CATARACT SURGERY

Multiple needles, tips, instruments, and devices enter and leave the anterior chamber during cataract surgery. One major step in the procedure is removal of the hard nucleus, but equally important is the final step—introduction of the IOL into the capsular bag.

Each step of cataract surgery has evolved over the decades. A wire vectis for nucleus removal was replaced by phacoemulsification, and femtosecond lasers appear to be replacing the knife for incision creation.\(^1\)\(^3\) Similarly, the place of lens holding and folding forceps is increasingly being taken by myriad IOL insertion systems.

The landscape of cataract surgery was irrevocably changed when Sir Harold Ridley introduced the first IOL in 1949.\(^4\)^\(^6\) Likewise, the introduction of phacoemulsification by Charles D. Kelman, MD, led to the era of small-incision cataract surgery.\(^2\)\(^7\)

Another breakthrough in evolution occurred in the 1980s, when Thomas R. Mazzocco, MD, developed the first foldable IOL.\(^8\)^\(^9\) This innovation allowed lens insertion without enlargement of the 3-mm phaco wound.\(^10\)

IMPORTANCE OF INCISION SIZE

Like any other operation, cataract surgery begins and ends with the making and closing of an incision. The importance of a small incision size was realized early in the history of cataract/IOL surgery, and safe and effective delivery and implantation of a foldable IOL through a small incision has been a continual area of interest for phaco surgeons.

Manual holding, folding, and insertion techniques have, in recent years, been largely replaced by the use of novel IOL injection systems. The concept of dispensing an IOL as a prepackaged, ready-to-insert, preloaded IOL has been adopted by many manufacturers. The focus of these innovations is on development of simple, safe, and effective devices for IOL implantation through a relatively small incision.\(^11\)^\(^12\)

CHARACTERISTICS OF PRELOADED SYSTEMS

Preloaded IOL systems must be surgeon-friendly and should offer safety, ease of insertion, and time-saving in the surgical procedure.\(^13\) The characteristics of an ideal preloaded IOL injection system include the following:

- One-step, ready-to-insert implant package;
- Optimized design for a small incision size;
- Smooth passage of the IOL through the device with minimum friction;
- No risk of damage to IOL optic or haptics;
- Smooth folding and unfolding of the IOL; and
- Convenient and cost-effective use.

The benefits of a good preloaded IOL injection system are several. First, the delivery system enables consistent, predictable, and controlled insertion with minimal incision size. Second, it eliminates the need for the postoperative cleaning and sterilization associated with reusable systems. Third, it saves time in the operating room, and, fourth, it eliminates handling and misloading of the IOL that can occur with a manual tucking mechanism.

CLINICAL EXPERIENCE

I have clinical experience with some of the preloaded insertion systems for both hydrophilic and hydrophobic IOL models (Tables 1 and 2 and Figures 1 through 7),\(^4\)^\(^14\) and my clinical

AT A GLANCE

- The concept of dispensing an IOL as a prepackaged, ready-to-insert, preloaded IOL has been adopted by many manufacturers.
- There are four key benefits of a good preloaded IOL injection system: (1) enabling consistent, predictable, and controlled insertion with minimal incision; (2) eliminating the need for the postoperative cleaning and sterilization associated with reusable systems; (3) saving time in the operating room; and (4) eliminating handling and misloading of the IOL that can occur with a manual tucking mechanism.
- IOL manufacturers are keenly working on the development of better preloaded IOL delivery systems to make IOL size, design, and thickness more compatible with the disposable plunger and cartridge assembly.
impressions are outlined in this article.

**Hydrophilic preloaded IOL systems.** The IOL insertion system for use with the Micro A and Micro AY IOLs (PhysIOL) is called the PhysIOL 123 system (Figure 1). The systems for the Quatrix IOL (Croma-Pharma; Figure 2), and the CT Asphina 603P (formerly XL Stabi ZO; Carl Zeiss Meditec; Figure 3) IOLs do not have designated brand names. In the PhysIOL 123 and Zeiss systems, the IOL is packaged separately from its cartridge and plunger. The Chroma IOL and inserter system are dispensed as one unit. With the PhysIOL system, the IOL is assembled into the delivery unit with a no-touch technique, and, aside from this step, it is the most effective IOL delivery system in my experience.

