Simultaneous vs Sequential Bilateral Cataract Surgery for Infants With Congenital Cataracts: Visual Outcomes, Adverse Events, and Economic Costs

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Objectives: To compare the incidence of adverse events and visual outcomes and to compare the economic costs of sequential vs simultaneous bilateral cataract surgery for infants with congenital cataracts.

Methods: Retrospective review of simultaneous vs sequential bilateral cataract surgery for infants with congenital cataracts who underwent cataract surgery when 6 months or younger at our institution.

Results: Records were available for 10 children who underwent sequential surgery at a mean age of 49 days for the first eye and 17 children who underwent simultaneous surgery at a mean age of 68 days (P = .25). We found a similar incidence of adverse events between the 2 treatment groups. Intraoperative or postoperative complications occurred in 14 eyes. The most common postoperative complication was glaucoma. No eyes developed endophthalmitis. The mean (SD) absolute interocular difference in logMAR visual acuities between the 2 treatment groups was 0.47 (0.76) for the sequential group and 0.44 (0.40) for the simultaneous group (P = .92). Payments for the hospital, drugs, supplies, and professional services were on average 21.9% lower per patient in the simultaneous group.

Conclusions: Simultaneous bilateral cataract surgery for infants with congenital cataracts is associated with a 21.9% reduction in medical payments and no discernible difference in the incidence of adverse events or visual outcomes. However, our small sample size limits our ability to make meaningful comparisons of the relative risks and visual benefits of the 2 procedures.

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Simultaneous bilateral cataract surgery is not commonly performed in the United States because of a belief that it puts patients at increased risk of developing bilateral endophthalmitis in addition to financial disincentives. Acceptance of simultaneous bilateral cataract surgery in other countries has been shown to correlate with physician reimbursement rates for this procedure. Proponents of bilateral simultaneous cataract surgery cite low rates of adverse events, including endophthalmitis, and benefits to patients and society, including (1) avoidance of multiple preoperative examinations, (2) decrease in travel time/costs, (3) fewer follow-up visits, and (4) less time off work.

The issue becomes more complicated in infants with dense bilateral congenital cataracts. In these cases, most ophthalmologists agree that surgery should be performed as soon as possible to mitigate deprivation amblyopia. Some pediatric ophthalmologists advocate simultaneous bilateral cataract surgery to expedite the visual rehabilitation of both eyes and to prevent children from having to undergo general anesthesia more than once.

Additional considerations include the economic costs to families and society and parental preference.

Although previous studies have evaluated the safety of simultaneous bilateral cataract surgery in children, to our knowledge no reports have been published comparing the costs of simultaneous vs sequential bilateral cataract surgery in infants with congenital cataracts. The purposes of our study were to compare the incidence of adverse events and visual outcomes and to compare the economic costs of simultaneous vs sequential bilateral cataract surgery for infants with congenital cataracts.
Patients who underwent surgery for bilateral congenital cataracts were identified from the operative records of one of us (S.R.L.). A retrospective review of medical records was then performed. Children were eligible if they had bilateral congenital cataracts and underwent bilateral cataract surgery when 6 months or younger between January 1, 1996, and December 31, 2007. The study was approved by the Emory University Institutional Review Board and was in compliance with the Health Insurance Portability and Accountability Act. Data were collected using a case report form that included the following information: (1) age at diagnosis, (2) age at surgery, (3) initial method of refractive correction after surgery, (4) time elapsed between surgery and optical correction in each eye, (5) intraoperative or postoperative complications, and (6) Snellen visual acuity in each eye at the examination closest to 4 years of age. All Snellen acuities were converted to logMAR units to facilitate data analysis. Patients generally underwent follow-up examinations 1 day, 1 week, and 1 month after surgery and then every 3 months until 4 years of age.

Patients were divided into the simultaneous and sequential surgery groups. Through 2001, parents were offered sequential surgery only. Beginning in 2002, parents were given a choice of sequential or simultaneous surgery after a discussion regarding the risks and benefits of each procedure, including the risk of bilateral endophthalmitis. Simultaneous surgery was defined as having cataract surgery on both eyes on the same day. Sequential surgery was defined as having the procedures separated by at least 24 hours.

