.

[2] The present invention relates to a method of treating an ocular condition, comprising the step of placing a biodegradable intraocular implant in an eye of the patient, the implant comprising a prostamide and a biodegradable polymer matrix that releases drug at a rate effective to sustain release of an amount of the prostamide from the implant to provide an amount of the prostamide effective to prevent or reduce a symptom of the ocular condition, wherein said ocular condition is elevated IOP.

2. Summary of the Related Art

[3] The anterior and posterior chambers of the eye are filled with aqueous humor, a fluid predominantly secreted by the ciliary body with an ionic composition similar to the blood. The function of the aqueous humor is two-fold: to 1) supply nutrients to the avascular structures of the eye, such as the lens and cornea and 2) maintain intraocular pressure (IOP) within its physiological range. Maintenance of IOP and supply of nutrients to the anterior segment are factors that are critical for maintaining normal visual acuity. Aqueous humor is predominantly secreted to the posterior chamber of the eye by the ciliary processes of the ciliary body and a minor mechanism of aqueous humor production is through ultrafiltration from arterial blood. Aqueous humor then reaches the anterior chamber by crossing the pupil and there are convection currents where the aqueous, adjacent to the iris, flows upwards, and the aqueous, adjacent to the cornea, flows downwards. There are two different pathways of aqueous humor outflow, both located in the iridocorneal angle of the eye. The uveoscleral or nonconventional pathway refers to the aqueous humor leaving the anterior chamber by diffusion through intercellular spaces among ciliary muscle fibers. Although this seems to be a minority outflow pathway in humans, the uveoscleral or nonconventional pathway is the target of specific anti-hypertensive drugs such as the hypotensive lipids, e.g. bimatoprost, that increase the functionality of this route through

remodeling of the extracellular matrix. In addition, bimatoprost may improve aqueous outflow through the trabecular meshwork ("TM") mediated through a prostamide receptor. In the human eye, the main outflow route is the trabecular or conventional outflow pathway. This tissue contains three differentiated layers. From the inner to the outermost part, the layer of tissue closest to the anterior chamber is the uveal meshwork, formed by prolongations of connective tissue arising from the iris and ciliary body stromas and covered by endothelial cells. This layer does not offer much resistance to aqueous humor outflow because intercellular spaces are large. The next layer, known as the corneoscleral meshwork, is characterized by the presence of lamellae covered by endothelium–like cells on a basal membrane. The lamellae are formed by glycoproteins, collagen, hyaluronic acid, and elastic fibers. The higher organization of the corneoscleral meshwork in relation to the uveal meshwork as well as their narrower intercellular spaces are responsible for the increase in flow resistance. The third layer, which is in direct contact with the inner wall of endothelial cells from Schlemm's canal, is the juxtacanalicular meshwork. It is formed by cells embedded in a dense extracellular matrix, and the majority of the tissue resistance to aqueous flow is postulated to be in this layer, due to its narrow intercellular spaces. The layer of endothelial cells from Schlemm's canal has expandable pores that transfer the aqueous into the canal and accounts for approximately 10% of the total resistance. It has been postulated that aqueous humor crosses the inner wall endothelium of Schlemm's canal by two different mechanisms: a paracellular route through the junctions formed between the endothelial cells and a transcellular pathway through intracellular expandable pores of the same cells. Once there is entry into Schlemm's canal, the aqueous drains directly into the collector ducts and aqueous veins that anastomose with the episcleral and conjunctival plexi of vessels. Aqueous humor outflow via the trabecular pathway is IOP dependent, usually measured as outflow facility, and expressed in microliters per minute per millimeter of mercury. The episcleral venous pressure controls outflow through the collector channels and is one factor that contributes to the intraocular pressure. Increases in the episcleral venous pressure such as seen with carotid-cavernous sinus fistulas, orbital varices, and Sturge-Weber Syndrome, can lead to difficult to manage glaucoma. Reducing episcleral venous pressure in disease states, such as treating carotid-cavernous sinus fistulas, can normalize the episcleral venous pressure and reduce the intraocular pressure. The mechanism of action of modern ocular hypotensive agents for treating ocular hypertension and open angle glaucoma are as follows: 1- reduce aqueous humor production, 2- improve uveoscleral outflow, 3- improve outflow through the TM with miotic agents by providing tension as the scleral spur with stimulation of the ciliary body muscle, 4- combination of any of the above.

Brief Summary of the Disclosure

[4] Unexpectedly, when sustained-release implants releasing bimatoprost were placed in an intracameral location, the outflow channels emanating from Schlemm's Canal were visibly dilated (See Figure 4). This results in a profound reduction in the intraocular pressure, i.e. -60% IOP reduction from baseline. (See Figure 5), This reduction is significantly more than what is typically observed with topical bimatoprost, i.e. -35% IOP reduction) The redirection of aqueous flow towards the TM is illustrated in Figure 1, lower image. The usual mechanism of prostamides is to remodel both the anterior ciliary body near the ciliary band and the TM. The intracameral implants, which are located adjacent to the TM , as shown in Figure 3, provide a high drug concentration into the outflow channels and dilate the vessels in the episcleral and conjunctival venous plexus, thereby resulting in a novel mechanism of IOP reduction. The dilation appears 360 degrees around the eye since drug released from an implant positioned at the 6:00 O'clock position is well-mixed throughout the anterior segment through the convection currents.

[5] This incremental reduction in the IOP with the intracameral bimatoprost implants is advantageous for patients with ocular hypertension and open angle glaucoma that require sustained reduction in IOP to prevent progressive optic neuropathy. Patients can avoid the need for combination eye drops and/or surgery (including incisional surgery such as trabeculectomy, laser procedures such as ALT and SLT, and aqueous humor bypass stents), if they are able to achieve profound reductions in IOP with the intracameral implant described herein.

In an aspect, there is provided the use of a biodegradable intraocular implant in the manufacture of a medicament for treating elevated intraocular pressure (IOP) wherein:

the implant comprises a prostamide in the amount of 15-25% by weight of the implant, the prostamide being associated with a biodegradable polymer matrix that releases an amount of the prostamide effective to prevent or reduce a symptom of the elevated lOP; and

the implant is to be placed in an intracameral location at the 6:00 o'clock position to dilate the outflow channels of the eye emanating from Schlemm's Canal and to thereby well-mix the prostamide throughout the anterior segment through the convection currents.

Brief Description of the Drawings

[6] Figure 1 (upper image) shows aqueous humor is predominantly secreted to the posterior chamber of the eye by the ciliary processes of the ciliary body.

[7] Figure 1 (lower image) shows an intracameral sustained-release bimatoprost implant releasing drug directly into Schlemm's canal resulting in visible dilation of the outflow channels.

[8] Figure 2 shows that aqueous humor reaches the anterior chamber by crossing the pupil and there are convection currents where the flow of aqueous adjacent to the iris is upwards, and the flow of aqueous adjacent to the cornea is downwards.