The Chroma Quatrix IOL comes out of the inserter completely hydrated, as it is packaged in balanced saline solution. Both the Chroma and PhysIOL devices include a silicone sleeve to facilitate pushing the IOL through a narrow cartridge canal. The Zeiss IOL inserter performed poorly in our hands. The disadvantages with this system included cumbersome assembly and unlocking and the use of a plastic plunger to push the IOL through the cartridge. This design factor increased the risk of haptic catch. I have compared the injection techniques for these three preloaded hydrophilic IOL systems in a video available on http://eyetube.net/?v=ducha.

**Hydrophobic preloaded IOL systems.** More recently, I had the opportunity to use three preloaded systems for hydrophobic IOLs: the AcrySert C inserter for the AcrySof IQ IOL (Alcon; Figure 4); the iSert for Hoya one- and three-piece
IOLs (Hoya; Figures 5 and 6); and the inserter for the CT Lucia one-piece IOL (Carl Zeiss Meditec; Figure 7).

The iSert received my best rating, owing to its easy handling and fail-safe delivery through a 2.75-mm incision. The AcrySert C was also good but lagged far behind the already established Monarch 2 and 3 systems (Alcon) for smooth intraocular delivery of the AcrySof IOL. (Editor’s Note: Since the writing of this article, Alcon has introduced the UltraSert Preloaded Delivery System for the AcrySof IQ Aspheric IOL.)

The Zeiss CT Lucia system is supposed to deliver the IOL through an incision of less than 2.2 mm. However, this narrows

### TABLE 1. COMPARISON OF SELECTED IOL INSERTION SYSTEM CHARACTERISTICS

<table>
<thead>
<tr>
<th>IOL Injection System Type</th>
<th>Injector Tip</th>
<th>Incision Size (mm)</th>
<th>IOL Design</th>
<th>IOL Optic Material</th>
<th>IOL Haptic Material</th>
<th>Assembly</th>
<th>Plunger Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Croma Quatrix</td>
<td>Silicone sleeve</td>
<td>2.8</td>
<td>Four-haptic</td>
<td>Acrylic hydrophilic</td>
<td>Acrylic hydrophilic</td>
<td>One unit, IOL in solution</td>
<td>Push</td>
</tr>
<tr>
<td>Zeiss CT Asphina</td>
<td>Plastic</td>
<td>3.2</td>
<td>Three-haptic</td>
<td>Acrylic hydrophilic</td>
<td>Acrylic hydrophilic</td>
<td>Cartridge with IOL dipped, plunger dry</td>
<td>Push</td>
</tr>
<tr>
<td>PhysIOL 123</td>
<td>Silicone sleeve</td>
<td>2.75</td>
<td>Four-haptic</td>
<td>Acrylic hydrophilic</td>
<td>Acrylic hydrophilic</td>
<td>Cartridge with IOL dipped, plunger dry</td>
<td>Push</td>
</tr>
<tr>
<td>Hoya iSert 251</td>
<td>Plastic</td>
<td>2.2–2.4</td>
<td>C-loop</td>
<td>Hydrophobic acrylic</td>
<td>PMMA</td>
<td>One unit dry</td>
<td>Screw</td>
</tr>
<tr>
<td>Hoya iSert PY60</td>
<td>Plastic</td>
<td>2.75</td>
<td>Three-piece C-loop</td>
<td>Hydrophobic acrylic</td>
<td>Hydrophobic acrylic PMMA</td>
<td>One unit dry</td>
<td>Screw</td>
</tr>
<tr>
<td>Alcon AcrySert C</td>
<td>Plastic</td>
<td>2.2–2.4</td>
<td>C-loop</td>
<td>Hydrophobic acrylic</td>
<td>Hydrophobic acrylic</td>
<td>One unit dry</td>
<td>Push</td>
</tr>
<tr>
<td>Zeiss CT Lucia</td>
<td>Silicone sleeve</td>
<td>≤ 2.2</td>
<td>C-loop</td>
<td>Hydrophobic acrylic, heparin coated</td>
<td>Hydrophobic acrylic</td>
<td>One unit dry</td>
<td>Push</td>
</tr>
</tbody>
</table>