**ECONOMIC COSTS**

Because the differences between health care charges and payments can be substantial, we elected to evaluate the costs of sequential vs simultaneous surgery based on the payer’s perspective (eg, payments). Because many of our bilateral congenital cataract operations were performed on patients with Medicaid coverage and because Medicaid hospital and physician payment information was readily available from the State of Georgia for 2009, we used Medicaid data to estimate the payer’s perspective. We began by collecting and aggregating administrative hospital and physician Medicaid payment data for each of the procedures from Children’s Healthcare of Atlanta at Egleston and the Emory Clinic. The hospital payment data were compiled by using hospital collection data from the 3 most recent patients who underwent sequential cataract surgery and simultaneous cataract surgery. The collection data included surgical operating room and anesthesia procedure times, specific drugs administered, a complete list of supplies used, and Medicaid payments. These collection data were grouped into hospital, drug, and supply costs.

Physician reimbursements for surgery and anesthesia were calculated from physician payments to Emory Clinic for simultaneous bilateral cataract operations performed in 2009 based on the Current Procedure Terminology (CPT-4) codes associated with the surgical and anesthesia procedures used. In 2009, this procedure was performed on 6 children. Payments were still pending for 2 patients, so the payments for 4 patients were averaged. There are 4 different Medicaid programs in Georgia, so the payments differed somewhat between patients. In 2009, the published Georgia Medicaid surgeon reimbursement rate for CPT-4 code 66840 (removal of lens material; aspiration technique, ?1 stage) was $507. We used this published number for the payment for sequential surgery because we did not perform any sequential bilateral lensectomies on infants in 2009. For simultaneous cataract procedures, the modifier 50 was added to CPT-4 code 66840 to indicate bilateral surgery, and the Medicaid surgeon reimbursement rate for this procedure was $527. We performed the analysis based on the Georgia Medicaid anesthesia reimbursement rate for sequential surgery as $219, whereas the mean anesthesia reimbursement rate for simultaneous cataract surgery was $322.

**STATISTICAL ANALYSIS**

Visual acuity was transformed to logMAR units for analysis. The interocular difference in logMAR acuity of each child at the examination closest to 4 years of age was used for the analysis. The mean interocular difference in visual acuity was compared between patients undergoing simultaneous and sequential surgery using an independent-group t test. The percentage of patients with intraoperative or postoperative adverse events was compared between the 2 groups using a χ² test.

**RESULTS**

Twenty-seven children were included in the study. All children underwent cataract extraction, primary posterior capsulotomy, and anterior vitrectomy by the same surgeon (S.R.L.) using the same surgical technique. The sequential operations were performed from 1996 to 2005, and the simultaneous operations were performed from 2002 to 2007. For patients undergoing simultaneous operations, after surgery on the first eye was completed, the surgical drapes were removed, a new surgical tray was opened, the next eye was prepared and draped, and the surgeon rescrubbed and regowned. On no occasion did the plan to perform simultaneous bilateral cataract surgery in any patient have to be abandoned because of a serious intraoperative complication in the first eye.