[9] Figure 3 is a slit lamp photograph through a gonioscopy lens showing an intracameral bimatoprost implant placed adjacent to the trabecular meshwork in the dog eye.

[10] Figure 4 is a photograph showing the outflow vessels that are dilated as a result of treatment of a dog with the high-release bimatoprost intracameral implant of Example 1.

[11] Figure 5 shows the IOP of a dog treated with the high-release bimatoprost intracameral implant described in Example 1 was reduced to approximately -60% from baseline and such reduction was sustained for at least 5 months.

[12] Figure 6 is a photograph showing the outflow vessels that are dilated as a result of treatment of a dog with the low-release bimatoprost intracameral implant of Example 2.

[13] Figure 7 shows the IOP of a dog treated with the low-release bimatoprost intracameral implant described in Example 2 was reduced to approximately -40% from baseline and such reduction was sustained for at least 42 days.

[14] Figure 8 shows the in vitro release rate of the Implant formulation used in Example 1 (arrow).

[15] Figure 9 shows the in vitro release rate of the Implant formulation used in Example 2 (arrow).

[16] Figure 10 shows the IOP is lowered in a dog treated with a single bimatoprost implant according to Example 3.

[17] Figure 11 shows the IOP is lowered in a dog treated with two bimatoprost implants according to Example 3.

Detailed Description of the Invention

[18] As disclosed herein, controlled and sustained administration of a therapeutic agent through the use of one or more intraocular implants may improve treatment of undesirable ocular conditions, in particular elevated IOP. The implants comprise a pharmaceutically acceptable polymeric composition and are formulated to release one or more pharmaceutically active agents, such as a prostamide, over an extended period of time. The implants are effective to provide a therapeutically effective dosage of the agent or agents directly to a region of the eye to treat or prevent one or more undesirable ocular conditions. Thus, with a single administration, therapeutic agents will be made available at the site where they are needed and will be maintained for an extended period of time, rather than subjecting the patient to repeated injections or repeated administration of topical drops.

[19] The above implants are utilized in a method of treating an ocular condition, comprising the step of placing a biodegradable intraocular implant in an eye of the patient, the implant comprising a prostamide and a biodegradable polymer matrix that releases prostamide at a rate effective to sustain an amount of prostamide effective to prevent or reduce a symptom of the ocular condition, wherein said ocular condition is elevated IOP and said implant is placed in an

intracameral location to dilate the outflow channels of the eye emanating from Schlemm's Canal.

[20] An intraocular implant in accordance with the disclosure herein comprises a therapeutic component. The therapeutic component comprises, consists essentially of, or consists of, a prostamide. A drug release sustaining component may be associated with the therapeutic component to sustain release of an effective amount of the prostamide into an eye in which the implant is placed. The amount of the prostamide is released into the eye for a period of time greater than about one week after the implant is placed in the eye, and is effective in treating or reducing a symptom of an ocular condition.

[21] The implant is made of polymeric materials to provide maximal approximation of the implant to the iridocorneal angle. In addition, the size of the implant, which ranges from a diameter of approximately 0.1 to 1 mm, and lengths from 0.1 to 6 mm, enables the implant to be inserted into the anterior chamber using an applicator with a small gauge needle ranging from 22 to 30G.

DEFINITIONS

[22] For the purposes of this description, we use the following terms as defined in this section, unless the context of the word indicates a different meaning.

[23] As used herein, an "intraocular implant" refers to a device or element that is structured, sized, or otherwise configured to be placed in an eye. Intraocular implants are generally biocompatible with physiological conditions of an eye and do not cause adverse side effects. Intraocular implants may be placed in an eye without disrupting vision of the eye.

[24] As used herein, a "therapeutic component" refers to a portion of an intraocular implant comprising one or more therapeutic agents or substances used to treat a medical condition of the eye. The therapeutic component may be a discrete region of an intraocular implant, or it may be homogenously distributed throughout the implant. The therapeutic agents of the therapeutic component are typically ophthalmically acceptable, and are provided in a form that does not cause adverse reactions when the implant is placed in an eye.

[25] As used herein, a "drug release sustaining component" refers to a portion of the intraocular implant that is effective to provide a sustained release of the therapeutic agents of the implant. A drug release sustaining component may be a biodegradable polymer matrix, or it may be a coating covering a core region of the implant that comprises a therapeutic component.

[26] As used herein, "associated with" means mixed with, dispersed within, coupled to, covering, or surrounding.

[27] As used herein, an "ocular region" or "ocular site" refers generally to any area of the eyeball, including the anterior and posterior segment of the eye, and which generally includes, but is not limited to, any functional (e.g., for vision) or structural tissues found in the eyeball, or tissues or cellular layers that partly or completely line the interior or exterior of the eyeball. Specific examples of areas of the eyeball in an ocular region include the anterior chamber, the posterior chamber, the vitreous cavity, the choroid, the suprachoroidal space, the conjunctiva, the subconjunctival space, the episcleral space, the intracorneal space, the epicorneal space, the sclera, the pars plana, surgically induced avascular regions, the macula, and the retina.

[28] As used herein, an "ocular condition" is a disease, ailment or condition which affects or involves the eye or one of the parts or regions of the eye. Broadly speaking the eye includes the eyeball and the tissues and fluids which constitute the eyeball, the periocular muscles (such as the oblique and rectus muscles) and the portion of the optic nerve which is within or adjacent to the eyeball.

[29] An anterior ocular condition is a disease, ailment or condition which affects or which involves an anterior (i.e. front of the eye) ocular region or site, such as a periocular muscle, an eye lid or an eye ball tissue or fluid which is located anterior to the posterior wall of the lens capsule or ciliary muscles. Thus, an anterior ocular condition primarily affects or involves the conjunctiva, the cornea, the anterior chamber, the iris, the posterior chamber (behind the retina but in front of the posterior wall of the lens capsule), the lens or the lens capsule and blood vessels and nerve which vascularize or innervate an anterior ocular region or site.

[30] Thus, an anterior ocular condition can include a disease, ailment or condition, such as for example, aphakia; pseudophakia; astigmatism; blepharospasm; cataract; conjunctival diseases; conjunctivitis; corneal diseases; corneal ulcer; dry eye syndromes; eyelid diseases; lacrimal apparatus diseases; lacrimal duct obstruction; myopia; presbyopia; pupil disorders; refractive disorders and strabismus. Glaucoma can also be considered to be an anterior ocular condition because a clinical goal of glaucoma treatment can be to reduce a hypertension of aqueous fluid in the anterior chamber of the eye (i.e. reduce intraocular pressure).

[31] A posterior ocular condition is a disease, ailment or condition which primarily affects or involves a posterior ocular region or site such as choroid or sclera (in a position posterior to a plane through the posterior wall of the lens capsule), vitreous, vitreous chamber, retina, optic nerve (i.e. the optic disc), and blood vessels and nerves which vascularize or innervate a posterior ocular region or site.

