cause eye pressure to be elevated. Other tonometers indicate corneal resistance to applanation or indentation in values that are converted to millimeters of mercury by a simple calculation or the use of conversion tables.

While all methods and instruments used for tonometry produce satisfactory measurements of intraocular pressure, each system has advantages and disadvantages. Because almost all tonometers actually touch the highly sensitive cornea, anesthetizing eyedrops are used in patients before testing. Some tonometers also require instillation of **fluorescein**, a dye solution, to aid in the alignment and visualization of the images seen in the slit lamp.

Applanation Tonometry

The most commonly used instrument for performing applanation tonometry is the **Goldmann applanation tonometer** (Fig 8-10); the compact **Tono-Pen** (Fig 8-11) is also popular. Other portable devices include the handheld **Perkins tonometer** and the **iCare tonometer** (Fig 8-12). The iCare tonometer is particularly useful in children and nervous patients because it does not require corneal anesthesia. However, the instrument can be used only when the patient is in an upright position. The electronic **MacKay-Marg tonometer** and the **pneumatonometer** use air to measure the intraocular pressure. The latter uses compressed air and a pistonlike wand to applanate the surface of the eyeball and measure the intraocular pressure. The air-puff tonometer is a noncontact applanation device that employs a burst of air to applanate the cornea.

Figure 8-10 The Goldmann applanation tonometer is usually attached to a slit-lamp (biomicroscope). Note the tonometer's black housing with the silver-colored force adjustment knob *(arrow). (Courtesy of Brice Critser, CRA, OCT-C, Department of Ophthalmology and Visual Sciences, University of Iowa.)*

Figure 8-11 Applanation tonometry with the Tono-Pen tonometer. *(Courtesy of Brice Critser, CRA, OCT-C, Department of Ophthalmology and Visual Sciences, University of Iowa.)*

Figure 8-12 Applanation tonometry with the ICare tonometer. *(Courtesy of ICare Finland Oy.)*

All applanation tonometers measure the force required to flatten a small area of the central cornea. The precise area to be flattened is predetermined and varies with the instrument used. The Goldmann applanation tonometer, for example, flattens a circle 3.06 mm in diameter. More force is required to flatten a circle on the cornea when intraocular pressure is high (a "harder" eye), and less force with lower intraocular pressure (a "softer" eye).

The Goldmann applanation tonometer is usually attached to a slit lamp, or biomicroscope (Fig 8-13A). The instrument consists of a double-prism head (the tonometer tip), attached by a rod to a housing that delivers