The mean age of cataract diagnosis for the 10 children undergoing sequential surgery was 41 days, and the mean age of cataract diagnosis for the 17 children undergoing simultaneous surgery was 67 days (P = .17). The mean age at the time of cataract surgery for the first eye was 49 days for the sequential group vs 68 days for the simultaneous group (P = .25). None of the patients underwent primary intraocular lens implantation. In the postoperative period, their apha-kia was corrected with gas permeable contact lenses or spectacles. Children in the simultaneous group received their optical correction at a mean age of 10 days after cataract surgery vs 18 days after cataract surgery on the first eye in the sequential group (P = .41). Generally, children in the sequential group were not prescribed their optical correction until after cataract surgery on their second eye. The mean follow-up was 5.0 years for the sequential group vs 2.5 years for the simultaneous group. The longer follow-up for the sequential group largely reflects the fact that most of these operations were performed from 1996 to 2001, whereas some of the operations in the simultaneous group were performed as recently as 2007. Snellen visual acuities were obtained from 8 patients in the sequential group and 6 patients in the simultaneous group. The mean (SD) logMAR acuity of the right eye was 0.96 (0.45) in the sequential group and 1.20 (0.59) in the simultaneous group (P = .54). The mean (SD) logMAR acuity of the left eye was 1.24 (0.59) in the simultaneous group (P = .54). The mean (SD) absolute interocular difference in logMAR visual acuities was 0.47 (0.76) for the sequential group and 0.44 (0.40) for the simultaneous group (P = .92). One eye in the sequential group experienced an intraoperative complication, an inadvertent iridotomy. One
eye in each group was noted to have a vitreous hemorrhage on the first postoperative day that cleared spontaneously within 1 week. Four patients (8 eyes) in the sequential group developed glaucoma and 2 patients (3 eyes) in the simultaneous group developed glaucoma. No eyes developed endophthalmitis.

The Table reports the Medicaid payment calculations for the sequential and simultaneous bilateral cataract operations and the respective percentage shares for each of the major components of the procedure and their payment differences. The sequential cataract operations, for both days, were associated with Medicaid payments of $10,577. For simultaneous operations, the Medicaid payments were $8,261. With both approaches, the hospital portion of the payment represented approximately 50% of the total Medicaid payment, whereas the physician portion of the payment was nearly identical, at 13.7% for sequential vs 13.9% for simultaneous cataract surgery.

The overall payment difference between the 2 approaches for bilateral cataract surgery was $2,316. This amount represents a 21.9% savings for Medicaid if the procedure was performed simultaneously rather than sequentially. The biggest share of the overall savings (80.1%) came from the hospital portion of the payment, which represented a savings of $1,855. The savings from the physician payment portion of the payment was $303, and, although it represented the next biggest share of the savings (13.1%), it was substantially lower than the savings from the hospital portion of the Medicaid payment.

### Comment

Bilateral simultaneous congenital cataract surgery is being increasingly performed with good results. Most studies have focused on the safety of this procedure. In our study, we found a similar incidence of adverse events between the 2 treatment groups. The most common adverse event was glaucoma, which occurred in 11 eyes (20%). Although more postoperative complications occurred in the sequential group, this was likely a result of the longer follow-up in this group. Aphakic glaucoma has been shown to increase in frequency in children with longer follow-up. We did not find a significant difference in the visual outcomes between the 2 treatment groups. We hypothesized that there would be a smaller interocular difference in visual acuity in the simultaneous group because their eyes would undergo surgical and optical rehabilitation at the same time, but we did not find this to be the case. However, our sample size was small and the power was insufficient to detect small differences between treatment groups. The relatively poor visual results in both groups likely reflect the older age of these children at the time of cataract surgery and the high incidence of glaucoma.

Although we did not find a significant difference in the incidence of adverse events or visual outcome, we did find a significant cost savings associated with simultaneous bilateral cataract surgery.

The acceptance of simultaneous bilateral cataract surgery for adults varies significantly among different countries. It has been suggested that these varying levels of acceptance arise at least in part from differences in reimbursement policies for bilateral surgery. For example, in Finland, where simultaneous bilateral cataract surgery is reimbursed at twice the rate as unilateral cataract surgery, 40% to 60% of all patients now undergo simultaneous bilateral cataract surgery. However, in most countries, simultaneous bilateral cataract surgery is reimbursed at a lower rate, and the frequency of simultaneous bilateral cataract surgery is correspondingly lower. In the United States, the Centers for Medicare and Medicaid Services policy requires that the modifier 50 be used when performing bilateral surgery, which reduces the payment to 150% of the amount allowed for unilateral surgery. The 2009 Georgia Medicaid payment for simultaneous bilateral lensectomies is also only 150% of the payment for a unilateral lensectomy. However, given the relatively low frequency of cataract surgery during infancy, economic issues are not likely to be important factors in determining the acceptance of simultaneous bilateral cataract surgery in this population.