[32] Thus, a posterior ocular condition can include a disease, ailment or condition, such as for example, acute macular neuroretinopathy; Behcet's disease; choroidal neovascularization;

diabetic uveitis; histoplasmosis; infections, such as fungal or viral-caused infections; macular degeneration, such as acute macular degeneration, non-exudative age related macular degeneration and exudative age related macular degeneration; edema, such as macular edema, cystoid macular edema and diabetic macular edema; multifocal choroiditis; ocular trauma which affects a posterior ocular site or location; ocular tumors; retinal disorders, such as central retinal vein occlusion, diabetic retinopathy (including proliferative diabetic retinopathy), proliferative vitreoretinopathy (PVR), retinal arterial occlusive disease, retinal detachment, uveitic retinal disease; sympathetic opthalmia; Vogt Koyanagi-Harada (VKH) syndrome; uveal diffusion; a posterior ocular condition caused by or influenced by an ocular laser treatment; posterior ocular conditions caused by or influenced by a photodynamic therapy, photocoagulation, radiation retinopathy, epiretinal membrane disorders, branch retinal vein occlusion, anterior ischemic optic neuropathy, non-retinopathy diabetic retinal dysfunction, retinitis pigmentosa, and glaucoma. Glaucoma can be considered a posterior ocular condition because the therapeutic goal is to prevent the loss of or reduce the occurrence of loss of vision due to damage to or loss of retinal cells or optic nerve cells (i.e. neuroprotection).

[33] The term "biodegradable polymer" refers to a polymer or polymers which degrade in vivo, and wherein erosion of the polymer or polymers over time occurs concurrent with or subsequent to release of the therapeutic agent. Specifically, hydrogels such as methylcellulose which act to release drug through polymer swelling are specifically excluded from the term "biodegradable polymer". The terms "biodegradable" and "bioerodible" are equivalent and are used interchangeably herein. A biodegradable polymer may be a homopolymer, a copolymer, or a polymer comprising more than two different polymeric units.

[34] The term "treat", "treating", or "treatment" as used herein, refers to reduction or resolution or prevention of an ocular condition, ocular injury or damage, or to promote healing of injured or damaged ocular tissue. A treatment is usually effective to reduce at least one symptom of an ocular condition, ocular injury or damage.

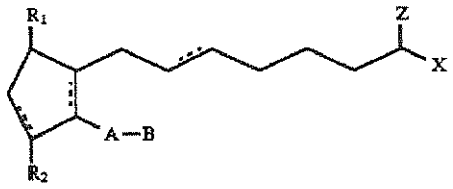
[35] The term "effective" as used herein, refers to the level or amount of agent needed to treat an ocular condition, or reduce or prevent ocular injury or damage without causing significant negative or adverse side effects to the eye or a region of the eye. In view of the above, a therapeutically effective amount of a therapeutic agent, such as a prostamide, is an amount that is effective in reducing at least one symptom of an ocular condition.

[36] Intraocular implants have been developed which can release drug loads over various time periods. These implants, which when inserted into an eye, such as the vitreous of an eye, provide therapeutic levels of a prostamide for extended periods of time (e.g., for about 1 week or

more). The disclosed implants are effective in treating ocular conditions, such as ocular conditions associated with elevated intraocular pressure, and more specifically in reducing at least one symptom of glaucoma.

[37] In one embodiment of the present invention, an intraocular implant comprises a biodegradable polymer matrix. The biodegradable polymer matrix is one type of a drug release-sustaining component. The biodegradable polymer matrix is effective in forming a biodegradable intraocular implant. The biodegradable intraocular implant comprises a prostamide associated with the biodegradable polymer matrix. The matrix degrades at a rate effective to sustain release of an amount of the prostamide for a time greater than about one week from the time in which the implant is placed in ocular region or ocular site, such as the vitreous of an eye.

[38] The prostamide component of the implant includes one or more types of prostamides. In certain implants, the prostamide component comprises a compound having the formula (I) .

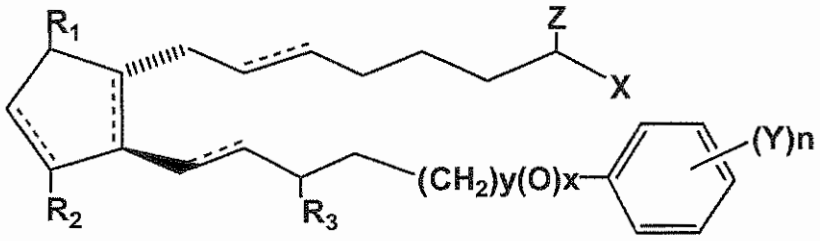


wherein the dashed bonds represent a single or double bond which can be in the cis or trans configuration, A is an alkylene or alkenylene radical having from two to six carbon atoms, which radical may be interrupted by one or more oxide radicals and substituted with one or more hydroxy, oxo, alkyloxy or akylcarboxy groups wherein said alkyl radical comprises from one to six carbon atoms; B is a cycloalkyl radical having from three to seven carbon atoms, or an aryl radical, selected from the group consisting of hydrocarbyl aryl and heteroaryl radicals having from four to ten carbon atoms wherein the heteroatom is selected from the group consisting of nitrogen, oxygen and sulfur atoms; X is $--N(R^4)_2$ wherein $R.^4$ is independently selected from the group consisting of hydrogen and lower alkyl radicals having from one to six carbon atoms,

[39] Z is =O; one of R_1 and R_2 is =O, -OH or a $-O(CO)R_6$ group, and the other one is -OH or $-O(CO)R_6$, or R_1 is =O and R_2 is H; wherein R_6 is a saturated or unsaturated acyclic hydrocarbon group having from 1 to about 20 carbon atoms, or $-(CH_2)mR_7$ wherein m is 0-10, and R_7 is cycloalkyl radical, having from three to seven carbon atoms, or a hydrocarbyl aryl or heteroaryl, as defined above; or a pharmaceutically-acceptable salt thereof or a pharmaceutically-acceptable salt thereof .

[40] Pharmaceutically acceptable acid addition salts of the compounds of the invention are those formed from acids which form non-toxic addition salts containing pharmaceutically acceptable anions, such as the hydrochloride, hydrobromide, hydroiodide, sulfate, or bisulfate, phosphate or acid phosphate, acetate, maleate, fumarate, oxalate, lactate, tartrate, citrate, gluconate, saccharate and p-toluene sulphonate salts.

Preferably, the prostamide has the following formula (II)



wherein y is 0 or 1, x is 0 or 1 and x+y are not both 1, Y is a radical selected from the group consisting of alkyl, halo, nitro, amino, thiol, hydroxy, alkyloxy, alkylcarboxy and halo substituted alkyl, wherein said alkyl radical comprises from one to six carbon atoms, n is 0 or an integer of from 1 to 3 and R_3 is .=O, --OH or --O(CO)R_6 and hatched lines indicate the .alpha. configuration and solid triangles indicate the .beta. configuration.

