A
cute postoperative endophthalmitis presents as one of the most challenging indications in the field of ophthalmic surgery. The elderly population continues to increase dramatically, and thus surgeons are performing more surgeries for conditions such as cataracts and those related to the posterior segment of the eye. Additionally, the rise in cases of diabetes, hypertension, and chronic immunosuppressive diseases will mean that more patients will require surgical intervention for the ocular manifestations of these conditions. As microsurgical technologies evolve, we must consider strategies to reduce the risk of postoperative endophthalmitis. To this end, the Micro-Surgical Safety Task Force, a panel of experienced retina surgeons, recently published pre- and intraoperative safety guidelines for 25-gauge vitrectomy.1,2

Although postoperative acute endophthalmitis is currently a rare complication in ocular surgery due to improved surgical techniques and modern antibiotics, it continues to be associated with a poor prognosis, and its occurrence is devastating to both patients and surgeons. Thus, it is essential to establish practice patterns based on robust scientific evidence. Because of the rarity of endophthalmitis, however, conducting conclusive studies on the identification of tangible risk factors or the efficiency of prophylactic or therapeutic measures is a difficult, if not impossible, task.

To be adequately powered, prospective studies require large patient numbers and multiple centers. Key criteria in a study evaluating risk of endophthalmitis include standardization of risk factors, operation techniques and time, and sterilization methods, the latter of which is difficult to achieve in a multicenter design, and which is why most endophthalmitis studies thus far have been retrospective. Further, in evaluating results of retrospective studies, we should always be aware of nonstandardized methods of data collection, which may compromise the overall validity of the data and allow only indirect conclusions.

LOW INCIDENCE OF POSTOPERATIVE ENDOPHTHALMITIS

With the introduction of phacoemulsification, the incidence of endophthalmitis after cataract surgery has been reduced to an average of approximately 0.1%, with individual studies reporting higher or lower rates (Table 1).3-9 The incidence of endophthalmitis following 20-gauge pars plana vitrectomy (PPV) seems to average between 0.05% and 0.14%.10-13

The incidence of postoperative endophthalmitis after cataract surgery depends on a wide variety of variables, including the status of the patient’s immune system, the microbial entities present on and in the patient’s eyes, and a number of technical factors in connection with the operation itself, such as the sterilization method, surgical technique, incision size and location, intraocular lens type, and antibiotic prophylaxis vs the formation of resistant strains. Tight closure of the incision after surgery can prevent the postoperative penetration of bacteria into the eye and is essential to reduce the risk of postoperative endophthalmitis.

ARE MODERN MICROINCISION TECHNIQUES TO BLAME?

Since clear corneal incisions (CCIs) were introduced in the 1990s, endophthalmitis has been a matter of sub-
substantial controversial debate; the evolution of microincision techniques for vitrectomy has renewed the energy in this discussion.

As previously mentioned, sufficient wound closure is a major factor in reducing risk for postoperative endophthalmitis. As CCIs became more common and rates of endophthalmitis also began to rise, insufficient postoperative wound closure tightness became suspect. A detailed review of currently available clinical studies procured no substantiation for these apprehensions. Although in some retrospective studies CCI was associated with increased rates of endophthalmitis,6,14 others found no evidence of any connection or correlation.8,15 Furthermore, a comprehensive nationwide Swedish study (n=225,471) with prospective design reported no clear relation between CCI and a significant increase in endophthalmitis.16 Although CCIs were associated with a slightly higher clinical incidence of endophthalmitis than sclerocorneal tunnel incisions (0.053% vs 0.036%), the difference was not statistically significant. Additionally, although a correlation between CCI and increased endophthalmitis rates was observed in Sweden in 2002 and 2003, this correlation disappeared in 2004.17

The authors of the study surmised that both optimized incision procedures and better prophylaxis measures contributed to this result. The risk of wound dehiscence may be increased in CCI, but when adequate hygiene measures and appropriate surgical techniques are applied the differences are small and not statistically significant.7,16,17 Other covariates that may have an effect on the overall risk of postoperative endophthalmitis include the general status of the patient’s immune system, his bacterial flora, presence or absence of physiological abnormalities in the anterior segment of the eye, preventive measures concerning perioperative hygiene and prophylaxis, and other details within the surgical procedure itself.