Endophthalmitis is one of the most severe complications associated with cataract surgery. It has been reported to have an incidence of 7 in 10,000 cataract operations in children. Opponents of bilateral simultaneous surgery emphasize several problems with simultaneous bilateral cataract surgery, including the risk of bilateral endophthalmitis and the inability to analyze the refractive outcome of the first eye before performing surgery on the fellow eye. When bilateral endophthalmitis has occurred after simultaneous bilateral cataract surgery, it generally has been reported after a lapse in sterile technique. None of the patients in our series developed endophthalmitis; how-

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**Table. Medicaid Payments and Percentage Shares for Bilateral Congenital Cataracts for Sequential and Simultaneous Lensectomies**

<table>
<thead>
<tr>
<th>Medicaid Payment, $ (%)</th>
<th>Sequential Group</th>
<th>Simultaneous Group</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>Day 2</td>
<td>Days 1 and 2</td>
<td></td>
</tr>
<tr>
<td>Hospital payment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>3336 (58.1)</td>
<td>2639 (54.6)</td>
<td>5975 (56.5)</td>
</tr>
<tr>
<td>Drugs</td>
<td>296 (5.2)</td>
<td>238 (4.9)</td>
<td>534 (5.0)</td>
</tr>
<tr>
<td>Supplies/other</td>
<td>1383 (24.1)</td>
<td>1233 (25.5)</td>
<td>2616 (24.7)</td>
</tr>
<tr>
<td>Provider payment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physician</td>
<td>726 (12.6)</td>
<td>726 (15.0)</td>
<td>1452 (13.7)</td>
</tr>
<tr>
<td>Total</td>
<td>5741 (100.0)</td>
<td>4836 (100.0)</td>
<td>10,577 (100.0)</td>
</tr>
</tbody>
</table>

**a** Percentages have been rounded and may not total 100.
ever, our small sample size and the infrequency of this complication prevent us from drawing a meaningful conclusion regarding its absence. To avoid this outcome, extreme vigilance must be maintained to adhere to sterile protocols when performing simultaneous bilateral cataract surgery. We used different instruments and solutions for each eye and redraped and rescrubbed between operations to reduce the risk of this complication. In addition, simultaneous bilateral cataract surgery should not be performed by inexperienced surgeons because they are known to have a higher complication rate.30,31 There are a number of contraindications to performing simultaneous bilateral cataract surgery in adults, such as untreated blepharitis, immunosuppression or immunodeficiency, untreated glaucoma, uveitis, high myopia or hyperopia, a history of refractive surgery, lens subluxation, pseudoexfoliation, and a serious complication occurring while performing surgery on the first eye.9 None of the patients in our series undergoing simultaneous surgery experienced a serious complication while undergoing surgery on the first eye. Because all the patients in our study were left with aphakic eyes owing to their young age, refractive surprises were not an issue in our study. It is unlikely that this would be a significant issue for infants even if intraocular lenses were implanted because it would take many months, if not years, to determine whether the optimal intraocular lens power implanted because it would take many months, if not years, to determine whether the optimal intraocular lens power implanted was appropriate. We found no difference in the visual results of the sequential bilateral cataract surgery group compared to the simultaneous bilateral cataract surgery group.32