[41] In at least one type of intraocular implant, the prostamide comprises a compound wherein R_1, R_2 and R_3 are OH, y is 1, x is 0, n is 0 and X is N(H)(C_2H_5) ,e.g.. cyclopentane N-ethyl heptenamide-5-cis-2-(3α.-hydroxy-5-phenyl-1-trans-pentenyl)-3, 5-dihydroxy, [1_{α}.,2_{β}.,3_{α},5_{α}.].

[42] The compound, cyclopentane N-ethyl heptenamide-5-cis-2-(3α.-hydroxy-5-phenyl-1-trans-pentenyl)-3, 5-dihydroxy, [1_{α}.,2_{β}.,3_{α},5_{α}.] , is also known as bimatoprost and is publicly available in a topical ophthalmic solution under the tradename, Lumigan.RTM. (Allergan, Inc., CA).

[43] Alternatively, the prostamide may be any of the prostamides disclosed in US Patent No. 6,395,787, which is hereby incorporated by reference.

[44] Thus, the implant may comprise a therapeutic component which comprises, consists essentially of, or consists of bimatoprost, a salt thereof, or mixtures thereof.

[45] The prostamide may be in a particulate or powder form and it may be entrapped by the biodegradable polymer matrix. Usually, prostamide particles will have an effective average size less than about 3000 nanometers. In certain implants, the particles may have an effective average particle size about an order of magnitude smaller than 3000 nanometers. For example, the particles may have an effective average particle size of less than about 500 nanometers. In

additional implants, the particles may have an effective average particle size of less than about 400 nanometers, and in still further embodiments, a size less than about 200 nanometers.

[46] The prostamide of the implant is preferably from about 10% to 90% by weight of the implant. More preferably, the prostamide is from about 20% to about 80% by weight of the implant. In a preferred embodiment, the prostamide comprises about 20% by weight of the implant (e.g., 15%-25%). In another embodiment, the prostamide comprises about 50% by weight of the implant.

[47] Suitable polymeric materials or compositions for use in the implant include those materials which are compatible, that is biocompatible, with the eye so as to cause no substantial interference with the functioning or physiology of the eye. Such materials preferably are at least partially and more preferably substantially completely biodegradable or bioerodible.

[48] Examples of useful polymeric materials include, without limitation, such materials derived from and/or including organic esters and organic ethers, which when degraded result in physiologically acceptable degradation products, including the monomers. Also, polymeric materials derived from and/or including, anhydrides, amides, orthoesters and the like, by themselves or in combination with other monomers, may also find use. The polymeric materials may be addition or condensation polymers, advantageously condensation polymers. The polymeric materials may be cross-linked or non-cross-linked, for example not more than lightly cross-linked, such as less than about 5%, or less than about 1% of the polymeric material being cross-linked. For the most part, besides carbon and hydrogen, the polymers will include at least one of oxygen and nitrogen, advantageously oxygen. The oxygen may be present as oxy, e.g. hydroxy or ether, carbonyl, e.g. non-oxo-carbonyl, such as carboxylic acid ester, and the like. The nitrogen may be present as amide, cyano and amino. The polymers set forth in Heller, Biodegradable Polymers in Controlled Drug Delivery, In: CRC Critical Reviews in Therapeutic Drug Carrier Systems, Vol. 1, CRC Press, Boca Raton, Fla. 1987, pp 39-90, which describes encapsulation for controlled drug delivery, may find use in the present implants.

[49] Of additional interest are polymers of hydroxyaliphatic carboxylic acids, either homopolymers or copolymers, and polysaccharides. Polyesters of interest include polymers of D-lactic acid, L-lactic acid, racemic lactic acid, glycolic acid, polycaprolactone, and combinations thereof. Generally, by employing the L-lactate or D-lactate, a slowly eroding polymer or polymeric material is achieved, while erosion is substantially enhanced with the lactate racemate.

[50] Among the useful polysaccharides are, without limitation, calcium alginate, and functionalized celluloses, particularly carboxymethylcellulose esters characterized by being water insoluble, a molecular weight of about 5 kD to 500 kD, for example.

[51] Other polymers of interest include, without limitation, polyvinyl alcohol, polyesters, polyethers and combinations thereof which are biocompatible and may be biodegradable and/or bioerodible.

[52] Some preferred characteristics of the polymers or polymeric materials for use in the present invention may include biocompatibility, compatibility with the therapeutic component, ease of use of the polymer in making the drug delivery systems of the present invention, a half-life in the physiological environment of at least about 6 hours, preferably greater than about one day, not significantly increasing the viscosity of the vitreous, and water insolubility.

[53] The biodegradable polymeric materials which are included to form the matrix are desirably subject to enzymatic or hydrolytic instability. Water-soluble polymers may be cross-linked with hydrolytic or biodegradable unstable cross-links to provide useful water insoluble polymers. The degree of stability can be varied widely, depending upon the choice of monomer, whether a homopolymer or copolymer is employed, employing mixtures of polymers, and whether the polymer includes terminal acid groups.

[54] Equally important to controlling the biodegradation of the polymer and hence the extended release profile of the implant is the relative average molecular weight of the polymeric composition employed in the implant. Different molecular weights of the same or different polymeric compositions may be included in the implant to modulate the release profile. In certain implants, the relative average molecular weight of the polymer will range from about 9 to about 64 kD, usually from about 10 to about 54 kD, and more usually from about 12 to about 45 kD.

[55] In some implants, copolymers of glycolic acid and lactic acid are used, where the rate of biodegradation is controlled by the ratio of glycolic acid to lactic acid. The most rapidly degraded copolymer has roughly equal amounts of glycolic acid and lactic acid. Homopolymers, or copolymers having ratios other than equal, are more resistant to degradation. The ratio of glycolic acid to lactic acid will also affect the brittleness of the implant, where a more flexible implant is desirable for larger geometries. The % of polylactic acid in the polylactic acid polyglycolic acid (PLGA) copolymer can be 0-100%, preferably about 15-85%, more preferably about 35-65%. In some implants, a 50/50 PLGA copolymer is used.

[56] The biodegradable polymer matrix of the intraocular implant may comprise a mixture of two or more biodegradable polymers. For example, the implant may comprise a mixture of a

first biodegradable polymer and a different second biodegradable polymer. One or more of the biodegradable polymers may have terminal acid groups.

[57] Release of a drug from an erodible polymer is the consequence of several mechanisms or combinations of mechanisms. Some of these mechanisms include desorption from the implant's surface, dissolution, diffusion through porous channels of the hydrated polymer and erosion. Erosion can be bulk or surface or a combination of both. As discussed herein, the matrix of the intraocular implant may release drug at a rate effective to sustain release of an amount of the prostamide component for more than one week after implantation into an eye. In certain implants, therapeutic amounts of the prostamide component are released for no more than about 30-35 days after implantation. For example, an implant may comprise bimatoprost, and the matrix of the implant degrades at a rate effective to sustain release of a therapeutically effective amount of bimatoprost for about one month after being placed in an eye. As another example, the implant may comprise bimatoprost, and the matrix releases drug at a rate effective to sustain release of a therapeutically effective amount of bimatoprost for more than forty days, such as for about six months.