**MICROINCISIONAL VITRECTOMY SURGERY**

It is reasonable to assume that these considerations are just as valid for innovative microincisional vitrectomy systems (MIVS). Due to sutureless sclerotomy and transconjunctival access, it has been suggested that 23- and 25-gauge vitrectomy increases the risk of postoperative endophthalmitis, compared with 20-gauge vitrectomy. Currently available studies, however, provide no conclusive evidence in this regard. Although recent studies report a significant increase in the incidence of endophthalmitis following 25-gauge vitrectomy, their design and validity have been debated to some extent.18-20 In contrast, another recent study found no statistically significant disparity: postoperative endophthalmitis was observed in 0.03% of cases after both 20- and 25-gauge vitrectomy.21 The authors of this study stress the importance of sufficient ocular irrigation with povidone-iodine, excision of peripheral vitreous, and tight postoperative closure. Two other recent studies, one admittedly compromised by the slim number of 92 enrolled patients, further support the low rates of endophthalmitis with 23-gauge and 25-gauge vitrectomy.22,23

Even if these data are regarded with skepticism, they emphasize the impact of sufficient antiseptic measures and the importance of a stable, well-created wound that seals sufficiently to prevent postoperative endophthalmitis. Oblique sclerotomies are used for 23-gauge vitrectomy; the intraocular pressure assists in closing the incision

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**TABLE 1. INCIDENCE OF ENDOPHTHALMITIS FOLLOWING PHACOEMULSIFICATION IN DIFFERENT COUNTRIES**

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Period</th>
<th>Design</th>
<th>Cases (n)</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayer et al³</td>
<td>UK</td>
<td>1991 - 2001</td>
<td>Retrospective</td>
<td>18,191</td>
<td>0.16%</td>
</tr>
<tr>
<td>Kamalarajah et al⁴</td>
<td>UK</td>
<td>1999 - 2000</td>
<td>Prospective</td>
<td>213</td>
<td>0.14%</td>
</tr>
<tr>
<td>Montan et al⁴</td>
<td>Sweden</td>
<td>1998</td>
<td>Prospective</td>
<td>54,666</td>
<td>0.10%</td>
</tr>
<tr>
<td>Nagaki et al⁴</td>
<td>Japan</td>
<td>1998 - 2001</td>
<td>Prospective</td>
<td>12,317</td>
<td>0.13%</td>
</tr>
<tr>
<td>Schmitz et al⁷</td>
<td>Germany</td>
<td>1996</td>
<td>Survey</td>
<td>340,633</td>
<td>0.148%</td>
</tr>
<tr>
<td>Miller et al⁹</td>
<td>USA</td>
<td>2000 - 2004</td>
<td>Retrospective</td>
<td>15,92</td>
<td>0.05%</td>
</tr>
<tr>
<td>Moshirfar et al⁹</td>
<td>USA</td>
<td>2003 - 2005</td>
<td>Retrospective</td>
<td>20,013</td>
<td>0.07%</td>
</tr>
</tbody>
</table>
as soon as the instruments have been removed and in procuring effective, tight wound closure.\textsuperscript{24} These effects could be observed as early as the first day postoperative, both in animal studies and in a recent prospective clinical study using optical coherence tomography.\textsuperscript{25,26}

Although previously 25-gauge trocars inserted perpendicularly to the scleral surface sometimes caused sclerotomy leaks,\textsuperscript{27-30} oblique sclerotomy has found its way to 25-gauge systems to improve wound closure.\textsuperscript{31,32} Proof of concept is conclusive enough in in vitro experiments,\textsuperscript{35} although significant clinical benefit (eg, lower rates of endophthalmitis) has yet to be demonstrated for oblique sclerotomy.\textsuperscript{21,31,32} Another interesting and plausible concept is conclusive enough in in vitro experiments,\textsuperscript{25} the blade by 30° or a little more. This wound configuration considers the course of the collagen fibers and could thus contribute to better wound closure and healing.

There is currently no conclusive evidence whether the rate of postoperative endophthalmitis is increased following MIVS.

There is currently no conclusive evidence whether the rate of postoperative endophthalmitis is increased following MIVS. It will be up to a sufficiently powered prospective study to definitively resolve this issue. We agree with the recommendation of Martidis and Chang,\textsuperscript{20} however, that until conclusive evidence is procured, vitreoretinal surgeons should continue their adaptation to and refinement of the revolutionary sutureless vitrectomy techniques using appropriate measures to reduce complications. In this connection, it seems to be highly advisable to follow the recently published guidelines of the Micro-Surgical Safety Task Force, which include advice on wound construction, ocular preparation, and the use of air-fluid exchange.\textsuperscript{1,2}

**ENDOPHTHALMITIS PROPHYLAXIS**

The underlying principle of endophthalmitis prophylaxis is to decrease the chance that any pathogen can enter the eye intra- or postoperatively. To achieve this, several measures—predominantly drug and surgery related—are proposed.