The advantages of simultaneous surgery include medical and social benefits. Medical benefits include undergoing preoperative care only once, being put under general anesthesia only once, and, when necessary, being hospitalized only once. Social benefits include less anxiety for parents because their infant has to undergo general anesthesia only once; time savings for parents, friends, and relatives arising from a reduced number of physician visits; and time savings for parents who would not need to take as much time off from work to care for their infant postoperatively. Sarikokta et al38 reported improved patient satisfaction with simultaneous bilateral cataract surgery. In their study, 91% of patients who underwent simultaneous bilateral cataract surgery reported that they would recommend it to relatives or friends. In a study by Lundstrom et al,33 adults undergoing simultaneous bilateral cataract surgery reported less difficulty performing activities of daily living and better binocular contrast sensitivity than patients undergoing sequential bilateral cataract surgery. Since 2002, one of us (S.R.L.) has given the parents of infants with bilateral congenital cataracts the option of having their child undergo sequential or simultaneous bilateral cataract surgery. During this period, the parents of only 1 of 18 children have chosen sequential surgery after the advantages and disadvantages of both approaches were explained. In the American Academy of Ophthalmology Preferred Practice Statement for Cataract in the Adult Eye,34 the need for general anesthesia in the presence of bilateral, visually significant cataracts is listed as one of the indications for performing simultaneous bilateral cataract surgery. This is a particularly compelling reason to perform simultaneous bilateral cataract surgery during infancy given the increased risks of general anesthesia in this age group.35

In addition to the medical and social benefits of simultaneous surgery, there are also economic advantages. Medicaid payments for the hospital, drugs, supplies, and professional services were on average 21.9% lower per patient in the simultaneous group. This finding is consistent with the Centers for Medicare and Medicaid Services policy that views bilateral operations—procedures performed on both sides of the body during the same operative session—as typically lower in costs for hospitals and physicians because they require fewer hospital (operating room time, drugs, and supplies) and professional (preoperative and postoperative time for surgical patients) resources. Arshinoff and Chen37 reported a 15% increase in the number of cataract operations that could be performed on a daily basis when performing simultaneous bilateral cataract surgery. This is a particularly compelling reason to perform simultaneous bilateral cataract surgery during infancy.

It has been reported that the incidence of congenital cataracts is 2.49 per 10 000 live births, and 60% of these are bilateral.41 In 2006, there were 4.3 million live births in the United States.34 Therefore, we estimate that there were 1071 births with congenital cataracts in the United States in 2006, of which 643 would have been bilateral. Performing simultaneous rather than sequential bilateral cataract surgery would have resulted in a savings of $3.2 million in 2009 in the United States using the Georgia Medicaid payment schedule. These savings could be even more significant from a global perspective. In 2008, the world population was estimated to be 6.705 billion and the estimated number of live births was 140 million.45 Consequently, we estimate that there were more than 350 000 live births with congenital cataracts and 210 000 births with bilateral congenital cataracts. These estimates are probably low because the incidence of congenital cataracts is higher in developing countries largely owing to the low rates of rubella vaccination in many of these countries.42,43 Therefore, it seems likely that removing infantile cataracts with the use of simultaneous bilateral cataract surgery would generate significant cost savings if instituted on a worldwide basis.

Our study had a number of shortcomings. First, our payment information was not based on actual payments but extrapolated payments. We initially tried to obtain all the hospital and physician payments for all 27 children studied. However, we discovered a number of problems with this procedure. Although most of the patients had Medicaid coverage, some of them had private insurance and the payments were higher for these patients. We also found that Medicaid payments decreased steadily during the study period; therefore, it was very difficult to compare payments from one year to the next. This was particularly a problem for sequential operations, which were primarily performed before 2002. Because the payments for these operations were much higher, using the actual payment data would have distorted the relative costs for the 2 treatment groups. Finally, the hospital did not have payment infor-
ination for all the operations performed before 2000. A second problem was that we studied only the direct payments for operations. It would have been better to consider all the direct and indirect medical costs, such as the cost for parents to travel to the hospital for the operations and to take time off from work, but the complexity of doing this was beyond the scope of this study.

Given the spiraling costs of health care in the United States, efficiencies that result in cost reductions without compromising outcomes are highly desirable. Our study found a 21.9% reduction in costs associated with bilateral simultaneous cataract surgery. Moreover, infants benefit from shorter hospitalizations, less travel time, fewer office visits, and a reduction in time receiving postoperative medications. Although we did not find a difference in adverse events or visual outcomes, our small sample limited our ability to make meaningful comparisons of the relative risks and visual benefits of the 2 procedures. These results underscore the importance of simultaneous bilateral cataract surgery and the need for a greater understanding of its benefits.

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