[58] One example of the biodegradable intraocular implant comprises a prostamide associated with a biodegradable polymer matrix, which comprises a mixture of different biodegradable polymers. At least one of the biodegradable polymers is a polylactide having a molecular weight of about 63.3 kD. A second biodegradable polymer is a polylactide having a molecular weight of about 14 kD. Such a mixture is effective in sustaining release of a therapeutically effective amount of the prostamide for a time period greater than about one month from the time the implant is placed in an eye.

[59] Another example of a biodegradable intraocular implant comprises an prostamide associated with a biodegradable polymer matrix, which comprises a mixture of different biodegradable polymers, each biodegradable polymer having an inherent viscosity from about 0.16 dl/g to about 1.0 dl/g. For example, one of the biodegradable polymers may have an inherent viscosity of about 0.3 dl/g. A second biodegradable polymer may have an inherent viscosity of about 1.0 dl/g. Additional implants may comprise biodegradable polymers that have an inherent viscosity between about 0.2 dl/g and 0.5 dl/g. The inherent viscosities identified above may be determined in 0.1% chloroform at 25.degree. C.

[60] One particular implant comprises bimatoprost associated with a combination of two different polylactide polymers. The bimatoprost is present in about 20% by weight of the implant. One polylactide polymer has a molecular weight of about 14 kD and an inherent viscosity of about 0.3 dl/g, and the other polylactide polymer has a molecular weight of about

63.3 kD and an inherent viscosity of about 1.0 dl/g. The two polylactide polymers are present in the implant in a 1:1 ratio. Such an implant may be effective in releasing the bimatoprost for more than two months. The implant is provided in the form of a rod or a filament produced by an extrusion process.

[61] A preferred implant formulation for the invention is API 30%, R203S 45%, R202H 20%, PEG 3350 5% or API 20%, R203S 45%, R202H 10%, RG752S 20%, PEG 3350 5%, wherein the API is bimatoprost. The range of concentrations of the constituents that can be used in the preferred implant formulation are API 5 to 40%, R203S 10 to 60%, R202H 5 to 20%, RG752S 5 to 40%, PEG 3350 0 to 15%. The PLA/PLGA polymers are from the Resomer product line available from Boehringer Ingelheim in Ingelheim, Germany and include the following:

Resomer	Monomer ratio	i.v. dL/g
RG502,	50:50 poly (D, L-lactide-co-glycolide)	0.2
RG502H,	50:50 poly (D, L-lactide-co-glycolide)	0.2
RG503,	50:50 poly (D, L-lactide-co-glycolide)	0.4
RG504,		0.5
RG505,		0.7
RG506,		0.8
RG752,	75:25 poly (D,L lactide-co-glycolide)	0.2
RG755,	75:25 poly(D,L lactide-co-glycolide)	0.6 (40000)
RG756,		0.8
RG858,	85:15 poly (D,L-lactide-co-glycolide)	1.4
R202H,	poly (D,L-lactide)	0.3
R203	poly (D,L-lactide)	1.0 (40000)
R206.	poly (D,L-lactide) ; acid end	0.2
R104	poly (D,L-lactide)	(3500)

[62] The release of the prostamide from the intraocular implant comprising a biodegradable polymer matrix may include an initial burst of release followed by a gradual increase in the amount of the prostamide released, or the release may include an initial delay in release of the prostamide component followed by an increase in release. When the implant is substantially completely degraded, the percent of the prostamide that has been released is about one hundred. Compared to existing implants, the implants disclosed herein do not completely release, or release about 100% of the prostamide, until after about one week of being placed in an eye.

[63] It may be desirable to provide a relatively constant rate of release of the prostamide from the implant over the life of the implant. For example, it may be desirable for the prostamide to be released in amounts from about 0.01 .mu.g to about 2 .mu.g per day for the life of the implant. However, the release rate may change to either increase or decrease depending on the formulation of the biodegradable polymer matrix. In addition, the release profile of the

prostamide may include one or more linear portions and/or one or more non-linear portions. Preferably, the release rate is greater than zero once the implant has begun to degrade or erode.

[64] The implants may be monolithic, i.e. having the active agent or agents homogenously distributed through the polymeric matrix, or encapsulated, where a reservoir of active agent is encapsulated by the polymeric matrix. Due to ease of manufacture, monolithic implants are usually preferred over encapsulated forms. However, the greater control afforded by the encapsulated, reservoir-type implant may be of benefit in some circumstances, where the therapeutic level of the drug falls within a narrow window. In addition, the therapeutic component, including the prostamide, may be distributed in a non-homogenous pattern in the matrix. For example, the implant may include a portion that has a greater concentration of the prostamide relative to a second portion of the implant.

[65] The intraocular implants disclosed herein may have a size of between about 5 .mu.m and about 10 mm, or between about 10 .mu.m and about 1 mm for administration with a needle, greater than 1 mm, or greater than 2 mm, such as 3 mm or up to 10 mm, for administration by surgical implantation. For needle-injected implants, the implants may have any appropriate length so long as the diameter of the implant permits the implant to move through a needle. For example, implants having a length of about 6 mm to about 7 mm have been injected into an eye. The implants administered by way of a needle should have a diameter that is less than the inner diameter of the needle. In certain implants, the diameter is less than about 500 .mu.m. The vitreous chamber in humans is able to accommodate relatively large implants of varying geometries, having lengths of, for example, 1 to 10 mm. The implant may be a cylindrical pellet (e. g., rod) with dimensions of about 2 mm.times.0.75 mm diameter. Or the implant may be a cylindrical pellet with a length of about 7 mm to about 10 mm, and a diameter of about 0.75 mm to about 1.5 mm.

[66] The implants may also be at least somewhat flexible so as to facilitate both insertion of the implant in the eye, such as in the vitreous, and accommodation of the implant. The total weight of the implant is usually about 250-5000 .mu.g, more preferably about 500-1000 .mu.g. For example, an implant may be about 500 .mu.g, or about 1000 .mu.g. For non-human individuals, the dimensions and total weight of the implant(s) may be larger or smaller, depending on the type of individual. For example, humans have a vitreous volume of approximately 3.8 ml, compared with approximately 30 ml for horses, and approximately 60-100 ml for elephants. An implant sized for use in a human may be scaled up or down accordingly for other animals, for example, about 8 times larger for an implant for a horse, or about, for example, 26 times larger for an implant for an elephant.

