There is disclosed a method and apparatus for safely reducing abnormally high intra-ocular pressure in an eye during a predetermined time interval. This allows maintenance of normal intraocular pressure during glaucoma surgery. According to the invention, a pressure regulator of the spring-biased diaphragm type is provided with additional bias by a column of liquid. The height of the column of liquid is selected such that the pressure at a hypodermic needle connected to the output of the pressure regulator is equal to the measured pressure of the eye. The hypodermic needle can then be safely inserted into the anterior chamber of the eye. Liquid is then bled out of the column to reduce the bias on the diaphragm of the pressure regulator and, consequently, the output pressure of the regulator. This lowering pressure of the regulator also occurs in the eye by means of a small second bleed path provided between the pressure regulator and the hypodermic needle. Alternately, a second hypodermic needle may be inserted into the eye to provide a controlled leak-off path for excessive pressure and clouded fluid from the anterior chamber.

11 Claims, 2 Drawing Figures
INTRA-OCULAR PRESSURE NORMALIZATION TECHNIQUE AND EQUIPMENT

ORIGIN OF THE INVENTION

This invention was made by an employee of the U.S. Government and may be manufactured or used by or for the Government of the United States without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to ophthalmic surgery and is directed more particularly to a method and apparatus for reducing intraocular pressure prior to surgery and for maintaining normal pressure during surgery.

2. Prior Art

Glaucoma is a disease of the eye involving abnormally elevated intraocular pressure. Such pressure can cause irreparable damage to the eye and eventual blindness. In the event that surgery is required on the eye, the intraocular pressure must be reduced to a safe level. Any attempt to penetrate the eye surgically while the pressure is markedly elevated involves a high risk of structural damage to the eye. This damage is a result of rapid pressure loss.

In the past, prior to ophthalmic surgery, intraocular pressure has been reduced by the administration of drugs or the use of other systemic means. Such procedures often require a time-period of several hours or more to obtain the desired reduction in intraocular pressure. Additionally, drugs may have undesirable side effects on some people and/or may be insufficiently effective on others.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to provide a method and apparatus for controllably and safely reducing intraocular pressure in an eye.

It is another object of the invention to provide a method and apparatus for controllably reducing the pressure in an eye to a predetermined safe value and then maintaining the pressure constant during a glaucoma surgery.

Still another object of the invention is to provide a method and apparatus for reducing and controlling the pressure of liquid supplied to an eye and for removing fluid from the eye at a controlled rate.

In summary, the invention provides a method and apparatus for controllably and safely reducing intraocular pressure in an eye by providing means for biasing a pressure regulator connected between a source of treatment fluid and a hypodermic needle to be inserted into the eye such that the pressure at the hypodermic needle is equal to that measured for the eye. After the needle is inserted into the eye, the bias is then reduced in a predetermined manner.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a pictorial diagram of apparatus utilized with the invention.

FIG. 2 is an oblique sectional view of the pressure regulator portion of FIG. 1.
vertical tube 13 may flow through the adjuster and past the spring 29 to the upper side of diaphragm 27 and through a bleed-off outlet port 32 into the tube 22. The pressure of the fluid adds to the bias of spring 29 to increase the pressure at outlet port 18. Thus, the height of the fluid in tube 13 can be adjusted such that the pressure at outlet 18 is equal to the measured intraocular pressure.

According to the inventive method, the intraocular pressure of an eye diseased by glaucoma, for example, is measured. A reservoir such as 12 containing a treatment fluid 14 is provided and connected to a tube such as 15 and 19 to the hypodermic needle 20. The reservoir 12 is raised to a height such that the fluid pressure at the tip of hypodermic needle 20 is equal to that measured in the eye as, for example, 60 mm of mercury. Hypodermic needle 20 is then inserted into the anterior chamber of the eye and the reservoir is gradually lowered until the pressure at the tip of the hypodermic needle is approximately that of a normal eye, for example, 20 mm of mercury. At the same time, some pressure is bled off through a pressure relief bleed.

Preferably the fluid 14 is directed to a pressure regulator such as 10 which, after the initial pressure reduction, will maintain pressure constant at the hypodermic needle 20.