### TABLE 2. PERFORMANCE COMPARISON OF SELECTED PRELOADED IOL INSERTION SYSTEMS

<table>
<thead>
<tr>
<th>IOL Injection System Type</th>
<th>Lens Insertion Time (Sec)*</th>
<th>Setting Simplicity</th>
<th>Superior Haptic Catch/Cut Risk (+/-)</th>
<th>Need for OVD</th>
<th>Passage of IOL Through Cartridge</th>
<th>Need for Excessive Force at End</th>
<th>Over-shooting</th>
<th>IOL Presenting in AC as Expected</th>
<th>Unfolding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Croma Quatrix</td>
<td>20</td>
<td>Good, wet feeling</td>
<td>-</td>
<td>Optional</td>
<td>Very smooth</td>
<td>Often</td>
<td>None</td>
<td>Always</td>
<td>Rapid</td>
</tr>
<tr>
<td>Zeiss CT Asphina</td>
<td>60</td>
<td>Poor</td>
<td>++</td>
<td>Mandatory</td>
<td>Need to be careful</td>
<td>Often</td>
<td>Often</td>
<td>Often</td>
<td>Rapid</td>
</tr>
<tr>
<td>PhysIOL 123</td>
<td>20</td>
<td>Good</td>
<td>-</td>
<td>Mandatory</td>
<td>Very smooth</td>
<td>Very often</td>
<td>None</td>
<td>Always</td>
<td>Rapid</td>
</tr>
<tr>
<td>Hoya iSert 251</td>
<td>30</td>
<td>Good</td>
<td>+</td>
<td>Mandatory</td>
<td>Very smooth</td>
<td>None</td>
<td>Rare</td>
<td>Random</td>
<td>Controlled</td>
</tr>
<tr>
<td>Hoya iSert PY60</td>
<td>30</td>
<td>Very good</td>
<td>±</td>
<td>Mandatory</td>
<td>Very smooth</td>
<td>None</td>
<td>Rare</td>
<td>Often</td>
<td>Controlled</td>
</tr>
<tr>
<td>Alcon AcrySert C</td>
<td>30</td>
<td>Very good</td>
<td>±</td>
<td>Mandatory</td>
<td>Not smooth</td>
<td>Often</td>
<td>Rare</td>
<td>Often</td>
<td>Slow</td>
</tr>
<tr>
<td>Zeiss CT Lucia</td>
<td>35</td>
<td>Good</td>
<td>+</td>
<td>Mandatory</td>
<td>Variable</td>
<td>Very often</td>
<td>Rare</td>
<td>Random</td>
<td>Slow</td>
</tr>
</tbody>
</table>

* Time spent by the surgeon from holding the IOL and its insertion device until placement of all haptics in the bag; AC = anterior chamber
the cartridge markedly at its preinjection position. One needs to apply excessive force to inject the lens, and my preliminary results showed increased risk of IOL haptic catch or damage.

The four-haptic design of hydrophilic IOLs such as the Croma Quatix appeared to be more compatible with preloaded insertion systems; however, these lenses are associated with a higher incidence of posterior capsular opacification (PCO), pigment deposition, and lens discoloration. The preloaded IOL insertion systems for hydrophobic C-loop one- and three-piece designs need more work to ensure fail-safe delivery; however, these lenses definitely perform better in terms of long-term lens clarity and less PCO.15-17

FUTURE TRENDS

IOL manufacturers are keenly working on the development of better preloaded IOL delivery systems. The focus is on making IOL size, design, and thickness more compatible with the disposable plunger and cartridge assembly.

I believe that, in the near future, all IOL implantations will be performed through preloaded IOL delivery systems. The healthy competition among manufacturers to achieve the best system will not only provide us with flawless IOL delivery but will also make these products more cost-effective.

4. Mazhry Z. Comparison between two aspheric preloaded IOL insertion systems. Paper presented at ESCRS annual meeting; September 17-23, 2011; Vienna, Austria.
14. Mazhry Z. Experience with preloaded IOLs. Paper presented at ESCRS annual meeting; September 17-23, 2011; Vienna, Austria.

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