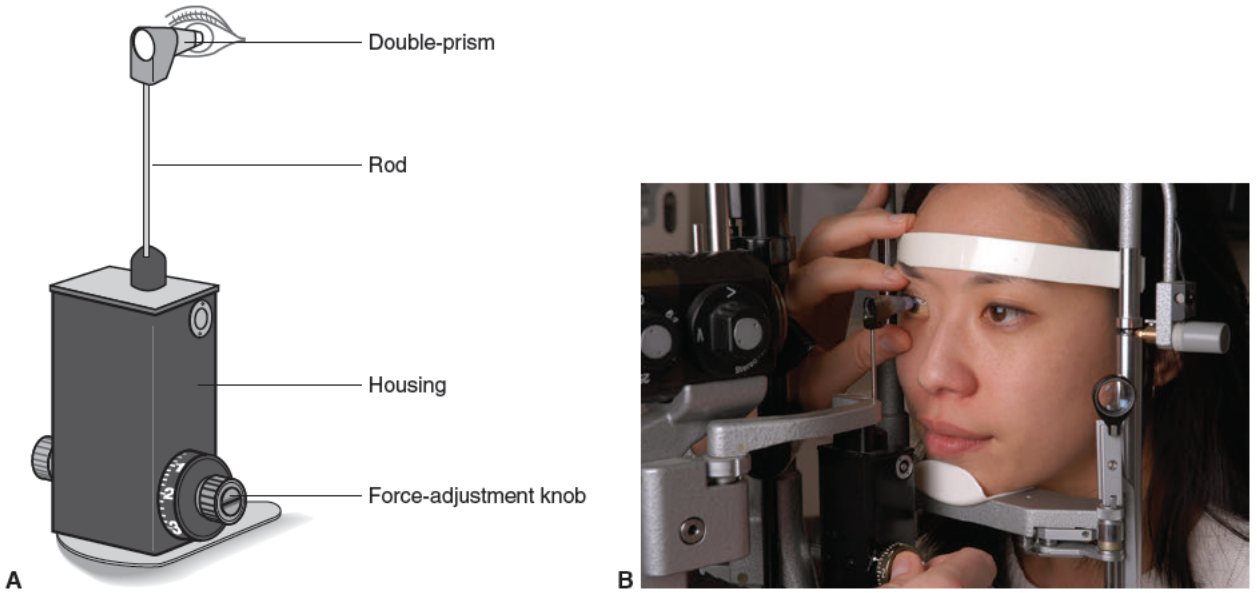

Figure 8-13 Primary parts of the Goldmann tonometer (**A**) and the positioning of the tonometer tip (**B**). *(Part B image courtesy of Brice Critser, CRA, OCT-C, Department of Ophthalmology and Visual Sciences, University of Iowa.)*

measured force controlled by an adjustment knob. Positioning of the tonometer tip can be observed through the slit-lamp oculars (Fig 8-13B). Force is increased by turning the tonometer's force-adjustment knob until a circle of cornea 3.06 mm in diameter is flattened. The amount of force required is indicated by a number on the calibrated dial on the adjustment knob. This reading is simply multiplied by 10 to express the intraocular pressure in millimeters of mercury. Goldmann applanation tonometers are popular and common in ophthalmic practice because of the ease of alignment with the cornea, and they are highly accurate. In addition, intraocular pressure is directly related to the readings on the drum. The main disadvantages are their cost and nonportability. These devices also require a relatively normal corneal shape for accurate measurement. Procedure 8-7 describes the steps in performing Goldmann tonometry.

Penlike in shape, the Tono-Pen portable electronic device consists of a stainless-steel probe containing a solid-state strain gauge that converts intraocular pressure to an electrical signal. A protective, disposable latex membrane is placed on the tip of the Tono-Pen before use with each patient. Intraocular pressure is measured by lightly touching the patient's anesthetized cornea with the tip of the Tono-Pen. Four measurements are recorded for each eye, resulting in an average intraocular pressure measurement. Measurements can be taken with the patient either sitting or supine, which adds to the versatility of the instrument. Although the Tono-Pen is not as accurate as the Goldmann applanation tonometer, its size and versatility make it useful for screening purposes and with patients who are unable to cooperate for applanation tonometry.

Video 8-9 demonstrates applanation tonometry.

Video 8-9
Applanation tonometry.
Courtesy of Lindreth G. DuBois, MEd, MMSc, COMT.

Indentation Tonometry

Indentation tonometry provides a recording of intraocular pressure by measuring the indentation of the cornea produced by a weight of a given amount. The technique is commonly performed with a relatively simple mechanical device called a **Schiøtz tonometer**. This instrument consists of a cylinder, the bottom of which forms a concave footplate that contacts the cornea (Fig 8-14A). Surrounding the cylinder is a frame with a pair of handles by which the examiner holds the device while positioning it on the cornea. A plunger passes through the cylinder and at the upper end moves a hammer, which, in turn, moves a needle across a calibrated scale fixed to the top of the device.

The examiner chooses a weight of a given size (5.5–15.0 g), attaches the weight to the top of the plunger, and gently lowers the device to rest on the patient's anesthetized cornea (Fig 8-14B). The amount of corneal indentation by a given weight is registered on the scale (for