Utilizing the pressure regulator 10, the vertical tube 13 is filled with suitable fluid (distilled water) to a level such that pressure at hypodermic needle 20 is equal to that measured in the eye. After the hypodermic needle 20 is inserted into the anterior chamber of the eye, the bias bleed orifice, tube 22, bleeds-off fluid from the vertical tube 13 causing the pressure at hypodermic needle 20 to decrease from a high magnitude as, for example, 60 mm of mercury, to a normal level as, for example, 20 mm of mercury. The pressure relief bleed 23 relieves some of the pressure at outlet port 18 and, consequently, at hypodermic needle 20. After the pressure of the eye is reduced to a normal level, surgical procedures can be initiated.

Preferably, the flow compensating regulator of the previously identified copending patent application would be used. This pressure regulator includes means for controlling output pressure despite variations in the flow rate of fluid to the eye during operative procedures.

The range of dimensions of various components of the apparatus are given below in Table I with preferred dimensions in parenthesis.

**TABLE I**

<table>
<thead>
<tr>
<th>Length</th>
<th>Inside Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standpipe 13</td>
<td>70-80cm (74 cm)</td>
</tr>
<tr>
<td></td>
<td>27.5-31.5&quot;(29&quot;)</td>
</tr>
<tr>
<td>Tube 22</td>
<td>30-100cm (38cm)</td>
</tr>
<tr>
<td></td>
<td>12-29&quot;(14.9&quot;)</td>
</tr>
<tr>
<td>Tube 23</td>
<td>50-200cm (100cm)</td>
</tr>
<tr>
<td></td>
<td>18-78&quot;(39&quot;)</td>
</tr>
<tr>
<td>Tube 25</td>
<td>50-200mm (100cm)</td>
</tr>
</tbody>
</table>

As shown in FIG. 1, standpipe 13 is calibrated to indicate actual pressure at outlet 18 for any particular fluid level in standpipe 13. The pressure regulator 10 is adjusted to a pressure of from 15-25 mm of mercury but a nominal pressure of 20 mm of mercury has been found to be satisfactory. It will be understood that changes and modifications may be made to the above-described method and apparatus by those skilled in the art without departing from the spirit and scope of the invention as set forth in the claims appended hereto.

1. Apparatus for ophthalmic surgery comprising:
   a. a pressure regulator of the spring-biased diaphragm type having an inlet, an outlet and a diaphragm having an upper side and a lower side;
   b. a supply of treatment fluid connected to said inlet of said pressure regulator;
   c. a first hypodermic needle connected to said outlet of said pressure regulator;
   d. a generally vertical bias fluid tube having a lower end communicating with the upper side of said diaphragm of said pressure regulator;
   e. a bias bleed means communicating with the upper side of said diaphragm of said pressure regulator for bleeding fluid from said vertical tube to reduce the pressure at said outlet at a predetermined rate; and
   f. pressure relief means providing an outflow path for fluid from said hypodermic needle.

2. The apparatus of claim 1 wherein said bias bleed means is a tube of predetermined length and inside diameter.

3. The apparatus of claim 2 wherein said tube has a length of from about 30 cm to 100 cm and an inside diameter of from about 0.75 mm to 1.5 mm.

4. The apparatus of claim 3 wherein said tube is about 38 cm long and has an inside diameter of about 1.5 cm.

5. The apparatus of claim 1 wherein said pressure relief means is a tube of predetermined length and diameter communicating with said first hypodermic needle.

6. The apparatus of claim 5 wherein said tube is about 50 cm long and has an inside diameter of about 0.75 mm.

7. The apparatus of claim 6 wherein said tube is about 200 cm long and has an inside diameter of about 1.5 mm.

8. The apparatus of claim 1 wherein said pressure relief means comprises a second hypodermic needle communicating with a tube of predetermined length and inside diameter.

9. The apparatus of claim 8 wherein said tube has a length of from about 50 cm to 200 cm and an inside diameter of from about 0.75 mm to 1.5 mm.

10. The apparatus of claim 9 wherein said tube is about 100 cm long and has an inside diameter of about 0.75 mm.

11. The apparatus of claim 1 wherein said pressure regulator is of the flow compensating type.

* * * * *