2. How to Set the Dials

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INTRODUCTION

Several years ago I was invited by Anton Banko to speak in an upcoming meeting. After he described the proposed topic, I agreed, and he then went on to ask what title I wanted for the lecture. I turned the question back to him and he suggested "Transocular Flow and Dynamic Equilibrium in a Stable Surgical Environment," but continued by saying I should put it in my own words. I gave it considerable thought and came up with "How to Set the Dials." The point is that engineers and surgeons do not necessarily speak the same language. As a result, an information gap exists for many surgeons on some of the practical features of the equipment they use. This is unfortunate, because you do not need to be an engineer to intelligently operate a phaco machine any more than you need to be a mechanic to drive a sports car. You do, however, need a basic understanding of how the machines work and some familiarity with operating their controls. That is the goal of this chapter, and you can relax in the promise that there will be no mathematics or formulas anywhere. Try not to skip around, however, because the concepts are developed in a sequential and, hopefully, logical order.

HOW TO SET THE DIALS

One of the difficulties in writing a chapter on how to set the dials is that at the time of this writing there are at least nineteen different phaco units on the market. Each uses one of three different pump designs (peristaltic, diaphragm, or venturi) and has significantly different design features. On the other hand, all machines have in common a variety of choices on how to set the power, flow, suction, and infusion bottle heights. It is therefore critical that every surgeon understand the effects of each of these parameters, how they interrelate, and in total how they determine the surgical environment we work within.

Regardless of design, all phaco machines are faced with the same technical problems. We will start by examining the nature of these problems and the ways that one type of machine attempts to solve them. We can then begin to discuss differences in machines and develop concepts that allow us to intelligently control any type of unit.

All phacoemulsification is carried out between two delicate structures: the corneal endothelium and the posterior capsule. A deep anterior chamber maximizes the distance between these two structures and increases our margin for safety. A deep anterior chamber, however, is of little value if the posterior capsule unpredictably moves forward, risking contact with our instruments. The goal, therefore, is to maintain not only a deep but also a *stable* anterior chamber. In principle this depends quite simply on maintaining a *constant* intraocular pressure. If during surgery the pressure within the eye suddenly decreases, the vitreous moves forward with the posterior capsule and iris diaphragm. The cornea may indent. Aside from the obvious risks to these structures, more subtle dangers may threaten patients with abnormalities of the choroid or retina; for example, retinal breaks in high myopes, or subretinal hemorrhage in patients with macular degeneration. Stability of intraocular pressure is therefore critical, but at what level?

In general, a very soft eye will not maintain a deep anterior chamber and is therefore undesirable. On the other hand, an overly pressurized eye introduces stress forces onto the posterior capsule, which predispose it to tearing and then will increase any tear should one occur. High intraocular pressures also tend to hydrate the vitreous and can cause vitreous bulging, especially in prolonged cases where a capsule has been broken. The ideal intraoperative pressure is probably around 30 mm Hg or slightly higher than physiologic. For the brief duration of surgery, this poses no risk to the optic nerve or retinal vessels and is adequate to keep the posterior capsule back without inducing any excessive stretch forces. To examine this further, a model is needed.

In a simplified system where an infusion bottle is connected to the anterior chamber by a watertight incision, the intraocular pressure depends entirely on the height of the bottle (Figure 2-1). If

Figure 2-1. In a simple closed system, intraocular pressure is controlled entirely by infusion bottle height.