[67] Thus, implants can be prepared where the center may be of one material and the surface may have one or more layers of the same or a different composition, where the layers may be cross-linked, or of a different molecular weight, different density or porosity, or the like. For example, where it is desirable to quickly release an initial bolus of drug, the center may be a polylactate coated with a polylactate-polyglycolate copolymer, so as to enhance the rate of initial degradation. Alternatively, the center may be polyvinyl alcohol coated with polylactate, so that upon degradation of the polylactate exterior the center would dissolve and be, rapidly washed out of the eye.

[68] The implants may be of any geometry including fibers, sheets, films, microspheres, spheres, circular discs, plaques and the like. The upper limit for the implant size will be determined by factors such as toleration for the implant, size limitations on insertion, ease of handling, etc. Where sheets or films are employed, the sheets or films will be in the range of at least about 0.5 mm.times.0.5 mm, usually about 3-10 mm.times.5-10 mm with a thickness of about 0.1-1.0 mm for ease of handling. Where fibers are employed, the fiber diameter will generally be in the range of about 0.05 to 3 mm and the fiber length will generally be in the range of about 0.5-10 mm. Spheres may be in the range of about 0.5 .mu.m to 4 mm in diameter, with comparable volumes for other shaped particles.

[69] The size and form of the implant can also be used to control the rate of release, period of treatment, and drug concentration at the site of implantation. Larger implants will deliver a proportionately larger dose, but depending on the surface to mass ratio, may have a slower release rate. The particular size and geometry of the implant are chosen to suit the site of implantation.

[70] Preferably the implant is sized to fit the anatomy of the iridocorneal angle of the eye.

[71] The proportions of the prostamide, polymer, and any other modifiers may be empirically determined by formulating several implants with varying proportions. A USP approved method for dissolution or release test can be used to measure the rate of release (USP 23; NF 18 (1995) pp. 1790-1798). For example, using the infinite sink method, a weighed sample of the implant is added to a measured volume of a solution containing 0.9% NaCl in water, where the solution volume will be such that the drug concentration is after release is less than 5% of saturation. The mixture is maintained at 37.degree. C. and stirred slowly to maintain the implants in suspension. The appearance of the dissolved drug as a function of time may be followed by various methods known in the art, such as spectrophotometrically, HPLC, mass spectroscopy, etc. until the absorbance becomes constant or until greater than 90% of the drug has been released.

[72] In addition to the prostamide included in the intraocular implants disclosed herein, the intraocular implants may also include one or more additional ophthalmically acceptable therapeutic agents as described in US Patent Application 10/837,260.

[73] For example, one implant may comprise a combination of bimatoprost and a beta-adrenergic receptor antagonist. More specifically, the implant may comprise a combination of bimatoprost and Timolol.RTM. Or, an implant may comprise a combination of bimatoprost and a carbonic anyhdrase inhibitor. For example, the implant may comprise a combination of bimatoprost and dorzolamide (Trusopt.RTM.).

[74] One implant may comprise a combination of bimatoprost and latanoprost. Another implant may comprise a combination of bimatoprost and travoprost.

[75] In addition to the therapeutic component, as described in US Patent Application 10/837,260, the intraocular implants disclosed herein may include effective amounts of buffering agents, preservatives and the like.

[76] In at least one of the present implants, a benzylalkonium chloride preservative is provided in the implant, such as when the prostamide consists essentially of bimatoprost.

[77] Additionally, release modulators such as those described in U.S. Pat. No. 5,869,079 may be included in the implants. The amount of release modulator employed will be dependent on the desired release profile, the activity of the modulator, and on the release profile of the prostamide in the absence of modulator. Electrolytes such as sodium chloride and potassium chloride may also be included in the implant. Where the buffering agent or enhancer is hydrophilic, it may also act as a release accelerator. Hydrophilic additives act to increase the release rates through faster dissolution of the material surrounding the drug particles, which increases the surface area of the drug exposed, thereby increasing the rate of drug bioerosion. Similarly, a hydrophobic buffering agent or enhancer dissolve more slowly, slowing the exposure of drug particles, and thereby slowing the rate of drug bioerosion.

In certain implants, an implant comprising bimatoprost and a biodegradable polymer matrix is able to release or deliver an amount of bimatoprost between about 0.1 mg to about 0.5 mg for about 3-6 months after implantation into the eye. The implant may be configured as a rod or a wafer. A rod-shaped implant may be derived from filaments extruded from a 720 .mu.m nozzle and cut into 1 mg size. A wafer-shaped implant may be a circular disc having a diameter of about 2.5 mm, a thickness of about 0.127 mm, and a weight of about 1 mg.

[78] Various techniques may be employed to produce the implants described herein, as described in US Patent Application 10/837,260, incorporated entirely by reference.

[79] The present implants are configured to release an amount of prostamide effective to treat an ocular condition, such as by reducing at least one symptom of the ocular condition. More specifically, the implants may be used in a method to treat glaucoma, such as open angle glaucoma, ocular hypertension, chronic angle-closure glaucoma, with patent iridotomy, psuedoexfoliative glaucoma, and pigmentary glaucoma. By implanting the prostamide-containing implants into the vitreous of an eye, it is believed that the prostamide is effective to enhance aqueous humour flow thereby reducing intraocular pressure.

[80] The implants disclosed herein may also be configured to release the prostamide or additional therapeutic agents, as described above, which to prevent or treat diseases or conditions, such as described in US Patent Application 10/837,260.

[81] In one embodiment, an implant, such as the implants disclosed herein, is administered to a posterior segment of an eye of a human or animal patient, and preferably, a living human or animal. In at least one embodiment, an implant is administered without accessing the subretinal space of the eye. For example, a method of treating a patient may include placing the implant directly into the posterior chamber of the eye. In other embodiments, a method of treating a patient may comprise administering an implant to the patient by at least one of intravitreal injection, subconjuctival injection, sub-tenon injections, retrobulbar injection, and suprachoroidal injection.

[82] In at least one embodiment, a method of reducing intraocular pressure in an eye of a patient comprises administering one or more implants containing a prostamide, as disclosed herein, to a patient by at least one of intravitreal injection, subconjuctival injection, sub-tenon injection, retrobulbar injection, and suprachoroidal injection. A syringe apparatus including an appropriately sized needle, for example, a 22-30 gauge needle, such as a 22 gauge needle, a 27 gauge needle, a 28 gauge needle, or a 30 gauge needle, can be effectively used to inject the composition with the posterior segment of an eye of a human or animal. Repeat injections are often not necessary due to the extended release of the prostamide from the implants.

[83] In addition, for dual therapy approaches to treating an ocular condition, the method may include one or more additional steps of administering additional therapeutic agents to the eye, such as by topically administering compositions containing timolol, dorzolamide, and iatoprost, among others.

