Mastering the Details of Phacoemulsification with Active Fluidics

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Phaco Machines Available in the United States

Only one supports active fluidics.

Financial Disclosures
• Alcon
• BVI
• Johnson & Johnson Surgical Vision
• Long Bridge Medical
• Oculus USA

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What is the relationship between bottle height, flow rate, and IOP?

Fundamental Concept

Electrical terms
• $\Delta V = IR$

Fluidics terms
• $\Delta P = FR$
• $\Delta P = FxR$ (where $F$ is flow, $x$ is resistance, and $R$ is resistance)
• The greater the flow across a resistor, the greater the drop in pressure.

Bottle raised to 110 cm above the eye

Higher bottle height creates higher intraocular pressure (IOP) at zero flow.

<table>
<thead>
<tr>
<th>Bottle Height</th>
<th>IOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 cm</td>
<td>55 mmHg</td>
</tr>
<tr>
<td>100 cm</td>
<td>74 mmHg</td>
</tr>
<tr>
<td>110 cm</td>
<td>81 mmHg</td>
</tr>
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What is the relationship between bottle height, flow rate, and IOP?

When flow > 0, IOP drops. Higher flows produce larger decreases in pressure (up to 50 mmHg drops at the highest flows of 60cc/min!). At very low IOP, chamber stability is at risk. Understandably, surgeons raise the bottle to compensate for this drop in IOP during surgery.

The Relationship between IOP and AFR (which = IFR)

Surgical IOP reduces somewhat linearly with increased aspiration flow rate. In an attempt to work at 55 mmHg, the surgeon must deal with surgical IOP fluctuations from 30 to 80 mmHg.

Raising the bottle is one way to compensate.

Pressurizing the bottle is another way to compensate.

This is how B&L Stellaris DigiFlow system works.

The Active Fluidics method used by Alcon is different.

A motor-controlled plate squeezes and releases a BSS bag, which allows an Active or Dynamic change in bag pressure. IOP is maintained at a user-selected set point. (Example: 55 mmHg) IOP remains constant while AFR and IFR vary.
Does Active Fluidics really work?

Brief Overview of the Remaining Talk
- Machine set up
- Making Adjustments to Settings
- IOP Regulation and Active Fluidics

Major Components of the Alcon Active Fluidics System
- An Active Fluidics irrigation bay
- A compressible BSS bag
- A high-performance pump system
- An intelligently designed FMS
- Proprietary hardware and software to set and maintain the target IOP

Centurion Active Fluidics Irrigation Bay
- The Active Irrigation Bay consists of:
  - A static side that holds the BSS bag against a Bag Pressure Sensor (BPS)
  - A single movable compression plate
  - A vision system that confirms the presence of a valid Alcon bag
  - An irrigating fluid escape
Components of the Centurion Fluidics Module

- Latching mechanism with consistent loading action
- Independent spring-loaded rollers
- Optical pressure sensor (OPS)

Stepper motor-controlled pump
Stepper motor-controlled valves

Optical Pressure Sensors

Features:
- Two Lasers & Two Cameras (Pressure Sensing)
- One Camera (Barcode reading)

Benefits:
- Accurately measures deflection of the Irrigation & Aspiration pressure sensor diaphragms
- Quick response to Irrigation or Aspiration changes
- Consistent performance with calibration info

Single Peristaltic Pump

SINGLE FLUID WAVE
Large Peaks
Large Troughs

Dual Segment Technology

Combined Fluid Wave = More efficient & smoother flow

Active Fluidics Components

1. Active Irrigation
2. IOP settings
   - Target IOP
   - IOP Range
3. Patient Eye Level 'PEL'
4. Vacuum Rise
5. Irrigation Factor
Passive Fluidics

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<td>50 cm H₂O</td>
<td>37 mmHg</td>
</tr>
<tr>
<td>75 cm H₂O</td>
<td>55 mmHg</td>
</tr>
<tr>
<td>95 cm H₂O</td>
<td>70 mmHg</td>
</tr>
<tr>
<td>100 cm H₂O</td>
<td>74 mmHg</td>
</tr>
<tr>
<td>125 cm H₂O</td>
<td>92 mmHg</td>
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Passive Fluidics

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Pressure is lost through the resistive tubing and infusion sleeve.

IOP varies in a Gravity Feed (passive) system as a function of Aspiration Flow Rate (AFR).
Sources of Irrigation Resistance

- No Flow
- Tubing Resistance
- Infusion Sleeve Resistance
- Aspiration Resistance

Active fluidics

Test Results

There is no need to operate at high IOP.

And there is no need to pressurize the infusion bottle with air.

IOP Ramp

The IOP Ramp is a feature that allows for the adjustment of how quickly the irrigation pressure builds in foot position 1. This function is designed to result in better patient comfort.

- The default IOP Ramp = 1.0 second.
- The adjustment ranges from 0 seconds to 3.0 seconds.
- IOP Ramp only applies when using Active Fluidics™.
- It determines the rate of rise of irrigation pressure when in foot position 1.
Active Fluidics Irrigation Resistances

The purpose of "IRRIGATION FACTOR Comp" is to adjust for $R_4$.

Active Fluidics needs to know these resistance values to properly maintain IOP:
- $R_1$, $R_2$, $R_3$ are fixed & known
- $R_4$ is variable

Irrigation Factor

Active Fluidics Irrigation Resistances

Active Fluidics and thicker walled aspiration tubing have reduced the occlusion break surge response.

Irrigation Factor Analogy

A higher irrigation factor means greater force will be applied to the BSS Bag to compensate for irrigation pressure loss.

The default Irrigation Factor is set to 1.0 based upon the flow characteristics of a 2.4 incision, w/ultra sleeve and 45º mini-Spear Kelman tip.

- 1.0 irrigation factor for 2.4-2.2 normal incisions with Ultra sleeve combination
- 1.2 irrigation factor for 2.4-2.2 tight incisions with Ultra sleeve combination
- 1.4 irrigation factor for 2.2-2.0 normal incision with Nano sleeve combination
- 1.6 irrigation factor for 2.2-2.0 tight incision with Nano sleeve combination
- LenSx surgeries may need a .1 or .2 increase irrigation factor due to tighter incisions.

Brief Review

- Machine setup
- Making Adjustments to Your Settings
- IOP Regulation and Active Fluidics
Thank you for coming to this course.