Preoperative prophylaxis measures start with the adoption of a universal sterilization regimen to maintain a sterile operative field and material. Considering that the patient’s external tissues represent the major source of contamination, sterilization has become a priority in preventive measures. Since Speaker and Menikoff\textsuperscript{25,36} demonstrated that two drops of povidone-iodine 5% significantly reduced the incidence of postoperative endophthalmitis from 0.24\% to 0.06\%, many studies have demonstrated the safety and efficacy of povidone-iodine in reducing the number of bacteria on the ocular surface during the time of surgery. Therefore, considering clinical studies published so far, thorough topical application of 5% povidone-iodine preoperatively is widely accepted as an effective standard measure for the prevention of endophthalmitis.

Antibiotic prophylaxis has been discussed with controversy in the ophthalmic community. Although preoperative administration (up to 3 days) of topical antibiotics effects a significant reduction of the microbial flora on the conjunctiva, no consequent decrease in the incidence of postoperative endophthalmitis could be clinically attributed to this measure thus far. There seems to be a considerable degree of synergistic interaction between povidone-iodine and antibiotics, however, especially when povidone-iodine is combined with gyrase inhibitors administered for a few days.\textsuperscript{37-40}

It seems obvious that, as described above, an optimized incision design during the surgery and consequent tight wound closure are essential pillars in reducing the incidence of postoperative endophthalmitis. Especially for high-risk patients (eg, those with capsule rupture in cataract surgery or silicone oil treatment in PPV), addition of sutures should be considered.

Intracameral antibiotic treatment resulted in a significant reduction of postoperative endophthalmitis rates when cefuroxime was administered in a large clinical multicenter trial treating more than 16,000 patients.\textsuperscript{41} The results of this study, however, kindled controversial debate upon which we choose not to dwell.

Postoperative topical antibiotic treatment presents a viable option and should be initiated immediately after surgery. Moxifloxacin (Alcon Laboratories, Inc.) or gatifloxacin (Allergan, Inc.) might be the best choices; both are fourth-generation fluoroquinolones that inhibit bacterial gyrase as well as topoisomerase IV and thus are equally effective against gram-positive and gram-negative entities. Complementing other data, three large clinical studies demonstrated high efficacy of these drugs in reducing postoperative endophthalmitis rates, which might suggest employing these drugs administered topically possibly for routine treatment.\textsuperscript{42,43} Other studies, however, though smaller in size ($n=42$) and retrospective in design, contrast these findings by observing only limited effects of these antibiotics.\textsuperscript{44} Preventive administration of vancomycin should be handled with utmost deli-
cacy, because vancomycin represents one of the few rescue antibiotics we have available.

Regardless of the general attitude toward and individual administration of antibiotic drugs, adequate dosage and treatment duration are the cornerstones to avoid the evolution of even more resistant strains of bacteria. Tapering antibiotic drugs should be avoided in all cases.

**TREATING ENDOPHTHALMITIS**

As soon as a case of endophthalmitis is suspected, rescue measures should be started immediately and quickly, preferably by an experienced vitreoretinal surgeon. According to the guidelines, treatment with intravitreal antibiotics should be initiated at once, and at the same time samples should be taken for strain identification. Even though the Endophthalmitis Vitrectomy Study (EVS) found no significant benefit for systemic antibiotic treatment in 1995, this attitude has changed, especially considering that intravitreal antibiotics wash out over time.\(^4\)\(^5\)\(^6\) Both routes of administration, intravitreal as well as systemic, require sufficient dosages to effect complete eradication of the pathogens and prevent the formation of resistant strains. Because infections, such as endophthalmitis, are usually associated with extensive tissue infiltration of leukocytes and monocytes, additional anti-inflammatory treatment with corticosteroids is recommended to combat the inflammatory reaction.\(^4\)\(^6\)

Based on the results of the 1995 EVS study, the subsequent guidelines for the treatment of endophthalmitis continue to recommend PPV only under certain circumstances, primarily special cases. Recent publications tend to question these directions.\(^4\)\(^6\)\(^8\)

Kuhn and Gini claim that complete vitrectomy yields far better results after postoperative endophthalmitis than those published in the EVS. In addition, they emphasize the availability of considerably better technical equipment, instruments, illumination, and optic systems compared to 1995, significantly reducing the risk associated with PPV at that time.\(^4\)\(^8\) Behrens-Baumann even declares instant PPV to be the "gold standard" treatment for acute postoperative endophthalmitis.\(^4\)\(^6\) All in all, there is a clear trend toward early complete vitrectomy for the treatment of acute postoperative endophthalmitis.

**CONCLUSION**

Endophthalmitis is a serious complication of intraocular surgery or injury. Considering demographic trends, it is expected to be seen more frequently in the years to come. Viable methods to reduce the risk of postoperative endophthalmitis are preventive medical prophylaxis, meticulous perioperative hygiene, and "surgical prophylaxis" by means of optimized incision design to prevent postoperative microbial infiltration of the eye. Innovative surgical techniques (e.g., CCI, MIVS) have thus far not been associated with significantly increased rates of postoperative endophthalmitis.

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