[84] In certain implants, the implant comprises a therapeutic component which consists essentially of bimatoprost, salts thereof, and mixtures thereof, and a biodegradable polymer matrix. The biodegradable polymer matrix may consist essentially of PLA, PLGA, or a combination thereof. When placed in the eye, the implant releases about 40% to about 60% of

the bimatoprost to provide a loading dose of the bimatoprost within about one day after placement in the eye. Subsequently, the implant releases about 1% to about 2% of the bimatoprost per day to provide a sustained therapeutic effect. Such implants may be effective in reducing and maintaining a reduced intraocular pressure, such as below about 15 mm Hg for several months, and potentially for one or two years.

[85] Other implants disclosed herein may be configured such that the amount of the prostamide that is released from the implant within two days of being placed in the eye is less than about 95% of the total amount of the prostamide in the implant. In certain implants, 95% of the prostamide is not released until after about one week of being placed in an eye. In certain implants, about 50% of the prostamide is released within about one day of placement in the eye, and about 2% is released for about 1 month after being placed in the eye. In other implants, about 50% of the prostamide is released within about one day of placement in the eye, and about 1% is released for about 2 months after being placed in the eye.

[86] The following examples are intended to illustrate the present invention.

[87] Example 1 Intracameral Bimatoprost Implant with High Initial Release Rate

[88] A bimatoprost implant comprising Bimatoprost 30%, R203S 45%, R202H 20%, PEG 3350 5% was manufactured with a total implant weight of 900 mg (drug load 270 ug). The in vitro release rates of this implant are shown in Figure 8. This implant releases ~70% over first 30 days. An implant with a 270 ug drug load would release 189ug over first 30 days or 6.3ug per day. The remainder of the implant (81ug) is released over the next 4 months (i.e. 675ng per day).

[89] A normal beagle dog was given general anesthesia and a 3 mm wide keratome knife was used to enter the anterior chamber of the right eye. The intracameral bimatoprost implant was placed in the anterior chamber and it settled out in the inferior angle within 24 hours. As shown in Figure 5, the IOP was reduced to approximately -60% from baseline and this was sustained for at least 5 months (See Figure 5). As shown in Figure 4,the episcleral vessels are dilated.

[90] Example 2 Intracameral Bimatoprost Implant with Slow Initial Release Rate

[91] A bimatoprost implant comprising Bimatoprost 20%, R203S 45%, R202H 10%, RG752S 20%, PEG 3350 5% was manufactured with a total implant weight of 300ug or 600ug (drug loads of 60 or 120 ug, respectively). The in vitro release rates of this implant are shown in Figure 9. The implant releases ~15% of the drug load over the first month. An implant with a 60ug drug load would release 9 ug over first 30 days or 300 ng per day, thereafter, it releases ~50 ug over 60 days or ~700ng/day. Like Example 1, it was found that the episcleral vessels were dilated.

[92] Example 3.

[93] The following experiment was carried out by inserting the implants described below in six Beagle dogs:

[94] **Implant Formulations:**

[95] 2mm Bimatoprost implant in applicator (20% Bimatoprost, 45% R203s, 20% RG752s, 10% R202H, 5% PEG-3350)

[96] 2mm, Placebo implant in applicator (56.25% R203s, 25% RG752s, 12.25% R202H, 6.25% PEG-3350)

[97] Dog 1,2,3: API implant intracameral OD (one 2 mm implant), OS placebo implant

[98] Dog 4,5,6: API implant intracameral OD (two 2 mm implants), OS placebo implant

Dog ID	**Implant Weight (mg)**	**Drug Dose (20% load, ug)**
CYJ AUS	0.317	63.4
CYJ AYE	0.326	65.2
CYJ AUR	0.315	63.0
CYJ AUG	0.302	126.6
	0.331	
CYJ BAV	0.298	125.4
	0.329	
CYJ BBY	0.306	126.6
	0.327	

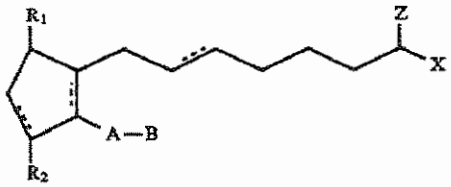
[99] Surgical Procedure: Implants were loaded in a customized applicator with a 25G UTW needle. Under general anesthesia, normal beagle dogs had the implant inserted in the anterior chamber through clear cornea and the wound was self-sealing. The applicator is described in Published United States Patent Application 20080033351 incorporated entirely by reference.

[100] The experimental results are reported in Figures 10 and 11. There was a reduction of IOP up to 40% in dogs treated with intracameral bimatoprost implants with a greater mean reduction at most time points in animals with 2 implants. As shown in Figure 6, the dilation of the episcleral outflow vessels was observed in the animals with the active implants in this Example 3, but said vessels were less dilated compared with the test animal treated with the faster drug releasing implant used in Example 1.

[101] Example 4

[102] Pre-filled applicators were used to administer the implant to 4 dogs per dose. (It was noted that the Bimato IC DDS, which is disclosed in Published US Patent Application 20080033351, releases only the amide. In Figures 12 and 13, PK data with different doses of the implant is shown. It is noted that there is a dose response, and the predominant species, especially in the ICB, is the amide.)

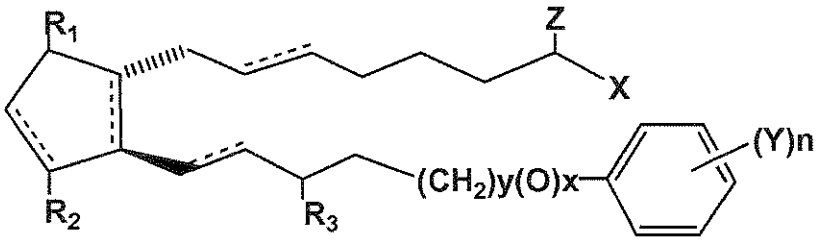
[103] The present invention is not to be limited in scope by the exemplified embodiments, which are only intended as illustrations of specific aspects of the invention. Various modifications of the invention, in addition to those disclosed herein, will be apparent to those skilled in the art by a careful reading of the specification, including the claims, as originally filed. In particular, while the present invention, as disclosed above discloses a prostamide as the active pharmaceutical ingredient or API, one may utilize a prostaglandin (or a drug that is effective to lower the elevated IOP of a patient) or a prodrug thereof as the API. The prostaglandin or prodrug thereof of the implant may include one or more types of prostaglandin or prodrug thereofs. In these implants, the prostaglandin or prodrug thereof comprises a compound having the formula (I) .



wherein the dashed bonds represent a single or double bond which can be in the cis or trans configuration, A is an alkylene or alkenylene radical having from two to six carbon atoms, which radical may be interrupted by one or more oxide radicals and substituted with one or more hydroxy, oxo, alkyloxy or akylcarboxy groups wherein said alkyl radical comprises from one to six carbon atoms; B is a cycloalkyl radical having from three to seven carbon atoms, or an aryl radical, selected from the group consisting of hydrocarbyl aryl and heteroaryl radicals having from four to ten carbon atoms wherein the heteroatom is selected from the group consisting of nitrogen, oxygen and sulfur atoms; X is $-(OR^4)$. wherein $R.^4$ is independently selected from the group consisting of hydrogen and a lower alkyl radical having from one to six carbon atoms,

Z is =O; one of R_1 and R_2 is =O, -OH or a $-O(CO)R_6$ group, and the other one is -OH or $-O(CO)R_6$, or R_1 is =O and R_2 is H; wherein R_6 is a saturated or unsaturated acyclic hydrocarbon group having from 1 to about 20 carbon atoms, or $-(CH_2)mR_7$ wherein m is 0-10, and R_7 is cycloalkyl radical, having from three to seven carbon atoms, or a hydrocarbyl aryl or heteroaryl, as defined above.

[104] Preferably, the prostaglandin or prodrug thereof has the following formula (II)



wherein y is 0 or 1, x is 0 or 1 and x+y are not both 1, Y is a radical selected from the group consisting of alkyl, halo, nitro, amino, thiol, hydroxy, alkyloxy, alkylcarboxy and halo substituted alkyl, wherein said alkyl radical comprises from one to six carbon atoms, n is 0 or an integer of from 1 to 3 and R_3 is .=O, --OH or --O(CO)R_6 and hatched lines indicate the .alpha. configuration and solid triangles indicate the .beta. configuration.

[105] In at least one type of intraocular implant, the prostaglandin prodrug comprises a compound wherein R_1, R_2 and R_3 are OH, y is 1, x is 0, n is 0 and X is (OC_3H_7) ,e.g.. cyclopentane hepten-5-oic acid-cis-2-(3α.-hydroxy-5-phenylpentyl)-3, 5-dihydroxy, isopropyl ester [1_{α}.,2_{β}.,3_{α},5_{α}.], i.e. latanoprost.

[106] In at least other one type of intraocular implant, the prostaglandin prodrug comprises a compound wherein R_1, R_2 and R_3 are OH, y is 0, x is 1, n is 1, Y is CF_3 and X is (OC_3H_7) ,e.g.. cyclopentane hepten-5-oic acid-cis-2-(3α.-hydroxy-5-phenylpentyl)-3, 5-dihydroxy, isopropyl ester [1_{α}.,2_{β}.,3_{α},5_{α}.], i.e. travoprost.

[107] Alternatively, the prostaglandin may be unuprostone. Thus, the implant may comprise a therapeutic component which comprises, consists essentially of, or consists of latanoprost, or travoprost or unoprostone.

[108] It is intended that all such modifications will fall within the scope of the appended claims.

What is claimed is:

1. Use of a biodegradable intraocular implant in the manufacture of a medicament for treating elevated intraocular pressure (IOP) wherein:

the implant comprises a prostamide in the amount of 15-25% by weight of the implant, the prostamide being associated with a biodegradable polymer matrix that releases an amount of the prostamide effective to prevent or reduce a symptom of the elevated IOP; and

the implant is to be placed in an intracameral location at the 6:00 o'clock position to dilate the outflow channels of the eye emanating from Schlemm's Canal and to thereby well-mix the prostamide throughout the anterior segment through the convection currents.

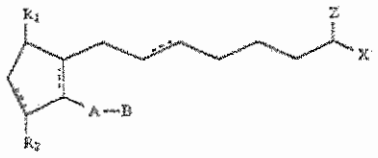
2. The use according to Claim 1 wherein said implant is to be placed in an intracameral location at the 6:00 o'clock position to dilate the vessels in the episcleral and conjunctival venous plexus.

3. The use according to Claim 1, wherein the implant is to be placed at the 6:00 o'clock position in the anterior chamber of the eye.

4. The use according to Claim 1, wherein the implant is to be placed at the 6:00 o'clock position in the iridocorneal angle of the eye.

5. The use according to Claim 1, wherein the implant is to be placed in the eye using an ocular implant delivery assembly comprising: (a) a cannula having an outer wall, a proximal end, a proximal end opening, a distal end, a distal end opening, and a lumen extending through the cannula; (b) an ocular implant sized and structured for implantation in an eye, the ocular implant being located in the lumen; and (c) a cap having a closed distal end, being in contact with the outer wall of the cannula, and covering the distal end and the distal end opening of the cannula, the cap being structured to allow the distal end and the distal end opening of the cannula to pass through the cap as the cannula is passed into an eye.

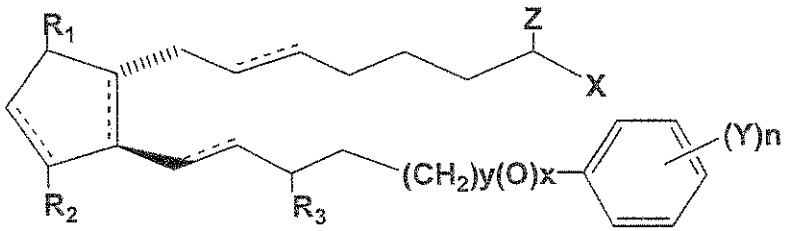
6. The use according to Claim 1 wherein said prostamide is a compound having the formula (I):



wherein the dashed bonds represent a single or double bond which can be in the cis or trans configuration, A is an alkylene or alkenylene radical having from two to six carbon atoms, which radical may be interrupted by one or more oxide radicals and substituted with one or more hydroxy, oxo, alkyloxy or alkylcarboxy groups wherein said alkyl radical comprises from one to six carbon atoms; B is a cycloalkyl

radical having from three to seven carbon atoms, or an aryl radical, selected from the group consisting of hydrocarbyl aryl and heteroaryl radicals having from four to ten carbon atoms wherein the heteroatom is selected from the group consisting of nitrogen, oxygen and sulfur atoms; X is -- $N(R^4)_{-2}$ wherein $R.^4$ is independently selected from the group consisting of hydrogen and lower alkyl radicals having from one to six carbon atoms, Z is =0; one of R_1 and R_2 is =O, -OH or a $-O(CO)R_6$ group, and the other one is -OH or $-O(CO)R_6$, or R_1 is =O and R_2 is H; wherein R_6 is a saturated or unsaturated acyclic hydrocarbon group having from 1 to about 20 carbon atoms, or $-(CH_2)mR_7$ wherein m is 0-10, and R_7 is cycloalkyl radical, having from three to seven carbon atoms, or a hydrocarbyl aryl or heteroaryl, as defined above; or a pharmaceutically acceptable salt thereof.

7. The use according to Claim 6 wherein the prostamide has the following formula (II):



wherein y is 0 or 1 , x is 0 or 1 and x+y are not both 1, Y is a radical selected from the group consisting of alkyl, halo, nitro, amino, thiol, hydroxy, alkyloxy, alkylcarboxy and halo substituted alkyl, wherein said alkyl radical comprises from one to six carbon atoms, n is 0 or an integer of from 1 to 3 and R_3 is =O,-OH or $-O(CO)R_6$ and hatched lines indicate the .alpha, configuration and solid triangles indicate the .beta, configuration.